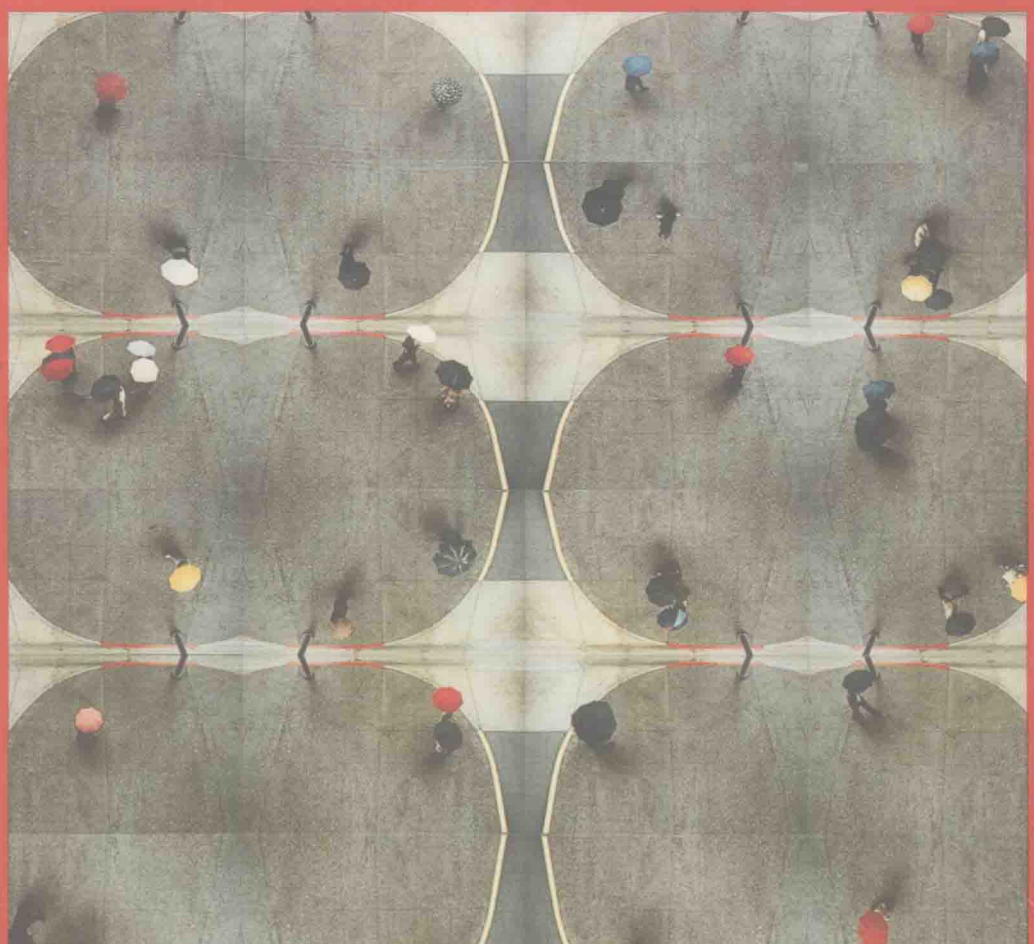
COGNITION

EXPLORING THE SCIENCE OF THE MIND

DANIEL REISBERG

THIRD EDITION



Cognition

EXPLORING THE SCIENCE OF THE MIND

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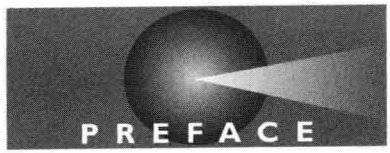


I was a college sophomore when I took my first course in cognitive psychology, and I've been excited about this field ever since. Why? First, cognitive psychologists are asking terrific questions. Some of the questions concern broad issues that have intrigued humanity for thousands of years. Why do we think the things we think? Why do we believe the things we believe? What are the limits of human ability? How can we make ourselves better, as individuals, and as a species?

Other questions asked by cognitive psychologists are of a more immediate, personal, concern: How can I help myself to remember more of the material that I'm studying in school? Is there some better way to solve the problems I encounter? Why is it that my roommate can study with the radio on, but I can't?

And sometimes the questions have important consequences for our social institutions: If an eyewitness reports what he saw at a crime, should we trust him? If a newspaper raises questions about a candidate's integrity, how will the voters react?

Of course, we want more than interesting questions. We would like some answers as well, and this is the second reason I find cognitive psychology so exciting: In the last half century, the field has made extraordinary progress on many fronts, providing us, now, with a rich understanding of the nature of memory, the processes of thought, and the content of knowledge. There are, to be sure, many things still to be discovered—that's part of the fun. Even so, we already have something to say about all of the questions just posed, and many more as well. We can speak to the specific questions and to the general, to the theoretical issues and to the practical. Our research has provided data of interest to scholars engaged in a range of intellectual pursuits; we have uncovered principles useful for improving the educational process; and we have made discoveries of considerable importance for the courts. What I've learned, as a cognitive psychologist, has changed how I think about my own memory; it's changed how I make decisions; it's changed how I draw conclusions when I'm thinking about events in my life.

On top of all this, I'm excited about the intellectual connections that cognitive psychology makes possible. In the modern academic world, intellectual disciplines are becoming more and more sophisticated, with their own methods and their own conceptual framework. As a consequence, these disciplines often become isolated from each other, sometimes working on closely related problems without even realizing it. In contrast, cognitive psychology has, in the last decades, actively sought out contact with neighboring disciplines, and, in this book, we will touch on topics in philosophy, economics, biology, linguistics, politics, computer science, and medicine. These connections bring obvious benefits, since insights and information can be traded back and forth between the domains. In addition, these connections

highlight the importance of the material we will be examining, and provide a strong signal that we are working on a project of considerable power and scope.

I have tried, in this text, to convey all this excitement. I've done my best to put in view the questions being asked within my field, the substantial answers we can provide for these questions, and finally, some indications of how cognitive psychology is (and has to be) interwoven with several other intellectual endeavors.

I have also had other goals in writing this text. In my own teaching, I work hard at maintaining a balance among several different elements—the nuts and bolts of how our science proceeds, the data provided by the science, the practical implications of our findings, and the theoretical framework that holds all of these pieces together. I've tried to find the same balance in this text. In particular, I've tried to make certain that the presentation of our science—the procedures we use, the exact nature of our data, and so on—is fully integrated with a presentation of the ideas and theories that derive from cognitive psychology research. These ideas provide the narrative that binds the pieces of the science together, and, indeed, it is these ideas that make the research interesting; it is these ideas that drive our endeavor forward. Therefore, I have tried, within each chapter, and from one chapter to the next, to convey how the various pieces fit together into a coherent package. In short, I have tried to emphasize what the result mean, and what the science is telling us.

I have also aimed at a text that is broad in its coverage and up-to-date in its presentation. Our field changes quickly, and students are entitled to a text that stays close to the current state of the art. Moreover, our theories are often rich and subtle in their treatments of a topic, and students deserve a text that conveys this sophistication. I've therefore tried, overall, to write a book that is deep enough, serious enough, but also clear enough so that by the book's close, students will have a full, rich, and contemporary understanding of cognition.

Perhaps most important, I have tried to write this book with language that is compatible with all these goals. To help students see how the pieces of our field fit together, the prose needs to emphasize the flow of ideas in research. To help students grasp the technical material, the prose needs to be approachable, but to provide real understanding of these issues, the prose needs to be precise. I hope my writing style will achieve these aims—but you, the reader, will need to be the judge of this.

Indeed, in general, others will have to decide whether I've accomplished what I set out to. In fact, I look forward to hearing from my readers—both the students I'm hoping to reach and the colleagues I'm hoping to serve. I would be happy to hear from both constituencies what I have done well in the book, and what I could have done better; what I've covered (but should have omitted) and what I've left out. It is unlikely that I'll be able to respond to every comment, but I do welcome the comments, either via regular mail (through W. W. Norton) or via e-mail (cogtext@reed.edu).

The book's fifteen chapters are designed to cover the major topics within cognitive psychology. The first section of this book lays the foundation. Chapter 1

provides the conceptual and historical background for the subsequent chapters. In addition, this chapter seeks to convey the extraordinary scope of this field and why, therefore, research on cognition is so important. This chapter also highlights the relationship between theory and evidence in this domain, and discusses the logic on which the field of cognitive psychology is built.

Chapter 2 then offers a brief introduction to the study of the brain. Most of cognitive psychology is concerned with the functions that our brains make possible, and not the brain itself. Nonetheless, our understanding of cognition has certainly been enhanced by the study of the brain, and, throughout this book, we will use biological evidence as one means of evaluating our theories. Chapter 2 is designed to make this evidence fully accessible to the reader—by providing a quick survey of the research tools used in studying the brain, and overview of the brain's anatomy, and also an example of how we can use brain evidence as a source of insight into cognitive phenomena.

In the second section of the book, we consider the problems of object recognition, and then the problem of attention. Chapter 3 discusses how we recognize the objects that surround us. This seems a straightforward matter—what could be easier than recognizing a telephone, or a coffee cup, or the letter "Q"? As we will see, however, recognition is surprisingly complex. Chapter 4 considers what it means to "pay attention." The first half of the chapter is concerned largely with selective attention, in which one seeks to focus on a target while ignoring distractors. The second half of the chapter is concerned with divided attention, in which one seeks to focus on more than one target, or more than one task, at the same time. Here, too, we will see that seemingly simple processes often turn out to be more complicated than one might suppose.

The third section turns to the broad problem of memory. Chapters 5, 6, and 7 starts with a discussion of how information is "entered" into long-term storage, but then turn to the complex interdependence between how information is first learned and how that same information is subsequently retrieved. A recurrent theme in this section is that learning that is effective for one sort of task, one sort of use, may be quite *in*effective for other uses. This theme is examined in several contexts, and leads to a discussion of current research on "memory without awareness." These chapters also offer a broad assessment of human memory: How accurate are our memories? How complete? How long-lasting? These issues are pursued both with regard to theoretical treatments of memory, and also the practical consequences of memory research, including the application of this research to the assessment, in the courtroom, of eyewitness testimony.

The book's fourth section is about knowledge. Earlier chapters showed over and over that humans are, in many ways, guided in their thinking and experiences by the broad pattern of things they already know. This invites the questions posed by Chapters 8, 9, 10, and 11: What is knowledge? How is it represented in the mind? Chapter 8 examines the idea that knowledge can be represented via a complex network, and includes a discussion of associative networks in general and connectionist

modeling in particular. Chapter 9 turns to the question of how "concepts," the building blocks of our knowledge, are represented in the mind. Chapters 10 and 11 focus on two special types of knowledge. Chapter 10 examines our knowledge about language, with discussion both of "linguistic competence" and "linguistic performance." Chapter 11 considers "visual knowledge" and examines what is known about mental imagery.

The chapters in the fifth section are concerned with the topic of thinking. Chapter 12 examines how each of us draws conclusions from evidence—including cases in which we are trying to be careful and deliberate in our judgments, and also cases of informal judgments of the sort we often make in our everyday lives. Chapter 13 turns to the question of how we reason from our beliefs—how we check on whether our beliefs are correct, and how we draw conclusions, based on things we already believe. Both of these chapters examine the strategies that guide our thinking, and some of the ways that these strategies can, on occasion, lead to error. The chapters then turn to the pragmatic issue of how these errors can be diminished through education. Chapter 13 also discusses how we make decisions and choices, with a special focus first on "economic" theories of decision-making, and then on some of the seeming, "irrationality" in human decision-making. Next, Chapter 14 considers how we solve problems. The first half of the chapter discusses problem-solving strategies of a general sort, useful for all problems; the chapter then turns to more specialized strategies, and with this, the topic of expertise. The chapter concludes with a discussion of the role of creativity and insight within problem solving.

The final chapter in the book does double service. First, it pulls together many of the strands of contemporary research relevant to the topic of consciousness—what consciousness is, and what consciousness is for. In addition, most students will reach this chapter at the end of a full semester's work, a point at which students are well served by a review of the topics already covered, and also a point at which students are ill served by the introduction of much new material. Therefore, this chapter draws most of its themes and evidence from previous chapters, and in that fashion serves as a review for many points that appear earlier in the book. By the same token, Chapter 15 highlights the fact that we are using these materials to approach some of the greatest questions ever asked about the mind, and, in that way, this chapter should help to convey some of the power of the material we have been discussing throughout the book.

This basic structure of the book is the same as it was in the previous (second) edition. In addition, though, much has changed in this, the third, edition. I have, of course, updated all chapters, to include important new research published since the previous edition. In some cases, this new research served largely to confirm previous claims (and, of course, it's always gratifying to see that the field had been on the right track, and that old hypotheses are confirmed by new data). In other cases, the new evidence has filled gaps in our previous knowledge, and so the presentation in this edition is, with these new findings, more filled-in than it had been before. For

many topics, this involves presentation of the relevant neuroscience, in light of our remarkable progress in exploring the biological bases for cognitive processes.

In other cases, though, the field's claims have had to evolve in response to new data, and so several sections of the book contain theoretical conceptions new to this edition. And, finally, new evidence has brought clarity to some issues that had been unclear in the past, and this has allowed a presentation that is more straightforward and more compact.

I have also taken steps to make this edition more accessible and more attractive to students. As part of this effort, the third edition is notably shorter than the previous two. I hope that this has not in any way reduced the sophistication or the richness of the book; the shortening was instead made possible by trimming of detail that wasn't crucial for the presentation, and removing some issues that were separate from the book's main themes. As a result, the book is not just shorter; it is more cohesive and more focused.

Also new for this edition are several ancillaries, including *supplemental essays,* available on the book's website, for each chapter. (The web site can be found at www.wwnorton.com/web/cognition) These essays were designed directly to address two requests I've often heard: First, many students want to explore various applied issues connected to cognitive psychology, both to deepen their understanding of the field, and also to put their understanding to good use. To help students with this, I've written a brief essay for each chapter exploring how the chapter's materials can be applied to a specific domain that is of enormous importance, and also of considerable interest to me—namely, the interface between psychology and the legal system. Some of these essays explore issues of eyewitness memory; others explore how juries make decisions; still others explore how legal concepts can be defined. In each case, I have tried to illustrate how legal issues can be influenced and illuminated by psychological research.

Another frequent request, both from students and from colleagues who use the book, was for fuller treatment of research methods. Within the book, I've always tried to integrate the discussion of what psychologists know with some explanation of how they know it. In the *supplemental essays* on the web for this edition, however, I've also covered some more fundamental points about how research gets done (and so have written on counterbalancing, and the importance of control groups, and the need to control for experimental demand, and so on). These essays are designed to accompany individual chapters, and so in each case are connected to the content of that chapter. In addition, these essays are designed so that, overall, the sequence of essays will provide a reasonable background in how studies get designed and interpreted.

Finally, let me turn to the happiest of chores—thanking all of those who have contributed to this book. I begin with those who helped with the previous editions: Bob Crowder (Yale University) and Bob Logie (University of Aberdeen) both read the entire text of the first edition, and the book was unmistakably improved by their insights. Other colleagues read, and helped me enormously with, specific

chapters: Enriqueta Canseco-Gonzalez (Reed College); Rich Carlson (Pennsylvania State University); Lila Gleitman (University of Pennsylvania); Henry Gleitman (University of Pennsylvania); Peter Graf (University of British Columbia); John Henderson (Michigan State University); Jim Hoffman (University of Delaware); Frank Keil (Cornell University); Mike McCloskey (John Hopkins University); Hal Pashler (UCSD); Steve Pinker (MIT); and Paul Rozin (University of Pennsylvania).

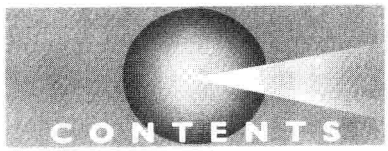
The second edition was markedly strengthened by the input and commentary provided by these colleagues: Martin Conway (University of Bristol); Kathleen Eberhard (Notre Dame); Howard Egeth (Johns Hopkins University); Bill Gehring (University of Michigan); Steve Palmer (University of California, Berkeley); Henry Roediger (Washington University); and Eldar Shafir (Princeton University).

And in the present edition, once again, I've been fortunate to have the advice, criticism, and insights provided by a number of colleagues who, together, have made the book better than it otherwise could have been, and I'd like to thank: Bill Gehring and Ellen Hamilton (University of Michigan); Steve Luck (University of Iowa); Evan Palmer, Melinda Kunar, & Jeremy Wolfe (Harvard University); Randall Engle (Georgia Tech); Nancy Kim (Rochester Institute of Technology); Daniel Simons (University of Illinois); Chris Shunn (University of Pittsburgh); Michael Miller, (UC Santa Barbara); Richard Catrambone (Georgia Tech); and Rich Carlson (Penn State).

I also want to thank the people at Norton. Jon Durbin and I have now been working together for a dozen years, and have built a bond of trust, respect and good will that is an enormous resource for me. Aaron Javsicas, as Assistant Editor, is better at managing book projects than anyone I have ever encountered. I'm grateful to Stephanie Hiebert for her skilled and careful editing, even if she is fonder of the APA style manual than I am. Kelly Rolf and Chris Granville have also been tremendously helpful in getting this edition to the finish line.

Finally, it is Jacob, Solomon and Friderike who make this all worthwhile. They forgive me the endless hours at the computer, but also (thank heavens) tug me away from the computer at the right moments. They remind me of what is important, and also keep my life on track. I couldn't do any of this without them.

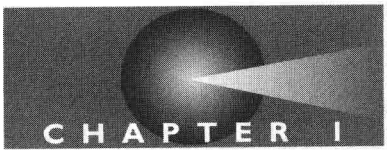
Daniel Reisberg
Portland, Oregon



THE FOUNDATIONS OF COGNITIVE PSYCHOLOGY

WHAT IS COGNITIVE PSYCHOLOGY? In Chapter 1, we will define this discipline and, with that, we'll offer an early sketch of what this field can teach us—both in terms of theory and in terms of practical applications. We will also provide a brief history, in order to explain why cognitive psychology takes the form that it does.

Chapter 2 has a different focus: In the last decade or two, cognitive psychology has formed a productive partnership with the field of cognitive neuroscience. Investigators in these two fields work together to describe how the mind works, what is involved in various mental processes, and how the brain makes these achievements and processes possible. In this book, our main emphasis will be on psychology, not neuroscience, but we'll make use of neuroscience evidence at many points in our discussion. To do this, though, we first need to provide some background, and this is the main purpose of Chapter 2. We'll include a rough map of what's where in the brain, but we must be clear from the start about what this means: Each area of the brain performs a specific function, but that doesn't mean that there are large-scale "centers" in the brain—a "reading center," for example, or a "memory center." Instead, any mental achievement you can name depends on the coordinated functioning of many different brain regions, with each region contributing its own small bit to the overall achievement. We'll show evidence for this pattern of "cerebral teamwork" at the very beginning of Chapter 2, when we consider a bizarre form of brain damage. This pattern will then remain in view throughout the chapter, and will certainly be evident late in the chapter when we'll zoom in on the visual system as a case study of how the brain functions.



The Science of the Mind

This is a book about intellectual functioning. It will take us several pages to spell out just what this means, but some of the questions to be asked are obvious from the start:

There you are, studying for next Wednesday's exam, but for some reason, the material just won't "stick" in your memory. You find yourself wishing, therefore, for a better strategy to use in studying and memorizing. What would that strategy be? Is it possible to have a "better memory"?

While you're studying, your friend is moving around in the room, and you find this terribly distracting. Why can't you just shut out your friend's motion? Why don't you have better control over your attention and your ability to concentrate?

A police officer is interviewing a witness to a crime and is dismayed by how little the witness remembers. You've been introduced to a woman at a party, but minutes later, you realize (to your embarrassment) that you have forgotten her name. Why do we forget? What sorts of things are we likely to forget, and what sorts of things are we likely to remember?

You pick up the morning newspaper and are horrified to learn how many people have decided to vote for candidate X. How do people decide whom to vote for? For that matter, how do people decide what college to attend, or which car to buy, or even what to have for dinner? What forces drive our decisions?