

The Demon-Haunted World Study Guide

The Demon-Haunted World by Carl Sagan

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Plot Summary

Popular science proselytizer Carl Sagan makes an impassioned plea for society to understand, accept and encourage science that goes far beyond the movement of planets or subatomic particles and extends to the heart of intellectual freedom and the meaning of democracy. Many may know the astronomer primarily from his television appearances as popular conduit to understanding the rarefied atmosphere of pure science. They may be startled at the ferocity and elegance with which Sagan attacks what could be called the approach of the second Dark Ages.

The text begins as a scholarly and deliberate attempt to explain how important intellectual curiosity is to science. It evolves into an impassioned statement for personal and intellectual freedom as understood during and after the Enlightenment. This was manifested in such uniquely American treasures as the Declaration of Independence through thought leaders like Thomas Jefferson. Sagan draws parallels between independent thinkers in science who explored unknown territories that have enriched everyone's lives and independent political thinkers such as Jefferson (who also was a scientist) who gave legal form to basic freedoms.

Sagan exults over his love of science as he warns about the "dumbing down" of America. This is reflected not only in popular anti-intellectual television fare but also in a steady decline in competitive/comparative test scores that now place American school children well behind most students of other industrialized nations on basic science and math skills. He then compares the loss of scientific literacy to language literacy. He also notes the intrusion of faith-based beliefs into our system of government and politics. Sagan sounds an alarm that funding for basic scientific research should not be cut.

If the spirit of scientific inquiry was handed down to western civilization largely from the ancient Greeks—along with the idea of democracy—so was an appreciation for skepticism, useful in both areas, according to Sagan. This he refers to as "The Fine Art of Baloney Detection." In one of his most sparkling chapters, he describes the process in detail and gives instructions for the gullible, the lazy, and the ideologically warped. As the author warms to his topic in a white hot fire of intensity, the amiable, easy-going persona of Carl Sagan, television guide to the solar system, slips away. The reader hears Sagan's voice rise in pitch until it is a call to arms for nothing less than the preservation of civilization, itself. Even the chronically incurious reader will be compelled to read on to find out what has Dr. Sagan so perturbed.

The astronomer's approach to his subject is to catalogue and describe in vivid detail the many demons, myths, gods, devils and strange obsessions that continue to plague humanity through the ages. He then describes how science emerged from this darkness as a candle of light and hope. It illuminated the way to truly stupendous advances by human beings in a few centuries. As science has upset some truly ancient religious beliefs in its evolution, it has also upset some clergy. They've responded with witch hunts, torture chambers, executions, excommunications, and truly mind-boggling contemporary brainwashing campaigns. Each questions basic notions about where we



as a species came from and are headed. Without condemning these reactionary trends per se, Sagan explains that there is a better way to understand such matters. The answer is science.

For example, Sagan frankly admits he'd love to know that flying saucers are transporting highly intelligent and technologically advanced beings to Earth from another galaxy. In fact, Sagan was one of the prime moving forces behind establishment of the Search for Extraterrestrial Intelligence (SETI) project that has been de-funded by Congress. However, he says there hasn't been a shred of scientific evidence that supports any of the claims about UFOs (unidentified flying objects) other than the sort of mass hysteria testimonies of witnesses and supposed abductees. Nothing can be scientifically measured, studied or analyzed. The UFO phenomenon, according to Sagan, reflects a sort of primitive religious impulse combined with a genuine sense of awe about the universe.

Science gives a focus to these very human impulses and a proven method for discerning truth and discarding "baloney," Sagan tells his readers. He emphasizes that one does not need to be a scientist to appreciate and use the scientific method. based on reason, it can sort through the myriad of irrational demons set loose in the modern world that threaten the very core of our civilization.



Chapter 1

Chapter 1 Summary and Analysis

The text begins with a quote from Albert Einstein to the effect that all science may be imperfect, but it is still the most valuable tool we have for understanding our world. Sagan catalogues some of the many forms of pseudoscience that masquerade as New Age enlightenment, old time religion, and simple dogma. Some of these popular pseudo scientific beliefs range from the legend of Atlantis to Transcendental Meditation, Soviet communism to Biblical literalism. Sagan stipulates that these argue in the face of scientific evidence.

Those who accept unquestioningly the astonishing but unproven myths of popular culture allow themselves to be dupes, taken in by the rising tide of irrationality that is as far from science as humanly possible. A bit of skepticism, or the ability to apply some simple tools for truth testing, is very simple and takes no more effort than becoming enmeshed in the latest pseudoscientific craze.

It's not just a question of intellectual laziness, but also a matter of very practical day-to-day survival. Americans struggle with such issues as stem cell research, abortion, nuclear arms capabilities, electronic eavesdropping, AIDS, and our broken health care system. How can they possibly make good decisions unless they have at least a modicum of understanding of science and its logical systems of operation? The political climate (in 1996 when Sagan published his book) seems to be tending toward a retreat from understanding and supporting basic science at a time when we most need it.

Hippocrates, founder of modern western medicine, employed some elements of the scientific method in his medical practice. Yet, he, himself admitted that fully half of his patients died of various diseases and injuries. Thanks to the scientific approach to medicine, Sagan reminds the reader, huge advances have been made from the introduction of antibiotics to vaccination and gene splicing. While medicine has been conquering disease, agriculture and modern food production methods also have thrived thanks to the application of scientific principles. This makes it possible to feed millions more people than just a few thousand years ago—and better.

Sagan concedes that science is both blessing and curse. It has made possible an exponentially longer human life span since medieval times but also presented us with the challenge of feeding a predicted 10 or 12 billion souls on earth by the end of this century. Science and technology alone can perform the task and find ways to provide for those people as well as the means to manage birth rates. Scientists are responsible for the development of nuclear weapons and even for pushing politicians to produce them. Unwanted byproducts of our technology have polluted the Earth. It's understandable that people have a fear of science.



However, the answer is not to retreat into ignorance and to disavow, dispute and disregard the answers that science has provided although many of them may be disquieting. For example, the scientific discovery that the age of our universe is between eight and 15 billion years instead of 6,000 to 12,000 years adds immensely to our appreciation for the scope of the cosmos. Yet, it also threatens religious beliefs held by many. In some ways, the proliferation of pseudoscience appears to be an attempt to conflate old religious beliefs with some of the more mind-blowing discoveries of science. It's an adaptation by people who may feel threatened, according to Sagan.

Some of the more colorful examples of pseudoscience cited by Sagan include the investment of millions by a former French president to find oil deposits in the atmosphere, and the use of experienced dowzers in Germany with forked sticks to detect carcinogenic earth rays. He also notes psychic surgery in the Philippines, supernatural religions in Japan, and the use of pills made from pulverized sacred scripture to treat disease in Thailand. These manifestations support the observation by Leon Trotsky just before the Nazi takeover in Germany that in today's world, the 13th Century still flourishes with its myriad half-baked ideas, superstitions and irrational fetishes.

With the collapse of the monolithic Soviet Union and after the death of Mao Zedong in China pseudoscience, UFOs, faith healers, ghosts, superstitions and witch doctors have sprung up like toadstools after a summer rain. In Russia, the result has been a sharp drop in life expectancy, a sharp rise in infant mortality and unchecked epidemic diseases. In China, the government issued a statement in 1994 decrying the decline in science education and the rise of pseudoscience. The Chinese statement calls for modernization of its educational system, saying "ignorance is never socialist, nor is poverty."

Sagan says science accepts human fallibility and thrives on the identification and correction of errors. New ideas are subjected to challenges by other scientists, tested, and modified or discarded. The net result is a gradual, incremental approach to truth. Pseudoscience presents its ideas so narrowly as to be impervious to any kind of testing to determine their validity. Practitioners and believers oppose any kind of careful scrutiny or questioning of their beliefs or methods. The "faith" in faith healing may well refer to the fact that the patient must accept the skills of the practitioner on faith alone devoid of any science.

The scientific method may be plodding and at times fractious as compared with some of the heady assumptions of pseudoscience. Yet, it is the only proven path to verifiable truth and reproducible results.



Chapter 2

Chapter 2 Summary and Analysis

Science offers hope in a way that other disciplines and world views can't. It has a built-in correcting mechanism by which scientists are continually searching for eternal, inviolable laws of nature and the universe. The process by which a hypothesis becomes a theory, then if it survives long enough a law is matched by no other process of human thought. Science is both imaginative and disciplined, and operates through a continual clash of new ideas with old in search of the truth.

As a child, Sagan was exposed to the World's Fair of 1939 where multiple exhibits displayed and depicted the latest advances in science and technology that could improve human life. At that point, he fell in love with science and determined to spread the word of its magic. Sagan admits that his love for the romance of science continues unabated along with his passion to elucidate in an age when the masses seem ready to retreat into blissful ignorance rather than to embrace the forward thrust of reason and science.

Like human beings, though, science is not perfect. Sagan notes the error bars that accompany scientific papers to signify the degree of certainty appropriate to the research presented. The laws of gravity as described and worked out by Sir Isaac Newton have been proven true over and over again and are accepted as bedrock science—almost. Sagan says Einstein's laws of general and special relativity show that Newton's laws are correct within the usual range of cosmic forces. However, they change as an object approaches the speed of light (186,000 miles per second). In turn, physicists are now searching for waves of gravity that would bend or break Einstein's laws.

This is the scientific method—painstaking, dogged, sometimes unsettling and unpleasant. Sagan poses the rhetorical question whether his reverence for science is nothing more than replacing one faith with another. He answers by explaining that his devotion to science is based on the fact it works. If there another method that worked better, he would embrace and advocate for it. He also asks rhetorically which of the major religions is dedicated to finding and rooting out doctrinal error, or to systematically testing the veracity or relevance of its teachings. Sagan confesses that the dogmatic and unquestioning nature of most religious belief systems is alien to his mind and spirit.

Sagan argues that science offers a path out of stagnation and poverty for Third World nations. This is why so many students from those nations come to study in the United States. He wishes that the U.S. understood the other side of this equation—that retreating from science is the pathway back into ignorance and poverty. In a global economy and environment, science can act as an early alert system to awaken us to the potential dangers of new and earth-changing technologies.



The astronomer also says science can teach us about our origins and the cosmic framework against which we emerged and continue to struggle. This is important for our spirituality and our understanding of our place in the universe. He believes that democratic and scientific values of open exploration, discovery and debate are essentially the same. Reason and the scientific method can advance not only our understanding of our world but help us become better citizens by giving us improved baloney detectors.



Chapter 3

Chapter 3 Summary and Analysis

The face of the Virgin Mary on a tortilla, the silhouette of Richard Nixon on an eggplant, a giant stone face from an ancient civilization that peers into space from the surface of Mars. What do these apparitions have in common? All are products of the human central nervous system that is primed from infancy to recognize patterns, particularly those that identify faces, especially the mother's face.

Carl Sagan explores two contemporary pseudoscientific myths to further delineate science from its counterfeit version. He notes that every modern science is shadowed by a counterfeit version: astronomy and astrology, chemistry and alchemy, physics and perpetual motion machines, psychiatry and parapsychology. Long before powerful telescopes and space travel, humans looked with awe and wonder at the Moon, "That orbéd maiden with bright fire laden," as the poet Shelley wrote.

The surface of the Moon that continually faces earth in its eerily synchronous orbit is pockmarked with millions of craters from asteroids as well as highlands created by lava flows from as long as 4.5 million years ago. Despite what children have been told for centuries about "the man in the Moon" and the assumption that our orbital partner is made of green cheese, better telescopes confirmed well before the American lunar landing that the Moon is a lifeless, airless, dead cinder with a rich astro-geological history.

The astronomer ridicules a recent book by a fan of the occult (*Natural Likeness*) that reports without questioning the story of a Wisconsin farmer who found inside rocks on his farm a complete history of the world recorded in a pictographic language only he could discern or interpret. There was also the discovery by a surrealist theologian named Antonin Artaud under the influence of peyote erotic images on the surfaces of rocks. When Artaud was diagnosed as insane, the author of the book laments that his patterns were greeted with such skepticism.

Mars has been the object of wild speculation for centuries. Sagan says he grew up surrounded by Martian mythology, largely generated by the observation of astronomer Percival Lowell, of so-called canals on the surface of Mars. These were seen as evidence of some kind of intelligent, organized life on the red planet. This gave rise to all sorts of speculation in pulp magazines and yellow journalism. Orson Welles' radio broadcast in the 1930s simulating a fictional Martian invasion of Earth was perhaps the zenith of this extraterrestrial pseudoscience. Unfortunately for the true believers, the observations of canals were nothing more than the overactive pattern recognition faculty at work on wavering images produced by poor optics.

Even astronaut John Glenn's description of lights buzzing around his capsule gave rise to reports of alien spaceships. Yet, the more prosaic—and more likely—explanation of



paint chips falling away from the craft was disregarded by devotees of the supernatural. However, the identification of strange faces and objects on Mars continues, as scientists pore over more than 100,000 photographic images captured by Martian orbiters and landers. In that many images, Sagan says, it's inevitable that someone will find something unusual because of our neural wiring to recognize faces. Space and our own planets thus become a kind of Rorschach test of our unconscious and irrational projections.

In the most notorious recent discovery of a face on the surface of Mars, careful analysis of photographs reveals that one of its "nostrils" is nothing more than a black dot caused by a gap in radio transmissions from Mars to Earth. Close examination of other features alleged to be sphinx-like reveal them as natural geological formations created over millions of years. Yet, like the true scientist he is, Sagan admits that he might be wrong.



Chapter 4

Chapter 4 Summary and Analysis

Most Americans believe aliens from another planet regularly visit Earth, according to public polls. In the same polls, a considerable percent of Americans also report episodes of missing time, awakening in a state of paralysis at night and flying through the air unassisted. From this, pollsters have concluded that 2 percent of Americans have been abducted by space aliens, some of them more than once. The only problem with all of this is that pollsters never asked anyone whether they were actually abducted.

Sagan recounts that as a young high school student, he was confronted with the flying saucer mythology, which by then was well developed. Although at first it seemed exciting, the mythology didn't hold up well to scientific investigation. As an example, Sagan says, no one could really explain why a race of such technologically advanced creatures would travel light years to Earth to conduct interstellar breeding experiments unless their understanding of biology was light years behind their ability to travel through space.

Even the origin of the term "flying saucer" was a misnomer, according to Sagan. The pilot who witnessed something strange while flying near Mount Rainier in Washington State in 1947 maintained he was misquoted. Originally, he was quoted as saying that the objects flew like a saucer that was thrown across the water—skipping and bobbing up and down. He never said the objects appeared like saucers, but rather were more like points of light. From that initial account, a whole collection of objects ranging from silvery to luminescent to cigar-shaped, ball-shaped, with or without flashing lights, has become central to the UFO mythology.

Extraordinary Popular Delusions and the Madness of Crowds, published in 1841 by Charles Mackay helped the future astronomer in development of a healthy skepticism while a college student. The book describes numerous hoaxes, fevers, scams, and great public lunacies over the ages. It states that each age has its own peculiar fantasy or delusion, joined in by masses of people and spurred on by political or religious interests. Sagan also cites Fads and Fallacies in the Name of Science by Martin Gardner as a useful text to help develop a scientifically skeptical attitude.

Although originally thrilled by the possibility of alien spaceships visiting Earth, Sagan is forced to conclude that every report he's seen is, at best, anecdotal. There remains a staggering void of evidence to support most of the claims about UFOs. Yet, he retains a fascination with the possibility of intelligent life somewhere else in the universe and wants government to support an objective investigation.

One of the earliest, dramatic reports of a crashed flying saucer complete with a gear from the UFO and close-range flash photos turned out to be an utter hoax. It was



perpetrated by two men who had been committing various frauds for more than 25 years such as selling bunk oil leases and prospecting machines. Sagan also mentions the crop circle phenomenon that gained worldwide publicity in the 1970s and 80s that turned out to be a hoax perpetrated by two Englishmen who later confessed their prank. The astronomer is amazed that, despite the uncovering of this prank, crop circle reports still surface around the world and, evidently, still have their believers.

One does not need an advanced degree in science to have a degree of skepticism, according to Sagan. All that is required is that people exercise at least the same degree of skepticism they would when purchasing a used car when confronted with fantastic or unproven pseudoscience.



Chapter 5

Chapter 5 Summary and Analysis

In the late 1940s and 1950s, in fact through much of the Cold War, the United States employed extremely high-altitude weather balloons loaded with meteorological devices, as well as espionage equipment, to fly through the upper atmosphere and peer across the Iron Curtain for a glimpse of what the Soviet Union might be up to. Some of these balloons also served as radar targets for the US to test its radar defenses to warn of aerial attack. In 1947, one of these weather balloons crashed near Roswell, New Mexico, leaving some debris that had strange markings on it. They were identifying marks placed by the toy manufacturer who produced the radar targets for the balloons. Why can't this explanation be accepted? Sagan wonders.

Why must UFO believers and non-skeptics insist this was the crash of a flying saucer with little green men that was subsequently covered up by the military? As just one instance of how a bit of skepticism might pay big rewards, Sagan mentions this episode as it does contain some elements of truth. Government secrecy about UFOs is legendary, weather balloons do occasionally crash. Yet, there are myriad other unanswered questions about the UFO phenomenon whose explanations, not yet given or discovered, would be even more revealing than this myth.

As one possible explanation for the UFO phenomenon, Sagan suggests spoofing, or the practice during the Cold War of scrambling American jet fighters to approach the US from the south as a test of its radar defenses. Most American radar defenses against a Soviet aircraft delivered nuclear attack were concentrated in the north and were considered adequate. However, the military occasionally sent jets into the US on a southern approach up the Mississippi Delta to see just when the alarms would sound. When the ground-based radar locked on the intruders, the jets would turn and race back south again. This maneuvering, according to Sagan, designed to spoof (test) US radar, would show up on monitors as a lot of unexplained (unidentified) flying objects.

Another interesting coincidence: at the height of the UFO frenzy, the military was making the transition from bomber-based nuclear weapons to missiles. There were numerous rocket nosecones falling into the atmosphere as a result of these tests, each of them capable of generating both fast-moving streaks of light as well as radar signatures. Despite all this, the military still retains its policy of secrecy about UFOs, largely for bureaucratic reasons having to do with turf issues. Yet there is no good reason why the military should not open all the files at this point, and continued secrecy only fuels the UFO mythology.

One example of blatant fraud in the UFO phenomenon involves the sudden appearance of an undeveloped roll of black and white film that contained images of documents dated Sept. 24, 1947. In it, former President Harry Truman purportedly directed the formation of a committee of 12 scientists and government officials to look into reports of



a series of UFO crashes that contained the small bodies of alien beings. Both the Air Force and an independent UFO expert have examined the film and declared it a hoax. The mere fact that its provenance—or history—can not be reliably traced should be a signal to the skeptic that it is bogus.

Further, it strains credibility that a government cover-up of alleged alien visitations to earth complete with abductions and cross-species breeding programs could operate successfully for 45 years without some leaks. Someone who would come forward and tell the true story, Sagan notes ironically.



Chapter 6

Chapter 6 Summary and Analysis

At what point do the normal manifestations of an active imagination become hallucinations? When do curiosity and inquisitiveness turn into gullibility and paranoia? Carl Sagan doesn't tell the reader where the line is, but asks that it be considered when trying to sort out the claims of those involved with UFOs, alien abductions, the paranormal and other pseudoscientific phenomena.

It's not an accident that a recent random copy of UFO Universe magazine contains a plethora of ads directed at the gullible, according to Sagan. Such ads are rife with amazing ancient and cosmic advice on love, psychic healing, wealth and the secrets of the universe—for a price. These advertisers know something about the magazine's readers that the readers may not know about themselves: they easily fall prey to fantastic, unfounded and mostly unbelievable claims. They know its readers are gullible, unskeptical and child-like.

In an amusing sidelight, Sagan says he sometimes gets mail from someone who claims to be in contact with aliens, and who encourages him to ask the extraterrestrials anything he desires. Sagan says one of his questions of these advanced creatures is usually to ask for a short proof of Fermat's Last Theorem. To this question, he's never received a reply. When he asks a broader question, such as whether the human race should strive to be good, there is always a reply in vaguely general terms. Sagan concluded that the aliens don't seem to know any more than the average American.

Sagan writes of two early flying saucer stories from the late 1950s and early 1960s—the Venusian visitors of George Adamski of California and the missing-time experiences of Barney and Betty Hill in New Hampshire. Adamski was a credible man who claimed to have encountered visitors from Venus in the desert near his home in Southern California who warned him of the dangers of nuclear war. His book and story created a large publicity wave in the late 1950s. Later discovery that the surface temperature of Venus is 900 degrees was sufficient to invalidate Adamski's tale.

Barney and Betty Hill were allegedly driving in a wooded area one night and taken aboard a spaceship where they were examined and returned. Their memories of the experience were repressed until they came out dramatically under hypnosis. Subsequently, many of the themes in the Hills' story were shown to be identical to those in a 1953 movie, *Invaders from Mars*. Their descriptions of big-eyed aliens matched almost exactly that portrayed on a television program, *The Outer Limits*.

What are the sources of these stories? Sagan says hallucinations are common, caused by a number of different chemical and environmental triggers. In addition, quite powerful drugs, like LSD, are intended to cause hallucinations. Its effects may linger in the body, Sagan says, as well as other psychotropic prescription medications. Nightmares and



parasomnias—sleep disturbances—also could account for some of these reports. Sagan believes it is significant that so many of these reports concern nighttime since it's known that the brain can experience sleep paralysis in that region between waking and sleeping when hallucinations and frightening apparitions are common.



Chapter 7

Chapter 7 Summary and Analysis

Sagan reviews some of the beliefs and literature from ancient times about demons, and finds striking parallels between those half-human creatures and the space aliens of the contemporary world. Demons lived in the skies between God and humans and served as a kind of intermediary. Demons were, in fact, created by God to rule humans, according to ancient beliefs. Demons could assume many forms and were capable of causing great harm, including regular sexual intercourse with women (incubi) and sometimes men (succubi).

People have always believed in demons and seem to be happier when they can believe in them. In an age when organized religion seems in decline, as measured by church attendance, why not recycle the old gods, demons, and witches and give them new currency as alien visitors from space? Perhaps belief in demons or aliens allows people to objectify their fears and guilt by assigning good and evil to agencies outside themselves, such as demi-humans and aliens. In ancient times, Sagan observes, it was never questioned that demons were external beings and not extensions of humans.

Incredibly, Pope Innocent VIII issued a decree in 1484 prohibiting both men and women from having intercourse with evil angels, incubi and succubi, demons and sorcerers. This decree initiated an era of witch-hunting, torture and burnings that characterized the Dark Ages. The pope named two of the faithful to write an analysis of the situation which produced the *Malleus Maleficarum* ("Hammer of Witches"), a guide to the systematic identification, torture and execution of witches. This process allowed no due process of law, no right to confront the accuser, no right to mount a defense and no rights of appeal.

As the number of confessions to witchcraft rose in proportion to the amount of torture used, so did the general conviction that there must be many more witches who were possessed by unholy demons. Witch hunting became a profitable business for many, especially since the hunters were often able to appropriate the belongings of the dispatched witches. Those who criticized witch burnings were themselves accused of being witches and burned at the stake. Although there is no flying saucer in ancient accounts of visitations by demons, there is a theme of cross-species breeding, creatures that fly and walk through walls and communicate without words.

Alien visitation enthusiasts are quick to point out, Sagan says, that extraterrestrials have always visited Earth, conducted weird sexual experiments, and taken people as abductees. If that is the case, then why is the record barren of any reported flying saucers before 1947? How could an inter-galactic breeding experiment last for thousands of years when the results could be known within a generation or two? The UFO phenomenon, Sagan concludes, can be explained by a common temporal lobe hallucination which someone describes to someone else; because it has a slight

resonance with the listener the story is re-told with a few embellishments. Soon, a full-fledged mythology emerges.

Despite the ghoulish nature of many UFO and abduction reports, there is a depressing banality and sameness in them: nothing to compare with the wonders of a cockatoo, or the miracles in any protozoology or bacteriology textbook, Sagan says.



Chapter 8

Chapter 8 Summary and Analysis

All human beings live awash in a sea of ghosts, visions, apparitions, fairies, aliens—you name it. The acceptability, or credibility of such experiences, seems to a large extent to be culturally determined, Sagan argues. For example, in England where belief in ghosts is widespread, many people report experiences with ghosts. There is a kind of pecking order that revolves around who has the best ghost story.

In the case of alien abductions recovered under hypnosis, studies have shown there is a strong chance that the beliefs and convictions of the hypnotist will be conveyed directly to the subject, whether through attitudes, types of questions, or other more subtle cues. In one California study, eight subjects were hypnotized and told that they had been abducted and examined on a spaceship. With no other direction, the subjects provided detailed accounts of their abductions that were nearly identical to those of subjects who claims to be abductees. The point is that in many cases therapists cue their subjects, whether directly or indirectly.

Under hypnosis, the slightest cues or suggestions can produce vivid but false memories of experiences in the subject, which is one reason that statements made under hypnosis can't be admitted as evidence in court. In fact, it's common that attorneys coach their witnesses in how to present their testimony, emphasizing certain shades of meaning and de-emphasizing others so the truth may be well obscured. Sagan uses this as another instance of how memories, once implanted are almost never challenged and can become almost a fictional work-in-progress.

Visions are well known to the saints. In fact, some of the UFO stories can be understood better when placed alongside some sacred visions. Appearances by the Virgin Mary are one instance. In these cases, someone tells of encountering a very small woman of three or four feet in height, who has an important message to convey to the proper authorities. Often, she tells the witness to obey the Ten Commandments or to build a shrine. Soon, there is a local cottage industry built up around the apparition, providing employment for carpenters, masons, merchants and priests. Does any of this suggest the tourist industry that has sprung up near Roswell, N.M. where little men were allegedly pulled from the wreckage of a flying saucer in 1947?

Sagan notes that many of these apparitions are reported when the witness is just awakening—again in that netherworld between sleep and alertness where many creatures of the id seem to live. To distinguish genuine from bogus visions, the Vatican issued a bull in 1517 that denounced apparitions in dreams and those that are divine. Joan of Ark, for one, was burned at the stake for her visions, Sagan reminds the reader.

Again, Sagan wonders why these celestial visions are so pedestrian if they come from infinite places of wisdom and clarity. Why does the Virgin Mary implore some poor



peasant to carry her message to the authorities when she could do so more effectively herself? Why do aliens who are in contact with earthlings speak in common moral judgments, but seem unable to master fundamentals of mathematics? The same thing that impels people to commit copycat crimes motivates many of those who report alien abductions; some are motivated by greed, others by a need for attentions.



Chapter 9

Chapter 9 Summary and Analysis

Is the intensity or force of emotions connected to a recalled (recovered) memory a legitimate basis for judging the validity of that memory? Harvard psychiatrist John Mack, an old friend of Sagan, seems to think so. He's written a book about his conversion to the side of the believers after interviewing and examining dozens of alleged abductees. For Mack, sadly, the only evidence he needs to accept these claims is the emotionality and seeming absolute conviction of his patients they have been taken aboard alien spaceships.

Sagan pulls out his baloney detector and asks, with regard to Mack, where's the scientific skepticism? Why should anyone believe the claims of so-called abductees over, say, people who have encountered witches, fairies, angels and ghosts? Sagan cites a study by Canadian psychologists that concludes alien abductees tend to be people with active fantasy lives and a tendency to interpret as real extrasensory experiences that occur around and during sleep. In other words, the chimerical other-worldly experiences reported by these people would, by most skeptics, be called simply hallucinations or dreams.

Due to the sexual component in many alien abduction stories, therapists who treat supposed abductees not only accept their stories but also try to unravel the patient's sexual history to see if perhaps the abduction script is a recovered memory of sexual abuse. Sagan notes that 10 percent of American women are raped—about two-third of those while still minors—and 20 percent by their fathers.

Although Sigmund Freud, the Austrian father of psychoanalysis, described a cluster of symptoms in women resulting from sexual repression that he called hysteria, he later abandoned that term and instead used the word fantasy. Freud was describing the protective mechanism by which people repress painful experiences. Yet a contemporary of Sagan's, another Harvard psychiatrist named Dr. Fred Frankel, believes hysteria is indeed the correct word to describe high suggestibility and imaginative ability, an unusual alertness to interpersonal cues and expectations, the traits of many so-called abductees.

Another possible source of alien abduction fantasies or beliefs could be childhood sexual abuse or both males and females. Sagan quotes an American psychologist at Emory University in Atlanta to the effect that false memories and confabulation are common among patients. Mis-rememberings are the rule rather than the exception. Led perhaps unconsciously by a therapist with his or her own beliefs about alien abductions, such patients' memories can be shaped just about any way and will retain that configuration. Once again, Sagan implores, skepticism on the part of therapists and psychiatrists about the patient's story or memories is called for.



At least one text that deals with childhood sexual abuse of women tells therapists they have a professional obligation to believe the survivor in order to help the patient heal and be completely exorcised of the self-destructive emotions that stem from sexual abuse. Sagan notes a striking similarity in both flavor and methodology between sexual abuse cases and alien abduction cases. He adds to this the category of satanism and witchcraft. He also reports that many of those in America who loudly decry the evils of satanism are Christian fundamentalists who require the existence of a devil to believe in God.

Of all the thousands of cases of satanic rituals complete with the sacrifice of infants and other appalling acts, a study of some 12,000 of these reportings by a University of California psychologist for the National Center on Child Abuse and Neglect could not find a single case that was credible. In some cases, families that have been damaged or hurt by therapists who help their clients recover false memories have sued the therapist and won large judgments.

Revealingly, a prominent UFO researcher says that only if the hypnotist who examines an alien abductee has knowledge of such abductions can the true nature of that experience be revealed and understood. Sagan asks the reader if he or she can see in that statement how a therapist can lead the patient with no awareness that he's leading.



Chapter 10

Chapter 10 Summary and Analysis

Sagan delves deeper into the epistemological aspects of the UFO phenomenon. He asks whether we're more prepared to believe solely on the verbal testimony of so-called witnesses that aliens are visiting Earth and abducting humans, or to believe there is some kind of mass hysteria or other psychological phenomenon at work.

To illustrate the squishy relationship with truth involved in the flying saucer claims, Sagan presents an imaginary dialogue between himself and the reader about whether he has a fire-breathing dragon in his garage. When the reader asks to see the beast, Sagan says he's invisible. When the reader suggests putting flour on the floor to mark his tracks, Sagan replies that the dragon floats in the air. When the idea of spray painting the dragon is suggested, Sagan says that won't work as the dragon is incorporeal, and the paint won't adhere. An on and on and on. The skeptic who wishes to be fair and not close the door on the possibility that invisible dragon owners and UFO abductees might be telling the truth would tentatively reject the dragon and UFO hypotheses. Yet, they'd keep an open mind to the possibility of someday being convinced by unequivocal evidence.

Harvard psychiatrist John Mack accepts at face value the stories of those who claim to have been abducted by aliens, largely on the strong emotionality of their experiences. This is not unlike the case of a brilliant physicist at Los Alamos who believed that in the future he would pilot spaceships through the far reaches of the universe. The physicist wrote long and detailed accounts of his adventures, and his co-workers began to wonder about his sanity.

When examined by a psychoanalyst, the physicist clung to his story and was refractory to the usual tools of analysis. Only when the therapist could enter into his world could he begin to reach the physicist. As he did so, the analyst began to believe the stories of the young physicist and accepted them as his truth—until the physicist said he made up the whole thing out of boredom. The analyst was crushed. The astronomer wonders whether his friend Mack might suffer a similar fate because of his enthusiasm to accept the truth of alleged abductees' stories without firm evidence.

As an alternative to the faith-based approach to the question of extraterrestrial life, Sagan mentions the search for interstellar life using radio signals. Since initial efforts by the Soviets in the early 1960s, groups of scientists and astronomers around the United States have been searching and tracking anomalous radio signals. Some come from distant stars undergoing change while others remain unexplained. Sagan says this kind of approach may one day yield some scientific evidence of intelligent life elsewhere in space.



On the question of existing evidence of UFO abductions, Sagan says many if not all of the alleged UFO photos could easily have been faked. He asks, with regard to one of Dr. John Mack's patients who has strange scars all over her body, why he didn't write a paper on her case for publication in a medical journal, such as the *New England Journal of Medicine*?

Isn't it odd that alleged abductees who have had small metal objects implanted in their nostrils have shown such a lack of curiosity whenever one fell out that they simply discarded the implant without showing it to anyone else? The astronomer seems genuinely appalled at Mack's assertion that UFOs could be some kind of extra-dimensional phenomenon that can move from our three dimensions to higher dimensions at will, purely on speculation and without a shred of evidence.

Sagan says again that he'd love to encounter a UFO or alien abduction case that is well documented with compelling evidence. Yet so far, unfortunately, "the invisible dragon has left no unfakable footprints."



Chapter 11

Chapter 11 Summary and Analysis

On the heels of publication in Parade magazine of an article by Carl Sagan summarizing his views about UFOs and alien abductions, the magazine was deluged with mail. Most of it was impassioned and from obviously distraught people. Sagan presents in this chapter a selection of those letters.

For example, one reader asks what animals experience when humans approach by helicopter, subdue them, examine their sexual organs, clamp a monitoring device to their ear, and let them go. Isn't this an analogue to the reported human abduction cases? the reader asks.

Another identified himself as a victim of childhood sexual abuse, and said he'd often drawn space aliens as a child and felt that he was overpowered and left his own body. The reader said alien abduction is nothing compared to being sexually abused by a parent—"the ultimate powerlessness."

One reader declared that he would sleep with his camera beside the bed so that when another abduction occurs, he can take a photograph. After studying UFOs for more than two decades, one reader said he got turned off by the whole UFO movement and its fellow travelers.

A 47-year-old grandmother wrote that she had been abducted numerous times and would rather hear a diagnosis of schizophrenia than have to live with her memories. She said she'd like firm evidence of her abductions but doubted if would ever be produced.

One reader said he thought the alien abduction phenomenon is only a dream recalled from memory. He claimed that the abductees only see images already in their brains. Another wondered why, if UFO reports are all fake, the topic is the most highly classified subject in the government?

A particularly religious reader wrote that Jesus had told him that UFOs don't exist as they would require an external energy source that doesn't exist. One claimed that a treason suit was filed against the government which signed a treaty with aliens in the 1940s to share some of their technology until it was learned they are hostile.

A reader said UFOs are a hoax with no factual basis at all. One believer wrote that we don't need to spend money on a program to see if aliens are sending radio signals as they are already here among us on Earth.



Chapter 12

Chapter 12 Summary and Analysis

Fed up with charlatanism, hucksterism, unqualified quackery, pseudoscience, and baloney in a thousand different flavors, Sagan is eager to share with the reader his tools for skeptical thinking. These tools may not necessarily soothe, but the user at least has a shot at understanding the truth. They include seeking independent verification of any claim that is presented as self-evident, and trying to find serious discussion about the evidence by those who are well versed in every viewpoint. He also cites rejecting "ex cathedra" arguments, or those based on authority as there are no real authorities in science, and arriving at multiple hypotheses by thinking of many different ways that something could be explained. The one thesis that survives this test is most likely to be the correct answer; staying detached from the various hypotheses so that your emotions don't cause you to play favorites.

Others include specifying quantity, numbers, and exact measurements of the hypothesis instead of making it vaguely qualitative. One should also make sure that in a logical argument, every step in drawing the conclusion works as well as every other. When confronted with two hypotheses that explain the problem equally well, choose the simpler solution. One should also determine whether the hypothesis can be falsified, since hypotheses that can be neither tested nor falsified are worthless. See if the hypothesis can be tested and reproduced.

Likewise, in addition to knowing the necessary steps to detect baloney, the true skeptic must learn to recognize and ignore certain logical and rhetorical pitfalls. This includes ad hominem attacks against the individual who proposes an argument, rather than against the argument itself. Avoid the authoritarian argument, such as saying George Bush must be reelected president as the president knows more about the terrorists than anyone else. Ignore the adverse consequences argument, for example, saying a defendant in a murder trial must be convicted of killing his wife so that other men don't kill their wives. Recognize argument based on ignorance, such as saying that because there is no proof that UFOs are not visiting Earth, they must be visiting Earth with aliens aboard. Don't assume the answer, such as arguing that we must continue fighting terrorists in Iraq so we don't have to fight them on American soil.

Another logical lapses to watch out for includes selective observation, as in claiming that a state has produced so many Rhodes Scholars but ignoring the number of its child molesters. There's also argument from the statistics of small numbers, as in saying that since I've not won anything on the last five lottery tickets, it's now time that I strike it rich. Avoid non-logical thinking (also called non sequitur), as exemplified in the Nazi slogan, "God is with us," which results from not having considered all possible explanations. Also included is false dichotomy, also known as the excluded middle, as in the statement: "If you're not with us, you're against us. There's also the argument on a slipper slope, related to the excluded middle, as in: If we withdraw our troops from Iraq

now, there will be a civil war that will spread throughout the Middle East. In addition, avoid rhetorical confusion of causation and correlation, as in the statement: There haven't been any more attacks on America since 9/11, therefore the Department of Homeland Security is a success. Finally, there's missing or incomplete evidence, as when Al Qaeda releases a video of Osama bin Laden denouncing the West in the wake of a terrorist bombing overseas. We have no proof of whether the terrorist leader was dead or alive when the video is released.

As one example of the importance of reasoned skepticism, Sagan notes that the \$50 billion-a-year tobacco industry in the United States has become a past master of the rhetorical and logical kinks that can be used to lure young people around the world to use tobacco. He notes that the World Health Organization figures smoking kills more than 3 million people per year worldwide. This figure will rise to 10 million deaths by 2020. Baloney detection is not only crucial to finding the truth, but also to human health.



Chapter 13

Chapter 13 Summary and Analysis

Sagan continues his assault on the irrational with the historical note that fundamentalist Christians and Jews reject claims by faith healers, UFO apostles, witches, fire breathers and all kinds of supernatural entities. This is due to admonition in Deuteronomy against consulting with wizards and diviners (fortune tellers). The only way to test and therefore accept a proposition is by examining the evidence to support it. Sagan tells of several outright frauds perpetrated on an unwary public and indolent media.

In one brazen example, a 19-year-old named Jose Luis Alvarez claimed to be able to channel the spirit of Carlos, "an ancient soul" who entered his body after a motorcycle accident. Alvarez/Carlos became a New Age icon, made numerous public appearances where the wisdom of the ancients was purveyed. During an appearance on Australian television, Carlos put a curse on the host for asking skeptical questions. His manager threw a glass of water on him, and they stalked out of the studio. On a subsequent TV appearance, Alvarez/Carlos terminated the interview when he didn't like the questions. Despite these and other public humiliations, Alvarez/Carlos grew a thriving business selling Carlos magic waters and statuary.

Some faith healers have decided on their career direction after witnessing the power of the human mind to believe in the face of the unbelievable. They recognize the strength of suggestion represented by the placebo, or sham treatment that seems to bring relief as the sufferer believes it will work. Sagan gives the example of a drug to reduce the nauseating effects of chemotherapy given to AIDS patients, rated as 96 percent effective in a double-blind study of patients. Yet, 10 percent of the patients also rated as effective an identical-looking placebo.

William Nolen, a Minnesota physician, spent almost two years tracking down and investigating claims of alleged faith healing, always asking whether the disease was truly in evidence before the claimed cure. After uncovering many instances of fraud, Nolan found not a single case where a cure of any serious organic disease such as cancer had been effected. In fact, by convincing people they are cured and don't need medical treatment, faith healers do a great deal of damage and cause many deaths, Nolan concluded.

Sagan does acknowledge that for certain diseases where the patient's state of mind plays a role in their health, such as joint pain, headaches, false pregnancies and hysterical blindness, faith healing may in fact provide some relief. It is known, for example, that in the week before the traditional Chinese Harvest Moon Festival, the death rate in that community drops by 35 percent. It increases by 35 percent in the week after the festival. In the Jewish community, the death rate among senior men drops during the time of Passover when older men play an important role, as it does generally around birthdays and other ceremonial occasions.



Other hoaxes that rely on people's gullibility include personalized horoscopes and astrology, palmists, psychics, seers, and repressed childhood sexual abuse, Sagan notes. "Baloney, bamboozles, careless thinking, flimflam, and wishes disguised as facts are not restricted to parlor magic and ambiguous advice on matters of the Heart," according to Sagan. "Unfortunately, they ripple through mainstream political, social, religious and economic issues in every nation."



Chapter 14

Chapter 14 Summary and Analysis

Sagan characterizes as antiscience the trendy, New Age mindset that reality is whatever you think it is, that one system of belief is as valid as another, that science is merely one kind of belief system. The astronomer argues that science is different than shamanistic or traditional religion in its requirements for proof through scientific experiment and observation of its findings. It may well be that faith-based healing is effective in treating certain conditions. However, just how effective can only be determined by a scientific process of culling out those seeming cures that result from suggestion.

In part, science itself is responsible for public distrust and misunderstanding. As the pace of change (which is the same as the rate of new discovery and new knowledge) is so fast in science—and in particular medicine which affects everyone—people have become suspicious of scientists as subversive and even dangerous challengers of the status quo. It is far easier to accept at face value the positions and posturing of New Age spiritualists than the admittedly absurd findings of quantum mechanics, which require 15 years of study to fully comprehend.

The difference between the two views of reality is crucial. The former rests on largely untestable and thus unprovable assumptions. The latter is built upon a foundation of rigid testing for rationally constructed and understandable evidence. To the non-scientist, it may appear that science asks of us the same as religion—blind faith. Yet, the difference is that when someone demands proof of a scientific finding or theory, it can be presented in mathematical or logical form. Religion only presents its own dogma as proof.

Sagan compares the process of scientific discovery to the process of writing history. Cultural and personal biases abound in both, sometimes distorting the truth. History, as they say, is written by the winners of wars, the victors, and minority viewpoints are usually swept away entirely. Sagan argues that responsible historians have an obligation to go back and correct the historical record, as much as possible, to get at the real truth. Science, too, is sometimes crippled by a wish to please wealthy and powerful interests, and by mistakes that can take too long to identify and correct. However, science continues to ask the important questions and to challenge itself, so doctrinal and factual errors eventually get weeded out.

When he suggests that scientists ought to publish and acknowledge their errors, Sagan lists some of his own: misjudging the atmosphere of Venus, assuming there would be plate tectonic on Mars, assuming the hot atmospheric temperatures of Titan are caused by a greenhouse effect. Yet because scientists are sometimes wrong and sometimes guilty of bending to social or political forces, it proves only that they are human. It should not give license to dispense with science or its methods altogether.



Chapter 15

Chapter 15 Summary and Analysis

In 1992, the Roman Catholic Church dispensed an official correction and apology to the effect that Galileo was, in fact, correct when he asserted that the Earth revolves around the Sun, instead of the other way around. In so doing, Carl Sagan wonders, was the church admitting in just one instance or, in a strangely oblique way, all instances that science can be correct when it challenges official church dogma?

No matter. An apology, even one that comes three centuries too late, is nevertheless welcome. Sagan reflects it's too bad that the church has so often stood in direct contradiction, denial and conflict with the findings of science. The core of this conflict, he tells his readers, is the fact science is evidence-based. Religious dogma is faith-based. Again, no news here, but this is another example of how the two modes of thinking—one mythical, magical and the other logical, factual—are often at loggerheads. In fact, Sagan says, the "whatever" 1960s world view that any belief or system of ideas is as valid as any other has a direct line of descent from that mythical, magical, non-logical point of view that most often produces reactionary, rather than rational, thought.

The title of the chapter comes from a bit of poetry by the English mystic and revolutionary William Blake. He evidently referred to the way science and its most famous practitioner of the time, Sir Isaac Newton, excludes from serious concern such things as souls, angels, witches, sprites and devils. As he examines the varieties of religious belief, Sagan emphasizes how widespread and deeply rooted this phenomenon is and how it can serve the interests of an orderly society. Societies that teach acceptance for the shortcomings of this world in view of a richly rewarded afterlife tend to be immune to revolution, for example.

The solipsism of self-indulgent New Agers who believe the only reality is in their minds stands in sharp relief against both the clear-cut dogma of organized religion as well as the evidence-based findings of science. The New Age seems more like a Dark Age, with its shamans, gurus, and reborn Christers. It's as if humanists have turned the tables on scientists, who have long held that art, literature, criticism, philosophy and religion are merely opinions that do not stand the scientific test. Science and scientists are resented by New Agers for daring to put limits on the potential powers of humans. In fact, it's nature that sets those limits, Sagan says.

Before the DNA code was sequenced, scientific skeptics doubted that life could be understood in terms of physical chemistry alone. Somehow, there must be a vitalizing force that is greater than physical matter. The view that life of any sort could be understood on a purely physical basis was termed reductionism, Sagan notes. When work began on trying to map and understand DNA as the structure of all life, anti-scientists scoffed that it would never work. Now, we know that the same basic genetic building blocks are responsible for all life forms on a purely physical basis. To Sagan,



this scientific understanding of life does not rule out all forms of spirituality, but only enriches it.

Sagan believes a large part of the ongoing conflict between religion and science stems from the fact that most of the tenets of religion can be scientifically tested. He asks rhetorically why all the prayers of all the ages for good crops, peace, or victory in war, for healing the sick and raising the dead have gone unanswered. Fundamentalist religions as practiced in the modern world rest upon a faith that is beyond questioning and unquestionable, thus vulnerable to scientific reasoning. Therefore, they fear science. Sagan concludes that people are always better off knowing the truth or the best approximation of the truth possible. Humans are not capable of knowing which overt lies or half-truths might serve some other alleged social benefit.



Chapter 16

Chapter 16 Summary and Analysis

What is the morality of science? Do physicists have an ethical obligation to the human race and to the Earth? If science rules out the precepts and proscriptions of unscientific religion, how should scientists behave when the pursuit of their science poses grave dangers to all known life?

Carl Sagan explores these questions by presenting two contrasting portraits of physicists at opposite moral ends of the nuclear age. Dr. Robert Oppenheimer, scientific director of the Manhattan Project that developed the first nuclear bomb used to demolish Hiroshima and Nagasaki in World War II, was afterwards haunted by guilt and the sense that he and other physicists had unleashed a Pandora's box of evil that could destroy the Earth. When he told President Harry Truman that scientists now had blood on their hands, the feisty Missourian said he never wanted to see Oppenheimer again.

Dr. Edward Teller, often referred to as the father of the hydrogen bomb, throughout his long life was a tireless promoter of thermonuclear weapons. He urged their use to dredge the sea and re-shape landscapes, to detonate on Mars to test its composition, and most importantly as a supposed deterrent to nuclear war. Sagan even suggests that Teller may have been the life model for Peter Seller's Doctor Strangelove in the movie, "Dr. Strangelove, or "How I Learned to Stop Worrying and Love the Bomb."

Sagan fears the nuclear winter that most likely would follow a nuclear exchange, an environmental blackout that would lower global temperatures by 10 to 15 degrees. He finds the premise of mutually assured destruction (MAD) to be mad, and anything but an argument for arming the world with thermonuclear weapons. The astronomer seems to share the terror of many people worldwide of nuclear weapons and nuclear technology, because of the lethal potential of both.

Teller, according to Sagan, was a vociferous and effective foe of arms limitation treaties as well as agreements to stop atmospheric testing of nuclear weapons. It was the Hungarian-born Teller who first planted in the brain of Ronald Reagan the idea of the strategic defense initiative, sometimes referred to as "Star Wars." At the time, 10,000 American scientists and engineers proclaimed publicly that they would neither work on Star Wars nor accept any funds for that project.

Having met with Teller privately and publicly at scientific sessions and before the media, Sagan concludes that Teller was corrupted by the power given him by politicians, although Teller may have had his own streak of grandiosity to begin with. Sagan notes the bloodthirsty history of our species, recorded in every ancient religious text alongside the admonition to be peace loving and kind to our fellows. It's a moral quandary no different than that faced by physicists and other scientists. In an age when truly terrifying threats such as nuclear war and global warming demand a super-rational,

super-moral response, Sagan wonders whether women and children may be the ultimate saviors of our testosterone-drenched militaristic race.



Chapter 17

Chapter 17 Summary and Analysis

If skepticism is the realm of the scientist and wonder the province of the poet, Sagan contends that a balance of the two is required for survival in a world torn in a million directions by controversies, wars, assaults on reason and appeals to primal urges. He concedes that skepticism has the defect of sometimes seeming cold, condescending and belittling to others whose beliefs may be based more on intuition and feelings. Yet, he reminds us that people of both casts of mind are human beings with true feelings who are just trying to figure out the world and their place in it.

Who is to judge so-called primitive societies that use seashells or young women as money, as in the Ik tribe of Uganda who also ignore the blandishments of the Ten Commandments? Their belief system has worked for them for thousands of years, so why try to change them and their culture by the application of scientific skepticism? The same scientist who in earlier chapters lambasted the irrational inanities of New Age believers, seems now to express a live-and-let-live philosophy. If people's beliefs give them comfort, Sagan seems to say, then why assault them with skepticism that could only make their life more difficult?

The skeptical movement, as Sagan calls it, produces an us-them kind of polarization that can actually impede the advancement of science and reason. It's just too bad that skeptics will never believe that he has an invisible, fire breathing dragon in his garage (as mentioned in an earlier chapter) as they are materialistic atheists.

No good scientists are able to retain the kind of open-mindedness essential to free inquiry while at the same exercising the most stringent kind of skepticism. Sagan feels both abilities are essential not only for good science, but also for sanity. Since no one can be either entirely skeptical or entirely credulous, a happy middle ground should be the goal. Both states of mind require continual honing, and school children should be taught to exercise both facilities, he says.



Chapter 18

Chapter 18 Summary and Analysis

Although official history reflects that the ancient Greeks invented modern science and its methods. Sagan points out that so-called primitive peoples and earlier civilizations also made astounding discoveries—such as gunpowder, rockets, moveable type, the magnetic compass, numerical and mathematical systems and advanced calendars. Yet the skeptical method of careful observation, testing and theorizing arose in ancient Greece.

That method of discovery and analysis arose from the Greek cultural norm of discussion and debate of ideas, persuasion and rational debate enhanced with a wealthy, educated merchant class, a profound literary tradition free of ecclesiastical control for a millennium. Yet, Sagan also points out that steps toward modern science also arose in other parts of the world, which he believes demonstrates that scientific curiosity is hard-wired into our human species.

True, many people find the sciences difficult to comprehend and to teach. Nonetheless, this may be merely a result of cultural attitudes and a western society that does not encourage the kind of intense concentration over extended period of time necessary to grasp science. The result in America is a society that enjoys and freely uses the fruits of science and technology without understanding the scientific approach and often misunderstanding or disdaining scientists.

To illustrate the universality of the scientific instinct, Sagan describes how African tribes use an encyclopedic knowledge of their environments, careful observation of animal movements as revealed in their tracks, and objective reasoning in determining where, how and when to hunt. This process is akin to astronomers searching out and studying objects in the far reaches of space. On that basis, Sagan blasts those who argue that certain peoples are just not advanced enough for science. It's not unlike children who are deemed unready for subjects usually taught to older students. That attitude is patronizing and racist, a holdover from colonial times. Sagan points out the numerous ways that so-called primitive peoples use their own folk technology and science every day for survival. As science is our birthright as humans, we need to teach it lucidly, clearly and enthusiastically to children so they can have the tools to understand science and to use its powers to enrich their futures.



Chapter 19

Chapter 19 Summary and Analysis

Why do young American children ask such great, inquisitive questions about science and the universe? Yet, by the time they reach high school, they seemingly have no more native curiosity left? Why are Americans, who pioneered the airplane, telegraph, telephone, electric light and computers, behind other nations in science comprehension among students? Could these dismal facts be signs of a science phobia? Sagan asks.

Too often, teachers don't know how to teach any better than students know how to learn, according to Sagan. Part of the problem may lie in the rate of change in our knowledge base, which complicates the art of passing along to the next generation the skills, wisdom and tools used by successful adults. Part may be accounted for by the fact adults often seem uncomfortable when children ask truly important, or even irreverent, questions. The message to kids seems to be they've committed a faux pas by asking the question.

Just to drive home his point, Sagan shares some startling statistics. Sixty-three percent of American adults don't know that the last dinosaur died before the evolution of homo sapiens. Seventy-five percent are unaware that everyday antibiotics only kill bacteria, not viruses. Nearly 60 percent do not know that atoms are bigger than electrons. Half of American adults are ignorant of the fact that the Earth revolves around the Sun once a year.

Although many high school seniors can recite facts about scientific discoveries, very few have any real understanding of how we know those facts. As if ignorance of science were not bad enough, Sagan tells his readers that both the Qu'ran and the Bible insist that the Earth is flat. Thus, anyone who believes in a round Earth is an atheist or heretic who is, in the Muslim world, subject to punishment.

American adults routinely vote down school bond issues. American students don't do enough homework compared with students in other nations. American students spend less than half as much time studying math, science and history as those in France, Germany and Japan. Sagan wonders why there is a common perception in America that science is just too difficult—in the country where the inventor, lone scientist with an idea, and entrepreneur were once held up as inspirational models.

The dumbing down of America is far worse than anyone imagined. Sagan relates that a major American electronics company finds that 80 percent of job applicants can't pass a fifth-grade math test! The economic costs to the American economy of poorly educated workers who have trouble reading, writing and counting is staggering. It's a crime that science is in such a state when there is so much excitement, discovery, challenge and reward in the discipline.



The astronomer even offers some tips to fellow scientists for getting their message across to nonscientists. He urges them to be careful to phrase statements in simple, easily understandable language, and not condescend to one's audience. They should respect the work of other scientists and their contributions, and remember the time when they themselves had little understanding of science. Popularization of science should spark the curiosity and wonder, without attempting to be a complete academic lecture and by allowing the newcomer to make their own discoveries.



Chapter 20

Chapter 20 Summary and Analysis

Faced with appallingly low literacy rates in language, math and science skills among school children, what can concerned parents do to improve the situation? Sagan offers a grab bag of ideas from his own experience as scientist and parent. From his experience as a contributor of articles to Parade magazine, Sagan presents a sampling of letters he received from some 10th graders in Minnesota about an article on the poor performance of both teachers and students in American schools. Many of the students didn't believe there is a problem. If there is one, they were indifferent. Some seemed to resent the implication they should sacrifice any of their social time for more studies. Most were inclined to deny Sagan's message completely.

Yet, adults who responded to his article largely seemed to agree there is a problem with American education. Many parents wrote to tell Sagan their child is passionate about science but doesn't receive enough instruction or is a victim of peer pressure not to excel academically. Some parents blamed teachers or the educational system. Some teachers blamed earlier grades for failing to nurture interest in science. Some suggested dismantling the public educational system.

Although there is not one solution to the dilemma of illiteracy, Sagan says there's a lot that parents and adults can do right in their own homes and communities to foster kids' interest in science. These include visiting museums and planetariums, doing at-home science experiments such as looking at a drop of pond water under the microscope, using a computer to generate a model of what the impacts of global warming might be, or visiting a large screen theater such as IMAX or OMNIMAX that presents dramatic scientific films.

Sagan tells the story of a group of dedicated parents and teachers in his hometown of Ithaca, N.Y. who dreamed of creating a permanent Sciencenter where kids could get a hands-on experience with science. With donated architectural plans, plus volunteer labor and materials, the group actually built the facility with the help of people of all ages. It now stands, with its 75 interactive exhibits, as a model of what dedicated people can do to promote science in their own communities.



Chapter 21

Chapter 21 Summary and Analysis

From one of the highest literacy rates in the world at the time of the American Revolution, the United States has slipped into an embarrassingly high illiteracy rate of 40 million or more barely literate adults. There is a direct correlation between functional literacy and income. With only 3 or 4 percent of the American population scoring in the highest of five national reading levels, the remaining majority are unaware of just how poor their reading skills are.

The difference in literacy translates into an income disparity in favor of those who read well of \$12,000 a year at the lowest of the five reading levels and \$34,000 per year at the highest. This means that the vast majority of Americans with poor reading skills are challenged to understand an election ballot, a home mortgage, or even a daily newspaper. Perhaps these are some of the reasons for the poor voter participation levels in the United States. Certainly, there is a connection between illiteracy and the impoverished family environments of children who do poorly in school, Sagan observes.

The author mentions Frederick Douglass, a slave who overcame every conceivable disadvantage—racism, economic exploitation, brutality—to teach himself to read and later to escape bondage. He became one of the great writers and orators in American history as he had mastered the ability to read and write. Noting the advances in literacy among African-Americans, Sagan argues that malnutrition plays an important role in undermining the ability to learn and supports the enrichment of programs such as Head Start, designed to help disadvantaged children.

Recent books that correlate relatively lower IQ scores and poor school performance with race are not helpful, Sagan says. They make the mistake of confusing causation with correlation—one of the logical lapses mentioned in Sagan's baloney detection chapter. He points out that an experimental learning program aimed at low income pre-school children in Kentucky raised literacy among both adults—who came to school with the children for part of the day—and helped pave the way for better learning by the children later in school. Sagan advances the argument that proper education is ultimately less expensive than ignorance both to individuals and society as a whole.



Chapter 22

Chapter 22 Summary and Analysis

Sagan takes a broad look at popular culture in search of opportunities to bring science to the level of mass consciousness. He sees ways to use sports to teach mathematics and laws of probability, for example, instead of the superstitions of winning streaks. In the various twists and turns of televised basketball, there's an opportunity to discuss converting fractions into decimals, Newton's laws of motion, parabolic arcs and the physics of gravity.

If sports and financial junkies willingly plow through sheets of statistics in the newspaper each day, why can't they be induced to devour scientific information with similar gusto? Isn't it just as interesting to know that so-called winning or losing streaks don't really exist, that successful shots by NBA basketball players are no more likely to cluster than could be expected by chance? Those who need to see significance in every event may be more gratified to believe that a player or team has some supernatural gift. Yet, the pragmatics of science don't support that view.

Commercial television, when it features science at all, is likely to do so in a distorted, bizarre, and completely misleading manner. Television, in Sagan's view, is a major purveyor of the uncritical, pseudoscientific world view that can present programs on the mysteries of the Bermuda Triangle, UFOs, and ancient astronauts without blinking a critical eye. This is too bad, since Americans have every conceivable technological advantage at their disposal to find and disseminate some of the excitement and enlightenment of real science.

Some of the possible remedies suggested by Sagan for improving TV coverage of science include regular, serious coverage of scientific discoveries and methods on news programs. Perhaps there could be a series called Solved Mysteries in which rational resolutions to puzzling dilemmas in forensic medicine and epidemiology are presented. Or, a series about major mistakes and misunderstandings of famous scientists, politicians and religious leaders, regular exposés of scientific fraud and pseudo-science.



Chapter 23

Chapter 23 Summary and Analysis

As a challenge to the American stereotype of the scientist as a nerd with pocket protector, glasses and no social skills, Sagan offers the story of the Scottish physicist James Clerk Maxwell. He is credited with working out the physics that made radio and television possible. In 1833, at the age of two, Maxwell discovered he could focus the image of the sun from a tin plate on surrounding furniture, and demanded an explanation of the adults in his household. In 1872, during his inaugural address as professor of experimental physics at Cambridge University, Maxwell referred to an already-existing stereotype of the scientist as some sort of misanthrope more interested in formulas and people.

Maxwell, a handsome and gregarious youth, demonstrated that a huge number of molecules in collision with each other behave according to exact statistical laws. He stated that the rings of Saturn are made of small particles, that the properties of a gas can be predicted and understood using a bell-shaped curve, then called the Maxwell-Boltzmann distribution. Maxwell's greatest finding is that electricity and magnetism join together to produce light. The modern understanding of the electromagnetic spectrum from gamma rays to radio waves was Maxwell's discovery.

Maxwell developed four equations to describe the behavior of electromagnetism that still stand today, and believed that good physics, like good art, is both beautiful and functional. Maxwell's findings led within four decades to Einstein's special theory of relativity and challenged existing notions about how light and energy travel through space. Although Maxwell is all but forgotten in popular culture, his discoveries have been seminal for the creation of the global electronic village and for the search for intelligent life elsewhere in the universe.

The astronomer makes a strong appeal for the continued government funding of basic scientific research of the kind practiced by Maxwell and countless other scientists whose work has led to many scientific and technological inventions of great benefit to humans. To dismiss basic science research as mere intellectual curiosity, as President Reagan did in a 1980 campaign speech, is to utterly miss the point of science and how it operates. Maxwell didn't envision radio and TV when he made his discoveries. Roentgen didn't imagine a device for medical diagnostics when he investigated a type of radiation he called X-rays. Watson and Crick didn't foresee cures for genetic diseases when they studied the composition and structure of DNA. They were doing basic research, Sagan says.



Chapter 24

Chapter 24 Summary and Analysis

Science must be kept free of corruption by politics and mass movements, Sagan says, or it will be nothing better than witchcraft which was created by the church to give the church more power through fear. Witches, political deviants, and weirdos have been singled out for persecution since the earliest times, most recently in Nazi Germany and in Soviet Russia. The extreme efforts by these two dictatorships to control speech and thought, especially political behavior, makes the surrealistic happenings in George Orwell's novel 1984 seem lightweight by comparison.

He notes that one of Thomas Jefferson's first acts as president was to wipe the Alien and Sedition Acts off the books and to pardon those convicted under its wrongheaded provisions. These laws had been enacted by the previous Adams administration to depart any foreigner who spoke or acted in a way deemed suspicious—usually French and Irish immigrants. Sagan comments that scapegoating these two groups and using them to push the electorate's fear buttons was merely a political ploy for the Federalist Party to gain power. Yet scientists, like all citizens, need to be wary of the tendency to water down the Bill of Rights whenever an external threat is perceived.

Sagan once again mentions witchcraft and the various methods of torture used in the 1600s by the Catholic Church to extract confessions from the accused. Friedrich von Spee, a German clergyman, Gianfrancesco Ponzinibio in Italy and Alonzo Salazaar de Frias in Spain should be accorded hero status for questioning and resisting the inhumanity of the Inquisition. Modern-day scientists must resist the temptation of pressure to adopt the political or cultural beliefs of their times, much the same way these courageous clergymen resisted the insanity of witch hunts.

Double Nobel laureate Linus Pauling is an example of a modern era scientific leader because of his work on behalf of the nuclear test ban treaty of 1963 that stopped above-ground explosions of nuclear weapons, Sagan says. Pauling was blasted in the press and had his passport revoked by the State Department because of suspicions he might be pro-communist. Meanwhile, in the Soviet Union, Pauling was blasted for his work on structural chemistry which was deemed incompatible with Soviet doctrine and therefore forbidden to its scientists. Although Sagan admits that many scientists do not want their work to become intertwined with issues of peace and war, he nevertheless praises and admires Pauling for his convictions and ability to continue his work even in the face of government intimidation.



Chapter 25

Chapter 25 Summary and Analysis

Sagan proposes that science and the scientific method can be used to improve society. This is not in the dialectical sense of Marxism or in the sense of conducting human experiments, but by a degree of social experimentation to see what works to improve the quality of life. The idea of using science to improve society is completely compatible with the notion of democracy and its free exchange of ideas. Noting that Thomas Jefferson always described himself as a scientist and understood that democracy itself is an experiment, the astronomer underscores the fact that both science and democracy are at their base iconoclastic, revolutionary, and ever changing.

Jefferson advocated freedom of speech and separation of church and state as essential pillars for democracy. He understood how the powerful take human rights away from the less powerful when given the opportunity. He recognized how religion can likewise extend its control and power through the secular state. Jefferson also believed firmly in the value of skepticism and in the need to ensure that the common citizen remained in control of the government. Sagan notes that so-called patriots who demand that other Americans accede to their notion of good citizenship just don't get it: America is all about a plurality of views and divergent, often clashing, opinions.

Essential to exercising both citizenship rights and the free inquiry of science is education, which means literacy in both areas, according to Sagan. The rights of freedom of speech, assembly, worship and political persuasions don't mean much unless we use them. Americans can't afford to be indifferent either to the laws of good democracy or to the laws of science—both have tremendous potential to improve the human condition and should be treasured.



Characters

Dr. Robert Oppenheimer

Dr. Robert Oppenheimer—scientific director of the Manhattan Project to develop the first atomic bomb that was later dropped on Hiroshima and Nagasaki, Japan during World War II, Oppenheimer later came to believe that he had sinned and was remorseful for his actions. Sagan mentions him as a scientist who developed a conscience, one of the "good guys" among nuclear physicists. After witnessing the devastation caused by the weapons he developed, Oppenheimer became chairman of the general advisory committee to the post-war Atomic Energy Commission (AEC). When Dr. Edward Teller, the so-called father of the hydrogen bomb, came before the AEC to argue that the United States should develop an arsenal of the newer, more powerful weapons because the Soviet Union was developing the same weaponry. Teller audaciously challenged Oppenheimer's loyalty to the United States when he opposed Teller's plan, although Oppenheimer's patriotism was never seriously doubted. However, mysteriously, Oppenheimer's security clearance was subsequently denied and he retired from the AEC. His name today is as much associated with pacifism as it is with the development of the first A-bomb.

Dr. Edward Teller

Dr. Edward Teller—the Hungarian-born nuclear physicist whose early contributions to science included quantum mechanical selection rules, solid state physics and cosmology. Teller was involved with urging Albert Einstein to write a letter to President Roosevelt during World War II encouraging the development of an atomic bomb. Teller, recruited to work at the Manhattan Project in Los Alamos under physicist Dr. Robert Oppenheimer, refused to cooperate. He believed the scientists should be working on a much more powerful fusion, or thermonuclear, bomb. Teller is one of two scientists credited with the invention of the thermonuclear bomb, or H-bomb. Sagan believes Teller was a misguided physicist who was instrumental in keeping the arms race between the Soviet Union and the United States alive. Later in his career, Teller was a persistent advocate for exploding hydrogen bombs under the sea, to move masses of earth, and even in outer space. Some, including Sagan, see a parallel between the one-armed, crazed scientist Dr. Strangelove in the movie of the same name, and the one-legged Teller, who lost a limb in an unfortunate childhood streetcar accident.

Travis Walton

Travis Walton—a recent commercially successful claimed alien abductee whose story was told in the movie, "Fire in the Sky." Although Sagan doesn't call Walton's story a hoax, he classifies it with many other debunked and discredited reports of UFOs.



John Glenn

John Glenn—the American astronaut who first orbited the Earth in a space capsule and claimed to have seen little points of light following his capsule. Sagan wonders whether those points of light might have a purely scientific explanation, such as paint particles coming off the capsule.

George Adamski

George Adamski—the first commercially successful alleged alien abductee who claimed to have been taken aboard a space ship and transported from his Southern California home to Venus. Although Sagan admits Adamski's evident sincerity, he points out that no human could have survived the blistering temperatures of Venus.

John Mack, MD

John Mack, MD—a Harvard psychiatrist who came to believe the stories of alien abduction told by his patients, based on their emotional intensity, and wrote about them in several popular books. Sagan believes Mack surrendered his professional and scientific objectivity in accepting their claims on an emotional, rather than rational, basis.

David Hume

David Hume—British philosopher who pointed out how unwilling people are to admit doubts about closely-held beliefs that are not completely rational.

Tom Paine

Tom Paine—American revolutionary who wrote that infidelity involves professing to believe what one does not believe, or holding a position about which one has real doubts. Paine said this kind of intellectual dishonesty makes it possible for someone to commit all sorts of crimes.

Ann Druyan

Ann Druyan—Sagan's wife ("the love of my life"), colleague and co-author of a portion of this book, as well collaborator on some of his other works. Sagan notes that he and Druyan came from similar lower middle-class backgrounds and share similar views and enthusiasms for science.

Alan Cromer

Alan Cromer— a physics professor at Northwestern University who was amazed to find that so many students had trouble grasping basic concepts of his physics class. He concluded in *Uncommon Sense: the Heretical Nature of Science* that hostility to science and inability to grasp its principles results from the fact science is something new in human evolution and somewhat outside the mainstream of development.



Objects/Places

Roswell, N.M.appears in non-fiction

Roswell, N.M.—the location of the first widely-reported incident of a space ship crashing on Earth, with its on-board crew of small aliens allegedly undergoing autopsies. Believers say the real story of this incident was covered up by Air Force investigators. However, no solid evidence has been produced to support those claims.

Mount Palomar Observatoryappears in non-fiction

Mount Palomar Observatory—the large sky watch station operated by the University of California in Los Angeles. Perched high atop a mountain, the observatory is beyond interference from the lights of the city, and within a stone's throw of supposed alien abductee, George Adamski's home.

SETIappears in non-fiction

Search for Extraterrestrial Intelligence (SETI)—a massive project to scan the universe for any sign or signals, radio waves or other sources, of intelligent life elsewhere in the cosmos. The project is an international undertaking that relies partly on volunteers who agree to donate the capacity of their computer when not in use to help tabulate SETI data. Carl Sagan was one of the initiators.

Whole Life Expoappears in non-fiction

Whole Life Expo— an annual New Age gathering at which various non-scientific nostrums and philosophies are offered, a place where Sagan says skepticism is definitely in order.

placeboappears in non-fiction

placebo —a medical term meaning a sugar capsule given those undergoing drug trials, as a way of correcting results against those who receive the actual drug. The name means "I please" in Latin, and is used synonymously with autosuggestion in which someone who expects to get better does improve temporarily. Sagan uses the term to refer to superstitious beliefs that often make people feel better with no rational or scientific basis.



perpetual motion machine appears in non-fiction

perpetual motion machine—a pseudo-scientific pipe dream to create a machine that never runs down or runs out of energy. According to the laws of physics, this is an impossibility. This is one example of the "baloney" Sagan hopes his readers will be able to detect.

UFOs appears in non-fiction

UFOs—Unidentified flying objects, flying saucers, spaceships, or mass hysteria? Sagan confesses he'd like to believe such things exist but finds no evidence to support that belief.

Los Alamos appears in non-fiction

Los Alamos—the location in New Mexico where the Manhattan Project, directed by J. Robert Oppenheimer, developed the first atomic bomb. To some, the term is synonymous with misguided, careless and irresponsible science in the service of politics.

Monticello appears in non-fiction

Monticello—Thomas Jefferson's home outside Charlottesville, Virginia where Sagan found ample evidence to support Jefferson's claim that he was a scientist as well as revolutionary political thinker.

Ancient Greece appears in non-fiction

Ancient Greece—the place where truly modern scientific thinking was born, according to Sagan. Just as democracy evolved in Greece through the free exchange of ideas, so did science with its logical methods of inquiry.

Themes

Science vs. Superstition

Superstition, witchcraft, sky gods, and a belief in the supernatural are as old as humanity itself, according to Carl Sagan, and have continued into the modern world under the guise of the New Age. Science was basically invented by the ancient Greeks less than 2,000 years ago but has come into its full flowering only in the last few centuries. The succubi demons that purportedly seduced and abducted people in the Dark Ages have been replaced by little men with big eyes from outer space. Yet, the irrational beliefs that spring from fear and ignorance remain. Contemporary humans are presented with a duality: rational science or irrational beliefs and practices.

The primary difference between science and superstition, according to Sagan, is that science relies on a rigorous process of observation, proposed answers and experiments to test the validity of information and theories. Superstition, on the other hand, is never subjected to testing of facts or conclusions and is presented *ex cathedra* as truth. It's clear which side of the divide Sagan stands on. His book is primarily a plea or argument to readers not to fall prey to superstition and pseudo-science as the stakes for the Earth and all its creatures at this moment in human history are greater than ever. Global climate change, unequal distribution of resources, the threat of nuclear annihilation can only be managed through a reasoned approach with science as one of its tools.

Sagan finds it especially disturbing that Americans, once the scientific and technological pioneers of the world, seem to have retreated into a kind of new Dark Age of ignorance and science phobia as faith-based and superstitious belief systems have proliferated. Once again, Sagan the science promoter tries to convey his passion for science as an adventure, and to appeal to the imagination of his readers.

Scientists as Flawed Human Beings

Lest his readers conclude that scientists, including Carl Sagan, stand atop white pillars of intellectual perfection and gaze down condescendingly upon their fellow man, the author goes to lengths to describe some of the follies, fallacies and dead-ends that scientists have taken. Nazi physicians who conducted ghastly experiments on prisoners, inhuman treatment of blacks in a study of syphilis conducted by the U.S. government, Sir Isaac Newton's "sleep," or indifference to the imaginative world of the arts as described by poet William Blake, are all instances of how science can be very wrong.

To this list could be added early astronomers who were convinced that "canals" on Mars were evidence of organized, intelligent life; a modern day astrophysicist named Fred Hoyle who proposed that AIDS and influenza viruses were dropped to earth from comets; or Sagan himself who wrongly believed there would be plate tectonics on Mars



and atmospheric clouds on Venus made up mostly of water (they're only one-fourth water). Sagan suggests that scientists should regularly publish an account of their mistakes and foibles, in the spirit of public accountability and maintaining the objective search for truth their discipline demands.

"It might play an instructive role in illuminating and demythologizing the process of science and in enlightening younger scientists," according to Sagan. "Even Johannes Kepler, Isaac Newton, Charles Darwin, Gregor Mendel and Albert Einstein made serious mistakes." Yet, the point is that science includes a mechanism whereby mistakes can be corrected, and the search for rational truth sustained.

Moral Responsibilities of Scientists

Sagan believes scientists have too often failed to exercise full moral responsibility for their work by distancing themselves from the potential impacts of their discoveries and by allowing themselves to become corrupted by power. This dilemma probably goes back to the creation of the earliest tools by flaking and shaping spear points from rocks. The situation is not unlike the position of the Catholic Church during the Spanish Inquisition, when the torture and execution of those deemed heretics was essentially sub-contracted to secular operatives so the church could both condemn its critics and maintain hands free of their blood.

Scientists display the same moral indifference when they claim their role is simply to pursue their research without regard to how its fruits are used in the world. Scientists must understand and acknowledge the moral implications of their work. Dr. J. Robert Oppenheimer, scientific director of the Manhattan Project that developed the first atomic bombs, afterwards acknowledged his guilt and shame at being a party to mass murder. Sagan mentions Oppenheimer as a scientist with a conscience and compares him to the physicist Dr. Edward Teller, known as the father of the hydrogen bomb.

Seemingly devoid of any moral conscience, Sagan says, Teller spent his entire adult lifetime advocating for more deployment of thermonuclear weapons and their use in a variety of crackpot schemes, such as blasting huge channels in the Pacific Ocean or sending thermonuclear explosives to the Sun. Power, Sagan observes, corrupts scientists as easily as politicians. The only remedy is a well-developed sense of morality and humility.

Style

Perspective

Carl Sagan may be one of the best-known scientists of the last half of the 20th Century. His book, *Cosmos*, which was made into an immensely popular television series, has been instrumental in spreading an awareness and enthusiasm for astronomy on a par with the interest in science fantasy generated by the film "Star Wars." As a tireless proselytizer for science, Sagan succeeds in making his passion highly appealing while also presenting it in language understandable by the reader with only a slight formal background in science who is ready to share in the excitement the astronomer purveys.

Sagan's passion for the sciences is evident in his reverence, even awe, at the discoveries made possible through application of the scientific method and its insistence on ruthless logic and testing of facts, premises and arguments. At the same time, his disavowal of the unscientific, pseudo-science, and the irrational or intuitive is portrayed not so much with arrogance as with compassion. Scientists, he is fond of pointing out, are just human beings and prone to make all kinds of silly mistakes. Sagan's perspective is that of a caring person who doesn't want to see America slip back into an anti-intellectual Dark Age in which scientists are feared and ridiculed. He'd like to equip his readers with the tools for baloney detection and rejection, otherwise known as the tools of skepticism, rational inquiry and logic.

Most of all, Carl Sagan wants to prod his readers into independent thinking and individual decision making without which we can neither hope to have good science or good democracy. His voice is that of the sentinel trying to awaken a somnolent and intellectually lazy society before it's too late for the survival of the species and the planet.

Tone

The author's tone is one of cautious optimism about the future of science and the ability of non-scientists to appreciate the beauty and necessity of rational, logical, scientific thinking. Despite his meticulous lambasting of popular fads and follies, such as the superstitions of the New Age, Sagan retains a sense of humor about the "extraordinary popular delusions" of the masses while also sounding an alarm for the human race.

Sagan is also careful to let his readers know that he, too, is very human and would like for many unproven and possibly unprovable ideas to be real, such as the invisible, fire breathing dragon in his garage and the claim that Earth is regularly visited by intelligent extraterrestrials in space ships. To further qualify himself as a fallible human being and scientist, he lists some of his own major professional mistakes. His tone is akin to that of the "Dutch uncle" who offers a few kindly but very serious words of advice, delivered in a spirit of love and compassion, to his fellow humans.



For every human shortcoming Sagan identifies as a threat to science and to democracy, he also offers inspiring examples of scientific achievement that most of us take for granted. The overall tone is positive, although the author discusses and dissects many troublesome and negative aspects of human behavior.

Structure

The structure of Sagan's book is rather freewheeling. It hops across time and space to present arguments and insights in a number of different areas—superstition and skepticism, truth vs. reality, personal and societal hallucinations, religious faith and scientific inquiry, blind spots of scientists and the need for intellectual freedom. This approach enables the author to relate scientific and historical facts to current events in a way that is easily understandable without being overly pedantic. The reader gets a sense of discovery that is crucial to science, and becomes enmeshed in Sagan's narrative out of a curiosity to see where it will go next. Absent are the devices of plot in fiction or the textual authority of history.

Sagan thus weaves a compelling and interesting story around what he sees as crucial issues that center on science but have profound ramifications for society. In a few pages, the reader may be transported from the forum of ancient Greece where men debate the nature of reality to the White House where atomic physicist Edward Teller tries to persuade the president to continue with atmospheric testing of hydrogen bombs despite the consequences for the Earth and for humans. The reader finds in Sagan's narrative very little difference between the little demons who visited sleepers in the Dark Ages and little green aliens who abduct people from their beds at night. This kind of free association strengthens the author's arguments for reason and skepticism while giving the reader an entertaining experience.



Quotes

"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." (Chapter 1, pg. 7)

"We can pray over the cholera victim, or we can give her 500 mg. of tetracycline every 12 hours. We can try nearly futile psychoanalytic talk therapy on the schizophrenic patient or we can give him 300 to 500 mg. a day of clozapine. The scientific treatments are hundreds or thousands of times more effective than the alternatives." (Chapter 1, pg. 9)

"The dumbing down of America is most evident in the slow decay of substantive content in the enormously influential media, the 30-second sound bites (now down to 10 second or less), lowest common denominator programming, credulous presentations on pseudoscience and superstition, but especially a kind of celebration of ignorance." (Chapter 2, pg. 26)

"Faith is clearly not enough for many people. They crave hard evidence, scientific proof. They long for the scientific seal of approval, but are unwilling to put up with the rigorous standards of evidence that impart credibility to that seal. What a relief it would be: doubt reliably abolished! Then the irksome burden of looking after ourselves would be lifted. We're worried—and for good reason—about what it means for the human future if we have only ourselves to rely upon." (Chapter 3, pg. 58)

"The whole idea of a democratic application of skepticism is that everyone should have the essential tools to effectively and constructively evaluate claims to knowledge. All science asks to employ the same levels of skepticism we use in buying a used car or in judging the quality of analgesics of beer from their television commercials." (Chapter 4, pg. 76)

"It's telling that emotions can run so high on a matter about which we really know so little. This is especially true of the more recent flurry of alien abduction reports. After all, either hypothesis—invasion by sexually manipulative extraterrestrials or an epidemic of hallucinations—teaches us something we certainly ought to know about. Maybe the reason for strong feelings is that both alternatives have such unpleasant consequences." (Chapter 5, pg. 94)

"It was their [early Christians'] firm persuasion that the air which they breathed was



peopled with invisible enemies; with innumerable demons, who watched over every occasion, and assumed every form, to terrify and above all to tempt their unguarded virtue. The imagination, and even the senses, were deceived by the illusions of distempered fanaticism and the hermit, whose midnight prayer was oppressed by involuntary slumber, might easily confound the phantoms of horror or delight which had occupied his sleeping and his waking dreams." (Chapter 7, pg. 126, from *The Decline and Fall of the Roman Empire* by Edward Gibbon)

"I would be very happy if flying saucer advocates and alien abduction proponents were right and real evidence of extraterrestrial life were here for us to examine. They do not ask us, though, to believe on faith. They ask us to believe on the strength of their evidence. Surely it is our duty to scrutinize the purported evidence at least as closely and skeptically as radio astronomers do who are searching for alien radio signals." (Chapter 10, pg. 180)

"Typical offerings of pseudoscience and superstition—this is merely a representative, not a comprehensive list—are astrology; the Bermuda Triangle; "Big Foot" and the Loch Ness monster; ghosts; the "evil eye;" multicolored halo-like "auras" said to surround the heads of everyone; extrasensory perception (ESP); the belief that 13 is an unlucky number; bleeding statues; the conviction that carrying the severed foot of a rabbit around with you brings good luck; diving rods, dowsing and water witching; "facilitated communication" in autism; the belief that razor blades stay sharper in small cardboard pyramids and other tenets of "pyramidology;" phone calls (none of them collect) from the dead; the prophecies of Nostradamus; the alleged discovery that untrained flatworms can learn a task by eating the ground-up remains of other, better-educated flatworms; the notion that more crimes are committed when the Moon is full; palmistry; numerology; polygraphy; comets, tea leaves and "monstrous" births as harbingers of future events; listening to gurgling stomachs; "photography" of past events such as the crucifixion of Jesus; faith-healer fraud; Ouija boards; the emotional lives of geraniums; spontaneous combustion; perpetual motion machines." (Chapter 13, pg. 221)

"Skeptical scrutiny is not only the toolkit for rooting out bunkum and cruelty that prey on those least able to protect themselves and most in need of our compassion, people offered little other hope. It is also a timely reminder that mass rallies, radio and television, the print media, electronic marketing, and mail order technology permit other kinds of lies to be injected into the body politic—to take advantage of the frustrated, the unwary, and the defenseless in a society riddled with political ills that are being treated ineffectively if at all." (Chapter 13, pg. 244)

Thomas Jefferson and George Washington owned slaves; Albert Einstein and Mohandas Gandhi were imperfect husbands and fathers. The list goes on indefinitely.



"We are all flawed and creatures of our times. Is it fair to judge us by the unknown standards of the future?" (Chapter 14, pg. 259)

"In a life short and uncertain, it seems heartless to do anything that might deprive people of the consolation of faith when science cannot remedy their anguish. Those who cannot bear the burden of science are free to ignore its precepts." (Chapter 17, pg. 297)

"Scientific thinking has almost certainly been with us from the beginning. You can even see it in chimpanzees when tracking on patrol at the frontiers of their territory, or when preparing a reed to insert into the termite mound to extract a modest but much-needed source of protein. The development of tracking skills delivers a powerful evolutionary selective advantage." (Chapter 18, pg. 315)

"Nearly every scientist has experienced, in a moment of discovery or sudden understanding, a reverential astonishment. Science—pure science, science not for any practical application but for its own sake—is a deeply emotional matter for those who practice it, as well as for those nonscientists who every now and then dip in to see what's been discovered lately." (Chapter 19, pg. 330)

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"What once was considered relatively mild under-nutrition is now understood to be potentially associated with lifelong cognitive impairment. Children who are undernourished even on a short-term basis have a diminished capacity to learn. And millions of American children go hungry every week. Lead poisoning, which is endemic in inner cities, also causes serious learning deficits. By many criteria, the prevalence of poverty in America has been steadily increasing since the early 1980s." (Chapter 21, pg. 360)

Topics for Discussion

Does Carl Sagan seem to be an atheist or a skeptic? Both or neither? Why?

Give three examples of pseudoscientific beliefs that Sagan says have arisen from the same instinct that produces religion. Discuss how they are similar to and different from established religions.

Discuss the ways that Sagan connects a low literacy rate in the United States with poverty and lack of understanding for, and interest in, science.

What are some of the steps that Sagan suggests to improve teaching and learning of science, as well as promoting interest in science to a mass audience?

How are science and democracy connected, in Sagan's view?

What does Sagan say is the moral responsibility of scientists to society, and what causes them to sometimes fail to exercise their responsibility?

What is the primary distinguishing characteristic between superstition (or pseudo-science) and science, according to Carl Sagan?