1.7 Myths about the Scientific Method

Many people learn a very trivial version of the scientific method. Often, people say something is scientific or unscientific based on naive ideas of how scientists work. The following are common "myths" about the scientific method.

1. Reproducibility. Some people have argued that science deals only with things which are *reproducible*, that is, things which the scientist can cause to happen over and over. This is not true; if it were, astronomy and archaeology would not be sciences! Science often deals with events which can not be reproduced.

The key to good science is that the data is available to anyone, not locked away secretly, available only to a chosen few. If the effect is reproducible, then of course this makes it easier for many people to look at the data, but there are other ways to share data. For example, in 1987 a supernova (an explosion of a star) occurred. We can not cause another star to explode. But scientists recorded the event, and many different people can look at those recordings. On the other hand, a magician might do a card trick many times, but if he explains it as mystical magic and does not allow examination of his secrets, it is not good science no matter how many times he reproduces it.

It is, of course, important that a prediction be tested many times and in many ways, if possible. Often, people jump to conclusions, making general conclusions after just a few particular observations, sometimes after only *one* observation. For example, a person might meet a German, find that he is an alcoholic, and instantly jump to the generality, "Germans have trouble with alcohol." The inductive method says that the more observations we have, the more certain we can be, and with only one or two observations, we are not justified in making confident generalities. But in some cases, if we do not have many observations, we can still learn things. For instance, the above example would not give strong confirmation of the general theory that all Germans have trouble with alcohol, but it would disprove the theory that no Germans have trouble with alcohol.

2. The Dispassionate Scientist. Some people have said that a good scientist must be "dispassionate," that is, must not care about the results of the experiment. This is rarely the case. Most scientists care deeply about their experiments and very much want their experiments to turn out one way and not another way. It is probably impossible to not care about whether an experiment goes the way you want.

Having passion about an exeriment is not a problem if the scientist has *integrity*, that is, will report the experiment honestly even if it doesn't go the right way. We usually suspect that a person who strongly wants something to be true will be tempted to be dishonest if the facts run to the contrary. But not everyone succumbs to this temptation. A good scientist reports the measurements without changing them; to do otherwise would be a serious ethical violation.

A more subtle problem is that a scientist will sometimes not "see" certain data because it does not fit into his or her preconceived ideas. This is especially true if the effect is a small one. Although this sometimes happens, good scientists are always on the lookout for unusual data, and they mostly love to report new and unexplained effects. The philosopher Thomas Kuhn painted a very different picture, saying that scientists always want to prove existing theories and never want to report violations of them. Most scientists will tell you otherwise.

3. Falsifiability. The philosopher Karl Popper taught that one unsuccessful prediction "falsifies" a theory, that is, proves it incorrect. This is almost never the way real science works. The results of an experiment would have to be absolutely certain in order for one experiment to overturn a theory. Generally, scientists talk of unsuccessful predictions "weakening" a theory, making them less certain.

Some experiments can be so dramatic that they falsify a theory overnight. But this has rarely happened.

3. Authority. Some people think that the scientific method says that scientists do not believe anything unless they can check it out themselves. This is far from the truth. Scientists rely to a large degree on the word of other scientists; if they did not, they would have to "reinvent the wheel." All scientists regularly consult libraries full of journals which they trust, and verify only a tiny fraction of the claims made in the journals. An "authority" is anyone whose word you can trust without checking it out yourself, and scientists trust in many authorities.

Science requires a *theory of authority* which is formed just like any other theory, by means of induction. Scientists learn by experience which journals and which scientists are trustworthy and which are not.

The studies of history, law, and journalism deal with this kind of theory of authority, that is, theories of who are reliable witnesses to trust when we cannot reproduce an event. Some tests of reliable witnesses are (1) *disinterest*—the person does not have a strong motive to tell a lie, such as financial profit, (2) *corroboration*—some of the parts of the story can be compared to other sources, such as physical facts or other witnesses, (3) *expertise*—the person has experience with the kind of thing being described, (4) *consistency*—the person does not keep changing the story, (5) *track record*—the person is not a known liar, and (6) *style*—the person is using words in a way that convey the intent to tell truth, as opposed to a fictional story (for example, starting out "once upon a time" does not indicate a truthful story).

4. Uncertainty. People seem to go to opposite extremes in thinking about scientific certainty. Some people think scientists do all things with "exact scientific precision" and prove things exactly. Other people say that all scientific theories are "provisional" and can not be trusted. Neither view is correct. Scientists recognize a range of degrees of certainty. Some theories are extremely certain, such as the theory that gravity makes things fall. Others are much less certain.

Sometimes many scientists can be wrong when they say a theory is certain. They usually do this not merely out of bias, however, but because the theory is very successful in one type of prediction, and this certainty is taken for granted in other areas. For example, in the 1800's many scientists felt certain about Newton's laws, but Einstein showed that these needed to be changed. As we will see in the later chapters, however, their certainty in Newton's laws was not without good reason. Most of the predictions of Newton's laws for the world around us are extremely accurate.

In the same way, it has become popular among some scientists to say "evolution is a fact," by which they mean that biological evolution is a very certain theory. What these scientists have in mind is that certain parts of the evolutionary theory have been very successful, such as studies which show that human DNA and animal DNA have much in common. Other parts of evolutionary theory are much less certain, such as explanations of the appearance of DNA in the first place. Einstein's theory kept those parts of Newton's laws which were accurate, and in the same way, if a new theory is to replace evolutionary theory, it must include those parts of evolutionary science which are accurate. We will return to the question of evolution in Chapter 11.

Assignment:

Memorize the six tests of a good witness (authority) given above, in your own words.

Thought Question:

Think of something you know about history, such as the date of Columbus's trip. Why do you believe it? Track down exactly how you came to this belief.