

An aerial photograph of a lush green vineyard. Numerous red and blue plastic crates are scattered across the ground, forming a winding path through the rows of grapevines. The perspective is from directly above, looking down on the scene.

DANIEL REISBERG

SIXTH EDITION

COGNITION

EXPLORING THE SCIENCE OF THE MIND



Cognition

sixth edition

Cognition

6e

exploring the science of the mind

Daniel Reisberg

REED COLLEGE



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For all my teachers,
and all they've taught me,
and for all my students,
and all they've taught me.

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Preface

I was a college sophomore when I took my first course in cognitive psychology. I was excited about the material then, and now, many years later, the excitement hasn't faded. Part of the reason is that cognitive psychologists are pursuing profound questions 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 is “knowledge,” and how *secure* (complete, accurate) is our knowledge of the world around us?

Other questions cognitive psychologists ask, though, are more immediate and personal: How can I help myself to remember more of the material that I'm studying in my classes? 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 and political institutions: If an eyewitness reports what he or she saw at a crime scene, should we trust the witness's recollection? If a newspaper raises questions about a candidate's integrity, how will voters react?

Of course we want more than interesting questions—we want *answers* to these questions, and this is another reason I find cognitive psychology so exciting. In the last half-century or so, the field has made extraordinary progress on many fronts, providing us with a rich understanding of the nature of memory, the processes of thought, and the content of knowledge. There are still many things to be discovered, and that's part of the fun. Even so, we already have something to say about all of the questions just posed, and many more. We can speak to the specific questions and the general, to the theoretical issues and the practical. Our research has uncovered principles useful for improving the process of education 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, how I make decisions, and how I draw conclusions when I'm thinking about events in my life.

On top of all this, I'm also excited about the connections that cognitive psychology makes possible. In the academic world, intellectual disciplines are

often isolated from each other, sometimes working on closely related problems without even realizing it. In the last decades, though, cognitive psychology has forged rich connections with its neighboring disciplines, and in this book, we'll touch on topics in philosophy, neuroscience, economics, 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'll be examining, since they make it clear that the issues before us are of interest to a wide range of scholars. This is a strong signal that we're working on questions of considerable power and scope.

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

I've also had other goals in writing this text. In my own teaching, I try to maintain a balance among many 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. Perhaps most important, though, both in my teaching and throughout this book, I try to “tell a good story,” one that conveys how the various pieces of our field fit together into a coherent package. I certainly want the specific evidence for our claims to be in view, so that readers can see how our field tests its hypotheses. And I want readers to see that our hypotheses *have been* tested, so that our claims must be taken seriously. But I also put a strong emphasis on the flow of ideas—how theories lead to new experiments, and how those experiments can lead to new theory. I also emphasize the ways in which different forms of evidence weave together, so that, for example, the coverage of neuroscience is not just presented as an adjunct to the discussion, but instead is used to address psychological questions that have long been of interest to the field.

The notion of telling a “good story” also emerges in another way. I've always been impressed with the ways in which the different parts of cognitive psychology are interlocked. Our claims about attention, for example, have immediate implications for how we can theorize about memory; and our theories about object recognition are linked to our proposals for how knowledge is stored in the mind. Linkages like these are intellectually satisfying, because they ensure that the pieces of the puzzle really do fit together. But, in addition, these linkages make the material within cognitive psychology easier to learn and remember. Indeed, if I were to emphasize one crucial fact about memory, it would be that memory is best when the memorizer perceives the organization and interconnections within the material being learned. (We'll discuss this point in Chapter 6.) With an eye on this point, I've made sure to highlight the interconnections among various topics so that readers can appreciate the beauty of our field, and can also be helped in their learning by the orderly nature of our theorizing.

I've also worked hard to help readers in other ways. First, I've tried throughout the book to make the prose approachable. I want my readers to gain a sophisticated understanding of the material in this text, but I certainly don't want them to struggle with the ideas. Therefore, I've kept the presentation as straightforward and focused as possible by highlighting the themes that bind the field together. This edition also includes many more illustrations—including many new data figures—to facilitate readers' understanding.

Second, I've taken steps that I hope will foster an "alliance" with readers. My strategy here grows out of the fact that, like most teachers, I value the questions I receive from students and the discussions I have with them. In a classroom, this two-way flow of information unmistakably improves the educational process. Of course, a two-way flow is not possible in a book, but I've offered what I hope is a good approximation: Often, the questions I hear from students, and the discussions I have with them, focus on the relevance of the material we're covering to their own lives, or the relevance of the material to the world outside of academics. I've tried to capture this dynamic, and to present my answers to these student questions in the Applying Cognitive Psychology essays at the end of each chapter (and I'll say more about these essays in a moment). Roughly half of these essays appear under the banner "Cognitive Psychology and Education," and as the label suggests, these essays will help readers understand how the materials covered in that chapter matter for (and might change!) the reader's own learning. The other essays appear under the banner "Cognitive Psychology and the Law," and explore how that chapter's materials matter in another arena: the enormously important domain of the justice system. I hope that both types of essays—Education and Law—will help readers see that all of this material is indeed relevant to their lives and, perhaps, is as exciting for them as it is for me.

Have I met all of these goals? You, the readers, will need to be the judges of this. I would love to hear from you about what I've done well and what I could have done better; and what I've covered (but perhaps should have omitted) and what I've left out. I'll do my best to respond to every comment. You can reach me via email (reisberg@reed.edu). I've been delighted to get comments from readers of the previous editions and look forward to more with this edition.

Organization of the Book

The fourteen chapters in this book are designed to cover the major topics within cognitive psychology. The first section 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 research on cognition is so important. This chapter also highlights the relationship between theory and evidence in cognitive psychology, and discusses the logic on which this field 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 been enhanced by the study of the brain, and throughout this book, we'll use biological evidence as one means of evaluating our theories. Chapter 2 is designed to make this evidence fully accessible to readers by providing a quick survey of the research tools used in studying the brain, an 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 next section of the book, we consider the problems of perception, object recognition, and attention. Chapter 3 is new to this edition and covers visual perception. At the outset, the chapter links to the previous (neuroscience) chapter with a description of the eyeball and basic mechanisms within early visual processing. In this context, the chapter introduces the crucial concept of parallel processing and the prospect of mutual influence among separate neural mechanisms. From this base, the chapter builds toward a discussion of the perceiver's *activity* in shaping and organizing the visual world, and explores this point by discussing the rich topics of perceptual constancy and perceptual illusions.

Chapter 4 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, and discussion of this complexity allows me to amplify key themes introduced in earlier chapters: how *active* people are in organizing and interpreting the information they receive from the world, the degree to which people *supplement* the information by relying on prior experience, and the ways in which this knowledge can be built into a *network*.

Chapter 5 then considers what it means to “pay attention.” The first half of the chapter is concerned largely with selective attention (cases in which a person tries to focus on a target while ignoring distractors), while the second half is concerned with divided attention (cases in which a person tries to focus on more than one target or task at the same time). Here, too, we will see that seemingly simple processes turn out to be more complicated than one might suppose.

The third section turns to the broad problem of memory. Chapters 6, 7, and 8 start 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, or one sort of use, may be quite ineffective for other uses. This theme is examined in several contexts and leads to a discussion of unconscious memories—so-called “memory without awareness.” These chapters also offer a broad assessment of human memory: How accurate are our memories? How complete or long-lasting are they? These issues are pursued with regard to theoretical treatments of memory, as well as the practical consequences of memory research, including the application of this research to the assessment in the courtroom of eyewitness testimony. These chapters—like the entire book—have expanded coverage in three major domains: fuller discussion of the relevant neuroscience; a broader exploration of theory, including working

memory's role in making someone *intelligent*; and a greater emphasis on key applied issues, such as eyewitness memory.

The book's fourth section is about knowledge. Earlier chapters show over and over that humans are, in many ways, guided in their thinking and experiences by what they already know—that is, the broad pattern of knowledge they bring into each new experience. This invites the questions posed in Chapters 9, 10, and 11: What is knowledge? How is it represented in the mind? Chapter 9 tackles 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 of both *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 make in our everyday lives. The chapter then turns to the question of how we reason from our beliefs—that is, how we check on whether our beliefs are correct, and how we draw conclusions based on things we already believe. The chapter also considers the pragmatic issue of how errors in thinking can be diminished through education. This chapter has updated coverage of theorizing from Nobel Laureate Daniel Kahneman and expanded discussion of the role of *emotion* within decision making.

Chapter 13 is also about thinking, but with a different perspective. This chapter considers some of the ways people differ from each other in their ability to solve problems, in their creativity, and in their intelligence. The chapter also addresses the often heated, often misunderstood debate about how different groups—specifically Whites and African Americans—might (or might not) differ in their intellectual capacities.

Chapter 14, 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 it is for. In addition, most readers will reach this chapter at the end of a full semester—a point at which they are well-served by a review of the topics already covered and ill-served by the introduction of much new material. Therefore, this chapter draws many of its themes and evidence from previous chapters, and so it can be used as a review of points that appear earlier in the book. Chapter 14 also 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, should help convey the power of the material we have been discussing.

New to this Edition

What's new in this edition? I've already noted that the perception chapter is new (Chapter 3), and fills what I believe was a conspicuous gap in the previous edition. And, of course, material has been updated throughout the

book to make the coverage as current as possible. I've also updated the art program for the entire book with several goals: I wanted to make the book as attractive as possible. I wanted the art to deepen and supplement readers' understanding. And, in addition, I've used the art to showcase the many points of contact between cognitive psychology and cognitive neuroscience—and so the new art will help readers grasp both the relevant brain anatomy and the nature of cognitive neuroscience research.

This edition also contains a number of entirely new elements. At the start of each chapter, the “What if...” section serves several aims. The mental capacities described in each chapter (the ability to recognize objects, the ability to pay attention, and so on) are crucial for our day-to-day functioning, and to help readers understand this point, most of the “What if...” sections explore what someone's life is like if they *lack* the relevant capacity. The “What if...” sections are rooted in concrete, human stories, and I hope these stories will be inviting and thought-provoking for readers, motivating them to engage the material in a richer way. Moreover, most of the “What if...” sections involve people who have lost the relevant capacity through some sort of brain damage. These sections therefore provide another avenue through which to highlight the linkage between cognitive psychology and cognitive neuroscience.

The sixth edition also includes explicit coverage of Research Methods. Much of this material was in the *Cognitive Workbook* for the previous edition, but I've updated and reorganized the material, and more importantly, moved the material into the text itself to make it easily accessible to all readers. At the same time, I've set the Methods coverage as an appendix to accommodate readers (or instructors) who prefer to focus on the book's substantive content. The appendix is divided into “modules” for each chapter, so that it can be used in a chapter-by-chapter basis. This organization will help readers see, for each chapter, how the research described in the chapter unfolds, and will simultaneously provide a context for each of the modules, so that readers can see why the methods are so important.

The appendix is surely no substitute for a research methods course, but nonetheless, is sequenced in a fashion that builds toward a broad understanding of how the scientific method plays out in our field. An early module, for example, works through the question of what a “testable hypothesis” is and why this is so important. Another module works through the power of random assignment, and another discusses how we deal with confounds. In all cases, my hope is that the appendix will guide readers toward a sophisticated understanding of why our research is as it is, and why, therefore, our research is so persuasive.

I've already mentioned another new element: the end-of-chapter essays. As I've discussed, these essays illustrate for readers why the chapter's materials are so important, and also how the materials are *useful*. In addition, I hope these end-of-chapter essays are inviting and maybe even *fun*, and so some readers may want to see more of them. For that reason, a fuller set of end-of-chapter essays is contained in the text's ebook, available to all readers at no additional cost.

As I flagged before, the end-of-chapter essays (both in the text and in the ebook) are of two types. For some, I draw on my own experience working with law enforcement and the criminal justice system. In this work, I'm called on to help juries understand how an eyewitness might be certain in his or her recollection, yet *mistaken*. I also work with police officers to help them draw as much information from a witness as possible without leading the witness in any way. Based on this experience, many of the essays discuss how the material in the chapter might be useful for the legal system. These essays, I hope, will be interesting for readers and persuade them that the material they're studying has important real-world consequences. In turn, it's my hope that this will make it obvious to readers why it's crucial that the science be done carefully and well, so that we bring only high-quality information into the legal system.

In addition, my students often seek take-home messages from the material that will, in a direct way, benefit them. We are, after all, talking about memory, and students obviously are engaged in an endeavor of putting a lot of new information—information they're learning in their courses—into their memories! We're also talking about attention, and students often struggle with the chore of keeping themselves “on task” and “on target.” In light of these points of contact, the other end-of-chapter essays build a bridge between the course materials and the real-life concerns of students. This will, I hope, make the material more useful for students, and make it clear just how important an enterprise cognitive psychology really is.

As in the previous editions, I've also included in the ebook various Demonstrations to accompany the book's description of research. Many of these demonstrations are miniature versions of experimental procedures, allowing students to see for themselves what these experiments involve and just how powerful many of our effects are. Margin icons in the text signal points for which demonstrations are available, but it's of course up to instructors (or readers) to decide how best to use the demonstrations. Readers who want to run the demonstrations for themselves as they read along certainly can, and instructors who want to run the demonstrations in their classrooms (as I sometimes do) are certainly encouraged to do so. Instructors who want to use the demonstrations in discussion sections, aside from the main course, can do that as well. In truth, I suspect that some demonstrations will work better in one of these venues, and some will work better in others. But in all cases, I hope the demonstrations help bring the material to life—putting students directly in contact with both our experimental methods and our experimental results.

Finally, I'm excited about another element I've added for this edition in the *Instructors' Manual*. Students love videos, and they probably spend more time than they should surfing the Internet (YouTube in particular) for fun clips. As it turns out, though, YouTube contains far more than cute-pet videos. It also contains intriguing, powerful material directly relevant to the topics in this text. The *Instructors' Manual* therefore provides a list of carefully selected online videos to accompany each chapter. In many cases, these videos introduce students to the individuals briefly described in the “What if...” sections,

making these sections even more compelling. I'll leave it to instructors to decide how best to use these videos in their courses, but I also want to issue an invitation: I'm sure there are other videos available that I haven't seen yet, and I would be grateful to any readers who can help me broaden this list, so we can make this resource even better.

For Students

As in previous editions, this edition of *Cognition* comes with various supplementary materials, some for students and some for instructors.

ZAPS 2.0 Cognition Labs. Every copy of the text comes packaged with free access to ZAPS 2.0 Cognition Labs—a completely updated revision of Norton's popular online psychology labs. Crafted specifically to support cognitive psychology courses, this version helps students learn about core psychological phenomena. Each lab (1 or 2 per chapter) is introduced in a brief video that relates the topic to students' lives. Students then engage in a hands-on experience that, for most labs, produces data based on their individual responses. The theories behind the concepts are then explained alongside the data the student has generated. A new assessment component lets students confirm that they understand the concept. By illustrating how research is conducted in the field, these ZAPS labs underscore that psychology is indeed a science.

Interactive Ebook. Every print copy of the text comes packaged with free access to the Interactive Ebook. This ebook can also be purchased separately at a fraction of the price of the print version. The ebook has several advantages over the printed text. First, the ZAPS 2.0 Cognition Labs are linked to the relevant topics in the ebook. Second, the ebook includes Demonstrations (mentioned earlier) designed to show students what key experiments described in the text actually involve. Third, the ebook has additional Applying Cognitive Psychology essays. While the printed text includes one of these essays at the end of each chapter, the ebook includes more. In addition, the ebook can be viewed on any device—laptop, tablet, phone, even a public computer—and will stay synced between devices. The ebook is therefore a perfect solution for students who want to learn more in more convenient settings, and pay far less doing so.

For Instructors

Interactive Instructor's Guide. This online repository of teaching assets offers materials for every chapter that both veteran and novice instructors of the course will find helpful. Searchable by chapter or asset class, the Interactive Instructor's Guide provides multiple ideas for teaching: links to YouTube-style video clips (selected and annotated by the author), teaching suggestions, and other class activities and exercises. This continually updated repository of lecture and teaching materials functions both as a course prep tool and as a means of tracking the latest ideas in teaching the cognitive psychology course.

Test Bank. The Test Bank features 980 questions, including 60 multiple-choice and 10 short-answer questions for each chapter. All questions have been updated according to Norton’s assessment guidelines to make it easy for instructors to construct quizzes and exams that are meaningful and diagnostic. All questions are classified according to educational objective, student text section, difficulty, and question type. This Norton Test Bank is available with ExamView Test Generator software, allowing instructors to create, administer, and manage assessments. The convenient and intuitive test-making wizard makes it easy to create customized exams. Other key features include the ability to create paper exams with algorithmically generated variables and export files directly to your LMS.

Lecture PowerPoints. These text-focused PowerPoints follow the chapter outlines and include figures from the text and feature instructor-only notes.

Art Slides. All the figures, photos, and tables from the text are offered as JPEGs, both separately and embedded in a PowerPoint set for each chapter. All text art is enhanced for optimal viewing when projected in large classrooms.

Coursepack (Blackboard, Canvas, Angel, Moodle, and other LMS systems). Available at no cost to professors or students, Norton Coursepacks for online, hybrid, or lecture courses are available in a variety of formats. With a simple download from the instructor’s website, adopters can bring high-quality Norton digital media into new or existing online courses (no extra student passwords required), and it’s theirs to keep. Instructors can edit assignments at the question level and set up custom grading policies to assess student understanding. In addition to the instructor resources listed above, the Norton Coursepack includes additional chapter quizzes, flashcards, chapter outlines, chapter summaries, and questions to follow up on the essays that appear in the printed text (as end-of-chapter essays) and in the ebook.

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Daniel Reisberg
Portland, Oregon

The Foundations of Cognitive Psychology

part
1

What is cognitive psychology? In Chapter 1, we'll define this discipline and offer a sketch of what this field can teach us—through its theories and practical applications. We'll also provide a brief history to explain why cognitive psychology has taken 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*—the effort toward understanding our mental functioning by close study of the brain and nervous system. In this book, our emphasis will be on psychology, not neuroscience, but even so, we'll rely on evidence from neuroscience at many points. To make sure this evidence is useful, we need to provide some background, and that's the main purpose of Chapter 2. In that chapter, we'll offer a rough mapping of what's where in the brain, and we'll describe the functioning of many of the brain's parts. We'll also discuss the broad issue of *what it means* to describe the functioning of this or that brain region, because, as we will see, each of the brain's parts is enormously specialized in what it does. As a result, mental achievements such as reading or remembering or deciding depend on the coordinated functioning of many different brain regions, with each contributing its own small bit to the overall achievement.



chapter **1**

The Science of the Mind



Almost everything you do, and everything you feel or say, depends on your *cognition*—what you know, what you remember, and what you think. As a result, the book you’re now reading—a textbook on cognition—describes the foundation for virtually every aspect of who you are.

As illustrations of this theme, in a few pages we’ll consider the way in which your ability to cope with grief depends on how your memory functions. We’ll also discuss the role that memory plays in shaping your self-image—and, hence, your self-esteem. As a more mundane example, we’ll also discuss a case in which your understanding of a simple story depends on the background knowledge that you supply. Examples like these make it clear that cognition matters in an extraordinary range of circumstances, and it is on this basis that our focus in this book is, in a real sense, on the intellectual foundation of almost every aspect of human experience.

The Scope of Cognitive Psychology

When the field of cognitive psychology was first launched, it was broadly focused on the *scientific study of knowledge*, and this focus led immediately to a series of questions: How is knowledge acquired? How is knowledge retained so that it’s available when needed? How is knowledge used—whether as a basis for making decisions or as a means of solving problems?

These are great questions, and it’s easy to see that answering them might be quite useful. For example, imagine that you’re 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”?

As a different case, let’s say that while you’re studying, your friend is moving around in the room, and you find this to be quite 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?

Here’s one more example: You pick up the morning newspaper, and you’re 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? And how can we help people make *better* decisions—so that, for example, they choose healthier foods, or vote for the candidate who (in your view) is obviously preferable?

preview of chapter themes

- The chapter begins with a description of the *scope* of cognitive psychology. The domain of this field includes activities that are obviously “intellectual” (such as remembering, or attending, or making judgments) but also a much broader range of activities that depend on these intellectual achievements.
- What form should a “science of the mind” take? We discuss the difficulties in trying to study the mind by means of direct observation. But we also explore why we *must* study the mental world if we are to understand behavior; the

reason, in brief, is that our behavior depends, in crucial ways, on how we *perceive* and *understand* the world around us.

- Combining these themes, we are led to the view that we must study the mental world *indirectly*, but as we will see, the (inferential) method for doing this is the same method used by most sciences.
- Finally, we consider examples of research in cognitive psychology to illustrate the types of data that psychologists consider and the logic they use in testing their theories.

Before we’re through, we’ll consider evidence pertinent to all of these questions. Let’s note, though, that in these examples, things aren’t going as you might have wished: You remember less than you want to; you’re unable to ignore a distraction; the voters make a choice you don’t like. But what about the other side of the picture? What about the remarkable intellectual feats that humans achieve—brilliant deductions or creative solutions to complex problems? In this text, we’ll also discuss these cases and explore how it is that people accomplish the great things they do.



TRYING TO FOCUS

Often, you want to focus your attention on just one thing, and you want to shut out the other sights and sounds that are making it hard for you to concentrate. What steps should you take to promote this focus and to avoid distraction?

The Broad Role for Memory

Clearly there is an important set of issues in play here, but even so, the various questions just catalogued risk a misunderstanding, because they make it sound like cognitive psychology is concerned only with our functioning as intellectuals—our ability to remember, or to pay attention, or to think through options when making a choice. As we said at the start, though, the relevance of cognitive psychology is far broader—thanks to the fact that a huge range of our actions, thoughts, and feelings *depend on knowledge*. As one illustration of this point, let's look at the study of *memory* and ask: When we investigate how memory functions, what exactly is it that we're investigating? Or, to turn this around, what aspects of your life depend on memory?

You obviously rely on memory when you're taking an exam—memory for what you have learned during the term. Likewise, you rely on memory when you're at the supermarket and trying to remember the cheesecake recipe so that you can buy the right ingredients. You also rely on memory when you're reminiscing about childhood. But what else draws on memory?

Consider this simple story (adapted from Charniak, 1972):

Betsy wanted to bring Jacob a present. She shook her piggy bank. It made no sound. She went to look for her mother.

This four-sentence tale is easy to understand, but *only because you provided some important bits of background yourself*. For example, you weren't at all puzzled about why Betsy was interested in her piggy bank; you weren't puzzled, specifically, about why the story's first sentence led naturally to the second. This is because you already knew (a) that the things one gives as presents are often things bought for the occasion (rather than things already owned), (b) that buying things requires money, and (c) that money is stored in piggy banks. Without these facts, you would have been bewildered as to why a desire to give a gift would lead someone to her piggy bank. (Surely you did not think she intended to give the piggy bank itself as the present!) Likewise, you immediately understood why Betsy *shook* her piggy bank. You didn't suppose that she was shaking it in frustration or trying to find out if it would make a good percussion instrument. Instead, you understood that she was trying to determine its contents. But you knew this fact only because you already knew (d) that children don't keep track of how much money is in their bank, and (e) that one cannot simply look into the bank to learn its contents. Without these facts, Betsy's shaking of the bank would make no sense. Similarly, you understood what it meant that the bank made no sound. That's because you know (f) that it's usually coins (not bills) that are kept in piggy banks, and (g) that coins make noise when they are shaken. If you didn't know these facts, you might have interpreted the bank's silence, when it was shaken, as good news, indicating perhaps that the bank was jammed full of \$20 bills—an inference that would have led you to a very different expectation for how the story would unfold from there.



A SIMPLE STORY

What is involved in your understanding of this simple story? Betsy wanted to bring Jacob a present. She shook her piggy bank. It made no sound. She went to look for her mother.



CELEBRATING HUMAN ACHIEVEMENTS

Many of the text's examples involve *failures or limitations* in our cognition. But we also need to explain our species' incredible intellectual achievements—the complex problems we've solved or the extraordinary devices we've invented.

Of course, there's nothing special about the “Betsy and Jacob” story, and it seems likely that we'd uncover a similar reliance on background knowledge if we explored how you understand some other narrative, or how you follow a conversation, or comprehend a TV show. Our suggestion, in other words, is that many (and perhaps all) of your encounters with the world depend on your supplementing your experience with knowledge that you bring to the situation. And perhaps this *has* to be true. After all, if you didn't supply the relevant bits of background, then anyone telling the “Betsy and Jacob” story would need to spell out all the connections and all the assumptions. That is, the story would have to include all the facts that, *with* memory, are supplied by you. As a result, the story would have to be many times longer, and the telling of it much slower. The same would be true for every story you hear, every conversation you participate in. Memory is thus crucial for each of these activities.

Amnesia and Memory Loss

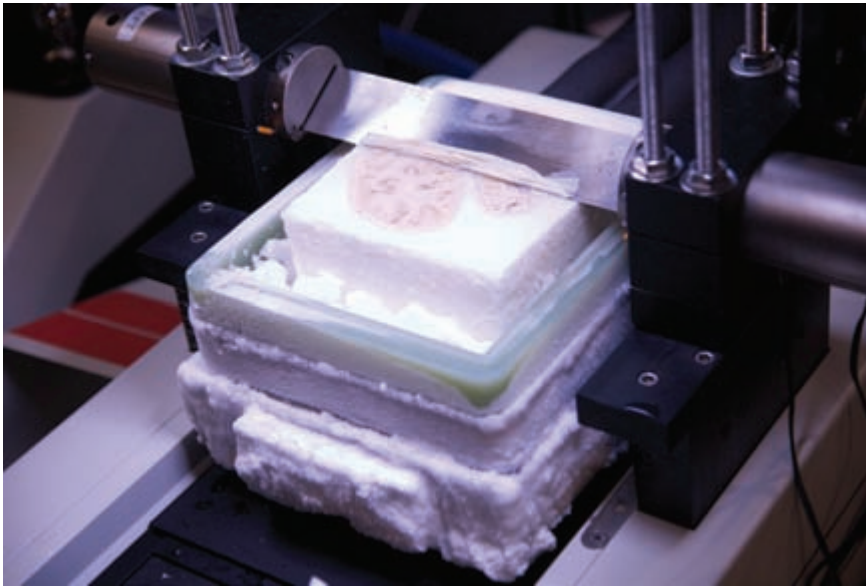
Here is a different sort of example: In Chapter 7, we will consider various cases of clinical *amnesia*—cases in which someone, because of brain damage, has lost the ability to remember certain materials. These cases are fascinating at many levels, including the fact that they provide us with key insights into what memory is *for*: Without memory, what is disrupted?

H.M. was in his mid-20's when he had brain surgery intended to control his severe epilepsy. He survived for more than 50 years after the operation, and for all of those years, he had little trouble remembering events *prior* to the surgery. However, H.M. seemed completely unable to recall any event that occurred *after* his operation. If asked who the president is, or about recent events, he reported facts and events that were current at the time of the surgery. If asked questions about last week, or even an hour ago, he recalled nothing.

This memory loss had massive consequences for H.M.'s life, and some of the consequences are perhaps surprising. For example, H.M. had an uncle he was very fond of, and he occasionally asked his hospital visitors how his uncle was doing. Unfortunately, the uncle died sometime after H.M.'s surgery, and H.M. was told this sad news. The information came as a horrible shock, but because of his amnesia, he soon forgot about it.

Sometime later, though, because he'd *forgotten* about his uncle's death, H.M. again asked how his uncle was doing and was again told of the death. However, with no memory of having heard this news before, he was once more hearing it “for the first time,” with the shock and grief every bit as strong as it was initially. Indeed, each time he heard this news, he was hearing it “for the first time.” With no memory, he had no opportunity to live with the news, to adjust to it. Hence, his grief could not subside. Without memory, H.M. had no way to come to terms with his uncle's death.

A different glimpse of memory function comes from H.M.'s poignant comments about his state and about “who he is.” Each of us has a conception



H.M.'S BRAIN

H.M. died in 2008, and the world then learned his full name, Henry Molaison. Throughout his life, H.M. had cooperated with researchers in many studies of his memory loss. Even after his death, H.M. is contributing to science: His brain (shown here) was frozen and has now been sliced into sections for detailed anatomical study.

of who we are, and that conception is supported by numerous memories: We know whether we're deserving of praise for our good deeds or blame for our transgressions because we remember our good deeds and our transgressions. We know whether we've kept our promises or achieved our goals because, again, we have the relevant memories. None of this is true for people who suffer from amnesia, and H.M. sometimes commented on the fact that in important ways, he didn't know who he was. He didn't know if he should be proud of his accomplishments or ashamed of his crimes; he didn't know if he'd been clever or stupid, honorable or dishonest, industrious or lazy. In a sense, then, without a memory, there is no self. (For broader discussion, see Conway & Pleydell-Pearce, 2000; Hilts, 1995.)

What, then, is the scope of cognitive psychology? As we mentioned earlier, this field is sometimes defined as the scientific study of the acquisition, retention, and use of knowledge. We've now seen, though, that "knowledge" (and, hence, the study of how we gain and use knowledge) is relevant to a huge range of concerns. Our self-concept, it seems, depends on our knowledge (and, in particular, on our episodic knowledge). Our emotional adjustments

to the world, as we have seen, rely on our memories. Or, to take a much more ordinary case, our ability to understand a story we've read, or a conversation, or, presumably, any of our experiences, depends on our supplementing that experience with some knowledge.

The suggestion, then, is that cognitive psychology can help us understand capacities relevant to virtually every moment of our lives. Activities that don't, on the surface, appear intellectual would nonetheless collapse without the support of our cognitive functioning. The same is true whether we're considering our actions, our social lives, our emotions, or almost any other domain. This is the scope of cognitive psychology and, in a real sense, the scope of this book.

The Cognitive Revolution

The enterprise that we now call “cognitive psychology” is roughly 50 years old, and the emergence of this field was in some ways dramatic. Indeed, the science of psychology went through changes in the 1950s and 1960s that are often referred to as psychology's “cognitive revolution,” and the revolution brought a huge shift in the style of research used by most psychologists. The new style was intended initially for studying problems we've already met: problems of memory, decision making, and so on. But this new type of research, and its new approach to theorizing, was soon exported to other domains, with the consequence that in important ways the cognitive revolution changed the intellectual map of our field.

The Limits of Introspection

The cognitive revolution centered on a small number of key ideas. One idea is that the science of psychology cannot study the mental world directly. A second idea is that the science of psychology *must* study the mental world if we are going to understand behavior.

As a path toward understanding each of these ideas, let's look at a pair of earlier traditions in psychology that offered a rather different perspective. We'll start with a research framework, prominent more than a century ago, that assumed we *could* study the mental world directly. Note, though, that our purpose here is not to describe the full history of modern cognitive psychology. That history is rich and interesting, but our goal is a narrow one—to explain why the cognitive revolution's themes were as they were. (For readers interested in the history, though, see Bartlett, 1932; Benjamin, 2008; Broadbent, 1958; Malone, 2009; Mandler, 2011.)

In the late 19th century, Wilhelm Wundt (1832–1920) and his student Edward Bradford Titchener (1867–1927) launched a new research enterprise, and according to many scholars, it was their work that eventually led to the modern field of experimental psychology. In Wundt's and Titchener's view, psychology needed to focus largely on the study of conscious mental events—feelings, thoughts, perceptions, and recollections. But how should



WILHELM WUNDT

Wilhelm Wundt (1832–1920) is shown here sitting and surrounded by his colleagues and students; Wundt is often regarded as the “father of experimental psychology.”

these events be studied? These early researchers started with the obvious fact that there is no way for you to experience my thoughts, or I yours. The only person who can experience or observe your thoughts is you. Wundt, Titchener, and their colleagues concluded, therefore, that the only way to study thoughts is for each of us to **introspect**, or “look within,” to observe and record the content of our own mental lives and the sequence of our own experiences.

Wundt and Titchener insisted, though, that this introspection could not be casual. Instead, introspectors had to be meticulously trained: They were given a vocabulary to describe what they observed; they were taught to be as careful and as complete as possible; and above all, they were trained simply to report on their experiences, with a minimum of interpretation.

This style of research was enormously influential for several years, but psychologists gradually became disenchanted with it, and it’s easy to see why. As one concern, these investigators were soon forced to acknowledge that some thoughts are *unconscious*, and this meant that introspection was inevitably limited as a research tool. After all, by its very nature introspection is the study of conscious experiences, and so of course it can tell us nothing about unconscious events.

Indeed, we now know that unconscious thought plays a huge part in our mental lives. For example, what is your phone number? It’s likely that the moment you read this question, the number “popped” into your thoughts without any effort, noticeable steps, or strategies on your part. But, in fact,