Science and the Attempt to Observe Reality

Can we ever observe the world as it is, independently of ourselves? Or do our very attempts to observe the world always *change* the world? Psychologists and sociologists often face this problem, because the very fact that people are being observed leads them to behave differently than they would if they were not being observed. The more accurately you try to determine how angry you feel, for example, the less you experience the anger you are trying to observe.

Or consider the results of a famous series of experiments called the Hawthorne studies, which tried to discover what kinds of job conditions would improve the productivity of workers. Workers were observed under various different working conditions (including noise, darkness, bright light, music, silence). The Hawthorne researchers discovered, much to their surprise, that the productivity of the workers they studied always improved no matter what the conditions. It was only much later that the researchers realized that it was the fact that the workers were being *observed* and were being rewarded with so much *attention* that led them to be more productive. Making objective observations—that is, observations that are not contaminated by the observer's activities and choices—is very difficult when observing the psychological or social world.

But surely the *physical* world can be observed objectively—that is, without it being changed by our observations. Or can it? Consider the problem of trying to measure precisely the temperature of a volume of warm water: If we insert a thermometer into the water, the temperature of the thermometer will change the original temperature of the water.

But it is when we reach the basic constituents of all matter—subatomic particles—that our attempts to observe the physical world most radically alter that world. For to observe that world, we must shoot some kind of radiation (light rays or gamma rays) at it and observe the reflected radiation. But the energy of the radiation will always disturb the subatomic particles, leaving us uncertain about what was there before the observation. In fact, modern physics explicitly holds that on principle it is impossible to observe subatomic particles without disturbing them so much that we cannot be sure where they are or how fast they are moving. Here is how a physics textbook explains the impossibility of observing the subatomic world in a way that would eliminate our uncertainty about that world:

> *In Newtonian mechanics, still applicable to the macroscopic world of matter, both the position and velocity of a body are easily calculable; e.g., both the position and the velocity of the earth in its orbit can be known precisely at any instant. Inside the atom this is not possible. We have already learned that electrons orbiting within atoms can absorb light energy in units proportional to the frequency of the light and that in doing so they shift energy levels. Now suppose that we could "see" an electron. You need light to see it, but when you turn on the light to see it, the electron absorbs some of the light energy and instantly moves to another energy level with a different velocity. This is implied in Heisenberg's uncertainty principle:* It is impossible to obtain accurate values for the position and momentum of an electron simultaneously. *In other words, observation causes a reaction on the thing observed.... This principle of uncertainty ... sets fundamental limits upon our ability to describe nature.*

QUESTIONS

1. What implications do the Hawthorne experiments and the uncertainty principle have for epistemology?
2. Do the Hawthorne experiments and the uncertainty principle demonstrate that we can never hope to know the world as it really is?

Source: Verne H. Booth, *Elements of Physical Science: The Nature of Matter and Energy* (London: Macmillan, 1970), 327–328.