

# Cognition



Sixth Edition

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MyPsychLab®

*Sixth Edition*

# COGNITION

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# PREFACE

## TO THE STUDENT

The psychology of human memory and cognition is fascinating, dealing with questions and ideas that are inherently interesting: how we think, reason, remember, and use language, to name just a few. When cognitive psychologists talk research at conventions, they are agitated, intense, and full of energy. In contrast to this enthusiasm, however, undergraduate texts often portray the field as dull, too concerned with the minutiae of experimental method and technical jargon and not concerned enough with the interesting issues. Without slighting the empirical foundation of the field, we have tried to capture some of the excitement of the area. All professors want their students to understand the material, of course, but we also want you to appreciate cognitive psychology as one of the most interesting and memorable topics of your student career. Several features of the text are designed to accomplish this:

- To engage your interest and understanding, examples of the main points are sprinkled throughout the text. Each of the chapters has a box that asks you to “Prove It.” This feature gives you a demonstration project that can be done quickly to illustrate the points being made.
- Mastering the terminology of a new field can be difficult. To help you with the jargon, critical terms are boldfaced in the text and defined immediately in italicized print. Each chapter’s terms are listed at the end of the chapter.
- Each major section of a chapter ends with a brief Section Summary. This, along with the listing of glossary terms at the end of each chapter, should help you check your understanding and memory as you study. Note that some people find it helpful to read the Section Summaries first as a preview of the section’s content.
- We use a more colloquial style than is customary in the field (or in texts in general), using the first person, posing direct questions to you, inserting parenthetical commentary, and so on. Our students have told us that these features make the text more enjoyable to read; one said, “It’s interesting—not like a textbook,” which we take as a compliment. Some professors may expect a more formal, detached style, of course. We would rather have you read and remember the material than have you cope with a text selected because of a carefully pedantic style. Besides, you will have plenty of time to deal with boring texts in graduate school.
- Although “how people think” is a topic that is likely to be of basic interest to just about everyone, most of you will not end up being cognitive scientists. So, although the material is written to be useful to people going on to a career some field of cognition, the exposition is also written to give insights to applications outside of formal cognitive science, in careers that more of you are likely to pursue.

## TO THE INSTRUCTOR

Like the first five editions, this sixth edition is directed primarily toward undergraduates at the junior and senior level, who are probably taking their first basic course in memory and cognition. It has also been used successfully in introductory graduate surveys, especially when first-year students need a more thorough background in memory and cognition. There is much continuity between the fifth edition of *Cognition* and this one: The foundation areas in cognition are still covered thoroughly, as you'll see in the Table of Contents.

But this revision has several new features that you'll want to note:

- There continue to be tremendous increases in the study of memory and cognition with the technologies and perspectives of cognitive neuroscience. This was reflected in prior editions, and this emphasis continues to grow in the sixth edition. There is now a chapter largely devoted to issues of cognitive neuropsychology. These discussions of neuroscience are further integrated within the individual chapter topics, along with a reference to Brodmann areas to help students more easily understand where processes may be occurring in the cortex.
- **Two new chapters** have been added to the text to cover emerging emphases in the field. **Chapter 13** covers cognition and emotion, and **Chapter 14** is on cognitive development. These are capstone chapters that recapitulate the topics in the text and can be used as desired, or not, by individual instructors wanting to give different flavors or emphases in their course. These chapters are also added because they cover topics that will be of interest to a broader range of students. **Chapter 14** is an online-only chapter: it is exclusively available within MyPsychLab (0-205-98653-6) and in all eText versions of *Cognition* 6th ed.
- The text has been thoroughly updated, adding and expanding on important topics and developments that are central to the field across a range of topics. As always, there has also been some careful pruning of topics and streamlining of presentation to make room for the new material. Specific example changes include:

Chapter 1: More concise presentation of the history of cognitive psychology; inclusion of a broad overview of cognitive science, and how cognitive psychology relates to the wider range of topic areas.

Chapter 2: More in-depth and extensive introduction to issues and methods of cognitive neuroscience; reference to brain areas by using Brodmann areas that are illustrated inside the front cover, and referenced throughout the text; introduction to connectionism placed here.

Chapter 3: Neuroimaging links to Gestalt grouping principles; links to dorsal stream processing in pattern perception; influences of embodied cognition on perception expanded.

Chapter 4: Updated discussion of attention capture processes; inclusion of inhibition of return concept, and its relation to embodied cognition; discussion of mind wandering.

Chapter 5: Deeper consideration of the regulation of working memory resources; embodied effects of mental rotation; evidence of changes in working memory abilities.

Chapter 6: Inclusion of the benefits of survival processing on memory; consideration of the testing effect; discussion of the HERA model.

Chapter 7: Expanded discussion of embodied semantic memory; connectionism moved to integrate with the rest of the chapter.

Chapter 8: Discussion of propositions tightened up; discussion of the process of reconsolidation; discussion of cultural schemas for the reminiscence bump.

Chapter 9: Added material on tongue twisters.

Chapter 10: Expanded discussions of gesture and conversation.

Chapter 11: Update perspectives on the SNARC effect; text on automatic decision making.

Chapter 12: Inclusion of embodied influences on problem solving; expanded discussion of analogical reasoning.

- As in the first five editions, we have tried to strike a balance between basic, core material and cutting-edge topics. As cognitive psychology continues to evolve, it is important to maintain some continuity with older topics and evidence. Students need to understand how we got here, and instructors cannot be expected to start from scratch each time they teach the course. I've preserved the overall outline and organization of the text, while updating the sections to reflect newer material.

## INSTRUCTOR SUPPLEMENTS

- An updated and expanded **Instructor's Manual** (ISBN 0-205-98699-4), **Test Item File** (ISBN 0-205-98689-7), and set of lecture **PowerPoint presentations** (ISBN 0-205-98701-X) are available on for download on [www.pearson-highered.com](http://www.pearson-highered.com) or by contacting your local Pearson sales representative.
- The test item file comes with the **Pearson MyTest** (ISBN 0-205-98700-1), a powerful assessment generation program that helps instructors easily create and print quizzes and exams. Questions and tests can be authored online, allowing instructors ultimate flexibility and the ability to efficiently manage assessments anytime, anywhere. For more information, go to [www.pearsonmytest.com](http://www.pearsonmytest.com).
- **MyPsychLab** (ISBN: 0-205-98653-6). Available at [www.mypsychlab.com](http://www.mypsychlab.com), this learning and assessment tool can be used to supplement a traditional lecture course or to administer a course entirely online. Instructors decide the extent of integration—from independent self-assessment for students to total course management. Students benefit from an easy-to-use site where they can test themselves on key content, track their progress, and make use of individually tailored study plans. MyPsychLab is an all-inclusive tool, including a Pearson eText, plus teaching and learning resources organized by chapter in the form of videos, simulations, animations, assessments, and other tools to engage students and reinforce learning. Fully customizable and easy to use, MyPsychLab meets the individual teaching and learning needs of every instructor and every student. To package MyPsychLab with the student text, use ISBN 0-205-99165-3.
- **Simulations.** Students participate in virtual classic psychology experiments and research-based inventories with the MyPsychLab Simulations. The simulations help reinforce your classroom teachings and textbook.



- **MyClassPrep.** Available for instructors within MyPsychLab, this exciting new instructor resource makes lecture preparation easier and less time consuming. MyClassPrep collects the very best class preparation resources—art and figures from our leading texts, videos, lecture activities, classroom activities, demonstrations, and much more—in one convenient online destination. You can search through MyClassPrep’s extensive database of tools by content topic or by content type. You can select resources appropriate for your lecture, many of which can be downloaded directly; or you can build your own folder of resources and present from within MyClassPrep.

## STUDENT SUPPLEMENTS

- **MyPsychLab.** With this exciting new tool students are able to self-assess using embedded diagnostic tests and instantly view results along with a customized study plan.

The customized study plan will focus on the student’s strengths and weaknesses, based on the results of the diagnostic testing, and present a list of activities and resources for review and remediation, organized by chapter section. Some study resources intended for use with portable electronic devices are made available exclusively through MyPsychLab, such as key terms flashcards and video clips. Students will be able to quickly and easily analyze their own comprehension level of the course material and study more efficiently, leading to exceptional exam results!

An access code is required and can be purchased at [www.pearsonhighered.com](http://www.pearsonhighered.com) or at [www.mypsychlab.com](http://www.mypsychlab.com).

- **CourseSmart eTextbook (ISBN: 0-205-98709-5).** CourseSmart offers students an online subscription to *Cognition, 6th edition* at up to 60% savings. With the CourseSmart eTextbook, students can search the text, make notes online, print out reading assignments that incorporate lecture notes, and bookmark important passages. Ask your Pearson sales representative for details or visit [www.coursesmart.com](http://www.coursesmart.com).

We hope that the balance between classic research and current topics, the style we have adopted, and the standard organization we have used will make the text easy to teach from and easy for students to read and remember. More important, we hope that you will find our portrayal of the field of cognitive psychology useful. As always, we are delighted to receive the comments and suggestions of those who use this text, instructors and students alike. You can contact G.A. Radvansky by writing in care of the Department of Psychology, University of Notre Dame, Notre Dame, IN 46556, or e-mail him at [gradvans@nd.edu](mailto:gradvans@nd.edu). You can contact Mark Ashcraft by writing in care of the Psychology Department, University of Nevada Las Vegas, 4505 S. Maryland Pkwy, Box 455030, Las Vegas, NV 89154-5030, or e-mail him at [mark.ashcraft@unlv.edu](mailto:mark.ashcraft@unlv.edu).

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***Mark H. Ashcraft***

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# Cognitive Psychology

## An Introduction

- **Thinking about Thinking**
- **Memory and Cognition Defined**
- **An Introductory History of Cognitive Psychology**
  - Anticipations of Psychology
  - Early Psychology
  - Behaviorism and Neobehaviorism
  - Emerging Cognition: The Winds of Change
- **Cognitive Psychology and Information Processing**
- **Measuring Information Processes**
  - Getting Started
  - Guiding Analogies
  - Time and Accuracy Measures
- **Information Processing and Cognitive Science**
  - The Standard Theory
  - A Process Model
  - Revealing Assumptions
  - Cognitive Science
- **Themes**

*What a piece of work is man. How noble in reason! How infinite in faculty! In form and moving how express and admirable! In action how like an angel! In apprehension, how like a god!*

(ACT 2, SCENE 2, OF SHAKESPEARE'S HAMLET)

This text is about human memory and cognition, and specifically about the scientific study of human memory and cognition. For the moment, consider memory and cognition to be the mental events and knowledge we use when we recognize an object, remember a name, have an idea, understand a sentence, or solve a problem. In this text, we consider a broad range of subjects, from basic perception through complex decision making, from seemingly simple mental acts such as recognizing a letter of the alphabet to very complicated acts such as having a conversation. We ask questions such as “How do we read for meaning?” “How

do we memorize facts?” “What does it mean to forget something?” “How do we know that we don’t know something?” The unifying theme behind all this is one of the most fascinating and important questions of all time: How do people think?

Here we are interested in a scientific approach to memory and thought. This is cognitive psychology. One of the central features of modern cognitive psychology is its allegiance to objective, empirical methods of investigation. We are experimentalists, and this is the approach you will read about here. However, although we do present a lot of studies, we also try to make connections with your everyday experiences and how they are relevant to the issues being discussed.

Within the boundaries of science, cognitive psychology is asking a wide range of fascinating questions. There has been an explosion of interest in cognition both in and outside of psychology proper. Questions that were on the back burner for too long—such as “How do we read?” or “How do we use language?”—are now active areas of research. The pent-up interest in these questions, unleashed during the **cognitive revolution** of the late 1950s, has yielded tremendous progress. Furthermore, we now acknowledge, seek, and sometimes participate in the important contributions of disciplines such as linguistics, computer science, and the neurosciences. This interdisciplinary approach is called **cognitive science**, *the scientific study of thought, language, and the brain—in short, the scientific study of the mind*.

The most basic aim of this text is to tell you what has been discovered about human memory and cognition, and to share the insights those discoveries provide about human thought. Human memory—your memory, with its collection of mental processes—is the most highly sophisticated, flexible, and efficient computer available. How does it work? As amazing as electronic computers are, their abilities are primitive compared with what you do routinely in even a single minute of thinking. The need to understand ourselves is basic, and this includes an understanding of how our minds work.

Another aim of this text is to describe how cognitive psychology has made these discoveries. You’ll better appreciate this information if you also understand how research is done and how new knowledge is acquired. Few of you will become cognitive scientists, but presumably most of you are majoring in psychology or a related field. Because the cognitive approach influences many areas of psychology—indeed, cognitive psychology is at the core and is “the most prominent school” of thought in psychology (Robins, Gosling, & Craik, 1999)—your mastery of psychology as a whole will be enhanced by understanding cognitive psychology.

A final aim of this text is to illustrate the pervasiveness of cognitive psychology and its impact on fields outside of psychology. Cognitive science is a multidisciplinary field. This fusion and cross-pollination of ideas stems from the conviction that researchers in linguistics, artificial intelligence, the neurosciences, economics, and even anthropology can contribute important ideas to psychology and vice versa. Psychology has a long tradition of influencing educational practice, and the potential for cognitive psychology to continue this is obvious and important. Even fields as diverse as medicine, law, and business use findings from cognitive psychology—for example, a cognitive psychologist named Kahneman won the Nobel Prize in Economics in 2003 for his work on decision making. But it should

not be surprising that cognitive psychology is relevant to so many other fields. After all, what human activity doesn't involve thought?

## THINKING ABOUT THINKING

Let's begin to develop a feel for our topic by considering three examples. For all three, you should read and answer the question, but more importantly try to be as aware as possible of the thoughts that cross your mind as you consider the question. The first question is easy:

### 1. *How many hands did Aristotle have?*

Here we are not particularly interested in the correct answer, "two." We are more interested in the thoughts you had as you considered the question. Most students report a train of thoughts something like this: "Dumb question. Of course he had two hands. Wait a minute—why would a professor ask such an obvious question? Maybe Aristotle had only one hand. Nah, I would have heard of it if he had had only one hand—he must have had two." An informal analysis will uncover some of the thoughts you had. This is tracked with the list in Table 1-1. Bear in mind that Table 1-1 illustrates the intuitive analysis and is not a full description of these processes.

**TABLE 1-1** Summary of the Intuitive Cognitive Analysis

Processes	Topic and Chapter
<b>Sensory and perceptual</b>	
Focus eyes on print	Visual perception, sensory memory: Chapter 3
Encode and recognize printed material	Pattern recognition, reading: Chapters 3 and 10
<b>Memory and retrieval</b>	
Look up and identify words in memory	Memory retrieval: Chapters 5–8
Retrieve word meanings	
<b>Comprehension</b>	
Combine word meanings to yield sentence meaning	Semantic retrieval, comprehension: Chapters 7–10
Evaluate sentence meaning, consider alternative meanings	Comprehension: Chapters 9 and 10
<b>Judgment and decision</b>	
Retrieve answer to question	Semantic retrieval: Chapters 8 and 9
Determine reasonableness of question	Comprehension, conversation: Chapters 9 and 10
Judge speaker's intent and knowledge	Decision making and reasoning: Chapter 11
<b>Computational (Question 2)</b>	
Retrieve factual knowledge	Semantic retrieval: Chapter 7
Retrieve knowledge of how to divide and execute procedure	Procedural knowledge: Chapters 6, 11, and 12

First, perceptual processes were used for the written words of the question to focus your eyes on the printed line, then move your focus across the line bit by bit, registering the material into a memory system. Smoothly and rapidly, other processes took the material into memory to identify the letters and words. Of course, few college readers consciously attend to the nuts and bolts of perceiving and identifying words unless the vocabulary is unfamiliar or the print is bad. Yet your lack of awareness does not mean that these processes didn't happen; ask any first-grade teacher about the difficulties children have identifying letters and putting them together into words.

We have encountered two important lessons already. First, mental processes can occur with little conscious awareness, especially if they are highly practiced, such as reading. Second, even though these processes can operate very quickly, they are complex. Their complexity makes it even more amazing how efficient, rapid, and seemingly automatic they are.

As you identified the words in the question, you were looking up their meanings and fitting them together to understand the question. Surely, you weren't consciously aware of looking up the meaning of *hands* in a mental dictionary. But just as surely, you did find that entry, along with your general knowledge about the human body.

Now we are getting to the meat of the process. With little effort, we retrieve information from memory that *Aristotle* refers to a human being, a historical figure from the past. Many people know little about Aristotle beyond the fact that he was a Greek philosopher. Yet this seems to be enough, combined with what we know about people in general, to determine that he was probably just like everyone else: He had two hands.

At a final (for now) stage, people report thoughts about the reasonableness of the question. In general, people do not ask obvious questions, at least not of other adults. If they do, it is often for another reason—a trick question, maybe, or sarcasm. So, students report that for a time they decided that maybe the question wasn't so obvious after all. In other words, they returned to memory to see whether there was some special knowledge about Aristotle that pertains to his hands. The next step is truly fascinating. Most students claim to think to themselves, "No, I would have known about it if he had had only one hand," and decide that it was an obvious question after all. This lack-of-knowledge reasoning is fascinating because so much everyday reasoning is done without benefit of complete knowledge. In an interesting variation, if students are asked, "How many hands did Beethoven have?" their knowledge of Beethoven's musical fame typically leads to the following inference: "Because he was a musician, he played the piano, and he could not possibly have been successful at it with only one hand; therefore he must have had two." An occasional student goes even further with "Two, but he did go deaf before he died."

Now *that's* interesting! Someone found a connection between the disability implied by the question "How many hands?" and a related idea in memory, Beethoven's deafness. Such an answer shows how people can also consider implications, inferences, and other unstated connections as they reason: A great deal of knowledge can be considered, and this illustrates the role of prior

knowledge in reasoning, where richer knowledge about Beethoven can lead to an inference.

One other thing to note from this example is that there are different cognitive processes that are all operating at the same time or similar times—perception, attention, memory, language comprehension, and so forth. These processes are also providing input and influencing one another. In essence, cognition is a complex and interactive thing, and it is going to take a lot of time and effort to tease it all apart and understand how it works.

### 2. *What is 723 divided by 6?*

This question uses your knowledge of arithmetic. Just as with the first question, many of your mental processes happened more or less automatically: identifying the digits, accessing knowledge of arithmetic procedures, and so on. Yet you may be aware of the steps in doing long division: Divide 6 into 7, subtract 6 from 7 to get the first remainder, bring down the 2, then divide 12 by 6, and so on. These steps are mentioned at the bottom of Table 1-1, “Computational,” which includes your knowledge of how to do long division. Cognitive psychology is also interested in your mental processing of arithmetic problems and knowledge you acquired in school, not just the kind of reasoning you used in the Aristotle question (see Chapter 12 for more on the cognitive psychology of arithmetic and math).

### 3. *Does a robin have wings?*

Most adults have little to say about their train of thought when answering this question. Many people insist, “I just knew the answer was yes.” The informal analysis for Question 1 showed how much of cognition occurs below awareness. The assertion that “I just knew it” is not useful, however certain you are that no other thoughts occurred. You had to read the words, find their meanings in memory, check the relevant facts, and make your decision as in the previous examples. Each of these steps is a mental act, the very substance of cognitive psychology. Furthermore, each step takes some amount of time to complete. Question 3 takes adults about one second to answer; the question “Does a robin have feet?” takes a little longer, around 1.2 or 1.3 seconds. Even small time differences can give us a wealth of information about cognition and memory. What is different for Question 3 is that most of the mental processes do not require much conscious activity; the question seems to be processed automatically. Because such automatic processes are so pervasive, we are particularly interested in understanding them.

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## Section Summary

- Cognitive psychology is the scientific study of human mental processes. This includes perceiving, remembering, using language, reasoning, and solving problems.
  - Intuitive analysis of examples such as “How many hands did Aristotle have?” and “Does a robin have wings?” indicates that many mental processes occur automatically (very rapidly and below the level of conscious awareness).
-



## MEMORY AND COGNITION DEFINED

Now that you have an idea of the topics in the area of cognitive psychology, we need more formal definitions of the terms *memory* and *cognition*. Most of us have a good idea of what the term *memory* means, something like “being able to remember or recall some information” or “the act of recalling previously learned facts or events.” Note that both of these definitions are hopelessly circular; memory is “being able to remember” or “the act of recalling.” However, the definitions do point to several critical ideas.

First, the information recalled from memory is from the past. The past could be a childhood memory from years ago or something that happened only moments ago. Second, *memory* is a process of storing information or recovering it for current use. Note that *retrieval* includes both the conscious, intentional recalling to mind and the more automatic (or even unaware) retrieval of the earlier examples.

Finally, *memory* is also a place where all the knowledge of a lifetime is stored. This is evident in theories of cognition that rely on divisions such as short-term and long-term memory. Although there is some physical location in your brain for storage, “location” is often taken metaphorically; regardless of *where* it happens, there is some memory system that holds information. With the advent of neuroimaging, we are making progress in understanding where functions and processes occur in the brain. Chapter 2 introduces you to some of this new methodology.

A formal definition of *memory* captures these essential ingredients. Consider **memory** to be *the mental processes of acquiring and retaining information for later retrieval and the mental storage system that enables these processes*. Memory is demonstrated whenever the processes of retention and retrieval influence behavior or performance in some way, even if we are unaware of it. Furthermore, this definition includes retention not just across hours, weeks, or years, but even across very brief spans of time, in any situation in which the original event is no longer present. Note that memory refers to three kinds of mental activities: acquisition (also called learning or encoding), retention, and retrieval (Melton, 1963). Because all three are needed to demonstrate remembering, we include them in our broader definition.

The term *cognition* is a much richer term. In Neisser’s landmark book *Cognitive Psychology* (1967), he stated that cognition “refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used . . . [including] such terms as sensation, perception, imagery, retention, recall, problem solving, and thinking” (p. 4). For the present, we use the following definition: **Cognition** is *the collection of mental processes and activities used in perceiving, remembering, thinking, and understanding, as well as the act of using those processes*.

Cognitive psychology is largely, though not exclusively, interested in what might be everyday, ordinary mental processes. These processes are entirely commonplace—not simple, by any means, but certainly routine. Our definition should not include only “normal” mental activities. Although cognitive psychology generally does not deal with psychologically “abnormal” states, such as schizophrenia, such “nonnormal” processes, although unusual or rare, may enrich our science.

Most cognitive research deals with the sense modalities of vision and hearing and focuses heavily on language. Some people have been bothered by the reliance on seemingly sterile experimental techniques and methods, techniques that ask simple questions that may yield overly simple-minded views about cognition. This reflects a concern that cognitive research lacks **ecological validity**, or *generalizability to the real-world situations in which people think and act* (e.g., Neisser, 1976). To some this criticism was sensible, but to many it was premature. Cognition is complex, even when using artificially simple tasks. At our current level of sophistication, we would be quickly overwhelmed if tasks were very complex or if we tried to investigate the full range of a behavior in all its detail and nuance. In the early stage of investigation it is reasonable for scientists to take an approach called **reductionism**, *attempting to understand complex events by breaking them down into their components*. An artificially simple situation can reveal an otherwise obscure process. Of course, scientists eventually put the pieces back together and deal with the larger event as a whole.

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## Section Summary

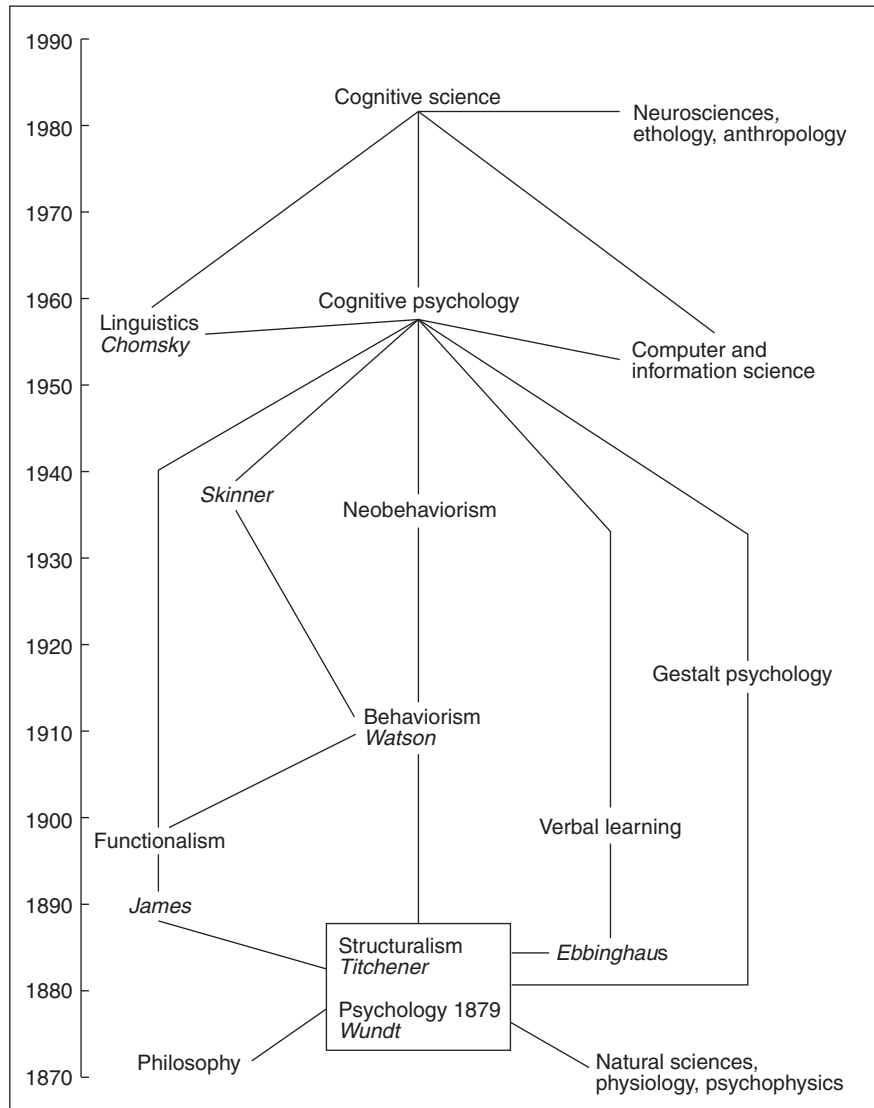
- Memory is composed of the mental processes of acquiring and retaining information for later use (encoding), the mental retention system (storage), and then using that information (retrieval).
  - Cognition is the complex of mental processes and activities used in perceiving, remembering, and thinking and the act of using those processes.
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## AN INTRODUCTORY HISTORY OF COGNITIVE PSYCHOLOGY

Let's now turn to cognitive psychology's history and development (for an excellent history of cognitive psychology, see Mandler, 2007). Figure 1-1 summarizes the main patterns of influence that produced cognitive psychology and cognitive science, along with approximate dates.

To a remarkable extent, the bulk of the scientific work on memory and cognition is quite recent, although some elements, and many experimental tasks, appeared even in the earliest years of psychology. However, interest in memory and cognition—thinking—is as old as recorded history. Aristotle, born in 384 BC, considered the basic principles of memory and proposed a theory in his treatise *De Memoria (Concerning Memory)*; Hothersall, 1984). Even a casual reading of ancient works such as Homer's *Iliad* or *Odyssey* reveals that people have always wondered how the mind works and how to improve it (in Plato's *Phaedrus*, Socrates fretted that the invention of written language would weaken reliance on memory and understanding, just as modern parents worry about television and computers). Philosophers of every age have considered the nature of thought. Descartes even decided that the proof of human existence is our awareness of our own thought: *Cogito ergo sum*, "I think, therefore I am" (Descartes, 1637, p. 52).

The critical events at the founding of psychology, in the mid- to late 1800s, converged most strongly on one man, Wilhelm Wundt, and on one place, Leipzig,



**FIGURE 1-1** The main patterns of influence that produced cognitive psychology and cognitive science.

Germany. In 1879, Wundt established the first laboratory for psychological experiments, at the University of Leipzig, although several people had already been doing psychological research (e.g., Weber’s and Fechner’s work in psychophysics, Helmholtz’s studies of the speed of neural impulses, and Broca’s and Wernicke’s identification of linguistic brain regions). A laboratory was even established by American psychologist William James in 1875, although apparently it was used more for classroom demonstrations than for genuine experiments. Still, the consensus is that 1879 is the beginning of the discipline of psychology, separate from philosophy and physiology.

## Anticipations of Psychology

Aristotle, for two reasons, is one of the first historical figures to advocate an empirically based, natural science approach. Although he was certainly not the only great thinker to insist on *observation as the basis for all science*, he was the first to express this—a position known as **empiricism**. Second, Aristotle’s inquiry into the nature of thought led him to a reasonably objective explanation of how learning and memory take place. The basic principles of association he identified have figured prominently in many psychological theories. Equally important was *Aristotle’s insistence that the mind is a “blank slate” at birth, a **tabula rasa**, or clean sheet of paper* (Watson, 1968). The idea is that experience, rather than inborn factors, “writes” a record onto the blank paper.


There have been many fits and starts in the study of memory over time since Aristotle. For example, St. Augustine, in Chapter 10 of his *Confessions*, presents a surprisingly modern account of memory. Most other anticipations of psychology date from the Renaissance and later periods and are largely developments in scientific methods and approaches. By the mid-1800s, more observational or empirical methods were adopted. By the time psychology appeared, the general procedures of scientific inquiry were well developed. Given the progress in scientific fields such as physics, biology, and medicine by the mid-1800s, it is not surprising that the early psychologists thought the time was ripe for a science of the mind.

## Early Psychology

Four early psychologists are of particular interest for cognitive psychology. They are Wilhelm Wundt, Edward Titchener, Hermann von Ebbinghaus, and William James.

**WILHELM WUNDT** To a large extent, the early psychologists were students of Wilhelm Wundt (1832–1920) (Benjamin, Durkin, Link, Vestal, & Acord, 1992). Beginning in 1875, Wundt directed more than 200 doctoral theses on psychological topics (Leahey, 2000). Wundt continually updated his book *Principles of Physiological Psychology*, reporting new results from his laboratory. He also founded the first psychology journal, *Philosophical Studies* (neither of these titles matches its modern connotations). Unfortunately, Wundt’s later interests went largely unrecognized until recently (Leahey, 2000). His work on language, child psychology, and other applied topics foreshadowed some modern insights but was rejected or ignored at the time.

In terms of psychology, Wundt believed that the study of psychology was “of conscious processes and immediate experience”—what today we consider areas of sensation, perception, and attention. To study these, in addition to extensive use of response time measures, Wundt used the method of *Selbst-Beobachtung*. Translated literally as “self-observation,” this generally is known as **introspection**, *a method in which one looks carefully*

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Wilhelm Wundt