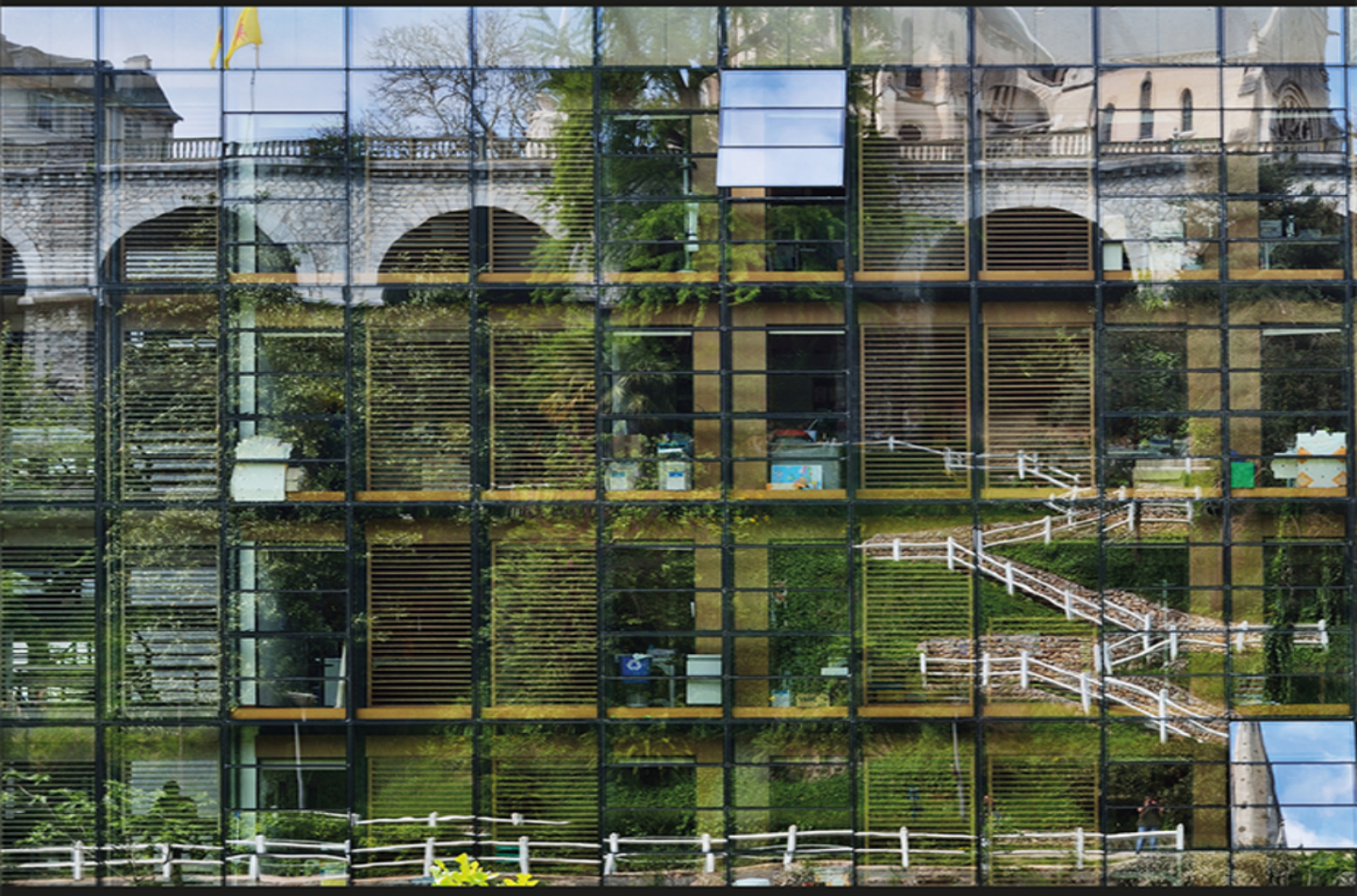
Eighth Edition

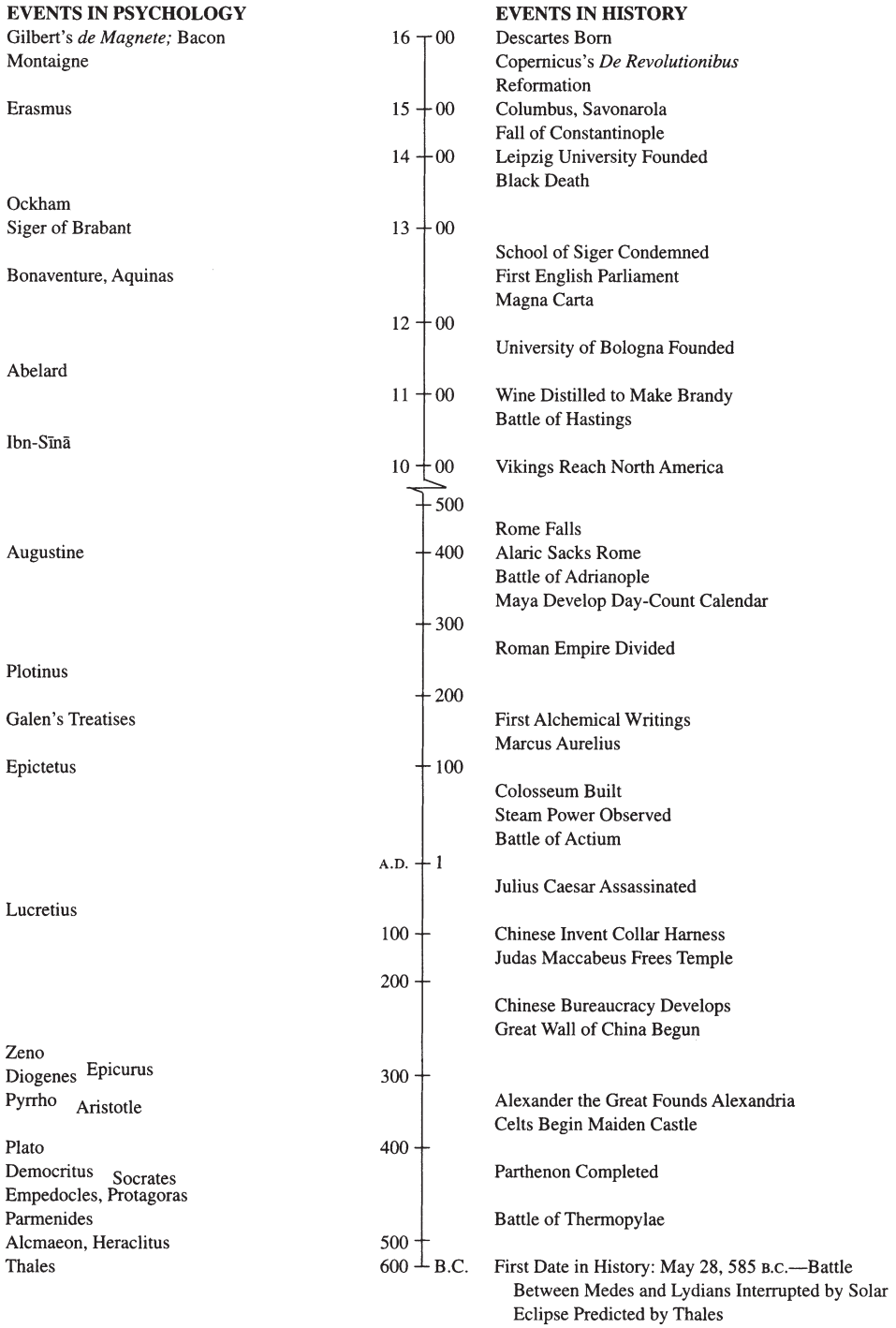
A History of PSYCHOLOGY

From Antiquity to Modernity



THOMAS HARDY LEAHEY

ROUTLEDGE


EVENTS IN PSYCHOLOGY
Gilbert's *de Magnete;* Bacon
Montaigne
Erasmus
Ockham
Siger of Brabant
Bonaventure, Aquinas
Abelard
Ibn-Sīnā
Augustine
Plotinus
Galen's Treatises
Epictetus
Lucretius
Zeno
Diogenes
Epicurus
Pyrrho
Aristotle
Plato
Democritus
Socrates
Empedocles, Protagoras
Parmenides
Alcmaeon, Heraclitus
Thales
16 00
15 00
14 00
13 00
12 00
11 00
10 00
500
400
300
200
100
A.D. 1
100
200
300
400
500
600 B.C.
EVENTS IN HISTORY
Descartes Born
Copernicus's *De Revolutionibus*
Reformation
Columbus, Savonarola
Fall of Constantinople
Leipzig University Founded
Black Death
School of Siger Condemned
First English Parliament
Magna Carta
University of Bologna Founded
Wine Distilled to Make Brandy
Battle of Hastings
Vikings Reach North America
Rome Falls
Alaric Sacks Rome
Battle of Adrianople
Maya Develop Day-Count Calendar
Roman Empire Divided
First Alchemical Writings
Marcus Aurelius
Colosseum Built
Steam Power Observed
Battle of Actium
Julius Caesar Assassinated
Chinese Invent Collar Harness
Judas Maccabeus Frees Temple
Chinese Bureaucracy Develops
Great Wall of China Begun
Alexander the Great Founds Alexandria
Celts Begin Maiden Castle
Parthenon Completed
Battle of Thermopylae
First Date in History: May 28, 585 B.C.—Battle Between Medes and Lydians Interrupted by Solar Eclipse Predicted by Thales

EVENTS IN PSYCHOLOGY		EVENTS IN HISTORY
Bain's *Emotions and the Will*	18 — 60	Darwin's *Origin of Species*
Spencer's *Principles of Psychology*		
Helmholtz Measures Reaction Time		
	18 — 50	1848: Year of European Revolutions
J.S. Mill		
		Darwin's First Abstract of Theory of Evolution
	18 — 40	
Comte		
	18 — 30	Darwin Sails on *Beagle*
Galls's *On the Functions of the Brain*		
Magendie-Bell Law	18 — 20	Faraday's Research on Magnetism
J. Mill		
		War of 1812
	18 — 10	
		University of Berlin (1st Research University)
Malthus's *Essay on Population*	18 — 00	Rosetta Stone Found
Stewarts's *Psychology of the Human Mind*	17 — 90	French Revolution
Bentham's *Principles of Moral Legislation*		
Kant's *Critique of Pure Reason*	17 — 80	
Mesmer's *Discovery of Animal Magnetism*		American Revolution
Hume's *Inquiry Concerning Human Understanding*		
	17 — 70	
		Watt's Steam Engine
	17 — 60	
		Helvetius's *Essays on Mind* Condemned
Condillac's *Treatise on Sensations*		
Hartley's *Observations on Man*	17 — 50	*Observations* is First English Work Using Term "Psychology"
La Mettrie's *L'Homme Machine*		
		American Philosophical Society
	17 — 40	
Hume's *Treatise of Human Nature*		
		Algaretti's *Newtonianism for the Ladies*
	17 — 30	First Tracheotomy
Berkeley		
	17 — 20	South Sea Bubble Collapses
	17 — 10	First Practical Steam Engine
Newton's *Optics*	17 — 00	Yale Founded
		Epsom Salts
Locke's *Essay Concerning Human Understanding*	16 — 90	English Glorious Revolution
Newton's *Principia Mathematica*		
		Halley's Comet
Leibniz	16 — 80	
		Greenwich Observatory Founded
Spinoza	16 — 70	
		Great Fire of London
Pascal	16 — 60	English Restoration
		Pascal's and Fermat's Letters on Probability
Hobbes's *Leviathan*	16 — 50	
		Invisible College Meets
Pascal Invents Calculating Machine		
	16 — 40	
Descartes's *Rules for the Direction of the Mind*		Harvard Founded
	16 — 30	Kepler Dies
Harvey Announces the Circulation of the Blood		
	16 — 20	Plymouth Rock
	16 — 10	King James Bible
		Jamestown Established
Galileo	16 — 00	Bruno Burnt as Heretic

EVENTS IN PSYCHOLOGY		EVENTS IN HISTORY
		Hitler Becomes *Führer*
Tolman's *Purposive Behavior in Animals and Men*		
Association of Consulting Psychologists		"New Deal" Declared
Freud's *Civilization and Its Discontents*		Smoot-Hawley Tariff
	19 30	
		Pluto Discovered
Hull's First Learning Machine		Stock Market Crash: Depression Begins
		First Talkie/Lindbergh Crosses Atlantic
Terman's "Mental Test as a Psychological Method"		
		Scopes Trial/First TV Transmission
Freud's *Ego and the Id*		
		Tomb of Tutankhamen Discovered
Wundt's *Völkerpsychologie* Completed	19 20	19th Amendment to Constitution/Women Vote
Yerkes's "Psychology in Relation to the War"		WWI Ends
		US Enters WWI
		WWI Begins
Watson's "Psychology as the Behaviorist Views It"		
		Titanic Sinks
	19 10	*The Firebird* Ballet (Stravinsky)
Freud Lectures in US		
		James's *Pragmatism*
Angells's "Province of Functional Psychology"		
Freud's *Three Essays on the Theory of Sexuality*		
		Special Theory of Relativity
		British "Physical Deterioration Report"
Gestalt and Würzburg Psychologies Begin		
Freud's *Interpretation of Dreams*	19 00	Picasso's First Major Painting "La Moulin de la Galette"
Titchener's "Postulates of a Structural Psychology"		
		Spanish-American War
Dewey's "Reflex Arc Concept in Psychology"/Witmer's Psychological Clinic		McKinley Elected US President
		First Professional Football Game
		Panic of 1893
APA Founded		
		Zipper Invented
James's *Principles of Psychology*	18 90	
		Kodak Camera Perfected
American Journal of Psychology		
Ebbinghaus's *On Memory*		
		Huckleberry Finn (Twain)
Romanes's *Animal Intelligence*		Medical Insurance Introduced (Germany)
	18 80	
Wundt's Founding Laboratory		*A Doll's House* (Ibsen)
		Telephone Invented
James's Informal Laboratory		
Mind, First Psychology Journal in English		
		Impressionism Begins
Metaphysical Club		
		Paris Commune
	18 70	
		Professional Baseball Founded
		US Civil War Ends
Sechenov's *Reflexes of the Brain*		Slavery Abolished in US
		US Civil War Begins
Fechner's *Elements of Psychology*	18 60	

EVENTS IN PSYCHOLOGY		EVENTS IN HISTORY
Kahnemann's *Thinking fast and slow*		Fukishima nuclear disaster
	20 10	
		Barack Obama elected President
APS becomes Society for Scientific Psychology		World financial crisis
		Iraq War
Kahnemann wins Nobel Prize		
New Mexico approves prescription privileges		Terrorists destroy World Trade Center
for clinical psychologists	20 00	G. W. Bush elected President
1990s "Decade of the Brain"		
		First Republican Congress in 40 Years
APA Centennial		Clinton Elected US President
		Persian Gulf War
Skinner Dies	19 90	
		Berlin Wall Topples: Cold War Ends
APS Founded		G. H. W. Bush elected President
PDP Research Group's *Explorations in*		Space Shuttle Challenger Explodes
Parallel Distributed Processing		Wreck of Titanic Discovered
		Invasion of Grenada
Sperry's and Hubel & Wiesel's Nobel Prizes		President Reagan Shot
Searle's "Minds, Brains, and Programs"	19 80	Reagan Elected US President
Simon's Nobel Prize/Cognitive		
Science Society		Jonestown Massacre
		Carter Elected US President
Wilson's *Sociobiology*		US Abandons S. Vietnam/Nixon Resigns
Vail Conference		
Skinner's *Beyond Freedom and Dignity*		Watergate Arrests
Journal *Cognitive Psychology* Founded	19 70	
		Moon Landing/King, R. Kennedy
		Assassinated/Nixon
		Elected US President
		Arab-Israeli 8-Day War
Neisser's *Cognitive Psychology*		
		Project Camelot Uncovered
		Johnson Elected US President
		J. Kennedy Assassinated
Kuhn's *Structure of Scientific Revolutions*		
		Berlin Wall Constructed
Hebb's "Second American Revolution"	19 60	J. Kennedy Elected US President
Chomsky's Review of *Verbal Behavior*		
Newell, Shaw, and Simon's General		
Problem Solver		Stereo Recordings
Skinner's *Verbal Behavior*		Soviet *Sputnik* Launch
Colorado Symposium on Cognition		Montgomery, Alabama, Bus Boycott
Skinner's *Science and Human Behavior*		Armistice in Korea
		Eisenhower Elected US President
Turing Test for AI Proposed/Dartmouth		
Conference on Learning Theory	19 50	Korean War Begins
Boulder Conference		
Tolman's "Cognitive Maps in Rats and Men"		*Sexual Behavior of the Human Male* (Kinsey)
		Cold War Begins: Churchill's "Iron Curtain" Speech
"New" APA Created		World War II Ends
Hull's *Principles of Behavior*		Effectiveness of Penicillin Demonstrated
		First "Electronic Brain" or Computer
OPP Established		Pearl Harbor/US Enters WWII
	19 40	
		World War II Begins
Skinner's *Behavior of Organisms/*		
AAAP Founded		
		"Guernica" (Picasso)
Hull's "Mind, Mechanism, and		
Adaptive Behavior"		Boulder Dam Completed

A History of Psychology

A History of Psychology places social, economic, and political forces of change alongside psychology's internal theoretical and empirical arguments, illuminating how the external world has shaped psychology's development, and, in turn, how the late twentieth century's psychology has shaped society. Featuring extended treatment of important movements such as the Enlightenment and the Scientific Revolution, the textbook approaches the material from an integrative rather than wholly linear perspective. The text carefully examines how issues in psychology reflect and affect concepts that lie outside the field of psychology's technical concerns as a science and profession.

This new edition features expanded attention on psychoanalysis after its founding as well as new developments in cognitive science, artificial intelligence, and behavioral economics. Throughout, the book strengthens its exploration of psychological ideas and the cultures in which they developed and reinforces the connections between psychology, modernism, and postmodernism. The textbook covers scientific, applied, and professional psychology, and is appropriate for higher-level undergraduate and graduate students.

Thomas Hardy Leahey is Professor Emeritus at Virginia Commonwealth University, USA. He has been President of the Society for Theoretical and Philosophical Psychology and the Society for the History of Psychology. He is a Fellow of the American Psychological Association and a Founding Fellow of the Association for Psychological Science.

Eighth Edition

A History of Psychology

From Antiquity to Modernity

Thomas Hardy Leahey

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BRIEF CONTENTS

CONTENTS

PREFACE TO THE EIGHTH EDITION

This new edition of *A History of Psychology* has taken longer than usual to appear because of a change in publisher from Pearson to Routledge. This move has, however, allowed me profitable time to research and write new material and rewrite older material that was awkwardly phrased, misleading, or out-of-date. Throughout, I have updated a lot, especially by adding paragraphs illustrating how psychological ideas have been shaped by the cultures in which they developed, strengthening a major theme of this book. For example, in chapter 2, I discuss how early Christians' wrestling with the problem of the expiation of sin—a concern unknown to pagans—deepened the mind–body problem bequeathed it by the Greeks and Romans. I have also worked to clarify and advance my contention that as a science, psychology was a product of modernism and a maker of postmodernism, by rewriting the Boxes and reinforcing their linkages to the main narrative of the text.

Larger changes include:

- At the request of reviewers, I have expanded my treatment of psychoanalysis as a movement past its founding by Freud, in chapters 9 and 14.
- In the chapter on Cognitive Science (chapter 12), I have added sections on important recent developments, including:
  - The appearance of embodied cognition theorists who reject the information-processing view of the mind, seeking to replace it with a radical behaviorism-like view emphasizing bodily doing over inner thinking.
  - Recent breakthroughs in artificial intelligence, such as building computers that are structured like the brain, and the deep learning algorithms fundamental to social media and driverless cars.
  - The rise of behavioral economics, a fusion of economics and psychology, whose findings are being used by social policy wonks at the highest levels of government to manage human behavior in the postmodern world, as in the Affordable Care Act (aka, Obamacare) in the US.
- I have added sections called Crisis calling attention to critical developments in both scientific and applied psychology.
  - In chapter 12 on Cognitive Science, I discuss the important recent discovery that many seemingly established and, importantly, widely reported psychological research findings fail to reproduce, casting doubt on the always dodgy status of psychology as a science.
  - In chapter 14 on the Psychological Society, I discuss the black eye received by the discovery of the American Psychological Association's complicity in the conduct of torture on detainees at Guantanamo Bay, revealing the temptations of power to practitioners of what considers itself to be a benign helping profession. As the British Lord Acton said, "Power corrupts."

I hope you find this new edition useful. Let me know what you think: tleahey@vcu.edu.

Thomas Hardy Leahey
Professor Emeritus, Virginia Commonwealth University
Richmond, Virginia, USA
March 26, 2017

PART I

Situating Psychology

CHAPTER 1

Introduction

UNDERSTANDING SCIENCE

Plato observed that philosophy begins in wonder. Science also begins in wonder—wonder at the inner workings of nature—and all sciences, including psychology, were originally part of philosophy. Over the centuries, the special sciences gradually became independent of philosophy. Psychology was one of the last of the special sciences to separate from the parent, remaining part of philosophy until the nineteenth century. The founders of psychology were philosophers as well as psychologists, attempting to find scientific answers for many philosophical questions.

Psychology means *psyche-logos*, literally, the study of the soul, though the term was not coined until the seventeenth century and was not widely used until the nineteenth century. Philosophers and religious teachers around the world have wrestled with the nature of the soul: Does the soul exist? What is its nature? What are its functions? How is it related to the body? While psychologists resist the term *soul*, preferring the less religiously loaded term *mind*, they have continued to address these vexing questions. Even psychologists who define psychology not as the study of the mind but as the study of behavior have different answers to these questions.

Since the time of the ancient Greeks, philosophers have inquired into how human beings know the world. This enterprise is called *epistemology*, from the Greek words *episteme* (knowledge) and *logos* (discourse). Asking how human beings know the world involves questions about sensation, perception, memory, and thinking—the whole realm of what psychologists call *cognitive psychology*.

Ethics is another area shared by philosophers (and religious thinkers) and psychologists. Although ethics is centrally concerned with how people ought to act, practical ethics depends on a conception of human nature. Are people, by nature, good? What motives do people have? Which ones are wholesome and which should be repressed? Are people social by nature? Is there a common good life all humans ought to live? Such questions are profoundly psychological and can be informed by scientific research on human nature. Ethical concerns manifest themselves in many areas of psychology. In *scientific psychology*, we find them in the studies of motivation and emotion, social behavior, and sexual behavior. *Applied psychology*, whether in business, industry, government, or in individual clinical and counseling psychology, is deeply involved in human ethics. People come to psychologists wanting to be happier or more productive, seeking the psychologist's scientifically informed help. The psychologist's knowledge of motivation, emotion, learning, and memory gives him or her tools to change behavior, but the psychologist must not be merely the client's servant. A business-consulting psychologist may need to tell a client that he or she is the problem in the company, and no ethical psychologist would teach a con artist how to improve his or her self-presentation skills. Science is traditionally value-neutral in pursuing the secrets of nature, but, as Francis Bacon said, "Knowledge is power," and the tools of the applied scientist must be rightly used.

Although the conceptual foundations of psychology are to be found in philosophy, the inspiration for the creation of an independent science of psychology came from biology. The idea that

FIGURE 1.1 When Wilhelm Wundt proclaimed the founding of psychological science, he said it was the outcome of an "alliance" between philosophical psychology and the new science of physiology. While this ambition proved premature, it is now coming to fruition in cognitive neuroscience, which uses methods undreamed of by Wundt to connect mind and brain.

Source: Bettmann / Getty Images.

the functions philosophers and others ascribed to the mind depended on underlying processes of the brain had been fitfully entertained since the days of the Greeks but had attained the status of a conviction by the mid-nineteenth century. The founders of psychology hoped that, by taking a path to the mind through physiology, what had been speculative philosophy and religion might become naturalistic science. A younger branch of biology—evolution—also shaped the founding of scientific psychology. Especially in Britain and America, philosophers and psychologists began to ask what the mind was good for in the struggle for existence that was evolution by natural selection. Why should we be conscious at all? Were animals conscious? These new questions would disturb, yet animate, psychologists from the beginning. Therefore, we will be concerned not just with the abstract questions of philosophy, but with the growing understanding of the brain and nervous system from the Classical era to the present.

Modes of Scientific Explanation

From the nineteenth century onward there has been general agreement that psychology is, or at least ought to be, a science. The nature of science—what psychology aspires to be—is a good starting point for understanding it. People expect science to explain how and why the world, the mind, and the body work as they do. *Philosophy of science* tries to understand how science works (Rosenberg, 2005). The modern style of scientific explanation began with Isaac Newton and the Scientific Revolution (see chapter 5).

BOX 1.1
Positivism

Positivism was a self-consciously modern movement, and thus part of modern*ism* even before the term came into use. It began with a rather eccentric Frenchman named Auguste Comte (1798–1857) and his positive philosophy. It wasn't positive in the sense of "positive psychology," but positive in a philosophical way. His enemy was speculative philosophy that trucked with unseen things like gods and Forms, and he wanted to replace it with a philosophy based on directly observable—positive—facts (if there are such things). He saw human history as passing through three stages, the first two of which were based on speculative philosophy. During the *theological stage*, people thought that gods caused events and the natural rulers of society were thus priests, who supposedly understood the gods and could entreat or control them to human advantage. The second stage was the *metaphysical stage*. People (or at least the elite) no longer believed that gods controlled the world, but did believe in unseen essences and forces that did. The natural rulers were thus kings and aristocrats—the elites—who understood these hidden Truths; we'll meet them as Plato's Guardians in the next chapter.

The last—modern—stage was the *scientific stage*. Gods and metaphysics were jettisoned for Newtonian science, which understood the genuine causes of events and which could therefore really deliver the goods for human welfare in a way that priests and aristocrats could only fake—to their own interest, rather than humanity's. The natural rulers would thus be scientists, specifically the scientists whose expertise was society itself—sociologists. Psychologists would count themselves among the number of the new elite. As founding psychologist James McKeen Cattell wrote, "Scientific men should take the place that is theirs as masters of the modern world" (quoted by Herman, 1996, p. 55).

THE NOMOLOGICAL APPROACH: EXPLANATION BY LAWS OF NATURE Newton defined his scientific enterprise as the search for a small number of mathematical laws from which one could deduce observed regularities in nature. His domain was the physics of motion, which he proposed to explain in terms of three laws of motion and a law of gravity, and he showed how his laws could precisely account for the movement of the bodies in the solar system. As an example of the Newtonian style of explanation (Cohen, 1980), we will take the law of gravity: Between any two bodies there is a mutually attracting force whose strength is inversely proportional to the square of the distance between them. Newton was criticized by his contemporaries for failing to provide any mechanism to explain how gravity worked; to them, action at a distance between two objects smacked of magic. Newton, however, replied, "*Hypotheses non fingo*," "I do not feign [propose] hypotheses." Newton refused, in other words, to explain his principle of gravity; for him, it was sufficient to postulate a force from which one could predict the motions of the heavenly bodies.

With Newton began a new philosophy for understanding nature that was later codified in an extreme form by Auguste Comte (1798–1857) and his followers, the *positivists* (see chapter 7), who said science worked because of the Newtonian style of remaining as close as possible to the observable facts and as far as possible from hypothetical explanations. Thus the basic job of science is *description* rather than explanation. Scientists are supposed to closely observe nature, looking for regular occurrences and reliable correlations. On the basis of their observations, scientists would propose scientific *laws*, such as Newton's law of gravity. Extending Newton's reluctance to frame hypotheses, positivists understood scientific laws to be mathematical summaries of past observations rather than truths of nature.

From the first function of science, description, ideally summarized as laws, arises the second function, *prediction*. Using Newton's law of gravity and his three laws of motion, scientists could predict future events, such as eclipses and the return of comets. Finally, prediction from laws made *control* of nature possible. Using Newton's laws, engineers could calculate the thrust required to throw satellites into precise orbits around the earth and send probes to the distant planets. Knowledge, as Francis Bacon said, is power, and control was the ultimate rationale for science in the positivist's philosophy. Comte looked forward to the scientific rule of society, and the desire to apply scientific psychological expertise to Comte's project played an important role in shaping twentieth-century psychology.

Description, prediction, and control were the only three functions assigned to science by the first positivists. They regarded the human desire for explanations—answers to *why* questions—as a dangerous temptation to indulge in metaphysical and theological speculation. However, in 1948, the contemporary era of philosophical understanding of explanation began with the publication of "Studies in the Logic of Explanation" by two logical positivists, Carl Hempel and Paul Oppenheim. Their "epoch-making" (Salmon, 1989) paper showed a way of incorporating an explanatory function for science within the positivist framework, and, despite its age and defects, the Hempel–Oppenheim model of explanation remains the starting point for all subsequent studies of explanation in science.

Hempel and Oppenheim proposed that scientific explanations could be regarded as logical arguments in which the event to be explained, the *explanandum*, could be deduced from the *explanans*—relevant scientific laws and the observed initial conditions. So a physicist would explain a solar eclipse by showing that, given the relative position of sun, moon, and earth sometime before the eclipse, one could use Newton's laws of motion and gravity to deductively predict their arrival into an eclipse-producing alignment. Since Hempel and Oppenheim said that explanations are deductions from scientific laws, their scheme is called the *deductive-nomological* (from the Greek *nomos*, "law") model of explanation. It is also called the *covering-law* model of explanation, since an explanation shows how an event is subsumed, or covered, under some set of scientific laws.

Certain features of the Hempel–Oppenheim model are important. First, it makes explicit a central and crucial feature of explanation that I will call the *Iron Law of Explanation: The explanandum may not be contained explicitly or implicitly in the explanans.* Violation of this rule renders an explanation null and void on grounds of circularity. An example borrowed from the French playwright Molière illustrates a circular explanation. Imagine asking "Why does Somitol make me sleepy?" and receiving the reply "Because it possesses the soporific power!" At first glance, this appears to be an explanation of one thing (sleepiness) in terms of another (soporific power), and indeed, stated forcefully in an advertisement, it might be able to pass itself off as one. However, when we learn that "soporific" means "sleep-inducing," we see that the proffered explanation is empty because it says, in effect, Somitol makes you sleepy because it makes you sleepy. The explanandum, causing sleep, was implicitly contained in the explanans, so the explanation was circular. The Iron Law is easy to violate because we often think when we have named something—the soporific power—that we have explained it. Because much of the mind cannot be observed, violating the Iron Law is especially easy in psychology. We may think we have explained why someone is shy and has few friends by calling him or her an "introvert," but all we have done is given a shorthand label to a person who is shy and has few friends. If introversion is to be a real explanation of being shy, it must be linked to something other than shy behavior, perhaps to a genetic predisposition.

A more controversial feature of the deductive-nomological model is that it sees prediction and explanation as the same thing. In the Hempel–Oppenheim model, the explanation of an event consists of showing that it could have been predicted. Thus, an astronomer *predicts* an eclipse in the year 2010 but *explains* one in 1010. In each case, the procedure is the same—applying the laws of motion

to the state of the sun, moon, and earth, and demonstrating the inevitability of the eclipse. However, the thesis that explanation and prediction are symmetrical runs into important problems. Consider a flagpole and its shadow (Rosenberg, 2005). If one knows the height of a flagpole and the position of the sun, one can deduce and so predict the length of the shadow from the laws governing light and the rules of geometry, and it seems reasonable to say that we have thereby explained the length of the shadow. By the same token, however, if we know the length of the shadow, we can deduce and so "predict" the height of the flagpole, but surely the length of the shadow does not explain the height of the flagpole.

THE CAUSAL APPROACH: LAWS ARE NOT ENOUGH The covering-law model for scientific explanation deliberately avoids questions about the real causal structure of nature, preferring to focus instead on how we can predict and control nature. Usable knowledge need not pretend to be profound or true. Although how aspirin works is only now being understood, physicians have long prescribed it to relieve pain, inflammation, and fever. Following Newton, who refused to worry about why his laws of motion were true, positivists demand of scientific explanations only that they make successful predictions, not that they reveal why they do so. Discomfited by the shortcomings of the positivist approach, some philosophers want science to probe deeper, telling us not merely how nature works as it does, but why it works as it does.

The main rival to the positivist approach to explanation is the *causal approach* (e.g., Salmon, 1984). Its starting point is the difficulty of identifying explanation with prediction. Although we can deduce the height of a flagpole from the length of its shadow, shadows cannot *cause* anything, and so they should not be cited in explanations; in contrast, objects blocking rays from the sun *causally* cast shadows. The mere existence of a predictive regularity is not the same as a law of nature, no matter how reliable and useful the regularity may be. The generalization "When the reading on a barometer drops, a storm will occur" states a useful correlation, not a causal law of nature.

More importantly for the explanation of human behavior, we intuitively accept explanations that cite no laws at all. When in the last chapter of a murder mystery the detective unravels the crime, explaining who did it, how, and why, he or she will not invoke laws of nature. Instead, he or she will show how a series of particular, unique events led, one after the other, to the commission of murder. We feel satisfied to learn that Lord X was murdered by his son to pay his gambling debts, but there is no law of nature saying "All (or even most) sons with gambling debts will kill their fathers." Much explanation in everyday life and history is of this type, connecting events in a causal sequence without the mention of laws. Not all satisfying explanations fit the covering-law model.

From the causal perspective, the positivists' fear of falling into metaphysics and their consequent unwillingness ever to stray beyond the facts have led them to miss the point of science and to ignore important intuitions about the nature of explanation. Instead of shunning metaphysics, the causal approach embraces it, arguing that the goal of science is to penetrate the causal structure of reality and discover—not just invent—the laws of nature. Science is successful, they say, because it is more or less right about how nature works, and it gains predictive power and control from being true, not from being logically organized. Science protects itself from the positivists' bugaboo—superstition—by rigorously testing every hypothesis and challenging every theory.

Nevertheless, the causal view has its own weaknesses (Kitcher, 1989). For example, how can we ever be certain we have grasped the causal structure of the world when it lies, everyone concedes, beyond the reach of observation? Because we cannot directly verify our hunches about real causes, they might be a metaphysical luxury that ought not be indulged, no matter how tempting. The debate between the causal and epistemic accounts of scientific explanation is not over (Rosenberg, 2005).

ARE EXPLANATIONS TRUE OR MERELY USEFUL? The difference between the nomological and causal approaches to explanation is a deep one, because they rest upon competing ideas about what science can achieve. Nomological theorists believe that all we can hope to do is describe the world as we find it; causal theorists believe we can go deeper, penetrating the hidden causal structure of the universe. In philosophy of science, this argument is known as the debate over *realism* in science.

The dispute may be historically illustrated by the late-nineteenth-century debate regarding the existence of atoms. Since the late eighteenth century, widespread acceptance had been gained by the theory that various observable phenomena such as the behavior of gases and the regularities governing the combination of chemical elements could best be explained by supposing that objects were composed of infinitesimally small particles called atoms. Yet, how to interpret the concept of atoms remained unclear. In one camp were the positivists, led in this battle by the distinguished physicist Ernst Mach (1838–1916), who argued that because atoms could not be seen, belief in their existence was faith, not science. He said atoms should be regarded at best as hypothetical fictions whose postulation made sense of data but whose existence could not be confirmed. The atomic camp was led by Russian chemist Dmitri Mendeleev (1834–1907), who believed atoms were real things whose properties and interactions explained the regularities of the periodic table he had invented.

Mendeleev's view is a *realist* view of inferred entities and processes: Behind observations lies a realm of unseen but real things about which science theorizes; observations are regarded as evidence for the underlying causal structure of the universe. Mach's positivist view is an *antirealist* view of science, regarding observations themselves as the only things science need explain. Antirealists come in agnostic and atheistic brands (Newton-Smith, 1981; Salmon, 1989). The most common form of antirealism is instrumentalism, which holds that scientific theories are merely tools—instruments—by which human beings come to grips with nature. If a theory predicts and explains events, we retain it as useful; if it fails to predict and explain, we discard it. We should ask no more of theories. At stake is the possibility of attaining truth in science. Realists say that science should strive to give us a true *picture* of the causal structure of the universe; antirealists say that science should strive to give us conceptual *tools* that enable us to deal with the universe. In short, the realist wants truth, the antirealist wants usefulness.

Disagreement over realism lies at the heart of the nomological versus causal dispute about explanation, and the nature of scientific theories. Science explains the world with theories, whether they are regarded as true (the causal–realist view) or merely useful (the nomological–antirealist view). Savage (1990) identifies three broad approaches to theories, with many variations within: (1) the *syntactic view*, holding that theories are axiomatized collections of sentences; (2) the *semantic view*, holding that theories are counterfactual models of the world; and (3) a view we will call *naturalism*, holding that theories are amorphous collections of ideas, values, practices, and exemplars. From this mélange, I have chosen to discuss three issues of particular relevance to psychology. First, I will discuss the granddaddy of syntactic views, the Received View on Theories, which has greatly influenced psychology. Second, I will briefly consider the semantic view of theories as models, which will take us to the final topic of this section—theory testing. The naturalistic viewpoint will be taken up in the following section on rationality.

Theories about Scientific Theories

THE SYNTACTIC APPROACH: THEORIES ARE COLLECTIONS OF SENTENCES At the end of the nineteenth century, the positivism of Comte and Mach was melded with advances in logic and mathematics to produce the movement called *logical positivism* (see chapter 11), which dominated the philosophy of science for several decades. So great was its influence that it became known as the Received View on Theories (Suppe, 1977). The atomists had won the debate over the existence of atoms.

The heirs to Comte and Mach, the logical positivists, therefore had to concede that, despite philosophical scruples, science could incorporate unseen, hypothetical concepts into its theories, and they attempted to show how it could be done without lapsing into the dangerous practices of metaphysics. Doing so, they set out a recipe for science that has had great influence.

Logical positivists divided the language of science into three sets of terms: *observation terms*, *theoretical terms*, and *mathematical terms*. Unsurprisingly, the logical positivists gave absolute priority to observation terms. The fundamental task of science remained description; observation terms referred to directly observable properties of nature and were taken to be unproblematically true. The bedrock of science was *protocol sentences*—descriptions of nature that contained only observation terms. Putative generalizations from the data—candidate laws of nature—were *axioms* that contained only theoretical terms connected by logico-mathematical terms.

The use of theoretical terms such as *atom* or *magnetic field* raised the issue of realism and, for logical positivists, the dangerous lure of metaphysical inference. They preserved the antirealism of earlier positivism by denying that theoretical terms referred to anything at all. Instead, theoretical terms were said to be given meaning and epistemological significance via *explicit*, or, more familiarly, *operational definitions*. Operational definitions were the third sort of sentences recognized by the logical positivists—mixed sentences containing a theoretical term and an observational term to which it was linked. The resulting picture of science resembles a layer cake. On the bottom, representing the only reality for positivists, were observational terms; on top were purely hypothetical theoretical terms organized into axioms; in between were sandwiched the operational definitions connecting theory and data:

Let us take an example from physics. An important axiom in classical physics is:

$$F = m \times a$$

force equals mass times acceleration. Force, mass, and acceleration are theoretical terms. We do not observe them directly, but we must define them in terms of something we do observe—often, by some procedure—which is why operational definitions are so-called. For example, mass is defined as weight of an object at sea level. Thus, in the Received View, theories are sentences (axioms) whose terms are explicitly defined by reference to observation terms. Note that, for the Received View, as for any antirealist philosophy of science, observations do not provide *evidence* for the existence and properties of inferred entities, but they *define* those entities the way a dictionary defines a word.

The Received View leads naturally to the Hempel and Oppenheim model of explanation. The laws of nature are theoretical sentences from which we logically deduce phenomena, or, more

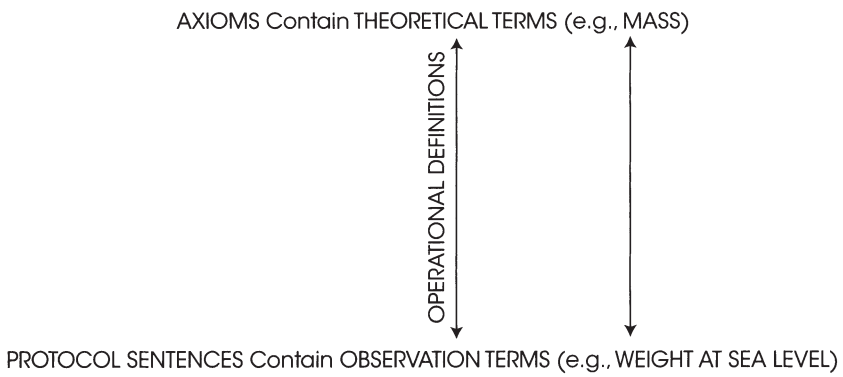

FIGURE 1.2 Logical positivism's layer cake model of scientific language.