6

Fallacies in the Name of Science

WHAT IS A FALLACY?

The faith of most people in the credibility of science is nearly unshakable. When we read in the newspaper or see on television that there is "scientific evidence for" or that "scientists have discovered" something new and interesting, our tendency is to assume that the evidence is impeccable. Certainly, the material we have covered in the previous chapters suggests that careful scientific investigation is perhaps the most powerful tool we have for getting at the truth of things. Unfortunately, scientific method can, and as we shall see, often is, misapplied.

In this chapter we will examine a number of fallacies committed in attempting to employ the methods introduced in the last four chapters. In logic, a fallacy is a mistake in reasoning. Thus, if I conclude that because (1) Morris is a mammal and (2) dolphins are mammals then (3) Morris must be a dolphin, I have committed a fallacy. The conclusion I have drawn (3) does not follow from (1) and (2), even if (1) and (2) are true. Similarly, the fallacies we will examine in this chapter all involve drawing conclusions that are logically suspect, in the process of applying some aspect of scientific method.

We must keep in mind here the difference between fallacious reasoning, on the one hand, and mistaken belief, on the other. Many ideas in the history of science have turned out to be mistaken, but the mistakes they involve are usually not the product of fallacious reasoning. Prior to the mid-eighteenth century, for example, scientists believed in the existence of something called phlogiston, sometimes called the "fiery substance."[1] Phlogiston, it was thought, was the stuff responsible for a number of observable reactions in matter: among other things, it was thought to be the stuff released rapidly into the atmosphere during combustion and slowly, as metals decay. Now, as it turns out, there is no such thing as phlogiston; the scientists of the time were mistaken. However, the theory of phlogiston reactions was well supported by a large body of experimental evidence; indeed, the best evidence available at the time. Among other things, the formulas by which metals were produced from ores derived from phlogiston theory. Subsequent experimentation revealed a better explanation for reactions than phlogiston theory, one involving a new chemical element later to be identified as oxygen. The point here is that both the work which established and ultimately overturned phlogiston theory involved correct applications of the methods we have discussed in previous chapters. Careful observations were made, experiments run, and bits and pieces of the overall theory were modified and finally rejected in light of new experimental results. By contrast, a fallacy occurs when the methods of science are illicitly applied. Fallacious applications of the methods of science lead only to a false impression that something has been established with great care and rigor. Indeed, many of the fallacies we shall consider involve ways of lending the appearance of scientific evidence where there is little or none.

One well-known fallacy in informal logic is called *argumentum ad hominen*: attacking the person rather than his or her argument. If, for example, I argue that every student ought to know something about science and so ought to read this book, you might reply that I receive a royalty from the sale of copies of the book. If your point is to mount an objection to my argument, you are guilty of an *ad hominem* fallacy. Even though what you say is true, the point you make is not relevant to the argument I have given. By pointing out that I stand to profit if students buy this book, you attack my motives for arguing as I have but you have not shown that my argument is flawed.

At the risk of committing an *ad hominem* fallacy, let me propose the following. Most, though certainly not all, of the fallacies we will discuss are committed typically by people on the fringes of science, not by mainstream scientists.[2] By "people on the fringes of science," I mean people who engage in fallacious scientific reasoning for one (or both) of two reasons. First, people commit fallacies because they have little knowledge of what rigorous scientific inquiry involves but nonetheless believe they are capable of undertaking such inquiry. Second, fallacies are committed by people who may well know a great deal about science but who are trying to create the impression that there is some real measure of scientific evidence for something when in fact there is very little. Thus, errors of the sort we will discuss are sometimes committed inadvertently, sometimes intentionally. But no matter what the motives of their authors, such mistakes are instances of what is generally called *pseudoscience*. The distinction between genuine science and pseudoscience is one about which we will have more to say later in this chapter. But for now let's begin by taking a look at several common fallacies, all committed in the name of science.

FALSE ANOMALIES

Were we to do a quick search of an internet book store we would turn up a large number of entries on just about every extraordinary claim we have discussed in previous chapters. The literature on ESP, UFOs, ghosts, crop circles, alternative medical cures, and so on is nearly endless. A small sample of such books would quickly reveal a common theme. The author(s) would get our attention by laying out a series of apparently well-documented anomalies, and then in the body of the book go on to offer new and revolutionary suggestions as to what their explanation might be. At some point a theme will emerge: the scientific community is embarrassed because they can't explain these anomalies and so can be expected to ignore the author's findings. All too often, however, the air of mystery surrounding the cases and events which have drawn us in will be no more than a carefully contrived illusion, a false anomaly.

One way to make something appear mysterious is to omit certain facts in describing the phenomenon, facts which suggest that the phenomenon may not be all that anomalous. In Chapter 2 we mentioned an apparent anomaly, crop circles. Large, symmetrical geometric figures, circular and otherwise, mysteriously appeared in wheat and corn fields in Southern England and have since been observed in many other countries, including the United States. We also noted that the circles are relatively easy to explain away given that there are tractor indentations near most of them and that several debunkers have demonstrated how easily and quickly an intricate crop figure can be constructed. Yet most books on this phenomenon conveniently omit these facts. Similarly, the six or so major books on the Bermuda Triangle, another example from Chapter 2, omit much well-documented information suggesting that their favored anomalies are the result of accidents, inclement weather, and inexperienced crews.

Another way to create a sense of mystery is to subtly distort the content of a factual description. For example, much research has been done in recent years on "near-death experiences." Some researchers claim that people who have been near death but have been revived, typically during a medical emergency, have reported a remarkable experience. Here is an account of that experience from one of the best known books on the subject, *Life After Life*, by Raymond Moody:

> A man … begins to hear an uncomfortable noise, a loud ringing or buzzing, and at the same time feels himself moving very rapidly through a long dark tunnel. After this he suddenly finds himself outside of his own physical body, but still in the immediate physical environment, and he sees his body from a distance, as though he is a spectator … after a while, he collects himself and becomes more accustomed to his odd condition.… soon other things begin to happen. He glimpses the spirits of relatives and friends who have already died, and a loving warm spirit of a kind he has never encountered before—a being of light—appears before him.… at some point he finds himself approaching some sort of barrier or border, apparently representing the limit between earthly life and the next life. Yet he finds that he must go back to earth, that the time for death has not yet come.[3]

Now, if this precise experience were reported by many people, we would have quite a remarkable phenomenon on our hands. In fact, the description provided in this passage is based on the reports of hundreds of people. But no two reports are precisely the same. The description we have just read combines elements from many varied experiences. Moreover, no single element in this description occurs in all reports and no single subject has given precisely this description. Though Moody quite openly admits all of this, many people who argue that near-death experiences provide evidence of life after death accept this artificial account as an accurate description of the strange experiences people report when near death. The fact that people are liable to report any of a number of things, that reports are frequently at odds with one another and that many people when near death report no such experience, all suggest that there may be a more mundane explanation for the things people report when near death. At any rate the appearance of a great mystery here is heightened by the subtle fabrication of an experience that, strictly speaking, no one has ever had.

The use of distortion and omission to create false anomalies is nowhere more in evidence that in the many conspiratorial theories surrounding the events of 9/11. The basic idea behind these theories is that many things happened on that tragic day that cannot be explained by the more or less standard account of what transpired. Moreover, those who know the real explanation for these anomalous events are engaged in a conspiracy to keep the public in the dark about what really went on. (We will have more to say about fallacious conspiracy theories later in this chapter.) Here are just a few of those claimed anomalies along with the facts that are omitted or distorted in their fabrication.[4]

(1) The American Airlines Boeing 757 that struck the Pentagon left suspiciously little wreckage, none of which was clearly from a 757. Omitted in this account is the fact that a small piece of the fuselage with the American Airlines logo visible was found and photographed on the lawn in front of the Pentagon.

(2) *Early coverage on 9/11 by CNN reported that no plane hit the Pentagon.* In fact, CNN reporter Jamie McIntyre did say "There's no evidence of a plane having crashed anywhere near the Pentagon." But Flight 77 did not crash "near" the Pentagon. It crashed into the Pentagon.

(3) *The Air Force could have scrambled fighter planes in plenty of time to intercept Flight 77. In 1999 golfer Payne Stewart's private jet was not responding to radio calls. Within 20 minutes fighter planes were alongside Stewart's plane.* Indeed, air controllers lost contact with Stewart's jet at 9:30 a.m. and the intercept did occur at 9:52 a.m. However, contact was lost at 9:30 *Eastern* Daylight Time and the interception was at 9:52 *Central* Daylight Time. The intercept took one hour and 22 minutes, not 22 minutes.

(4) *The impact of a commercial jet alone could not bring down either of the twin towers. In 1945 the Empire State Building was hit by a B-25 bomber and certainly did not collapse.* Like most skyscrapers of the time, the Empire State Building was stiffly constructed with reinforced concrete columns and a thin masonry

exterior. Its weight was 38 pounds per cubic foot. The World Trade Center, by contrast, was constructed with a much thinner exterior shell fabricated from steel plates. Its density was less than 10 pounds per cubic foot. The bomber that hit the Empire State Building was traveling at roughly half the speed of the 767s that hit the twin towers, carried one-tenth as much fuel and weighed less than one-tenth the weight of a 767.

One final way to create the appearance of an anomaly is by over-reliance on anecdotal evidence, a technique commonly found in works about revolutionary medical cures. For example, there are hundreds of books available on homeopathy, a type of medical practice discovered in the 19th century. According to homeopathic theory, a person can be cured of an ailment by being given minute doses of whatever substance creates its symptoms in a healthy person. Moreover, the smaller the dosage, the greater will be its effects. Precisely how and why homeopathy should work is unclear and is often chalked up to an "unknown mechanism." But does it work? The way to answer this question, of course, is to undertake a series of carefully controlled causal studies of the sort discussed in Chapter 5. Most of the books on homeopathy acknowledge that little rigorous scientific evidence is currently available. For a variety of reasons, few such studies have been done. Lack of funding and skepticism on the part of the mainstream medical community are often cited. Most authors make their case for the efficacy of homeopathy by citing numerous anecdotes, remarkable stories of actual people who have been cured by homeopathic remedies. Yet such anecdotal evidence is of little scientific value. It is estimated that about 50% to 60% of all the ailments for which people seek medical help will, if left untreated, go away within 90 days. Thus, the fact that someone has a problem, submits to homeopathic treatment, and gets better is not evidence that their improvement is due to the treatment! The fact that many ailments will disappear without treatment is almost always ignored, as authors set forth their amazing stories of homeopathic cures.

A good piece of advice when confronted with evidence that is wholly anecdotal is to ask yourself, "What is missing, what haven't we been told?" A well known medium, John Edwards, claims to be able to communicate with dead relatives and friends of people in the audience for his television program, *Crossing Over*. On a typical episode Edwards will tell audience members things about their dead loved ones that he would have no way of knowing unless he were somehow in psychic contact with them. The program, of course, is carefully edited so that we are not privy to much of what he communicates that turns out to be wrong.

QUESTIONABLE ARGUMENTS BY ELIMINATION

Suppose we know that either A or B must be true and subsequently discover that B is false. Logically we can conclude that A must be true. This pattern of reasoning is sometimes called *argument by elimination*, for it involves establishing one alternative, A, by eliminating the possibility of the other. An argument by elimination is fallacious when it ignores other likely possibilities in the process of arguing for one of the given alternatives. Imagine that I want to establish a particular explanation. First I list possible rival explanations and then proceed to show that none of the rivals are likely to be correct. Have I established my favored explanation? For two reasons, our answer here must be "no." First, there may be other possible explanations I have failed to consider. Second, even if I succeed in ruling out all the rival candidates we can think of, the failure of these rival explanations only entitles us to conclude that the phenomenon in question needs explaining, not that my favored explanation is correct.

A common strategy in ESP research is to claim that an explanation involving some sort of extrasensory mechanism can be established by showing that experimental subjects can achieve results in an ESP experiment that would be highly unlikely by chance alone. For example, a study might claim that a particular experimental subject has the gift of mental telepathy (the ability to read the mind of another) because he or she is able to guess the playing card an experimenter is thinking about more frequently than chance would suggest. Implicit in this claim is a fallacious argument by elimination. That the subject is telepathic follows only if we assume there are only two possibilities—telepathy or sheer luck—and if we can effectively rule out luck or chance under tightly controlled experimental conditions. Yet this assumption is flawed. First, there may be other possible explanations. Maybe an invisible imp peeks at the cards and whispers the right answer in the subject's ear. As wild as this "explanation" seems, it would appear to be as well supported by the experimental outcome as is the telepathy hypothesis. (What experimental outcome would support telepathy and rule out imps, or vice versa?) Second, even in the absence of rival explanations, the outcome of this experiment does not confirm the claim that the subject has telepathy. The only conclusion we are warranted in drawing, based on the results of this experiment, is that something quite interesting, something we do not fully understand, is going on. What we are conspicuously not entitled to conclude is that we have evidence for any particular explanation.

Conspiracy theorists often fall prey to a subtle version of this fallacy. As we have noted in the case of various 9/11 conspiracies, they begin by citing a number of apparent anomalies. The conclusion that these anomalies are evidence for some sort of conspiratorial explanation assumes there are only two possibilities. If the anomalies cannot be completely explained in more or less conventional ways, then there must be a conspiracy lurking in the shadows. But even if it could be shown that some events have yet to be explained, it does not follow that their explanation must involve conspiracy.

ILLICIT CAUSAL INFERENCES

People all too often draw conclusions about causal links based on evidence that is all too sketchy. In most cases the inference of a causal link seems plausible only because rival explanations are overlooked or ignored. Conclusions about a causal link between A and B are often drawn on the basis of a number of specific kinds of evidence, none of which, taken alone, is sufficient to support a claim of causal connectedness. The most prominent of these are:

1. A simple correlation between A and B
2. A concomitant variation between A and B
3. The fact that A precedes B

Let's look at an example or two of each and the plausible rival explanations our examples fail to take into consideration.

A simple correlation between A and B. In Chapter 3 we noted that the simplest sort of correlation is a claim about the levels of a characteristic in two groups, only one of which has another characteristic. Thus, A is correlated with B if more As than non-As have B. This does not necessarily mean that A and B are causally linked but people frequently make the illicit inference that they are.

Imagine we were to read the results of a study which purported to show a link between a person's astrological sign and his or her profession. Reading further, we discover that the birth dates of a large group of lawyers were examined and that it was discovered that more were born under the sign of Leo than under any other sign. Clearly, there is a positive correlation between being a lawyer and being a Leo. Now, this may suggest that there is a causal link between the two factors. However, there seem to be at least two plausible explanations for the data—explanations that do not involve any sort of causal link between profession and astrological sign. The first is that the correlation is just a *coincidence*. If we look at a number of groups by profession, we may now and then find one where there is a significantly greater number of people born under a particular sign, particularly if we restrict our investigation to groups that are none too large. Imagine we were to do a study of plumbers and astrological sign. If we restrict our sample to one or two dozen subjects, chances are quite high we will not find an even distribution under all signs. What we will find is some entirely predictable "clumping." Some signs will have more subjects than others. From here it is but a short step to a claim about a remarkable correlation between being born under a few astrological signs and becoming a plumber!

The fact that our study only cites one profession and one correlation suggests another possible explanation. It may be that the researchers who undertook the study have presented us with only one small part of their overall data, the part that appears to confirm the possibility of a causal link. Or it may be that, convinced of the truth of astrology, they have inadvertently pruned away just enough data—say, by excluding certain subjects—to lend support to the idea of a correlation.

The explanation for a correlation need not be coincidence or even fudging, inadvertent or otherwise. Frequently, correlations are explained by some third factor which suggests a possible indirect link between the correlated factors. Suppose, for example, that we discover—from careful observation of a number of classes—that students who sit near the front of the classroom tend to achieve higher grades than do students who sit near the rear. It may be that this is a coincidence. At any rate it hardly seems likely that I can improve my grade simply by moving to the front of the classroom. What seems a more likely explanation is that students who want to do well are enthusiastic and want to sit "where the action is," namely near the front of the classroom. Thus, it may be that some additional motivational factor accounts for the correlation between the two factors in question.

Several recent medical studies have suggested that there may be a link between church attendance and health. In one study, 21,000 subjects were tracked for eight years. During this time 2,016 died. The researchers discovered that those who regularly attended church were much less likely to have died in that eight-year period. Though it is possible there is a direct link between church attendance and health, it is entirely likely that this effect is due to a third factor. Unhealthy people are less likely to lead an active life and so less likely to attend church.[5]

A concomitant variation between A and B. Concomitant variation[6] is a convenient name for the second sort of correlation discussed in Chapter 3. Concomitant variation occurs when a variation in one factor, A, is accompanied by a variation in another factor, B. It is quite tempting to conclude that there must be some connection between A and B if changes in the level of one are regularly accompanied by changes in the level of the other. The problem with such a conclusion is that an enormous number of entirely unrelated things tend to vary in very regular sorts of ways. Over the past ten years there has been a dramatic increase in the popularity of country-western music. At the same time there has been a corresponding increase in the cost of a loaf of bread. What is the explanation here? A genuinely baffling causal link? Some overlooked third factor? The most likely explanation is that we have managed to pick two completely unrelated trends that happen to be going in the same direction at the same time.

The fact that A occurs prior to B. In most circumstances, we would not automatically assume that because one event precedes another, the two are causally linked. But the inclination to infer a link increases dramatically when something out of the ordinary is preceded by something equally unusual. Our thinking seems to be that one remarkable thing must have an equally remarkable cause; if two remarkable things happen in close proximity, they must be connected. We have all had experiences like this before: just as you think of someone, the phone rings, and it is the person you were thinking about. ESP? Perhaps. But a more likely explanation is coincidence. Consider the number of times you have thought of that person and they haven't called as well as the number of times they have called though you were not thinking about them. That the two events should occur in close proximity every so often seems not all that unusual.

Recently, an electrician fixed my furnace. A few days later, I noticed that the clock on the thermostat that controls the furnace wasn't working. It seems natural to conclude that something the electrician did caused the clock to stop. In such cases, the fact that one event precedes another is probably best explained as nothing more than a coincidence. What would be required to discount the possibility of coincidence would be some sort of independent evidence linking the work of the electrician and the behavior of the thermostat.

UNSUPPORTED ANALOGIES AND SIMILARITIES

In attempting to explain something puzzling, it is sometimes useful to consider something similar but whose explanation is well understood. Thus, for example, in the late 19th century, physicists hypothesized about the existence of what was then called the luminiferous ether, the medium in which light waves are propagated. They arrived at this notion by thinking of certain similarities between light and sound. Both appear to be wave phenomena and sound waves are propagated in a medium, our atmosphere, much as the waves created by dropping a pebble in a pond are propagated out of the surrounding water. Thus, physicists reasoned, there must exist a medium for the transmission of light waves as well, a luminiferous ether. Subsequent experimentation, however, demonstrated that there is no such stuff, and so physicists went on to consider other possible explanations for the propagation of light waves. Interestingly enough, physicists next thought about light in terms of another well-understood phenomenon, electro-magnetic fields.

This example illustrates the way in which thinking about a puzzle in terms of something similar but better understood can lead to possible explanations. But it also illustrates the need for independent testing of the explanation arrived at in this way. Analogies and similarities are fallaciously exploited when the fact that an explanation works in one case is given as evidence for the correctness of a similar explanation in another case. At the very most, a well-chosen similarity guides us to a possible explanation; it should not be thought to provide evidence that the explanation is correct. Only careful testing can provide such evidence.

Consider one explanation often proposed by astrologers. Grant, for the moment, that there may be something to astrology and that, indeed, the position of the stars and planets at the time of our birth can influence our personalities or even our choices of profession. What is the explanation? How is it that the stars and planets influence our lives? Astrologers are likely to give something like the following explanation:

> Much as the moon influences the tides and sun spot activity can disturb radio transmissions, so do the positions of the planets have an important influence on formation of the human personality. Modern science is constantly confirming the interconnectedness of all things. Is it any surprise that distant events, like the movement of the planets and the decisions people make, should be connected?

So the stars and planets affect our lives much in the way the moon influences the tides, etc. Of course, there is no claim here that the relation between the stars and our lives is precisely the same as between the moon and the tides or the sun and radio transmissions. What we have, then, is the barest suggestion that an explanation may be possible for astrological effects and that it may somehow be similar to whatever it is that explains the relation between moon and tides, sun and radio transmissions. What we do not have is any of the details of what that explanation might be. Nonetheless, by appealing to something that is understood and suggesting that the explanation for something else must be similar, our astrologer has managed to create the impression that something like an explanation has been given.

UNTESTABLE EXPLANATIONS AND PREDICTIONS

To test an explanation we begin by devising a set of experimental conditions under which we predict that something will occur if the explanation is correct. If the predicted result fails to occur, we conclude that the explanation is probably wrong. What this means is that an explanation, to be subject to scientific testing, must, in principle, be falsifiable. Don't confuse falsifiability with falsehood. To be falsifiable is simply to be testable. By contrast, an unfalsifiable explanation would be one whose falsity could not be detected by any conceivable test. It may seem that an unfalsifiable explanation is simply true, but this is not so. An explanation that is in principle unfalsifiable is not a scientific explanation at all. Precisely why this should be so can best be explained by way of an example or two.

I cashed a large check yesterday and today discover that it bounced. Looking over my checkbook register, I discover a glaring error in addition; I had much less money in my checking account than I thought. My miscalculation, then, explains why my check bounced. Had I not miscalculated, I would not have written a bad check. Imagine instead I gave this as the explanation for my bad check: "It must have been fate. What happens, happens." But what if my check had not bounced? Once again fate, I say, is the real culprit. Now it may be that fate determines what we do and do not do. But insofar as the notion of fate is consistent with everything that happens, it cannot be invoked to explain why a particular thing and not something else happened. Maybe fate determined I would bounce a check, maybe not. But by invoking the notion of fate I do not thereby explain why my check bounced as opposed to not bouncing.

A group of people, calling themselves "special creationists," claim that there is "scientific evidence" that the universe was created by God. Some believe creation occurred only a few thousand years ago while others believe it may have occurred billions of years in the past. Both groups claim however that the processes by which God created the world are "special" in the sense of no longer operating in the natural world; the "laws of nature" by which God created are different from those we currently observe. Well, this is all very interesting. But what prediction about the world could we make, provided this claim is true? The processes by which God created so quickly and completely are no longer in existence, so we should not expect to find evidence of their continuing operation. And for precisely the same reason we should expect to find no evidence against the theory of special creation. It would seem, then, that the creationist explanation is consistent with everything that is happening or could conceivably happen, and so could not possibly be falsified.

But this means that the creationist account of how things began is not an explanation at all! To explain something is to try to make clear how or why it and not something else happened. A proposed explanation that is consistent with what happened and anything else that could have happened instead explains nothing. Perhaps God created all things and did so in a very short time using special processes no longer in operation. But by venturing this scenario, the creationist has not explained why things are as they are and not some other way; the creationist scenario is consistent with anything that could conceivably happen. Though the creationist's account is interesting it is not a scientific account of things. Does this mean the creationist is wrong? No. What it does mean, however, is that special creationism does not constitute a scientific explanation.

If we find that an apparent explanation cannot be falsified, we have uncovered a compelling reason to reject it as an instance of genuine scientific explanation. As a rule of thumb, it is always a good idea to ask of any proposed explanation: "Under what conditions would we be willing to set aside the explanation on the grounds that it is false?" If no such conditions can be imagined, we are dealing with something that is at best fascinating speculation, perhaps even an article of faith, but not a genuine scientific explanation.

Predictions made by psychics, tarot readers, astrologers, and others claiming the ability to foresee the future are often couched in terms that render them unfalsifiable. "A big career move awaits you," a psychic tells us. Just how big and how soon we are not told. What would falsify this prediction? A few months pass and no new job is on the horizon. Is the prediction false? Well, the big career move may not involve a job change and whatever is to occur may still await us. As you can see, it would be hard to imagine anything that might prove such a vague prediction to be false. Astrologers are fond of cautioning their clients that the stars "impel, they don't compel." Presumably, what this means is that anything the astrologer predicts cannot be false since it may be about a future path the client will choose not to take.

Many conspiracy theories seem attractive and plausible largely because they are immune to falsification. Imagine, for example, that I claim to understand why gasoline prices continue to rise at a much greater rate than the cost of living. There is, sorry to say, a plot, a conspiracy, among the major oil companies to insure that just enough gasoline is refined to keep demand slightly ahead of supply. Might I be wrong, you ask? After all, there have been many congressional investigations of the oil industry and none has yet turned up evidence for such a plot. Well, what do you expect, I reply. The one thing we can be sure of in a conspiracy of this magnitude is that the conspirators are going to do everything necessary to cover their tracks, even if this requires buying the services of a few congressmen. Note here how I have attempted to turn the lack of any evidence against my theory into evidence that it is so. Thus, far from viewing its inability to be falsified as evidence that my theory is not scientific, I take this to be evidence that it must be correct. 9/11 conspiracy theorists are fond of calling their detractors "sheeple." Presumably any criticism of the theory can be discounted on the ground that it has been fabricated to throw us off the track. Nothing, it seems, can count against the theory.

Conspiracy theories, as we have noted, are often designed so that nothing can count against them. Remarkably, many such theories retain an air of

Box 6.1

People who are attracted to conspiracy theories usually make a series of assumptions:

A. *Nothing happens by accident.* Events that appear to be coincidental are intended to appear that way.

B. *Everything is connected precisely because nothing is accidental.* The web of connections underlying seemingly unconnected events is, of course, hidden.

C. *Nothing is as it seems.* Appearances are deceptive because conspirators wish to deceive in order to disguise their activities or their identities.

D. *Most information flowing from mainstream institutions such as the government and the mass media is suspect.* Such institutions are frequently seen either as participants in conspiratorial activities or as the victims of such. By contrast, obscure sources, little known Internet sites, periodicals, newsletters, and unverifiable personal testimony are generally regarded as more reliable than mainstream information.

Adopted from *A Culture of Conspiracy*, by Michael Barkun. (Berkeley: University of California Press, 2003.)

plausibility in the eyes of their supporters despite a complete lack of evidence. This is due to another misapplication of scientific method. The claims such theories are invoked to explain are then treated as evidence they are true. Earlier we discussed several apparent anomalies associated with the events of 9/11. The explanation, we are told, is that a powerful group of conspirators, probably involving our government and others, planned and executed the attacks. What evidence is there for this conspiratorial explanation? The long list of events that occurred on 9/11 which nobody seems able to explain away. As you can see, this kind of thinking is like a dog chasing its tail. A series of anomalies is introduced. An explanation is proposed. Its subsequent vindication involves nothing more than a rehash of the anomalies that gave rise to the explanation in the first place. The appearance of a body of independent evidence has been cleverly insinuated where in fact there is none!

EMPTY JARGON

The language of the sciences is notoriously jargon-laden. Scientists often deal with ideas that are not part and parcel of the ordinary world and so must resort to terminology that is for the most part unfamiliar to the layman. Astronomers speak of pulsars, quasars, Doppler shifts and dark matter, physicists of leptons, fermions, strong and weak interactions and geneticists of genes, chromosomes, alleles, DNA, and the double helix. One way to make a claim appear to be scientific is to appropriate the jargon of the scientists. All too often, however, claims made by stringing together bits of jargon tell us nothing even though they have the look and sound of real science. Psychokinesis is the ability to manipulate objects by sheer mind power. Presuming such a thing is possible, you might wonder how it works. "Photon radiation from the brain of the sender," I tell you, "destabilizes the wave function of the light nuclei in the object being manipulated." Sounds impressive and very scientific. But what have I actually said? I must admit, I don't really know, for I've just strung together bits of jargon.

This sort of misappropriation of scientific jargon can be quite effective. Deepak Chopra, a well known medical doctor and writer on alternative medicine, claims that illness can be banished by the power of the mind. He believes that the explanation is to be found in modern quantum physics. Commenting on cases of cancer remission, Chopra explains: "Such patients apparently jump to a new level of consciousness that prohibits the existence of cancer ... that is a quantum jump from one level of functioning to a higher level."[7] In physics, quantum "jumps" occur when electrons instantaneously move from one discrete position to another. What is not clear is that this idea makes sense when applied to anything other than the behavior of electrons and a few other sorts of sub-atomic particles. Chopra's "explanation," then, sounds good but in the end tells us nothing about cancer remission and its causes.

We've examined several cases involving ESP of one sort or another. But the acronym, ESP, has become a bit shopworn. Many of its practitioners have been caught engaging in fraudulent activities and little progress has been made in making sense of what ESP might involve. Recently, paranormal researchers have come up with a new name for ESP. They're now calling it *anomalous cognition*. This phrase certainly sounds scientific and does manage to avoid the bad publicity associated with ESP. But it is just another name for the same old thing.

AD HOC RESCUES

Imagine we have conducted an experiment but that the results are negative. As we found in our discussion of experimental design in Chapter 4, we need not immediately dismiss the claim at issue. The test may have overlooked something that compromised the results. An initial test that fails to get the results expected can be modified and redone. But this sort of holding maneuver can only take us so far. If numerous modifications continue to yield negative results, there is a point at which we must admit that our initial expectations were wrong. To persist in defending a claim in the light of repeated experimental failures is to engage in what is called an ad hoc rescue. Such a move is not intended to find new and better ways to test a claim nor even to provide grounds for modifying the claim. Rather, the aim of an ad hoc rescue is simply to save the claim in the face of mounting evidence that it is wrong. To argue, for example, that some unknown factor must be confounding the results of a test is, thus, to engage in an ad hoc rescue.

As we have noted, there is nothing fallacious about rethinking and modifying an experiment when the initial results are inconsistent with expectations, particularly when those expectations have some measure of independent support. Such maneuvers are part and parcel of the way science is done. The discovery of the planet, Neptune, provides a good example. In the early 1800s, six of the seven known planets in our solar system seemed to obey laws set forth by Kepler and Newton: the planets trace out elliptical orbits at precisely predictable rates unless their motion is affected by other gravitating objects. But the outermost planet, Uranus, did not square with these laws. Now, one possibility was that the laws in question were a special case, only capable of explaining the motions of some of the planets. But astronomers were not ready to give up on prevailing theory, given its effectiveness at accounting for the behavior of all other objects then known to make up our solar system. In the mid-1800s they speculated that the peculiar movement of Uranus could be explained in a way consistent with Newton and Kepler if another planet were to exist out beyond the orbit of Uranus that was affecting its movement by gravitational attraction. Now, at this point in the story, we must regard the proposed new planet with some suspicion. With no evidence for its existence, it seems like an ad hoc rescue intended to save prevailing theory. Fortunately, however, astronomers were able to predict just where the new planet should be in order to exert the postulated gravitational influence on Uranus and shortly thereafter Neptune was discovered precisely where predicted.

By way of contrast, consider the following. Imagine that a psychic has agreed to be tested and further agrees that he can perform under the experimental conditions we have set up. Alas, our psychic fails. Nevertheless, claims our psychic, this does not show that he cannot do the things in question. For psychic abilities are subject to something called the "shyness effect"; psychic abilities ebb and flow and frequently seem to ebb just when we want them to flow. It is almost, adds our psychic, as though they don't want to be tested. It would seem that the psychic's appeal to the shyness effect is calculated not to help us rethink our experiment, particularly if there is no independent way of testing for its presence or absence. It is rather nothing more than an attempt to make sure that, no matter how carefully we design our experimental test, no conceivable result need be taken as repudiating the psychic's claimed ability. Unlike the planet Neptune, the "shyness effect" cannot be verified. Our psychic's maneuver seems clearly to constitute an ad hoc rescue. The only redeeming feature of the "shyness effect" is that, if true, it would save our psychic in the face of his failure to perform under controlled conditions.

EXPLOITING UNCERTAINTY

Uncertainty is a fact of life in science. As we saw in Chapter 4, experimental results stand only on the assumption that unforeseen factors have not been overlooked. Causal studies, like those in Chapter 5, typically yield conclusions that are highly probable but not a certainty. When scientists publish their results, they take great pains to make clear the probability that their findings are correct and to outline any considerations that might suggest otherwise.

The careful manner in which scientific findings are set forth can be exploited to make highly questionable views appear to be considerably less so. Here, in a nutshell, is how the argument goes: *If scientists are unsure of the truth of their favored view, there is a reasonable chance they are mistaken and that a rival view may be true.* If, in addition, a few "experts" can be found to defend the rival view, it can be made to seem even more respectable.

The Shroud of Turin is a large piece of linen cloth that bears the indistinct, full-length image of a bearded man who, some say, appears to have been crucified. Is it the burial cloth of Christ? In 1987, the Vatican—the official owner of the Shroud—agreed to have samples from the Shroud tested by carbon dating.[8] The results were published in a major scientific journal, *Nature*. They indicated that the material from which the Shroud was woven had been harvested sometime between 1260 and 1320 A.D. though it was possible that it could have been harvested as late as 1390 A.D. The Shroud, it seems, is not nearly old enough to be Christ's burial cloth.

Nevertheless, controversy continues to this day about the authenticity of the Shroud. Believers point out that scientists are not really certain of the exact date when the material was harvested, so it is possible that their estimate is wrong. They go on to point out that it is at least possible that the samples from the Shroud were contaminated with material from other sources and that experts in carbon dating admit this. What they often fail to mention is that three independent laboratories—picked by the Vatican—tested Shroud samples and all three arrived at dates for the Shroud that were very close to one another. Moreover, all three agreed that though a precise date could not be fixed, chances were exceedingly high that the material was harvested somewhere between 1260 and 1320 A.D. What little uncertainty results from the estimated dates or from that small possibility of contaminated samples, then, does not make it reasonable to assume the Shroud is old enough to be Christ's burial cloth.

Much of what controversy remains about whether human activity contributes to global warming involves another twist on this fallacy. By now the vast majority of scientists in fields that study global climate accept as fact the notion that human-caused CO_2 in the atmosphere is responsible for a significant part of the greenhouse effect. The precise amount that is human-caused can only be estimated. Moreover, a clear picture of what will happen to the environment in the near future if nothing is done to curtail CO_2 production remains somewhat murky. What is a near certainty, however, is that human activity contributes to global climate change. The few remaining, but persistent, global warming skeptics tend to exploit uncertainty—in current measurements and about the precise details of what is going to happen—while ignoring the overwhelming consensus that human activity is responsible for a large part of global warming. You've probably figured out their argument by now. *If scientists are unsure about the extent of global warming and about how much of it is due to natural causes as opposed to human causes, and if a few reputable scientists have doubts about the conventional view, it may well be that the very idea that human activity causes global warming is wrong.* Needless to say, scientific uncertainty about the precise level of the human contribution to global warming does not translate into uncertainty about the larger picture.

SCIENCE AND PSEUDOSCIENCE

Our discussion of fallacious applications of scientific method provides a first clue as to how to distinguish genuine from pseudoscience. Genuine science involves the rigorous testing of new ideas; as such, the results of a genuine scientific investigation will reflect the methods introduced in Chapter 2 through Chapter 5. Pseudoscientific ideas will frequently be supported by arguments and evidence that depend on one or more of the fallacies discussed in this chapter. Though adherence to the methods of science is at the heart of the distinction between genuine and pseudoscience, there are a number of other important differences between the two, as well as a number of mistaken ideas about what the distinction involves.

Science cannot be distinguished from pseudoscience simply on the basis of the results each produces. In science, at any rate, ideas earn their respectability not because they are right but because they are developed and tested in the right sort of way. At one point in the history of Western thought, the best-informed scientific view was that the earth is at the center of the universe. Though this view was ultimately shown to be wrong, it nonetheless constituted the best science of the time. Though Ptolemy and his followers were mistaken, their view of the cosmos provided a coherent, testable explanation for a wide variety of phenomena. Our discussion earlier in this chapter of phlogiston theory and the luminiferous ether provides striking examples of genuine—though ultimately mistaken—science.

Though much of pseudoscience is simply false or incoherent, it is possible that some claim will turn out to be of scientific value even though the evidence for it now appears to be entirely pseudoscientific. Acupuncture theory claims that the human body is covered with channels of energy, called *chi*, that intersect at numerous "meridians." Today there is no scientific evidence for the existence of chi. Its existence is confirmed only by a multitude of anecdotal evidence in the form of satisfied customers. But even if it turns out that something in acupuncture theory is right or even on the right track, the theory will remain an artifact of pseudoscientific thinking until it can be confirmed, modified, or rejected on the basis of controlled experimentation.

The distinction between science and pseudoscience cannot be drawn along lines of scientific discipline. We cannot say, for example, that astronomy is a science while astrology is not, that psychology is, but parapsychology isn't. This is not to say that astronomy or psychology does not deserve to be called a science. But the notion of a science, or scientific discipline, is much too broad for our purposes. My dictionary defines astronomy as "the science which treats of the heavenly bodies—stars, planets, satellites, and comets," and I suppose this is as good a definition as any. But within this broad discipline we sometimes encounter instances of pseudoscience as well as of genuine science.

For example, in the 1950s a self-proclaimed astronomer and archaeologist, Immanuel Velikovsky, hypothesized that the planet Venus was created out of an enormous volcanic eruption on Jupiter. Velikovsky speculated that as the newly formed planet hurtled toward the sun, it passed by Earth, causing several cataclysmic events, and eventually settled down to become the second planet in our solar system. Yet careful examination of Velikovsky's work has shown that this sort of cosmic ping-pong is quite impossible, and that Velikovsky either ignored or was unaware of certain physical constraints which his hypothesis violated. One of Velikovsky's most glaring mistakes involves a well-known law of motion: if one body exerts a force on a second body, then the second exerts a force that is equal in strength and opposite in direction. An explosion of sufficient magnitude to allow an object the size of Venus to overcome the gravitational attraction of Jupiter would simultaneously send Jupiter off in the opposite direction, despite Jupiter's great mass. Yet in Velikovsky's theory, the orbit of Jupiter remains unaffected by this most cataclysmic of events. Here, then, we have an example of pseudoscience, yet one which we can certainly classify under the broad heading of astronomy.

Similarly, early in the 20th century, the British psychologist, Sir Cyril Burt, claimed to have decisive evidence that heredity, not environment, plays the dominant role in determining intelligence. As it turned out, much of Burt's work was based on fictional or distorted data. Burt invented experimental subjects and altered test results to conform to his expectations, in the process of trying to make his findings appear to be scientific.

Disciplines we might tentatively classify as pseudoscientific can be subject to legitimate scientific investigation. Many of the extraordinary claims discussed in Chapters 2 and 4 come from disciplines such as astrology, special creationism, and parapsychology, disciplines generally not regarded as legitimate sciences. Nonetheless, such claims can be tested in rigorous scientific ways.

The distinction between science and pseudoscience has nothing to do with the distinction between "hard" and "soft" sciences. The sciences that study human behavior—sociology, anthropology, psychology, political science, to name a few—are sometimes characterized as "soft" as opposed to the "hard" physical and biological sciences. Though in a number of respects the soft and hard sciences differ, none of the differences is sufficient to support the complaint, occasionally leveled against the soft disciplines, that they are pseudosciences. The hard sciences do not have to deal with the complexities posed by the human ability to choose what to do in their attempts at describing and understanding nature. It is sometimes said that only the hard sciences are "exact" and this is generally taken to mean that predictions about human behavior cannot hope to be as precise as, say, predictions about what will happen to a gas under a specific set of conditions. Moreover, it is difficult to think of a single "soft" scientific theory that is as broad in scope as the theories of modern physics and chemistry. The law of gravity describes the behavior of all gravitating objects; it is hard to imagine a similar law describing a single aspect of the behavior of people, societies, and economic or political institutions.

Yet despite their obvious differences, the hard and soft sciences are all properly sciences. All aim at explaining phenomena of the natural world, be it the behavior of matter, plants, or animals (including humans). And both hard and soft sciences adhere to the methods we have discussed in Chapters 2 through 5 in advancing and testing their "hows" and "whys." Many philosophers argue that the social sciences will never produce the kinds of grand, unifying theories characteristic of the physical and biological sciences; it may be that the "soft" sciences will have to be satisfied with discrete bits of explanatory material, each of which is suited to a limited aspect of human behavior. But insofar as research in the social and behavioral sciences conforms to the more general methods of good scientific research, we have no reason to doubt their qualifications as disciplines capable of delivering genuine scientific insight.

Genuine science tends to be self-correcting; pseudoscience is not. We have examined a number of instances in which the results of scientific inquiry have been overturned. Yet in most cases, mistaken ideas have been rejected on the basis of further scientific inquiry. It is estimated that there are currently about 40,000 active scientific journals worldwide. These journals contain detailed synopses of research projects, generally written up by those who have done the research. An article reporting on new research will contain a description of the design and results of the experiment, discussion of the significance of the results and suggestions for future research. Most journals are peer reviewed: submitted articles will be reviewed by other scientists who will check to make sure the article is accurate and complete. The referees will finally decide whether the research described in the article is sufficiently interesting and important to merit publication. It is not unusual for a submitted manuscript to be returned to its author or authors for substantial revision. Thus the process by which journals decide what to accept and what reject serves to correct numerous potential errors.

This process is far from perfect. Given the sheer number of journals and articles, mistakes are bound to go unnoticed, some of them pretty spectacular. In the past few years, several instances have surfaced of published research that has involved fabricated data. Fortunately such incidents are fairly rare.[9] The fact that they have been discovered is itself a testimony to the self-correcting tendency of the process by which research is made public. When fraudulent research is detected, it is usually by other scientists, peers who have taken the time to look carefully at the published results.

Scientific journals serve another function as well. They provide a forum for critics of current research. Often journals will publish articles aimed at mounting objections to and uncovering flaws in previously reported research. Since the early 1980s, for example, an enormous amount of research has been directed at understanding AIDS and its cause or causes. The vast majority of AIDS research points to a retrovirus—Human Immunodeficiency Virus (HIV)—as the cause of AIDS. This contention has emerged from thousands of experiments and clinical trials—both on animals and humans—undertaken by medical doctors, biologists, geneticists, and specialists in other related disciplines. Yet a handful of AIDS researchers, notably, Peter Duesberg, a professor of molecular and cell biology, and Robert Root-Bernstein, a professor of physiology, have mounted serious objections to the mainstream view. Duesberg argues that a careful analysis of the evidence strongly suggests that AIDS is not caused by HIV; Root-Bernstein believes that HIV is but one of several cofactors that must be present for AIDS to develop. Both have suggested that much of the research into AIDS and its causes undertaken in the last 25 years has been largely misdirected. As you might suspect, the work of Duesberg and Root-Bernstein has met with a great deal of resistance from the vast majority of AIDS researchers. In the last few years many articles have appeared in the scientific literature that are highly critical both of the methodology and the findings of Duesberg and Root-Bernstein.[10]

This episode illustrates several of the reasons why science stands a good chance of correcting its own mistakes. Note first that the research criticized by Duesberg and Root-Bernstein was readily available in the form of published articles in scientific journals. Second, Duesberg and Root-Bernstein are themselves credentialed, mainstream researchers. Third, the critiques produced by Duesberg and Root-Bernstein were taken sufficiently seriously to be published in reputable scientific journals. Duesberg's work has appeared, for example in both *Science* and *Nature*, two of the most visible and highly respected scientific journals. Finally, their criticisms were not simply dismissed out of hand, on the grounds that they were out of step with mainstream views. Other scientists have taken them sufficiently seriously to devote considerable time and space to rebuttals; again, in the forum provided by scientific publications.

Interestingly enough, most critical discussion of controversial pseudoscientific ideas comes from mainstream science as well. In recent years, for example, a new version of special creationism has emerged, calling itself "intelligent design" theory. The central ideal of this theory is that many biological entities are "irreducibly complex." What this means is that such entities could not have evolved by random mutation and natural selection. Rather, their existence must be the product of intervention by some intelligent entity. From here it is but a short step to the postulation of a supernatural intelligent designer. The notion that some natural systems are irreducibly complex has come under heavy attack; its central examples have been pretty much discredited. But discussion of difficulties facing its central idea has not come from within the intelligent design community. It has come, instead, in the writings of mainstream biologists, paleontologists, geneticists, and philosophers of science. Intelligent design theory, it would seem, is not self-correcting in the way crucial to the development of ideas in science.[11]

As a scientific discipline develops, it will gradually produce a maturing body of explanatory or theoretical findings; pseudoscience produces very little theory. One major aim of science, as we discussed in Chapter 1, is to "make sense" of nature by providing better and better and, often, more and more encompassing bodies of explanatory material. Think, for example, of all that is known about the mechanisms involved in the transmission of genetic information from one generation to the next, in contrast with what was known 150 years ago at the time of the birth of the science of genetics. Gregor Mendel, the founder of genetic research, introduced the somewhat vague and mysterious notion of a "genetic factor" in his attempts to explain the observable characteristics of some simple varieties of plants. Today, modern geneticists can provide us with the details of the explanation Mendel could only hint at, how those characteristics are encoded in DNA (a notion wholly unknown to Mendel).

By contrast, pseudoscientific research almost always produces spectacular claims for extraordinary abilities and events, but little else. Ideas tend not to develop and mature over time as they do in genuine science. As it turns out, ESP research began only a little later than did genetic research. Yet today we find little more than an enormous body of controversial evidence that a few people have psychic ability and almost no theoretical understanding of how ESP might work. What little explanatory material emerges in many pseudoscientific endeavors is likely to be based on vague analogies and similarities drawn from some well-understood area of science. So, for example, a book on ESP published in the 1930s was entitled, *ESP: Mental Radio*; an interesting idea, but hardly a reliable explanation. Today's ESP theorists exploit analogies with computers and quantum mechanical effects rather than the radio. Though the analogies are more up to date, little progress has been made at producing anything like a coherent theory for ESP.

The findings, theoretical and otherwise, of genuine science are always open to revision; rarely do pseudoscientific claims change much over time. It is hard to imagine a thriving scientific discipline today wherein much of what was believed one hundred or even fifty years ago has not been supplanted by a more accurate picture of things. Fifty years ago, particle physics provided us with a picture of the world in which the most fundamental particles were the electron, the proton, and the neutron. A few stray experimental results were in conflict with this picture, but few physicists questioned its rough fit with reality. Today physics provides a more comprehensive picture in which protons and neutrons are composites built out of more fundamental particles, quarks. The landscape of particle physics has changed dramatically in a brief period of time. The openness of science to revision does not mean that scientific results cannot achieve a kind of permanence. Many of the findings of science will doubtless not be repudiated by new research. Science will not discover that water molecules are composed of something other than two atoms of hydrogen and one of oxygen; no one doubts that Newton was correct in seeing that gravitational attraction is directly proportional to mass and inversely proportional to distance. The changes we can anticipate in well-established areas of science will generally occur at the level of underlying explanation. Why do gravitating objects behave in the way Newton discovered? What is the internal structure of "stuff" of water? And just how—if at all—are the forces at work inside the atom connected to the force responsible for gravity?

By contrast, it is interesting to look at the work of modern astrologers. If you were to have a competent astrologer draw a detailed horoscope, his or her work would be based on classic astrological texts, written over two thousand years ago. Pseudoscientists often claim the long history of their ideas to be evidence for their correctness. Thus, an astrologer might boast that his or her techniques are derived from the discoveries of ancient Babylonian and Egyptian astronomers. In and of itself, this is not reason to classify astrology as a pseudoscience. But at the level of underlying explanation, astrology remains today in much the position it was at its inception. After more than two thousand years, astrologers have conspicuously failed to produce even the beginnings of a plausible explanation for its purported effects. Conspicuously missing in the history of astrological research is any evidence of the kind of proposing, testing, modifying, and revising of new ideas that typifies scientific progress.

Genuine science embraces skepticism; pseudoscience tends to view skepticism as a sign of narrow-mindedness. The first reaction of a competent scientist, when faced with something new and unusual, is to try to explain the phenomenon away by fitting it into what is already known. Many people who engage in pseudoscience see this as the worst sort of skepticism; the fact that one's initial reaction is to try to rob something of its mystery is taken to be a sign that one is unwilling to entertain new ideas. It is perhaps this attitude toward scientific skepticism more than anything else that contributes to the tendency in pseudoscience to accept claims in the absence of solid scientific evidence.

The question of whether a piece of "scientific" research is genuine or bogus is not always easy to answer. Though the contrasts we have drawn can provide some initial sense of the presence of pseudoscience, we should not wield them dogmatically. If someone purports to have "scientific evidence" for something, we should not dismiss their work simply because, for example, they refuse to countenance serious criticism, complain that their critics lack an open mind, or proclaim the longevity of their ideas. Rather, such moves should only be taken as a sign that something may well be seriously amiss. The fundamental difference between genuine science and bogus science is really a difference in method. The results of genuine scientific inquiry are the product of open and honest applications of the methods we have discussed in previous chapters. Pseudoscientific results, by contrast, are produced with little regard for these methods.

A person claims to have "scientific evidence" for X. Are we confronted with genuine science or pseudoscience? To answer this question there is no substitute for taking a careful, critical look at the methods employed in establishing X.