The Nature of Theory

In the middle of the 19th century, Darwin presented the world with a scientific explanation for the data that naturalists had been accumulating for hundreds of years — the theory of evolution. The term theory does not refer to a mere idea or guess. Scientific theories provide interpretations of natural phenomena and processes so that they are understandable in terms of human experience. In science, as opposed to common usage, the term theory is applied only to an interpretation or explanation that is well-substantiated by evidence. Useful theories incorporate a broad spectrum of the information available at the time the theory is proposed. Facts, inferences, natural laws, and appropriate well-tested hypotheses are all part of the construction of a strong theory. Thus, a theory is very different from a belief, guess, speculation, or opinion.

Scientific theories are continually modified as we learn more about the universe and Earth. Let's look at three examples.

➢ In 18th century science, combustion was explained by a complex theory having to do with the supposed presence of an undetectable substance called phlogiston. Then Joseph Priestley discovered oxygen and Antoine Lavoisier showed that fire was not a material substance or element, it was the combining of a substance with oxygen. The phlogiston theory was abandoned.

➢ In the 20th century, the theory of continental drift was a step in the direction of recognizing that continents change their geographic positions through time. Continental drift was succeeded by the much more comprehensive theory of plate tectonics, which provided a mechanism for movement of continents, opening and closing of ocean basins, and formation of mountains.

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➢ People once thought that diseases were caused by evil spirits, ill humors, or curses. The germ theory showed that many diseases are caused by microbes. In turn, the germ theory of disease has been modified as we have learned that diseases can be caused by things other than germs, such as dietary deficiencies and genetic factors.

Notice that while a particular theory may be discredited or modified, still-valid observational and experimental data, as well as our knowledge of natural laws, are not abandoned; they are incorporated in a new or revised theory.

We have tested some observations so thoroughly that we accept them as facts. For example, we consider it a fact that the sun appears in the eastern sky each morning or that an object released from the top of a building will fall to Earth. Some explanations are so strongly supported by facts, and describe so well some aspect of the behavior of the natural world, that they are treated as scientific laws. Good examples of these include the laws of thermodynamics, which govern the mechanical action or relations of heat; or the laws of gravitation, which cover the interactions between objects with mass.

We continue every day to learn more about the world and the universe in which we live. Thus, scientific theory is always subject to reaffirmation, reinterpretation, alteration, or abandonment as more information accumulates. This is the self-correcting nature of science; dogma does not survive long in the face of continuous scrutiny of every new idea and bit of data. When scientists do not understand how some aspect of our universe operates, they do not assume an unknowable supernatural cause. They continue to look for answers that are testable within the realm controlled by natural laws as we understand them at any given moment. It may be years or centuries before scientists unravel a particularly difficult problem, but the search for answers never stops. This quest for understanding is the wonder and excitement of science!

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