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# Introduction

## *The Nature of Science*

The primary goal of this book is to demonstrate how to build theory in the social sciences. Specifically, it deals with science, social science, social science theory, and social science theory building.

## ❖ SCIENCE

When we say that this book deals with *science,* we greatly constrain what it is about. Although we often focus on what we know, this book is not so much about what science has taught us as about how to do science. As such, it deals not so much with what we know as with how we know. The word *science* is based on the Latin verb *scire,* which means "to know." It comes from the present participle of that verb, *sciens,* and thus literally means "knowing" (*Webster's New World Dictionary,* 1962). Science is a way of knowing. Science, however, is a particular way of knowing different from other ways of knowing, such as authority, intuition, or tenacity.

People often tell us what they know, either because we ask them or because they tell us anyway. When we ask people how they know something—why they believe it—their answer often reveals the ways of knowing they have relied upon to reach that knowledge. Some people believe that science is at odds with other ways of knowing, to the point where if one accepts science one must reject other ways of knowing. However, science and other ways of knowing are not totally incompatible. Actually, they often lead to the same conclusions, and other ways of knowing can be no less efficient and satisfying than science. If they were not, we would stop relying on them.

Relying on trusted authority, for example, can be a reasonable way to know. If my mother tells me that I should not eat too much candy because it will rot my teeth, then I may find it much more efficient and helpful to take her word for it than to attempt to question her authority and to use other ways of knowing to determine the correctness of her position.

Likewise, I may not know at all what science has to say about the value of having a household pet, and I may not care at all that my best friends strongly believe that pets are more trouble than they are worth. My intuition may tell me that my dog helps relieve stress in my life, and that may be all I need to know about it.

We sometimes hold something to be true simply because it has been that way for as long as we can remember. I have always been happy to receive paper money. I understand that it is just a piece of paper, but I also understand that it is "backed" by the government, which has reserves of gold in Fort Knox, or something like that. I do not really know all the details. In fact, when I start to think about it, I realize that my understanding is quite vague. However, paper money has always worked for me, so I am content to continue using it. We often hold on tenaciously to those things that have worked for us, as long as they continue to work.

In many cases, nonscientific ways of knowing such as authority, intuition, and tenacity serve us well. Much of what we know about ways of knowing comes from a wonderful book by Morris Cohen and Ernest Nagel, published in 1934, in which they explore at length the differences between science and other ways of knowing. The book is divided into two parts. The first part teaches how logic works. There we learn about syllogisms and other principles of logic. The second part teaches how science works. There we learn about hypotheses and other principles of science. It is at the beginning of this second part that

Cohen and Nagel describe so well how science differs from other ways of knowing. They make the compelling argument that science is nothing more than applied logic. Thus, they teach the principles of logic in the first half of their book, and then in the second half they show how these principles can be applied.

The major difference between science and other ways of knowing is that science applies logic to question itself constantly. We will have more to say about this later, but the point here is that this book is about one particular way of knowing, called science, and it is not about other ways of knowing, regardless of how valuable they may be.

## ❖ SOCIAL SCIENCE

When we say that this book applies to *social* science, we further constrain what it is about. Much of science deals with knowledge of nature and the natural world. It focuses on the study of naturally occurring phenomena and how they relate to each other, the structure of the universe, and the activity of its elements. This has become known as *natural science.* Natural science has been divided further into a number of subareas, including botany, chemistry, geology, physics, and zoology, with each of these fields concentrating on a different aspect of the natural world.

Social science, on the other hand, deals with knowledge of society and the social world. It focuses on the study of socially constructed phenomena and how they relate to each other, the structure of society, and the activity of its members. It also has been divided further into a number of subareas, including anthropology, communication, economics, history, political science, psychology, and sociology, with each of these fields concentrating on a different aspect of the social world.

There is nothing magical or mysterious about these demarcations. They are mostly a matter of convenience. Likewise, each of the subareas of the natural and social sciences is divided into further areas of specialization. One's study of chemistry, for example, may be limited to inorganic chemistry, or one's study of psychology may be limited to cognitive psychology.

When we say that this book is about the social sciences, as opposed to the natural sciences, we are not saying that the scientific method is substantially different in these two major branches of science. The natural and social sciences differ in how long they have existed, in the varieties of research methods they tend to use, and in other ways, but if one studies the scientific method in the natural sciences one will learn essentially the same general approaches to knowing as one learns from the study of the scientific method in the social sciences. The scientific way of knowing how chemical elements interact is similar to the scientific way of knowing how members of a social group interact. What differs most is the object of study. Therefore, those interested in the natural sciences could use this book to learn how to build theory in the natural sciences. What they will not find here are many particular references to and examples from the natural sciences.

Some scholars will hold that we are not going far enough here in noting the significant differences between the natural and social sciences. The eminent sociologist Robert Merton (1957) wrote thoughtfully about differences between the "more mature" sciences and the "immature" and "fledgling" discipline of sociology, noting that "between sociology and these other sciences is a difference of centuries of cumulating scientific research" (p. 87). Two major developments have occurred since Merton wrote this in the 1950s. First, sociology and other social sciences have grown. The "more mature" sciences always will have—by definition—an advantage of centuries more of cumulative scientific research, but the social sciences since the 1950s have made considerable strides in research and theory. They will always be less "mature" than the natural sciences, but as time passes these differences become less characteristic and meaningful, just as the differences between a 17-year-old human and a 27-year-old seem more substantial than the differences between a 50-year-old and a 60-year-old. Second, rather than simply adding to the cumulative firmament, some recent research in the natural sciences is calling into question fundamental beliefs about the nature of things. Previously unshakable principles, some so basic that they were elevated to the status of natural "laws," are now being challenged. A half-century ago, it was commonplace to believe that the natural sciences had a decided advantage in that their objects of study were much more predictable than those of the social sciences. If one knew the laws of motion, one could predict how a billiard ball would react when struck by another ball. A chemist could predict with great confidence how a mixture of two elements would react. The social sciences, in contrast, deal with people—objects that appear to be much less predictable than billiard balls and chemicals.

This difference was believed to be so significant that the natural sciences became known as "hard" science and the social sciences as "soft." Now these differences are not so clear, and challenges believed to be limited to the social sciences are being faced in the natural sciences as well. We now know that when subatomic particles are observed, they move in unpredictable directions. It is interesting to learn that the behaviors of people are no less predictable than the subatomic particles of which they are made. In view of these developments, we prefer to focus more on the similarities between the natural and social sciences than on their differences. We appreciate Merton's (1957) recommendation that in discussing sociological theory

> [e]very effort should be made to avoid dwelling upon illustrations drawn from the "more mature" sciences—such as physics and biology—not because these do not exhibit the logical problems involved but because their very maturity permits these disciplines to deal fruitfully with abstractions of a high order to a degree which, it is submitted, is not yet the case with sociology. (pp. 85-86)

We follow Merton's advice here and use illustrations drawn from the social sciences rather than the natural sciences, but not because we believe it is unrealistic in the social sciences to deal with abstractions of a high order. To us, it is more a matter of efficiency. All sciences, natural and social, are becoming more specialized. As research accumulates and literatures grow, it is becoming increasingly difficult to master even subareas of a discipline. We limit our illustrations here to the social sciences for two reasons: one, to help readers by using examples they may find familiar and, two, to introduce readers to new territory in related but not exceedingly distant fields.

## ❖ THEORY

When we say that this book deals with social science *theory,* we further constrain what it is about. The word *theory* sends a glaze over the eyes of most people. This is somewhat ironic because the word *theory* comes from the Greek *theoria,* which means "a looking at." To most people, however, *theory* seems to mean "removed from reality." Most people may not know much of anything about theory, but they see it as impractical, irrelevant, and nonessential. To them, theories are either so esoteric and complicated as to be incomprehensible or so commonplace and obvious as to be platitudinous. Either way, to most people, theories seem to be of little use.

Most people, however, misunderstand what a theory is and what a theory does. In reality, people use theories every day. They have informal theories about how to choose a bait, a date, a mate. A theory is simply one's understanding of how something works. Theories we accept we may affectionately refer to as common knowledge or common sense, aphorisms or maxims. Theories we disfavor we may disparagingly call folktales or folklore, superstitions or old wives' tales. Informal theories are handed down to us from many different sources, including relatives, friends, business associates, teachers, spiritual leaders, and government officials. As long as they work well, we tend not to question them.

Science is another source of theories. In fact, science is all about theory. The goal of science is to produce and test theories. As we pointed out earlier, the major difference between science and other ways of knowing is that science constantly questions itself. Science tries explicitly to state its theories, to pose them in formal ways using precise statements so that it is clear what they are saying, to test them, and to confirm, modify, or discard them. Science is the ongoing business of coming up with new ideas and finding ways to challenge them. This notion of testing and revising is what separates scientific theories from the informality that characterizes informal theories.

Some scientists would sneer at the idea of predicting the future, but that is precisely what they often are trying to do. The reason we want to understand how something works is to enable us to make plans, to have expectations about how something will behave, to control things better—to predict the future. Though it is true that some science is intent on explaining past behavior, with no regard for whether that behavior currently exists or may exist tomorrow, most science is concerned with explaining what is happening now and is likely to happen again. Furthermore, even the study of the past is often fueled by an interest in what it might tell us about the present and the future. Thus, although textbooks often state that theory is meant to describe, explain, or predict, theory almost always is meant to explain in order to predict. The goal of theory is not so much to explain things as to use explanations to predict things.

When science is successful, it changes our understandings of how things work. There is an irony here. Humans generally want things to be predictable. They want their planes to arrive on time, their jobs to be there in the morning, their peach trees to produce sweet peaches. The very reason humans value science is its awesome ability to allow them to predict things. How does science accomplish this goal of making things predictable? It strives to challenge and change our predictions. Science is thus a never-ending battle between the world as we think we know it and the world as we *will* think we know it.

It is also somewhat ironic that humans can be so amused at the misunderstandings of those living in the past without recognizing the extent to which they themselves are also misunderstanding things. The Earth is flat. The atom is indivisible. The speed of light is insurmountable. We believe things today that our children will not believe tomorrow. Not long ago, a daily newspaper ran a story with this headline: "The speed of light is exceeded in lab" (Suplee, 2000, p. A1). The lead paragraph said that the scientists caused "a light pulse to travel at many times the speed of light." An inset quote from one of the researchers said, "Our experiment does show that the generally held misconception that 'nothing can move faster than the speed of light' is wrong." What other "laws" of nature will become "misconceptions" tomorrow? Science is not for the faint-hearted.

## ❖ SCIENTIFIC JARGON

Many people get confused by the jargon used by scientists to describe what they do, and they are particularly confused by such terms as *theory, hypothesis,* and *law.* To some extent, the confusion is understandable because the differences among these terms are blurred. The differences rest on the nature of the evidence that supports the law, theory, or hypothesis. Although we have just said that we intend here to use examples mostly from the social sciences rather than from the natural sciences, in the following discussion our examples come from the natural sciences because we want to use examples with which most people are familiar, without having to explain them. Also, one would be hard pressed to find an example of a scientific law from the social sciences.

Scientists rarely elevate a scientific statement to the status of *law* because that implies that observations have been made with unvarying uniformity. Thus, scientists refer to "the law of the conservation of energy" because this is a principle of science that has never been successfully challenged. As we noted earlier, however, recent scientific discoveries are challenging even some of the most long-standing and cherished of scientific principles. Because science is in the business of constantly questioning its findings, it would seem wise to limit greatly the use of the term *law.* Perhaps science should outlaw the use of the term *law.* Some would argue, however, that the term does serve a useful purpose in that it distinguishes the many "mere" theories from the very few that have never been successfully challenged. Perhaps these do deserve a special designation to note their rare and special status.

In contrast to a scientific *law,* a scientific *theory* is a statement of science that implies considerable evidence but not complete uniformity of findings. Given the nature of science, it is therefore understandable why science consists primarily of theories and research testing theories. Because theory implies the existence of competing ideas, theories are by nature controversial. Scientists also may disagree about what constitutes "considerable" evidence. The scientific method is designed to help scientists resolve such debates, but the fact remains that scientists are humans and humans make mistakes, so there is always a certain amount of fuzziness and uneasiness surrounding theories. If scientists can be wrong about scientific laws, they certainly can be wrong about scientific theories. Thus, although there is a vast amount of evidence supporting the theories of electromagnetism, evolution, and relativity, it is perhaps better to think of them nonetheless as theories rather than as laws.

Considerably more confusion exists regarding the differences between a *theory* and a *hypothesis.* Even dictionaries can lead one astray. *Webster's New World Dictionary* (1962), for example, defines a hypothesis as an "unproved theory." However, no theory is ever completely proven or disproved (Popper, 1968)—that's what makes it a theory and not a law. The sort of thinking that treats a hypothesis as an "unproved theory" contributes to the confusion of these terms. Thus, Webster's defines the nebular hypothesis as "the theory that the solar system was once a nebula which condensed to form the sun and the planets" (p. 980). In actuality, the reason the nebular hypothesis is a hypothesis and not a theory is that it lacks enough evidence to support it. If and when enough compelling evidence is gathered, the nebular hypothesis may be raised to the status of a theory. A hypothesis is a scientific statement that asks to be tested. Thus, new scientific ideas are by definition hypothetical. With considerable evidence, they may become scientific theories. If they ever reach the point where every observation invariably supports them, they may even come to be called scientific laws.

## ❖ DOING SCIENCE

Science has contributed much to our understanding of how the world works, and many books have been written describing the discoveries of science. New students of psychology, chemistry, anthropology, economics, and other sciences will read about the major theories in the history of their discipline, the research that has been done to test those theories, and the leading contemporary theories and research. If they are successful, these students will take this knowledge and apply it, becoming practitioners in their field.

Some of these students, having learned what science is, will endeavor to do science. They will turn to a smaller set of books, those that teach the student the methods of science in their field. They will read about how to conduct research in order to test theories and to improve methods. If they are successful, these students will take this knowledge and apply it, becoming researchers in their field.

Some of these students, having learned what science is and how to do it, will endeavor to change science. They will turn to an even smaller set of books, those that teach the student how to create theories in their field. They will read about how to build new models of things that offer better understandings of how they work. If they are successful, these students will take this knowledge and apply it, becoming theory builders in their field.

It is for these last few students that this book is written. Our hope, however, is that this book will increase the numbers of those interested in doing this most difficult job of science—creating new theories.

The authors of this book remember well their advanced formal studies that included readings about theory building. Because we all now regularly teach advanced theory and methods courses, we also get to relive with our students the experience of being introduced to this difficult topic. There is just no getting around it: Building theory is a tough job, and learning how to build theory is almost as challenging.

Theory building is difficult because it requires both great discipline and great creativity, and although a person may possess one of these attributes, few people seem to possess both. In fact, we suspect that those who possess one of these attributes are likely not to possess the other—that those characteristics that make for a great disciplinarian do not make for great creativity, and vice versa. But that is just an untested hypothesis we have. What we do know, tried and tested from many personal experiences, is that theory building requires excruciating attention to detail coupled with wild flights of imagination. About the only solace we can give those about to embark on theory building is that it probably won't kill you and that if it doesn't kill you it probably will make you stronger.

Theory building requires hard work, but, unfortunately, hard work isn't enough. Theory building also requires an ability to see things that others have not been able to see, to synthesize disaggregated parts into a new whole. It is this part of theory building that is perhaps most frustrating. For though it is possible to teach someone to work hard, how do you teach someone to be creative?

The eminent social scientist and teacher William McGuire (1976) grappled with this question. He claimed that social science instruction devotes at least 90 percent of its time to teaching students ways of testing hypotheses and that "little time is spent on the prior and more important process of how one creates these hypotheses in the first place" (p. 40). This neglect of the creative phase of science, he argued, probably comes neither from a failure to recognize its importance nor from a belief that it is trivially simple; "rather, the neglect is probably due to the suspicion that so complex a creative process . . . is something that cannot be taught" (p. 40). But although he admitted that "creative hypothesis formation cannot be reduced to teachable rules" and that "there are individual differences among us in ultimate capacity for creative hypothesis generation," he nevertheless maintained that "we have to give increased time in our own thinking and teaching . . . to the hypothesis-generating phase of research, even at the expense of reducing the time spent discussing hypothesis testing" (p. 40).

We agree with McGuire that social science would benefit greatly if we devoted more attention to teaching future scientists to be both creative and critical in their approach to their work. It is in this spirit that we write this book. That is the task we have set before us, and it is no easier a task than the one we ask the reader to assume.

## ❖ OUTLINE OF THE BOOK

In this chapter, we have attempted to make it clear to the reader what this book is about. In the process, we briefly noted some of the essential ideas, such as what a theory is and why we need theory. These ideas will be explored more fully throughout the rest of the book.

Theory building is a process that can be broken down into a series of steps. We have designed the book so that each of the subsequent chapters covers one of these steps. Although it is possible to read the chapters out of order and to read any one chapter independently of the others, the best way to understand fully the process of constructing a theory in the social sciences is to master each chapter in turn. We feel confident that the patient and careful reader who follows this plan will be rewarded.

Let us focus for a moment on the importance of patience. One of the great obstacles to learning how to build theory is the jungle of jargon one encounters whenever exploring this subject. Students can quickly become frustrated when faced with myriad terms that are sometimes distinguished without appearing to have any meaningful differences and at other times are used interchangeably when meaningful differences exist. We have already encountered disputes about the "proper" use of terms such as *law, theory,* and *hypothesis.* One of our primary goals in writing this book is to attempt to bring some order to this bewildering and confusing use of jargon. This requires both discipline and patience on the part of the reader. In each chapter, we introduce an important step in theory building, we identify the important elements of that step, we define these elements, and we note how they are similar to and different from other terms found in the literature of theory building. Thus, when we introduce the idea of *concepts,* we note how they are similar to and different from other ideas, such as *constructs.* We then state when and how we will use important terms, which terms we will ignore, and why. Then, when we move on to the next step in theory building, we use only the selected terms.

The rest of this chapter describes the remainder of the book. We hope that the reader will give each chapter the attention it deserves before moving on to the next. In this way, the reader will learn the challenging activity of theory building with the minimum amount of difficulty.

Chapter 2 introduces the concept of concepts. As the chapter title notes, we consider theoretical concepts to be the building blocks of theory. Theories are statements, and statements are made up of concepts. Our first job in theory building, then, is to identify and define the concepts in our theory. Chapter 2 discusses the various types of concepts used in theories, as well as distinguishing concepts from other terms used in theory building. In this chapter we will learn about the differences between concepts, constructs, and variables and why these differences are important in building theory. We then will discuss the notions of independent versus dependent variables, categorical versus continuous variables, and dimensions, which are ways of converting categories into continua. We also will explore the differences between theoretical and operational definitions and the "meaning space" of a concept. At least some of these ideas probably sound unfamiliar to you, but once you are able to identify these basic elements of theory building, you will be ready to consider how to use them to construct your own theory.

Beginning with Chapter 3, we discuss ways to combine concepts into theoretical statements. We start with the simplest case, which is the construction of a theoretical statement relating just two variables. Just as there is an array of terms similar to *theoretical concept,* there is an array of terms similar to *theoretical statement.* We will identify the commonly used synonyms and related terms, including *axiom, postulate, hypothesis, assumption, theorem,* and *proposition,* and show how they are alike and different. We also will discuss the difference between a research question and a hypothesis and between categorical statements and continuous statements and why these differences are important in theory building.

In Chapter 4, we discuss theoretical and operational linkages. Once we have produced a theoretical statement, the next step in the theory-building process is to state explicitly why we think this statement makes sense. The rationale for our theoretical statement is called a *theoretical linkage.* Suppose, for example, that we suspect that the more television violence a child watches, the more aggressive the child will become. The theoretical linkage for this statement would include the various reasons supporting our hunch. These might include research that shows how children learn to model behavior they see on television and studies that demonstrate how children are attracted to violent content on television. The theoretical linkage builds our case for our theoretical statement. It is our argument for why we think it is reasonable to believe that one concept, such as television violence, may be connected to another concept, such as child aggression, in the way that we have specified.

Once we have laid out *why* we think our concepts are connected, we lay out *how* we think they are connected. This is called the *operational linkage.* Some connections between concepts may be simple, but others may be complex. For example, it might be the case that a little television violence has no discernible effect on aggression but that as viewing becomes heavier, aggression increases exponentially. Or the opposite might be true, so that just a taste of television violence might have a profound effect on aggression and additional increments have little added impact. The operational linkage describes explicitly how we think the concepts in our theoretical statement are related. In Chapter 4, we also introduce a particular and important kind of connection between concepts, the causal relationship.

In Chapter 5, we extend our discussion of theoretical statements to those containing three concepts. Here, we explore how three variables might be related, including the notions of control variables, contingent conditions, and intervening variables. Five types of three-variable relationships are identified. We also discuss how to express three-variable relationships in hypothesis form, as well as theoretical and operational linkages for three-variable relationships.

Chapter 6 continues and concludes our discussion of theoretical statements with a treatment of those that relate four or more variables. As we will see, the addition of just one variable to a theoretical statement can greatly complicate it, and strategies for dealing with this complexity are suggested.

Chapter 7 introduces the notion of theoretical models and how to use them to build theory. As we will see, a *model* is not the same as a theory, but a model can be employed as a form to represent a theory. A model simply represents an object or process so as to highlight its key components and their connections. We also will discuss how to derive theoretical statements from models.

In Chapters 2 through 7, we describe the process of theory building as a series of steps leading from the identification and definition of concepts to the expression of their relationship in a theoretical statement, the construction of a rationale, and the specification of measurements. If one knows this format for the production of a scientific theory, then one is well prepared to build theory. Generating a good theory, however, requires more than knowledge of the rules. Following these procedures, one can produce a theory that is brilliant or one that is pedantic. The subject matter of the theory, the insights it produces, the contributions it makes to the advancement of science—these will depend upon the creativity of the theory builder. In Chapter 8, we discuss ways to think creatively in order to produce an insightful theory. Some may argue that it is impossible to teach someone to be imaginative, but we beg to differ. In this chapter, we suggest some techniques and exercises for producing the creative spark that can lead to a significant theory.

In Chapter 9, we discuss the uses of theory and the criteria for evaluating a theory. Here we also promote an effective approach to research known as *strong inference*, and we cover important constraints on theory building that every theory builder should know and try to address.