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## Science and Its Critics

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A few years ago I served as an examiner for a doctoral dissertation. The student had done an excellent job of collecting qualitative data to support a conceptual model. Indeed, the dissertation was both theoretically and methodologically sophisticated. One examiner asked what seemed a relatively unproblematic question: “What is the major knowledge claim your thesis makes?” The student, however, assumed this was more of a philosophical question and launched into a discussion regarding the relativity and plurality of knowledge claims. After hearing the student argue that knowledge was relative and there was no way of deciding which claim might be more adequate, the examiner paused and reflected. The next question was “Are you telling me that there is no difference between the data and theory that you took three years to develop and, for example, the opinions of a local taxi driver?” The student, pleased that the postpositivist argument had been correctly understood, said, “Yes!” The examiner’s next question was obvious: “Why then do we not award the taxi driver the doctoral degree?”

This anecdote points out the importance of the issues that I discuss in this chapter. At the core of these issues is a most fundamental question regarding the nature of human knowledge and its production and accumulation. After all, if the student in this anecdote is correct, then there is no need to maintain great universities at taxpayers’ expense. Likewise, the very foundation of education and knowledge is put into question.

This chapter addresses the criticisms of theory and science launched by postmodern critics. It would be very easy to address these criticisms with a sweeping dismissal, such as by citing the success of science in providing us a better life. Such a response seems, however, to be overly defensive on the

part of scientific theorists and might very well dismissively throw out valuable insights that are the basis of these criticisms. Rather, the strategy I pursue here is first to address some of the basic notions in traditional philosophy of science so that when we move to the analysis of the criticisms, the basic concepts and distinctions will already be in hand. This will also have the additional benefit of avoiding the impression that distinctions are being introduced *ex nihilo* simply in order to obviate a criticism.

## Basic Philosophy of Science

### Caveat

Before we begin this discussion, one caveat should be forwarded. Philosophy of science, like its close relative history of science, is first and foremost an after the fact (*ex post facto*) reconstruction. I cannot sufficiently stress the importance of this fact. Science developed over centuries, refining its methods and logic to more adequately address empirical problems. Long after the success of science, philosophy of science evolved as a way to study this apparently successful and influential body of knowledge and methodology. Somewhere, somehow, students and colleagues seem to have gotten the impression that science was based on this or that epistemology (theory of knowledge) or this or that ontology (theory of being), but this is far from the case. For the most part, scientists have not been very profound thinkers in either philosophy of knowledge or philosophy of being. As we shall see, one of the great strengths of scientific thinking has been to fold two contradictory epistemologies (rationalism and empiricism) into the basis of scientific methodology. This has been the grounds for great philosophical consternation (Norris, 1989) while providing relatively few problems for scientists. The point that philosophy of science is “reconstructive” will need to be revisited several times during the course of this book.

### Science and Diversity

Critics and defenders alike often refer to “science” as representing a certain unity of disciplines. One of the most interesting observations about science is that it is anything but a unity. In some areas, such as the physics of time, science is much closer to literary metaphor than to “hard” measurement. Certainly the methods of contemporary wildlife biology, microchemistry, and geology defy common representation by the most glaring generalities. If we take a more historical perspective, science has used many different methodologies.

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Indeed, in Chapter 1 I hinted at this fact by stating that there was a return to Baconian inductionism. Bacon (1561–1626) focused on observation and the accrual of observations as the foundation of scientific method. Since that time, his perspective has been largely rejected by several other views of science. Finally, there is always the argument within the sciences about which disciplines are sciences. Is physics the model to which every other science should be compared? To what extent is science unified by a common method? Are the social sciences to be considered sciences? Is history a science or one of the humanities? The point is, however, that science is not easily treated as one monolithic codified and unified whole.

This insight might seem relatively unimportant until criticisms are launched at all of “science” or until one wants to glorify one’s discipline by stating that it is a “science” or increase the legitimacy of one’s theory by calling it “scientific” theory. The successes of some of the physical and natural sciences have created the common perception that “science” is responsible for such progress rather than a particular theory or method or instrumentation. This glorified perception of “science” is perhaps tied to the reason some family researchers preferred the term family “science” over the term family “studies” during the discussions of the name for the new discipline in the 1980s. Clearly the “science” name would be viewed as more serious and worthwhile. Simultaneously, critics have wanted to paint all of the sciences with the same brush regardless of epistemological and methodological differences between these disciplines.

### Defining “Science”

When we turn to lexical definitions of science found in most dictionaries, a terrible and uncomfortable generality leaves us knowing less than we did before we availed ourselves of the dictionary definition. I have performed these searches over several decades and remain undeterred by the results. It is always my first line of analysis even though it has been uniformly unrewarding. “Science” is equated with a body of knowledge achieved through scientific methods. “Scientific methods” are illuminatingly defined as the methods of observation and experimentation commonly used in the sciences. Although this does somewhat determine the meaning, it is less than revealing or informative for our purposes.

Another way to proceed is to use some of the myriad characterizations of science offered in the diverse discourse known as philosophy of science. The inherent danger in this approach is that these interpretations might tell us as much about the philosophical commitments of the philosopher as they do about science. Yet another danger is that philosophers of science have tended

to take one discipline, often physics, as representing the pinnacle of how science exists in its most sophisticated form. Interestingly, such judgments expose dubious assumptions but also clearly fail to see “science” in historical perspective. If we were to define science by its “pinnacle discipline,” will such a characterization capture the meaning of science as studied by the historian? And, of course, as I stated earlier, there may be multiple models of science rather than one unifying solitary pinnacle discipline.

Kaplan (1964) uses a metaphorical story to capture both the fact that philosophy of science “reconstructs” science and the manner in which biases enter such reconstructions. He first states that philosophers seem drawn to fields, such as physics, that have elegant mathematical formulae and a relatively unambiguous, unproblematic use of deductive theory. He states,

But the crucial question concerns, not the intrinsic values of the reconstructed logic taken in itself, but rather its usefulness in illuminating the logic-in-use. There is a story of a drunkhard searching under a street lamp for his house key, which had dropped some distance away. Asked why he didn't look where he had dropped it, he replied, “It's lighter here!” Much effort, not only in the logic of behavioral science, but also in behavioral science itself, is vitiated, in my opinion, by the principle of *the drunkhard's search*. (p. 11)

I believe Kaplan's parable to be a useful one, and I will freely cite *the drunkhard's search* as standing for examinations that choose to avoid the difficult and messy in favor of the clear and obvious, even though it fails to address the issue.

Yet another distinction that plagues our quest to define “science” is the distinction between science as “product” and science as “process.” I don't remember where I first came across this distinction, but it has been useful in sorting out approaches to science. As an example, the reader may turn to almost any lexical (dictionary) definition of “science” and find definitions that refer to (1) science as a body of systematic knowledge, and (2) science as knowledge arrived at by means of the scientific method (induction, deduction, or both). Certainly science as a product is “systematized knowledge.” Later in this book, I will argue that this systematizing is largely a function of theory. Science is also that product produced by a specific method. The trick here is whether there is consensus on the exact nature of scientific method or methods. Certainly over the history of science the understanding of the nature of the scientific method has changed. Naturally, disciplines (e.g., physics, biology, archaeology) of inquiry may emphasize certain methods and exclude others. So defining science as any body of knowledge achieved by means of the scientific method does not supply us with an unambiguous definition.

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Although I have not defined science nor solved how to define science, I have noted some of the problems in arriving at such a definition. The failure to arrive at a definition may not seem particularly instructive, yet when we eventually examine the criticisms of science we may find that what is a complex, diverse, and difficult issue may be uncritically viewed by critics of science as a monolithic and uniform endeavor.

### History and Science

Many readers may know about the history of science mainly through reading or being informed of the effects of Kuhn's (1962, 1996) *The Structure of Scientific Revolutions*. Later in this chapter we will need to address the constructionist perspective attributed to Kuhn's work as well as Kuhn's concept of "paradigm." Of course, the history of science is much broader than just the work of this single author. For our purpose in this section, however, we are not so interested in the interpretive elements of the history of science as encountered in works such as Kuhn's. Rather, we turn to the descriptive and accounting aspects of the history of science to provide us with a great deal of illumination about science.

Hellemans and Bunch (1988) discuss science across the sweep of human history. It is instructive that these authors do not expend much energy on finding a definition of science so much as listing scientific discoveries and advances. Of course, their list of these discoveries must be at least unconsciously driven by a definition of science even if it is not explicit. As we review some of these discoveries, this implicit definition will be increasingly clear.

Hellemans and Bunch (1988) state from the outset that science is anything but a consistent and coherent monolithic endeavor.

Historians of science have abandoned the idea that science develops linearly, according to rules. Instead, the growth of science is much like a stream, growing slowly from its source, meandering through plains, and fed by other small streams until it becomes a river. (Preface, p. v.)

This analogy of science finally becoming a "river" is further qualified by the authors' perspective that sometimes the main channel of the river is dominated by one discipline, such as physics in the 20th century, but at other times other disciplines might be dominant or the river could spread into several channels.

We can only guess at the first scientific advance because these discoveries had to be made in human prehistory. For example, prehistoric humans had to have made substantial advances in regard to fire, seasons, animal

behavior, and climate. Even in the most elementary forms, such as food, we can see that they had to have some categorization about which plants were poisonous to eat and which were edible. These basic categorical dimensions have been discussed by Levi-Strauss (1966) in his book *The Savage Mind*. Today, ethnobotanists study the wealth of natural science information that was represented by these prehistorical groups in some of the well-preserved medicine bundles for healing. We believe that many elaborate systems of categorization (taxonomies) were developed so this information could be passed from one generation to another. By the time civilization started, about 10,000 years ago, there was already an abundance of information stored in these taxonomic silos. The full-fledged blossoming of civilization showed further developments such as the performance of brain surgeries and mummification of the dead in ancient Egypt. So although the rudimentary beginnings of science were first and foremost tied to taxonomies, early discoveries were also attempting to explain and understand so that interventions could mitigate effects (e.g., medicine, alchemy, and climatology) (Hellemans & Bunch, 1988).

Certainly most of us would equate the advances in science during early civilization with the cultures that flourished in ancient Greece and Egypt. However, other cultures such as the Mayans and Chinese were also flourishing during this time. Although there were advances in almost every area, the major advance came from the developments in mathematics. Not only did these advances include Euclidean geometry, but in Mesopotamia mathematics developed to the point of being able to solve quadratic equations (Hellemans & Bunch, 1988, p. 3). The mathematical advances, especially geometry, made it possible for forms of engineering to develop that would create edifices that remain impressive to this day. It was just as important for our understanding of science that during this time the notion of science developed.

Scientific thinking originated in Greece with the Ionian philosophers Thales, Anaximander, and Anaximenes. . . . [T]he Ionian philosophers were the first to believe that people could understand the universe using reason alone rather than mythology and religion. They searched for a prime cause for all natural phenomena. No personal forces of gods were involved, only impersonal, natural processes. (Hellemans & Bunch, 1988, p. 21)

One of the first tenets of science that developed, then, was a faith in human reason over superstition, myth, and religion. This faith in reason seemed justified by the great progress many cultures had made in mathematics during this period. Interestingly, this faith in reason changed the very

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way phenomena were defined. For example, Anaximander put forth the opinion that the rainbow was a natural occurrence rather than a divine act of the gods (Hellemans & Bunch, 1988, p. 21). Indeed, the faith in reason was destined to redefine the phenomena around us because, rather than look to the gods, humans turned to observation and reason.

The themes we see for science as we approach the Christian era were (1) that by observation and taxonomy we can organize phenomena in a consistent and stable way, and (2) that by applying reason and mathematics to our observations we can explain phenomena without the use of explanations based on myth or divine interdiction. However, these two tenets did not occur uniformly throughout all cultures.

The attitude of Chinese society toward nature was quite different from the attitude that developed in Europe during the Renaissance. The Chinese never separated the material from the sacred world, and did not have the conviction that people can dominate nature. They were not interested in developing a scientific method; thus their theories often remained divorced from observation and experimentation. (Hellemans & Bunch, 1988, p. 59)

This is not to say, however, that European science continued to make uniform progress. During the Roman cultural dominance there was little interest in science. Indeed, if it had not been for the rise of Islamic scholarship and the fact that many Greek and Indian works were saved in the libraries and universities of Islam, much of the knowledge acquired might have been wiped out. In addition, Arabs were responsible for major advances in number systems and the invention of algebra and optics (Hellemans & Bunch, 1988, pp. 58–59).

The lack of development in science during the period after the birth of Christ is extremely important because it shows that despite the obvious progress and material advances that could be tied to scientific thinking it was easily dampened if not extinguished for almost a thousand years. Although the causes are complex, Hellemans and Bunch (1988) put one critical aspect succinctly:

Several reasons for the decline of science in Europe between 530 and 100 have been put forward by historians. For one, European culture was still strongly influenced by the Romans, who were notoriously little interested in theoretical science. (p. 58)

It must also be recalled that Christianity itself originated from a largely nonscientific culture and so did not offer supports for the development of science. In addition, the Black Death that swept Europe in several waves

created a huge distraction. But what is instructive about this era is that without cultural and social support and value for scientific theory, the activity of science can be lost.

With the Renaissance in the 1400s, science once again began to flourish. Most readers are familiar with the Copernican revolution in astronomy (1543) and the acceptance of this position by Galileo until the Inquisition of Pope Urban VIII led to his recanting the Copernican theory (1633). The position of the church was that a literal interpretation of the Bible states that Earth is the center of the universe. Although Copernicus had developed a theory that allowed for better prediction of planetary motion, at the time of the Inquisition it was still one among many theories. It is, however, much more revealing that the church did not change its denial of Copernican theory until well into the 20th century (1922) (Hellemans & Bunch, 1988, p. 134).

The Renaissance was also marked by a flurry of explorations and demands for better navigational systems. Universities were founded throughout Europe, although this process began in the 1200s. Leonardo da Vinci developed the notions of capillary action, pendulum clocks, and drawings for a flying machine. In some ways the late Renaissance also gave birth to the philosophy of science. Bacon's *Novum Organum* (1620) argued that induction is the basis of the scientific method. Bacon's logic of induction would serve as counterpoint to the writings of rationalist philosophers such as Descartes (b. 1596) and would later be pilloried by the success of Newton (b. 1642).

Hellemans and Bunch (1988) state that the period 1660 to 1734 provides a fundamental revolution in the thinking within science. Newton's *Principia* (1687) described the three laws of motion and the universal law of gravity. The great advances of Newton were in part due to the mathematical advances in calculus prompted by both Newton and Leibniz. In relation to the scientific methods, Newton provided a combination of the pure rationalism of Descartes and the inductive empiricism of Bacon. Indeed, it might be impossible to separate his empirical observations such as musing on falling bodies (apple and moon) from his rationalistic deductive approach using mathematical equations to predict observations. Newton's great success was to cement the perspective that rational empiricism and theory are necessary components of science.

It is interesting that after the theoretical work by Newton, physics, astronomy, geography, and earth sciences made great strides. However, chemistry was mired in adherence to a theoretical dead end with Stahl's (1723) theory of phlogiston and did not emerge from the intellectual doldrums until the 18th century (Hellemans & Bunch, 1988, p. 191). The inductive taxonomic work of Linnaeus (*Systema Naturae*, 1707) positioned biology to become



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theoretical; however, Linnaeus dampened such moves with his dismissal of the notion of evolution in 1751 (Hellemans & Bunch, 1988, p. 206).

By the 1800s, however, chemistry was on its way to atomic theory (Dalton) and the biological sciences were to develop evolutionary theory (Darwin) and genetics (Mendel). Indeed, although science in the 1700s was clearly dominated by physics, the 1800s were dominated by chemistry and even more so by biological sciences. Although Adam Smith (1723–1790) had laid the foundation for economics, this was expanded to population dynamics in the work of Malthus (1798/1872). Throughout the 1800s, the embryonic social sciences struggled to separate moral philosophy and religion from scientific observation and theory. This was, of course, the same gauntlet through which physics and astronomy had passed (Galileo and the church) and through which evolutionary theory would have to pass in the 19th century. Even before Wallace or Darwin published any influential works on evolution, the public had rejected the notion put forth by geologists that Earth was much older than indicated in the Bible. This was, of course, only a mild prelude to the public response the theory of evolution was to receive. With the spread of evolutionary theory and natural history during the 1800s, the social sciences of archaeology and anthropology also developed (Hellemans & Bunch, 1988, p. 272).

The 20th century was marked by enormous technological change in addition to scientific progress. The development of the theory of chemical bonding (Pauling) finally cemented theory in chemistry. In physics, of course, Einstein's theories of relativity and the resulting technological implications (nuclear bomb) showed that Newtonian theory had been eclipsed. In addition, the development of quantum physics (Planck, Bohr) threatened to split physics into two disparate areas: microphysics and macrophysics. In medicine, Fleming's discovery of penicillin saved millions of lives. Some of the social sciences, especially anthropology and economics, made significant advances. And at the close of the century, geneticists completely mapped the human genome. Physicists and astronomers were wrestling with one of the most basic notions in physical sciences, the concept of time and how it might be measured. In many ways, science in the 20th century is still too close for us to gain a perspective of which of these developments, if any, is the main channel of the river.

What we can summarize from this very brief historical perspective on science is that physics alone does not represent science. Second, sciences seem to advance on the basis of foundational observation and categorization followed by theoretical advances. Third, the public has continually been annoyed with the fact that science proceeds without the assistance of commonly held myths and religious beliefs, and explains events without

invoking gods. Finally, the methods of science seem much more a mixture of induction and deduction combined with generous amounts of creativity and intuition than any philosopher of science would want to admit.

## Critics and Postpositivism

Thomas and Wilcox (1987) use the term “postpositivism” to refer to the cluster of criticisms about positivistic science that have emerged in the last 50 years. Gross and Levitt (1994) see postpositivist claims as threatening to return science to the “dark ages.” In general, what are viewed with such dismay are claims about the “relativity” of knowledge, whether or not there is an underlying reality, and the objectivity of a knowledge claim. Although these issues and arguments are not new to many social scientists, they have taken on new and formidable statements in the hands of current postpositivists.<sup>1</sup>

### Positivism

Before we find out about the nature of “postpositivism” it is useful to depict the character of “positivism.” The term “positivism” is associated with one of the fathers of social science, August Comte, rather than a scholar from the physical sciences. Comte (1798–1857) imagined a pantheon of sciences with sociology occupying its highest rung. The details regarding “positive” methods of knowledge are somewhat sketchy. Comte believed that observation by the physical senses was the foundation of positivism. He stressed that observation could only be useful when it was guided by theory. It was not his emphasis on theory that marked Comte’s work but his emphasis on observation. Until and including Comte, social theory had been infused with large amounts of ideology, utopianism, and moralistic banter. Comte’s “positivism” emphasized sense data and scientific principles. In large part, the radical contribution of Comte was his argument that the methods of science used in the physical sciences could and should be adopted in the social sciences.

After Comte, the social sciences in general headed down the road of positivism. Contributions by Durkheim, Burgess, and many others drove the social sciences into a headlong imitation of the methodological techniques used by the physical sciences. That is not to say that there were not some sidetracks, such as the Weberian method of *verstehen*. But the early analytic positivism of sociology led by Durkheim and Tönnies moved forcefully into the 20th century. Throughout the 20th century, scholars such as Merton and Parsons (for general sociology) and Burgess and Hill (in the area of family) emphasized

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a moderate view of positivism. (A more extreme view is represented in the work of Lundberg (1942).)

As White and Mason (1999a) observe,

Even though positivism has been inextricably linked with quantification by some of its critics, this is not a necessary criteria for a discipline being positivistic. For example, much of contemporary biology, geology and geography developed without the formal mathematics found in chemistry and physics. So quantification is not one of the defining factors of positivism. Martindale (1960) identifies positivism as “. . . the view that the methods which had proved their worth in the physical sciences were appropriate to the study of social phenomena. . . .” (1960, p. 73). This view then presents us with an historically diverse picture since scientific methods and our understanding of them have changed over time. For example, Bacon’s *Novum Organum* (1620) presented an inductivist’s view of science where all knowledge was gained by observation. By the time of Newton, this notion that by classifying and organizing our findings scientists will “find” laws and theory, has been overwhelmingly rejected. As Martindale notes “Sir Isaac Newton’s *Principia* (1687) fused the two major elements of science—rational proof and experimental-observational evidence” (1960, p. 24). The inductivists’ emphasis on observation, measurement and data lacked the creative ingredients of science which are the rational and mathematical. Today’s science can be characterized as “rational empiricism.” (p. 4)

Today, most philosophers of science would characterize science as a combination of two disparate epistemologies: rationalism and empiricism. On the one hand, empiricists such as Hume (1711–1776) argue that all our knowledge comes from experience of sense data and associations. The empiricist perspective is very much focused on induction and would assume that knowledge is “discovered” from observations. On the other hand, rationalists such as Descartes (1596–1650) or Kant (1724–1804) posit that the associations and connections formed are based on *a priori* structures or forms of thinking that ground formal reasoning, such as mathematics. Indeed, the newer versions of rationalism might be represented in structural works such as those by Chomsky and Levi-Strauss.

The argument between these two epistemologies is an old one (see, for example, Plato’s *Meno*). The basic argument is whether our knowledge is “out there” and “discovered” or is already in our heads and is “constructed” or “*a priori*” to experience. Fortunately, we do not have to get into this debate because contemporary science is quite ecumenical (though philosophically incoherent) in this regard. Contemporary science has largely adopted criteria from both epistemologies. From the rationalists, science has adopted the criteria that knowledge must be in a logical or systematic form. This is

not as restrictive as it might sound because there are a great many ways to think “logically.” At the base of all of these various logical systems, however, is the assumption that our thinking should at least be internally consistent and not contradictory with what we are saying. One might debate whether this is a criteria for a knowledge claim or a criteria for the “comprehension” of a knowledge claim because I am not sure how humans would understand a proposition ( $a = a$ ) is simultaneously true and false.

Empiricism, on the other hand, has a long history in science. Certainly early philosophers of science, such as Bacon (1561–1626), believed that observational inductionism was the *sine qua non* of science. After the advances in physics by Newton, sheer unadulterated inductionism was de-emphasized in science. However, the criteria persist that any knowledge claim must be judged and scrutinized by comparison to sense data. Indeed, science without empiricism would be only speculative philosophy or theory. The notion of measurement is especially tied to the criteria of subjecting claims to sense data validation. In the next chapter we will need to explore the nature of measurement and sense data to better understand how theory works. For the moment, all we need is to understand that the empirical criteria is essential to contemporary science.

Even though these two epistemological positions may be at odds, contemporary science is catholic in its use of both. Contemporary science would like knowledge claims to be both rational and empirical. That is, science would like a knowledge claim to be logically coherent (within a system) and to be empirically valid. The characterization of positivism as rational-empiricism would not pertain to the entire history of science because at times science has been dominated by observationalism, inductionism, and rationalism. At the present, however, any discussion of positivism (meaning contemporary science) must take this dual character into account.

These two perspectives on science were fused together by the positivist philosophers (especially Braithwaite, 1953; Carnap, 1966; Hempel, 1966; Popper, 1959; Reichenbach, 1958; Rudner, 1966) into a picture of science commonly known as the “hypothetico-deductive” model. This model of science sees empirical induction building general propositions, which are then tested by deducing predictions that are either “true” or “false.” It is this model of science that is the principal subject of criticism.

### Three Critiques of Positivism

The philosopher of science Frederick Suppe noted in 1977 that critiques of the positivistic view of science had been so devastating that by the end of the 1960s science was in a state of disarray and confusion (p. 618). Among

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the many critics are Feyerabend (1975), Gadamer (1982), Habermas (1971), Knapp (1997), and Longino (2002). Although there are many critiques from diverse sets of background assumptions (see Knapp, 1997; White, 1997; White & Mason, 1999a), three principal areas of criticism seem to emerge: constructionism, relativism, and the impossibility of a science of human behavior. A few years ago, White and Mason summarized the many and varied arguments against positivism in two overarching questions. Since White and Mason (1999a, 1999b), important arguments, such as those raised by Longino (2002), have been launched that clarify and focus the questions to a much greater extent than previous discussions. In this section I will discuss each of the following three critiques of positivism: contextual arguments, decidability arguments, and arguments about the possibility of science of human subjects.

### Contextualism

The contextual argument is most properly identified with Kuhn (1962, 1996). Kuhn argues that the history of science is characterized by political upheavals rather than scientific discoveries. The most radical interpretation of Kuhn is that knowledge claims are accepted by the scientific world according to the same political principles of greed, career enhancement, and fame that drive many other political agendas. Thus replication and certitude are illusory compared to the desire for scientists to conform to the expectations of colleagues or to be on the “winning” side.

Positivism is a social construction that is a product of its time and place. Critics point out that science itself, as all knowledge, is a social construction. Scientists are convinced of measures and findings on the basis of status and rewards within the historical context or period, rather than any kind of objectivity. As a result, the notion that science is objective is suspect. Because science proceeds as a political process, the accumulation of knowledge that science supposedly holds as a goal may be illusory and unreachable.

### Relativism and Decidability

Decidability arguments focus on whether any knowledge claim from science can actually be proven to be true or false. Clearly, if knowledge claims cannot be verified then science becomes speculative philosophy at best. There are several components of this argument.

One important component of this argument comes from logicians. Scientific rationalists often held up deductive systems as offering science the power to predict and accumulate knowledge across contexts. However, mathematicians

such as Godel brought such assumptions into question. Later, Suppes (1960) in his work on axiomatic set theory demonstrated that not all assumptions could be generated for any logical deductive system. As a result, deduction becomes less than the definitive and certain tool envisioned by rationalists.

In addition, the analytic philosopher Wittgenstein (1958b) suggested that the natural language we use to compose knowledge claims and propositions is incomplete. Other scholars, such as Derrida (1976), continued to discuss the vagueness in language systems (propositions) that make any knowledge claim inherently ambiguous. As a result, every scientific proposition is viewed as so ambiguous that it will not afford definitive tests for its truth or falsity.

The second closely related component and extension of the preceding criticism is the argument that science lacks any “foundation” that would assure that its knowledge is objective. This criticism is often called “antifoundationalism.” The antifoundational argument assails the assumption that science has any epistemological claim to objectivity. Certainly the arguments about deduction and vagueness feed into this argument, but the crux of the argument focuses on objectivity and the fact that all knowledge is a social construction. It often is pointed out that objectivity is an illusion since it would mean curtailing normal human valuations and perceptions colored by time and place. Certainly Kuhn’s (1962, 1996) work establishes that measurement is tied to the scientist’s time and place. In addition, anti-foundationalists argue that evolutionary theory in both biology and physics predicates a changing world of existences, such as an expanding universe. What we observe today may be different the next day, not because of measurement error but because change is endemic to the world.

## Science of Human Behavior

Many scholars have expressed doubts as to the possibility of a science of human behavior. Certainly Weber (*Gesammelte Aufsätze zur Wissenschaftslehre*, Gerth & Mills, 1958) expressed concerns, and more recently so did such scholars as the philosopher Winch (1958) and the sociologist Blumer (1962, 1969). The criticism is that humans and their activities are more complex in their meanings than can possibly be captured by quantitative measures. Although this is often a complex series of arguments, it can be summarized as the argument that human activity is a meaning construction activity of the actor developed by the actor’s manipulation of symbols and meanings in the actor’s social world. A “behavior,” therefore, does not have the same uniform meaning across actors and situations. But counting a “behavior” assumes a uniformity of meaning of the activity, one that for

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Blumer does not exist except in the mind of the quantitative social scientist (Turner, 1991, p. 400). This critique, popular among ethnomethodologists, suggests a more qualitative and interactive type of research process. Turner (1991) notes that for Blumer,

the research act itself must be viewed as a process of symbolic interaction in which the researchers take the role of those individuals whom they are studying. To do such role taking effectively, researchers must study interaction with a set of concepts that, rather than prematurely structuring the social world for investigators, sensitize them to interactive processes. (p. 401)

An important element in this criticism is that positivistic science does not incorporate the reflexive nature of humans into its perspective. Since humans learn and change, they modify their behavior and actions based on the very knowledge gained by science. White and Mason (1999a) use the following example:

Twenty years ago it was relatively uncommon to hear people discussing *social roles*, however, this is common today. The social science concept of “role” has entered the vernacular of the social world and is now used by the general public to explain and interpret their behavior. The social scientist now finds herself interviewing respondents who describe and explain their behavior in what was just a short time ago regarded as the “arcane jargon” of sociology. Knowledge is reflexive in the sense that it becomes formative of human behavior. Science in general and the social sciences in particular have failed to incorporate the reflexive nature of knowledge into their picture of knowledge construction. (p. 16)

## Certainty, Relativity, and Knowledge Claims

One of the notions I developed in the previous history of science is that science is not a monolithic institution following prescribed sets of rules. Rather, science has changed over time, and as a result of these changes it is very difficult to define. Critics of science often focus on the philosophers of science in the 1950s and 1960s that viewed science as being characterized by the hypothetico-deductive model. This particular focus, however, assumes that physics is the model of science to which other sciences should be compared. This assumption is particularly problematic for the social sciences and life sciences. The relevance of this observation will become more clear as we address the issues raised by the critiques of science. This section deals with one among many possible responses to each of the criticisms discussed in the previous section.

## Contextualism

I see the realization that science is subject to political and status-driven behaviors as akin to the observation that “science is a human activity.” Kuhn’s discussion of these processes is quite correct, and anyone who has been a working member of the scientific community can supply examples to further elaborate this point. The problem, however, arises when critics believe that these so typically human foibles compose the totality of science and hence doom science to be nothing more than a political process. Even more important, some critics might take this further and argue that scientific knowledge is not to be trusted.

Some very important points within this critique provide keys to addressing the problem. First, science is a human activity, but it also is a selective human activity that is organized in a particular way with particular membership criteria. Some human activities, such as eating and sleeping, are universal, but science is not of this kind. Rather, science, as we have seen from our brief history, evolved over several centuries and was organized along certain principles. Foremost were the following principles:

1. Science would not look to gods, metaphysics, or other worldly forces to explain what is observed. (principle of metaphysics)
2. Science would not appeal to authority (church, peer, or state) to resolve disputes or supply explanations. (principle of authority)
3. Science was founded on sense observations of our world that could be repeated by any other observer. (principle of replication)
4. Accounts of the way things work must be buttressed by observations. (principle of empiricism)

These four principles forced those interested in science to form a community of scholars that were assailed by kings and princes, bishops and vicars, to see the world in ways that conformed to religion, metaphysics, or the “common sense” of peers. So, for example, the argument that the world was flat received great force from a deeply rooted “common sense.” It was this same common sense that believed Earth to be the center of the universe or skin color to be related to intelligence. Each of these beliefs slowly gave way to the observation and arguments of science.

Clearly the community of scientists irritated church, state, and commoner because they used criteria for knowledge and argument not based on the appeals to authority. Indeed, scientific skepticism of knowledge based on such appeals to authority garnered rejection and persecution of scientists. To protect



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themselves and the knowledge they acquired, scientists tended to discuss and exchange ideas within their community. Thus the scientific community became identified with certain beliefs and methodological criteria necessary for the continuation of inquisitiveness.

Like many organized human activities, the development of a scientific community enabled scholars to elucidate certain ideals. One of these ideals, for which science is currently pilloried, is the ideal of “objectivity.” Objectivity was a term that captured what the four aforementioned principles were attempting to achieve. That is, knowledge that was founded on replicable observations rather than authority and metaphysics. However, this “objectivity” could only be approached and was an ideal, rather than a claim regarding knowledge as some critics contend. As an ideal it was tantamount to not allowing influence from peers, church, or state dictate observations and knowledge. Of course, scientists are human, and even Galileo had to recant the Copernican view of the universe when threatened by the papacy.

So I believe Kuhn and others are correct that science is a human activity with all the normal failings of humans. I find it even less problematic to agree with contextualists that science is constrained by the historical period and place. This agreement with the contextualist view, however, should be complemented by the realization that the great strength of science has been the particular ideals and principles around which these humans are organized. The fact that scientific associations and organizations allow relatively unfettered discussion and argumentation regarding observations and theories is testimony to the evolution of these principles and ideals within this community.

### Relativism and Decidability

If all knowledge is a social construction and the “objectivity” of science is simply an unattainable ideal, doesn’t that suggest scientific knowledge is no different from any other form of knowledge? Furthermore, if there is no epistemological foundation to ensure that scientific knowledge is “superior” or “objective,” then scientific knowledge claims should be judged as all other knowledge claims. Critics of positivism might argue, however, because there is no agreement as to how to decide the superiority of a knowledge claim, that all knowledge claims are either equally true or equally false. This perspective ends up in what Cheal (1991) has termed a “paralogy” of theory and leads the philosopher of science Longino (2002) to conclude,

Knowledge is plural. There may be multiple sets of practices, each capable of producing knowledge of the same process or phenomenon. Different knowers

differently situated and motivated by different cognitive goals may have different and nonreconcilable knowledge of the same phenomenon. There may be multiple epistemically acceptable correct (i.e., conforming) representations of a given phenomenon or process. Which among these counts as knowledge on which to act depends on the cognitive goals and particular cognitive resources of a given context. (p. 207)

Longino, however, fails to address whether this relativism of knowledge is indeed the state of knowledge within science.<sup>2</sup>

As we have seen in our discussion of the development of the scientific community in the previous section, scientists would not be particularly upset if the church, state, or peers failed to accept their theories and claims. However, if knowledge claims and theories were rejected by the scientific community, this would have far greater meaning. The reason for this, as pointed out by Peirce (1955), is simply that the scientific community has developed ways of resolving disputed knowledge claims. Certainly the religions can resolve disputes by means of excommunication, and the state may resolve disputes by wars, but these avenues were neither preferred nor open to scientists. The community of scientists developed criteria for resolving disputed knowledge. First and foremost, scientists would ask which theory or account would best fit with what was observed. If two accounts were equally capable of accounting for observations then logical criteria such as noncontradiction or extralogical criteria such as simplicity (Occam's razor) were invoked.

Some scholars, such as Knapp (1997), have argued that science relies on a "representational" epistemology. That is, science views adequate knowledge as where our knowledge construction corresponds to an independent reality. Certainly the history of philosophy, from Plato's allegory of the cave to the infamous fight between George Berkeley and Lord David Hume,<sup>3</sup> is replete with arguments about the degree of independence between the knower and known. Although I believe this is an important area for continued philosophical speculation, I do not regard it as central to science. Certainly the core of science is that there should be a correspondence between knowledge and observations, but that does not necessarily entail a metaphysical position so much as long-standing methodological criteria. Certainly the correspondence between the "shadow" of an electron and nuclear theory goes way beyond a simple version of representationalism, as does the theory regarding a parallel universe. The important point here is not which criteria are used but is the fact that the community of scientists invoke shared, agreed-on criteria to resolve knowledge disputes. Over time, these criteria will change and evolve as new methodological rules come into vogue and old ones vanish.

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Decidability of the superiority of knowledge claims within science will be decided by the criteria commonly agreed on within science. Of course within particular sciences, such as biology, sociology, and physics, the criteria will vary. Science has, for the most part, been uncomfortable with simultaneously maintaining competing claims such as light particles and rays, or quantum and macrophysics. As Kuhn (1962) has pointed out, however, several schools of thought might develop around particular disputes until they are eventually resolved. But this is not evidence in favor of relativism so much as the normal process of scientific accumulation, thought, and testing.

Relativism is the doctrine that assumes that there is no independent “truth” to knowledge. It assumes that knowledge is relative to the knower and is commonly tied to “subjectivism.” Certainly the quote we used earlier from Longino (2002) could be used as an example of such a position. However, the notion that there is some permanent, epistemologically privileged objective truth is equally noxious. It would be especially upsetting to scientists because it would probably entail a strong metaphysical element. The problem is that world, reality, or whatever, is somewhere between these two positions. As I have argued elsewhere (White, 1997), we only have knowledge that is relatively superior for some purposes over other knowledge. This is the position I equate with the writing of Peirce (1905, 1955, 1958) and more recently the epistemologist Haack (1993, 1998).

Basically, scientific knowledge has proved superior to many other forms of knowledge for certain purposes but not others. If one desires *feelings* of unity, perhaps religion or other forms of mysticism are superior to science. However, if one deals with the social, organic, or physical world for certain purposes, science seems clearly superior. This “superiority” is of course relative to the use and the further caveat that it is fallible. Indeed, Peirce’s “fallibilism” is the hallmark of today’s science. Indeed, the history of science is rich with disproved and discredited theories. Science proceeds by tentatively holding a theory until it is revised, disproved, or simply surpassed. To hold a theory as “true” would turn science (the tentative) into religion (the true). Hatcher (1991) argues this pragmatist perspective.

The same kind of argument applies to the diagnoses and treatment in modern medicine versus those of the witch doctors. Each employs different methods, each has a different conceptual scheme, and perhaps each was considered rational for their particular culture or historical context. It does not follow, however, that the methods of modern medicine are no closer to the truth concerning the causes and treatment of disease than those of the witch doctor. The fact is, I believe, we understand a lot more about how the human body works than our preceding generations, and the burden of proof is on whomever endorses a

position that claims otherwise. We should, in the spirit of fallibilism, conclude that our present understanding is limited and subject to change, but it is superior to prior understanding because it is more effective in restoring health to sick patients. (p. 11)

Thus the problem for many scholars is that the actual situation in which we find our knowledge is not well described by the oppositions of absolute objectivism or subjective relativism. We live in a scientific world of tentative hypotheses and theories, not absolutes at either end of the continuum.

### Science of Human Behavior

From the outset, the term “behavior” creates problems. “Behavior” often denotes unintentional acts and “action” is seen as denoting intentional acts. The intentionality of acts is viewed as critical in certain social sciences (see, for example, Parsons & Shils, 1952). But what I am trying to get at by using “behavior” is the entire pantheon of human activity, including species-specific behavior (ontogenetic), habit (sociogenic), and action (intentional).

The single question that most critics pose is in regard to the reflexive nature of human action. However, reflexivity is a potential and not necessarily an attribute. For example, we still do not fully understand nor can we accurately predict individual fertility. We do not know at this time which behaviors are better analyzed as aggregate behaviors and which as individual behaviors. But the question of whether a social science is possible (rather than desirable) can certainly be answered.

Many scholars contend that studying humans is not the same as studying subatomic particles or geological strata. The scientific study of the physical world is somehow seen as appropriate since these inanimate objects do not direct themselves as do humans. However, if we change the model of science from physics or geology to biology or zoology we have an entirely different argument. Now the question becomes “Can we study human behavior in the same way we study primate behavior?” The answer to this question would seem to be affirmative. So, in large part, many of the objections come from assuming the physical science model as determining what is and is not a “science.”

This is not to say that this perspective addresses many of the important issues raised by such scholars as Winch (1958). In the next chapter we will need to address the use of teleological explanations and intentionality, issues about predicting aggregates rather than individual behavior, and the notion of rule-governed behavior. But for the moment it would seem that a social science is at least as possible as any other life science.

## Theory and Its Critics

One of the glaring omissions in this chapter is an adequate discussion of social science theory. This is intentional. Before we can move to an understanding of how and why scientific theory works, we needed to first have a foundation in science. This chapter has tried to develop such a foundation. I have not pursued the traditional philosophy of science approaches emphasizing various scientific epistemologies because I feel that although such approaches might be philosophically accurate, they are often responsible for some of the confusion social scientists experience in dealing with postpositivist thinking. Rather, this chapter has tried to maintain a larger historical picture and to keep issues as straightforward as possible. If I have erred it will not be in terms of generality but in terms of detail.

The next chapter will, however, make up for many of these oversights. Theory is indeed the driving force behind any science. Science will always be concerned with how we make sense of our world, and it is theory that performs that function. So it is my expectation that the next chapter will address any grievous oversights contained in the discussion of science and its critics.

## Notes

1. This section builds on the discussion of this topic in a previous paper by myself and Lisa Mason (White & Mason, 1999a, 1999b).
2. I remain unconvinced by Longino's (2002) examples from the history of science.
3. I was told about this as an undergraduate in philosophy. Hume the empiricist is rumored to have thrown a book at Berkeley the idealist to awaken him to a world independent of his cognitions.