Science, belief and rational debate

The Scientific Alliance Newsletter – June 12, 2009

The scientific method is a valuable way to advance objective knowledge. By testing a hypothesis against observation, it can either be falsified or supported. Not *proved*, of course, but nevertheless over time sufficient evidence can accumulate for a hypothesis to be generally accepted as the best available explanation. It is then known as a theory. Hence, although the vast majority of scientists and citizens (at least in Europe) accept Darwin's description of evolution, this is still regarded as a theory rather than fact. This is important, because as our understanding develops, apparently satisfactory theories may be replaced by others.

For simple things such as the effect of the Earth's gravity on objects we are familiar with, collecting the evidence is straightforward and no experiments have been done which contradict the theory of gravity. But over the last century, it has been accepted that classical Newtonian mechanics is actually only valid at a certain scale (which encompasses everything in our normal Earthbound existence). At the atomic scale, we enter the abstruse realm of quantum mechanics, and on a cosmic scale Einstein's theory of relativity is currently the best description of what goes on across the observable universe.

Importantly, both of these deviations from the familiar everyday world as explained by Newton arose because observation did not fit with prediction: the theory broke down at very large and very small scales. The boundaries of knowledge have since been pushed back steadily, leading to a general acceptance of quantum mechanics and relativity as the best theories to date to explain observations.

On a cosmic level, there is still much we do not know. It is now generally accepted that the Big Bang theory describes the universe better than the previously-competing Steady State model. But current models require the universe to be composed largely of as-yet-undetected "dark matter" and "dark energy" if observations are to be consistent with theory. And on a broader scale, the search for a "theory of everything" which brings together quantum mechanics and relativity and explains gravity remains unresolved, with the large amount of work on the development of string theory potentially being a historical dead end.

This sort of work engenders fierce scientific rivalries, and the formation of a consensus view can take many years, but it is essentially an internal professional competition, of little direct relevance to the average citizen (apart from the fact that their taxes pay for it). However, when we come to issues which affect non-scientists more directly, other interest groups become more involved.

A classic recent example which is often quoted is of the cause of stomach and duodenal ulcers. Many readers will remember that stress and spicy foods were considered the primary causes of peptic ulcers, until the Australian scientists Robin Warren and Barry

Marshall discovered the bacterium *Helicobacter pylori* in 1982 and proposed that colonization by this micro-organism was the main factor. Warren took the rather extreme step of deliberately infecting himself (and inducing symptoms of gastritis) and publishing the results before the theory began to gain acceptance.

In this case, doctors and scientists "knew" that stress and diet were the main causative factors for ulcers because that was what they had been taught and that was the basis on which patients were treated. It is human nature to accept facts rather than continually question them: indeed, society would probably not function if we did not behave like this. To overturn received wisdom requires either unexplained observation (as for the behaviour of the universe) or one or more awkward individuals who are sufficiently motivated to do their own experiments.

But when we turn to environmental issues, the situation becomes more complex still. To test a hypothesis, it is always best if only one independent variable can be changed at a time. In the laboratory, this is usually possible, but when hypotheses have to be tested purely by observation of highly complex systems, life gets much more difficult. And it is difficult to think of something much more complex than global climate.

It is well known that there were serious concerns raised about climate change in the 1970s, although at that time the worry was about cooling and descent into a new Ice Age. However, attention soon turned instead to global warming. A sudden jump in temperature in the mid-1970s was followed by an upward trend over the next two decades, and it was perfectly logical to hypothesize that this increase was caused by rising levels of carbon dioxide in the atmosphere.

This quickly became the new paradigm, linking humankind's burning of fossil fuels directly to environmental change on a global scale. Unfortunately for the cause of rational debate, this also quickly became the *only* acceptable hypothesis for large swathes of the scientific community, pretty much everyone who considered themselves an environmentalist and the liberal elites in Western democracies. The problem was, is (and will remain so for the foreseeable future) that it is impossible to do experiments on the Earth's climate. All we can do is observe.

Scientists often model systems to predict what effects might be expected if variables change in a certain way. In the absence of anything resembling evidence for the causative effect of global warming, computer modeling was enthusiastically embraced to project likely changes on the basis of the understanding of how climate worked. So far, so good, but the output from these models, rather than being seen as indications of what might happen if the hypothesis was right, have taken the place of experimental observation.

So, in a circular argument, the models which are based on a particular hypothesis (the greenhouse effect with positive feedback) are taken to "prove" the hypothesis because they reproduce the pattern of twentieth century temperature change. Similarly, the projections for future temperature rise (which, we should remember, cover a large range) are regularly quoted as what *will* happen if carbon dioxide emissions are not drastically cut back.

Large numbers of people have been sufficiently convinced by the arguments to take it as read that the greenhouse gas hypothesis is essentially correct and that disaster will occur unless radical cuts are made in emissions. They have moved beyond the stage of questioning to simply not listening to anyone who raises doubts. But, what is worse, they are putting their faith in a hypothesis unsupported by anything more than circumstantial evidence. Because no-one can do more than point to observations, no new evidence is going to be produced which - as in the story of peptic ulcers - will provide direct, irrefutable corroboration of an alternative theory.

In the meantime, the belief in the greenhouse has hypothesis is such that legitimate criticism based on contradictory evidence - the lack of predicted warming of the upper troposphere, the measured cooling of Antarctica, the lack of change in the rate of sea level rise or the failure of the models to explain or predict recent temperature trends, for example - are dismissed as the propaganda of paid lobbyists or cranks. All societies will gain if we make sure we understand the problem before taking corrective action rather than jump on the currently fashionable bandwagon. Addressing critics' questions seriously is a necessary first step.

Whatever the result, a better understanding of our climate will ensure that we take appropriate action rather than invest so much in one particular preferred "solution" which shows little chance of success. Whatever the result, science will be the stronger for it. But, if things continue as they are and the catastrophists' view of climate change turns out to be wrong, it would hardly be surprising if the average person fails to place much faith in science.