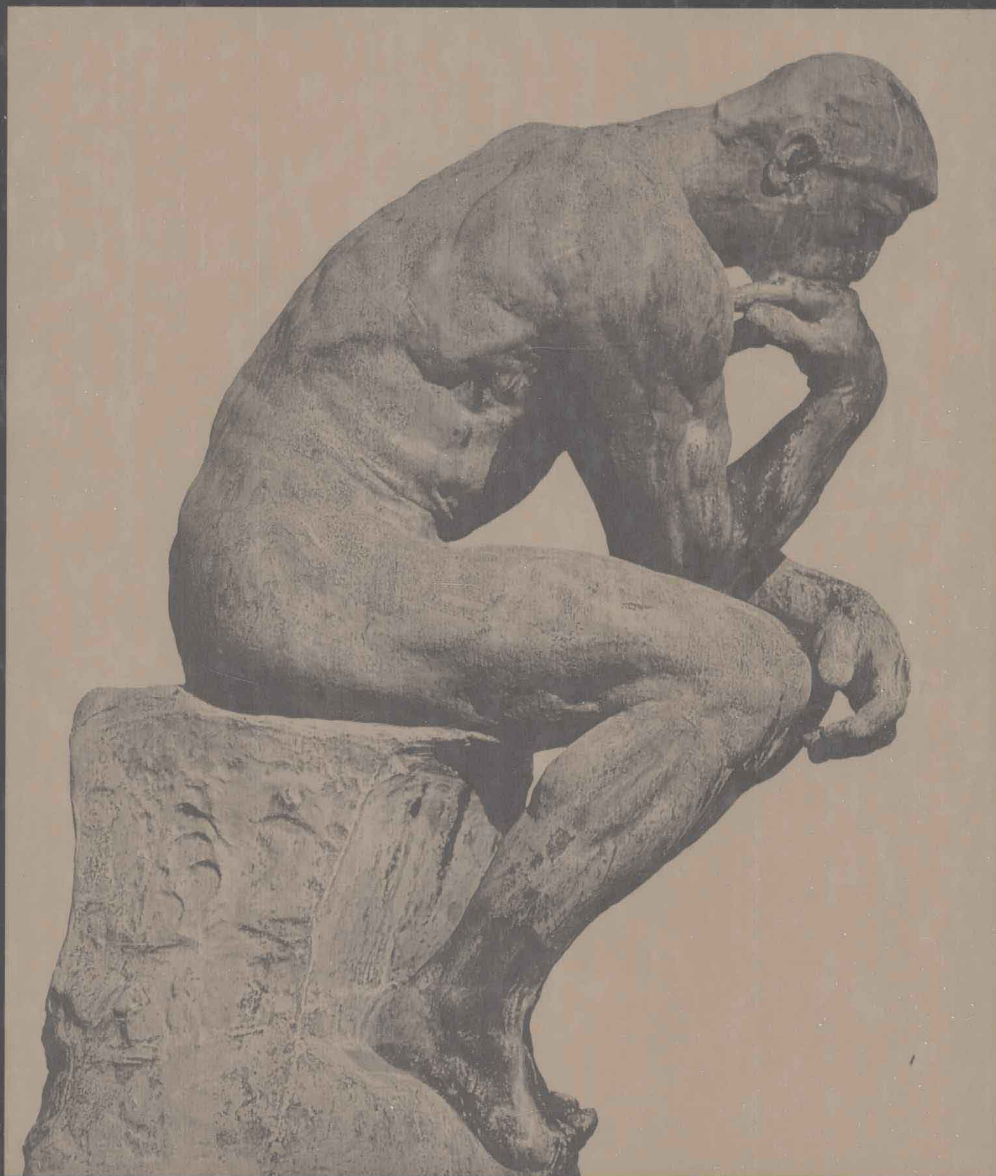


COGNITION

THE THINKING ANIMAL

SECOND EDITION



DANIEL T. WILLINGHAM

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The Thinking Animal

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Preface

A long-standing goal of human enquiry is to understand ourselves. How can we characterize the human species? Here are some well-known definitions of “man.”

Man is by nature a political animal. —Aristotle

Man is a noble animal. —Sir Thomas Browne

Man is a tool-using animal. —Thomas Carlyle

Man is a reasoning animal. —Seneca

Man is a social animal. —Benedict Spinoza

Man is a rational animal who always loses his temper when he is called upon to act in accordance with the dictates of reason. —Oscar Wilde

All these proposals are, in a sense, correct, but are all rooted in another characteristic. We are able to act politically, use tools effectively, understand nobility, and so on because of our ability to think. The book you are reading is a study of cognition—of how humans think.

READABILITY

Cognitive psychology does not seem to have the intrinsic interest of some other areas of the field. Textbook authors are aware of this problem, but to be honest, I’ve never cared much for their remedies. The usual strategy is to include “real world” examples and demonstrations, usually found in little boxes that appear every few pages. This strategy seems to confirm the reader’s growing suspicion that they are bored by sending the implicit message. “Yes, yes, I know this stuff is boring, but hang in there, and every few pages I’ll toss in one of those boxes with a demonstration or real-world application to keep you going.”

I’ve done three things in this book to try to arouse readers’ interest in the material.

- I have explicitly stated the questions that motivate cognitive psychologists. These questions we ask are of general interest, but psychologists don’t always do the best job of explaining the questions in any detail. We plunge right into the answers, which seem arcane. Each chapter in this book is organized around two or three straightforward questions that are easy to appreciate and explained in detail.
- To the extent possible, I have used a narrative structure. By that I mean that there are causal links within and across chapter sections, so that it

is clear why you are reading something. Nothing is more boring than a list of unconnected facts.

- I have tried to write in a non-stilted, not-especially-academic style.

Despite the light tone, this book is not light in content. An easy way to check the coverage is by examining the key terms section at the end of each chapter.

PEDAGOGY

Readability is fine, but the goal of a textbook is, after all, that students learn the material. Different students like and use different pedagogical features, so I've included a few different ones to help them learn.

- A brief preview poses the broad questions and provides the broad answers covered in each section.
- Key terms are identified by boldface type and are defined immediately thereafter. They are also collected in a glossary.
- Each section closes with a series of questions. The "stand-on-one-foot" summary questions ask students to summarize what they learned in the section they just read. The name comes from the Talmudic story of the heretic who went to great sages, asking each to summarize all of the Torah during the time he could stand on one foot. (He finally found a willing sage in Hillel, who quoted from Leviticus: "What is hateful to you, do not to others.") The idea is simply to get readers to pause for a moment and make sure they understood the major points.
- The end of each section also includes questions that require considerably more thought; the student will need to apply what he or she has just learned to new situations, or go beyond the material in some way. I call these "questions that require two feet." Answers to all questions are provided at the back of the book.

I've also included an appendix containing background information and explanations of several concepts, such as statistical significance, that will be familiar to students who have taken other psychology courses but that beginning students may not know.

THE BRAIN

The influence of neuroscience on cognitive psychology is substantial and increasing. This trend poses two problems for teachers of cognitive psychology courses: how much of this material to include (given that it could support a semester-long course) and how to deal with the fact that understanding cognitive neuroscience requires some background knowledge of the brain.

With regard to background, there is a section of the book titled “Interlude: The Brain” after chapter 1. Other cognitive textbooks include some description of neuroscience, but I handle this topic a bit differently. I don’t think it’s optimal to try to present the basics of neuroscience in a dozen pages. The truth is that much of the basic material (such as the workings of an action potential) is not needed for beginning cognitive neuroscience. Instead, I focus on three points: (1) Why do cognitive psychologists want to learn about the brain? (2) How do they gather information about the brain? (3) What are the brain structures that cognitive neuroscientists frequently refer to?

How much cognitive neuroscience should be in a cognitive psychology textbook? My goal is to give the instructor some flexibility. Certain findings have had such an impact on cognitive psychology that they simply must be part of any course. I have tried to describe these findings in a way that assumes no background on the part of the student. For the instructor who prefers a greater emphasis on cognitive neuroscience, I have included additional materials. Besides the “Interlude,” key studies from cognitive neuroscience are discussed in supplemental boxes set off from the main text. Those instructors who place less emphasis on cognitive neuroscientific approaches can, of course, instruct students to simply skip over this material.

I hope that I have written a textbook that will make students enthusiastic about this field and will make them want to know more than they can find in this book. Hillel’s answer to the impatient heretic is not always quoted in full; after providing the summary of the Torah, Hillel added, “Now go and study,” acknowledging that a one-sentence summary was bound to be lacking and that the heretic should learn more. I have not succeeded in summarizing cognitive psychology in a sentence, but I hope that this book will serve as a starting point for students who will then want to learn more about the field.

Supplement Program

Web site—www.prenhall.com/willingham

Prepared by Glenn E. Meyer, Trinity University includes an online study guide for students, chapter objectives, web links, flashcards of key terms, and much more!

PowerPoint slides

Prepared by Glenn E. Meyer, Trinity University includes selected art from the text available in a chapter-by-chapter lecture format. These slides can be accessed on the text web site: www.prenhall.com/willingham and can be customized to fit your lecture style.

Instructor’s Manual with Tests

includes chapter outlines, suggestions for demonstrations, classroom activities, research and discussion questions, and more. The testing portion of the manual has approximately 65 questions per chapter.

TestGen Software

Prepared by John Philbeck, George Washington University Computerized version of the test questions, which operates on both PC and MAC systems, includes 65 questions per chapter.

Research Navigator

Is there a writing requirement to your course? Prentice Hall's new Research Navigator helps students conduct online research. Research Navigator provides students with extensive help on the research process and gives the students access to three exclusive databases full of relevant and reliable source material including EBSCO's **ContentSelect** Academic Journal Database, *The New York Times* Search by Subject Archive, and the Best of the Link Library. FREE when packaged with any Prentice Hall text. Contact your local Prentice Hall sales representative for more details or take a tour at www.researchnavigator.com.

WHAT'S NEW IN THE SECOND EDITION?

Needless to say, all chapters have been updated as appropriate. I have tracked all of the relevant journals to be sure the book is as up to date as possible. In some cases, new material represents true breakthroughs that have been made in the last few years; in other cases, the new material supports the central points of the story told in the last edition. Likewise, there have been numerous small changes that I hope will make things clearer to the student; I've expanded important points that seemed unclear, changed examples, and dropped a few discussions that seemed more distracting than enlightening. Still other changes are more revolutionary than evolutionary.

- A new chapter on motor control discusses perception, attention, memory, problem solving, and other aspects of cognition that have an impact on the world only if the perceiver or attender makes some motor movement. Despite the centrality of motor control to mental life, most cognitive psychology textbooks don't cover the topic. This new chapter will make it easier for instructors to include this topic in their courses.
- The brief introduction to brain anatomy in the "Interlude" is handled differently than it was in the first edition. Many books, including my first edition, begin with a high-level description of brain anatomy. But for a course in cognitive psychology, most of this material needs to be understood at only the most basic level. At the same time, continued and repeated reference is made to particular cortical areas, with the mad-tea-party approach to nomenclature that marks that field. Thus in this edition I pass over most of the brain in silence and focus on three things: first, what cognitive psychologists learn from studies of brain localization; second, how brain localization information is obtained;

and third, the names of the cortical areas to which repeated reference will be made.

- In chapter 3, "Attention," greater coverage is given to attentional blink, psychological refractory period, and inhibition of return. The final section, "Why Does Selection Fail?" now includes logical subsections to make clear how this material relates to the rest of the chapter.
- In chapter 10, "Decision Making," I've expanded coverage of the work of Gigerenzer, Hoffrage, Tooby, and Cosmides and others as a viable alternative to the framework of Kahneman and Tversky. This work is discussed in two sections: "Probabilities versus Frequencies" and "Social Factors."

I would greatly appreciate feedback and suggestions regarding this text. It is easiest to reach me via electronic mail: willingham@virginia.edu.

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I have had the remarkable good fortune to learn from and work with some great cognitive psychologists, all of whom are also gentle, warmhearted people. My thanks to my graduate school advisors—Bill Estes, Steve Kosslyn, and Mary Jo Nissen—who were so generous with their time and wisdom. John Gabrieli has also been an enduring influence as a colleague and friend. I'm also grateful to my cognitive colleagues at the University of Virginia—Chad Dodson, Michael Kubovy, Denny Proffitt, Tim Salthouse, Jackie Shin, and Bobbie Spellman—for their helpfulness with particular questions, for their encouragement in all matters, and for making it fun to come to work.

My thanks to my daughter Rebecca for her understanding on the days and evenings missed as Dad sat hunched over the word processor.

My thanks to my wife Trisha, for her unfailing love and support in this project and in all other projects that we undertake together or separately.

Finally, my special thanks to my parents, who have been patient and supportive guides throughout my life. I dedicate this book to them, for the advices.

Daniel T. Willingham
University of Virginia

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1

Cognitive Psychologists' Approach to Research

WHY MAKE ASSUMPTIONS?

HOW DID PHILOSOPHERS AND EARLY PSYCHOLOGISTS STUDY THE MIND?

Philosophical Underpinnings
The Beginnings of Modern Psychology
The Response: Behaviorism
Behaviorism's Success

HOW DO COGNITIVE PSYCHOLOGISTS STUDY THE MIND?

What Behaviorism Couldn't Do
Failures of Behaviorism to Account for Human Behavior
The Computer Metaphor and Information Processing
The Behaviorist Response
Abstract Constructs in Other Fields
So What, Finally, Is the Cognitive Perspective?

Have you ever wondered how we see or how we remember things? Have you ever contemplated the strange nature of attention?

I didn't think so.

Most of the people I know do contemplate how the mind works, but only when their mind lets them down. They contemplate memory ("Why can't I find my keys?"), attention ("I *want* to find my keys, so why can't I concentrate?"), and vision ("How could I not see my keys when they were right in front of me the whole time?"). Questions such as "How does vision work?" seem somewhat interesting, but no more interesting than thousands of other questions. It's like someone asking you whether you want to know about the history of guitar making. "I don't know; maybe. Is it interesting?"

Truthfully, "How does vision work?" is a bad question because it's too general. In cognitive psychology, as in most fields, the devil is in the details, but that's where the fun is, too. Vision, attention, and memory become interesting only when you pose more specific questions about them.

This book poses questions about the mind and describes the answers cognitive psychologists have uncovered. The first thing we have to decide, then, is which questions to ask—how to get more specific than "How do we see?" You'll find that the questions we ask are deeply influenced by assumptions we make about the mind and, indeed, assumptions about what it is to be human. It seems obvious that it would be better not to make assumptions when we are just starting to study the mind. Therefore, the first question to take up is **Why make assumptions?** As we'll see, the answer is that it is difficult or impossible to avoid making assumptions. If that's true, we should at least be clear about the assumptions cognitive psychologists make. If you know the assumptions, it will be clearer to you why cognitive psychologists ask the questions they do, and if you understand why they ask a particular question, it will be much easier to understand the answer.

But the approach of cognitive psychologists developed in part as a response to other approaches that people had tried but that seemed to have flaws. Thus our second question is **How did philosophers and early psychologists study the mind?** As we'll see, a number of different approaches have been tried in the last 2,000 years, but it was only about 125 years ago that a serious, systematic effort began to apply the scientific method to human thought. That date is some 200 years or more after the scientific method had been used in other domains of knowledge. Furthermore, cognitive psychology was not the first scientific approach to studying the mind; it arose in response to the flaws in other methods.

Finally, our third question is **How do cognitive psychologists study the mind?** As we'll see, the cognitive approach is informed largely by an analogy of the mind to a computer; like a computer, the brain takes in information, manipulates it, and then produces responses. The truth is more complicated than that, of course, and we will elaborate on this metaphor later.

WHY MAKE ASSUMPTIONS?

► **Preview** People make two types of assumptions when they study the mind. The first assumption concerns what the important questions are. We can't study everything at once, so we must pick some aspect of the mind as a starting point for study. What we perceive to be the starting point is biased by our assumptions about the mind. The second type of assumption concerns beliefs about the mind (even very general, vague beliefs) that affect how everyone thinks about vision, attention, or memory before really knowing anything about them. In this section we look at examples of these assumptions in the study of vision.

Psychologists typically make two types of assumptions in studying the mind. First, we make assumptions about what aspects of the mind are important enough to explain. We can't say, for example, "This study will explain everything about vision." Of course we want to do that eventually, but we have to start somewhere. So what aspect of vision will we tackle first?

The second type of assumption is more obviously an assumption in that it is something we believe (maybe for good reason, maybe not) that affects our ideas about vision before we even start trying to learn about it.

Here's an example of each type of assumption. To begin with, we make an assumption about what it is that needs to be explained. For most of the last 2,000 years, people interested in vision have wanted to explain the conscious experience of visual perception, asking, "How do we consciously perceive the qualities of an object—its shape, size, and distance?" Unconscious processes involved in vision were not considered. Cognitive psychologists also seek to explain conscious visual perception, but they are more interested in the unconscious processes that eventually lead to conscious perception. In some ways, visual information in consciousness is the endpoint of vision; we need to explain the many steps that lead to this endpoint. Indeed, it has recently become obvious that some types of vision never become conscious. For example, some parts of the visual system help you move your body, but you are never aware of any aspect of this type of vision; I explain how this is possible in chapter 2.

The second type of assumption involves the beliefs that influence the questions we pose when we study something. For example, one dilemma about vision was this: The lens of the eye inverts the image of the world so that the image is projected onto the back of the eye upside-down. We obviously don't see the world upside-down, so how does the image get turned right side up? (See Figure 1.1.)

This question was posed in 1604 after Johannes Kepler speculated that the crystalline body of the eye functions as a lens does and therefore inverts the image. (René Descartes put the idea to the test some 20 years thereafter,