SECTION 1

WHY IS THIS COURSE SO HARD? IT'S ONLY PSYCHOLOGY!

Principle: Science is a single enterprise united by a seamless web of facts, laws, and theories.

The student who asked this question had just failed her first test in introductory psychology and had come to see what had gone wrong. When I asked my usual diagnostic question about how much she had studied, she said, "I'm a premed major; my father told me to concentrate on my science courses, so I didn't study much for your test—after all, it's only psychology!" The pained expression on my face was real, albeit well practiced, because I hear this all the time.

My student's answer reflected a number of mistaken ideas about psychology. She assumed that psychology is not a technical subject and that it is mostly common sense (see Section 23). But the main idea behind her answer was that psychology isn't a science along with biology, chemistry, physics, and the rest. Now, she has a lot of company in holding that idea, including many professors of those subjects, a good number of psychology majors, and even some psychologists. Many different factors contribute to the idea that psychology is not like the "real" sciences, including the fact that the majority of psychologists are clinicians rather than laboratory psychologists. We cannot deal with each of the factors here. We will consider only the principle that answers them all: the unity of science.

Although we speak of physics, chemistry, biology, psychology, and others as sciences, they are really just different branches of one single science. Science is a way of knowing based on empirical methods—methods based on experience. Any discipline that uses these empirical methods is a branch of science. The philosopher Leibniz said that "[science] is an ocean, continuous everywhere and without a break or division" (cited by Gigerenzer, 2000, p. 1). As one goes from the Atlantic to the Indian Ocean, the water may change from blue to green. But it still flows downhill, boils at about 100°C, and so on. Similarly, it is often hard to tell when one scientific discipline leaves off and another begins. Here's why: First, there are no sharp divisions among the various disciplines; we have physical chemistry, biochemistry, and biological psychology, for example. In fact, the divisions among the scientific disciplines often have more to do with bureaucratic considerations in universities and historical accident than anything else.

Second, many problems that science deals with are interdisciplinary; for example, my own area of special interest is the sense of taste. The main professional meeting for scientists interested in taste is attended by chemists, zoologists, physiologists, anatomists, neuroscientists, and psychologists, among others. All of these scientists apply their expertise to learn how the senses of taste and smell function in humans and other animals.

Third, and most important, although there are some differences among the branches of science, there is an unbroken web of connections among their laws and theories. Humans and animals behave in ways that are compatible with the principles of biology. To take only one example, the brain is the most metabolically expensive organ in the human body. Although it constitutes only about 3% of the body's weight, it consumes up to 25% of its energy. The consideration known as *the expensive tissue principle* implies that the brain must pay its costs by performing vital tasks. Throughout the course of human evolution, those individuals who focused on finding food and mates and avoiding danger became our ancestors. Those who spent their energies contemplating life, the universe, and everything else lost out. In addition, the expensive tissue principle is one reason why it is highly unlikely that we use only 10% of our brain (see Section 21). As Barry Beyerstein (1999) puts it, how long would we go to the expense of heating a 10-room house if we never left the kitchen? Notice also that we have just appealed to the theory of evolution to explain human behavior, another part of the web that connects the sciences.

So human behavior must follow the principles of biology. Biology, in turn, must be compatible with physics. Have you ever seen a horror film in which insects the size of horses terrorize people? We can sleep peacefully at night because the principles of physics make such gigantic insects impossible: Insects lack skeletons needed to bear the required weight; their respiratory systems couldn't move oxygen throughout such large bodies, and so forth. Giant insects are fiction, of course.

In sum, if psychology is a science at all, it is a science essentially like any other because science is a unity.

Exercise: Are there any professors in your psychology department who have Ph.D.s in another field? Are there psychologists in other departments of your college?

Exercise: Ask your instructor to point out contributions of scientists from other disciplines mentioned in your psychology text.

SECTION 2

WHY DO PSYCH
USE SO MUCH JA

Principle: Terms are used in scie
very different from the everyday

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and boring instead.

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SECTION 3

WHY DON'T YOU SKIP THE THEORIES AND GIVE US MORE FACTS?

Principle: The main goal of science is theories, not facts.

People like facts. They seem direct and concrete. Theories, on the other hand, seem tentative and speculative. The line made famous by Sergeant Friday in *Dragnet* was, "Give me the facts, Ma'am, just the facts." Psychologists, on the other hand, always seem to be talking about theories: Pavlov's theory of conditioning, Freud's theory of the unconscious, and so on. Some of these theories contradict one another. As a result, students get the idea that nothing in psychology is known for sure and that we develop theories because we are unsure of the facts.

As a matter of fact (!), theories are far more important to science than facts. A *theory* is a set of interrelated concepts that explains a large number of facts in a particular area of study. Pavlov's theory of conditioning explains why dogs salivate to a bell after the ringing of the bell has been paired with the appearance of a little food in the dog's mouth. Pavlov developed his theory to explain why the dog salivated when the bell was rung without any food. Pavlov's theory is an explanation of the facts.

Science differs from most other human activities in that its primary goal is the understanding of a set of phenomena, not simply being able to predict or control them. An animal trainer may know a great deal of practical information about how to get a dog to jump through a hoop. In fact, most animal trainers certainly know far more about how to train a dog than almost any psychologist who does not happen to be an animal trainer as well. The goal of the animal trainer is to get the animal to jump through the hoop. The goal of the psychologist is to develop a theory to explain the processes that are involved when the dog learns to jump through the hoop.

The goal of the animal trainer is practical. The goal of the scientist is understanding. This is the difference between a cook and a chemist, an electrician and a physicist, a physician and a physiologist, an engineer and a scientist. My inclusion of the last two pairs of professions may require some

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introductory psychology, a stude
from her place of business that s
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But you are probably still
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elaboration in order to make the point clear. The physician and the engineer study a lot of science in their training. And physicians and engineers may both at times be involved in scientific research. But the goal of physicians is healing people, whereas the goal of engineers is building a device. The practical and scientific roles of some professions overlap enough that we often talk of science and engineering as a single category for purposes of education, employment, and the like. Nevertheless, it is necessary to understand that generally the scientist is the only one whose main goal is to develop an understanding of whatever it is she is working on.

You might object that both the scientist and the practitioner have the goal of understanding. But the goal of the practitioner is recipe knowledge: practical, or "how-to," knowledge. The goal of the scientist is theoretical, or "why," knowledge. Once, when I was teaching about personality theory in introductory psychology, a student offered to bring in some very good films from her place of business that she thought would be helpful in studying personality. Upon questioning her, I discovered that the films were training films on how to get along better with fellow employees, how to be a better manager of people, and similar topics. No doubt these were excellent films, and very helpful to her company and its employees. But they were aimed at imparting how-to knowledge, not theoretical knowledge.

There are many reasons why scientists are so interested in theory. A good theory will explain facts that previously were not seen to be related; it will suggest further research that results in new facts; it will suggest new ways of dealing with problems that people face. Someone has said that nothing is as practical as a good theory. Theoretical understanding of learning has improved animal training as well as classroom instruction; theoretical understanding of disease processes has led to new treatments for disease, new medicines, and so on.

But you are probably still bothered by my emphasis on the importance of theories. Don't we ever get to the point where we prove a theory to be a fact? Actually, a theory that is accepted by all as true is still a theory. We still talk about the germ theory of disease, or the gene theory of heredity, or Einstein's theory of relativity, even though there is no serious doubt that they are all true.

Once when I was trying to explain this to a class, one of the students asked, "Do you mean that a theory never grows up to become a fact?" The student had gotten the point. Some theories are wrong; some theories are better supported than others. But a theory cannot grow up to be anything else, because there is nothing better for it to become.

This last point is misunderstood by religious fundamentalists, who claim that creationism should be taught in schools along with evolution because Darwin's theory is only a theory. The State of Kansas for a time removed evolution from the material to be tested on state-level examinations in biology because it is a theory, not a fact. Now, evolution is a "fact" because it happened. (In other words, the theory of evolution is true because it explains a great many facts.) But it is still a theory because it is an explanation (the only scientific one, in fact) of a (very large) set of observations. As several commentators on the Kansas situation noted, science *is* theory; without theory, we just have a bunch of facts, not science. Without theory, we couldn't teach that the Earth goes around the sun or that germs cause disease.

Exercise: Name several theories of science that are facts in the everyday sense because they are universally accepted as true.

SECTION 4

BUT THAT'S JU
YOUR THEOR

Principle: Scientists as a ru
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theory I am describing is th
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complete explanations or ove
are often competing theories
will explain certain facts bet
claim that any particular theo

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ases influence how they decid
tist will prefer one theory to
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found that the female actually

SECTION 6

BUT YOU'VE TAKEN ALL THE MYSTERY OUT OF IT!

Principle: The goal of science is to solve puzzles, not to wonder at mysteries.

Once when I was in college, I went to a humanities class straight from biology lab smelling of formaldehyde. The professor asked me, "Why do biologists have to kill animals in order to study them? Biology is supposed to be the study of life!" Many people share the opinion of my humanities professor that scientists destroy what they try to study. They think we take the mystery out of it.

The truth is, we do. The term *mystery* is often used in the sense of a puzzle—we try to solve the mystery before the author reveals who the murderer was. But strictly speaking, *mystery* refers to something that we can never figure out; the answer has to be revealed to us by someone who knows, a prophet. A *puzzle,* on the other hand, is something that ordinary people can figure out.

Everybody enjoys a mystery. We look at a flower, a baby, or a sunset and are struck with awe. But some people go into science expecting their study to contribute to this sense of wonder. Too many times, however, the wonder is blown away by a mass of decidedly unmysterious notions, and they decide to major in something else. What these students are missing, however, is that science does not treat the world as a mystery, strictly speaking, but as a puzzle to be solved. A good example of the difference between a mystery and a puzzle is found in the motivations of those who study extrasensory perception (ESP).

In the early 1960s there was a great deal of interest in the claims that certain Russian women were able to read with their fingertips. Because of the Cold War, it wasn't easy to find out what was going on in Russia. So when an American psychologist named Richard Youtz heard a report of an American woman who could tell colors with her fingers, he decided to study her. His experiments, which seemed to be well controlled, showed that she actually could tell colors with her fingertips.

Youtz reported his results at a meeting that I happened to attend. In fact, he gave his paper immediately before I was to deliver my first-ever scientific paper. The room was packed with hundreds of people for his talk. When he was done and it was my turn, the room emptied out except for about 20 people, which is the usual number who attend such talks.

A friend of mine named Walter Makous studies the senses. He wondered if there was some known ability of the skin that would make it possible to tell colors with the fingertips. He knew that the body gives off heat in the form of infrared radiation and that different colors reflect this heat back differentially. So he sat down and did some calculations that showed, on the basis of what was known about the temperature sensitivity of the skin and the reflectance of heat by colored objects, that it was theoretically possible for people to tell colors using the skin.

Then he did a simple experiment that showed that ordinary people could in fact do what he had found to be theoretically possible. He wrote up his findings in a paper for a major psychological journal.

What do you suppose was the result of his paper? Do you think that the ESPers rejoiced that the physiological basis of this extrasensory ability had been identified? The result was that interest in *dermo-optical perception* died completely and instantly.

The moral of this story is that people who study ESP are looking for a mystery—they are looking for something that *cannot* be explained. Scientists, on the other hand, try to find the answer to a puzzle. The difference is profound, as the story of dermo-optical perception indicates.

If you want a mystery, look at a flower, but don't take it apart; look at a baby, but don't ask questions that might have empirical answers. If you want a puzzle, go into science. There will be plenty of puzzles to solve, and you might even wind up deciding that there is some great mystery to the universe after all is said and done. Many scientists do find that their sense of mystery is actually increased by doing science. But when scientists do science, they are motivated by puzzles, not mysteries.

Exercise: How might considering child development as a puzzle to figure out, rather than a mystery to wonder at, lead one to take a different approach to working with children?

Exercise: Is someone who considers human behavior a puzzle rather than a mystery necessarily a killjoy?

SECTION 7

BUT THAT CO
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Principle: Science contrad
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SECTION 7

BUT THAT CONTRADICTS SOMETHING I BELIEVE!

Principle: Science contradicts everyone's beliefs, and that can be threatening for anyone.

Students often get upset because something they learn in psychology contradicts some strongly held belief of theirs, or at least seems to. They may have been taught in Sunday school that we have free will, and the professor may teach that all behavior has a physical cause.

The relation between science and religion is a very large topic, and we cannot do justice to it here. Certainly some professors take some pleasure in challenging their students' religious beliefs. But the point here is a simple one. Science challenges *everyone's* beliefs, not just those of religious people. Being a scientist requires us to put our beliefs up to empirical testing, to see if what we believe is in fact the case. And that is just as true whether the belief concerns free will or the mechanisms of memory.

So students who feel anxiety because something they learn challenges their view of the world are feeling exactly the same thing that every other person feels at one time or another. It may threaten our self-esteem the first time we learn that we aren't the most beautiful person in the class, or the smartest person taking the test, and so forth. And we develop ways to deal with these threats as we grow and mature.

What makes science different in this regard is that doing science requires us to make our beliefs explicit and then test them against reality. For example, suppose that you believe that people who experience frustration will tend to become aggressive. A scientist who wishes to test this idea will devise a situation in which it will be possible to find out if that belief is true or false. In other words, we deliberately set ourselves up so that our idea can be proven wrong. In fact, philosophers say that we should set up our experiments so that we *try* to prove our ideas wrong. According to this notion, we are *successful* when we *fail* to knock our ideas down, not when we find evidence *for* them.

Science is one of the few human activities in which we deliberately and systematically set out to prove our beliefs wrong, or at least to put our beliefs at risk. We should not be surprised to find that doing this arouses some anxiety and that not everyone is prepared to undertake it.

Exercise: Write down some things you have learned in this class that have caused you anxiety because they challenged something you believed. Now do the same thing for some things you learned in everyday life. How are they similar?

SECTION 8

HOW CAN PS
BE A SCIENCE
FREE WILL?

Principle: Science assume

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