to mean the mental processes of retaining information for later use and retrieving such information, and the mental storage system that allows this retention and retrieval. Operationally, memory is demonstrated when the processes of retention and retrieval influence your behavior or performance in some way, even if you are unaware of the influence. Furthermore, we understand this definition to include not just retention across hours, days, or weeks, but even across very brief spans of time, in any and all situations in which the original stimulus event is no longer present. In a broader sense, memory also refers to the various kinds of mental activities: initial acquisition of information (usually called learning), subsequent retention of the information, and retrieval of the information (Melton, 1963). Since all three kinds of mental activity are logically necessary to demonstrate that remembering has taken place, we include them in our broader definition of the term memory as well.

The term cognition is considerably richer in its connotations and indeed is almost an umbrella term that covers all of the higher mental processes. "Webster's defines it as "the process of knowing in the broadest sense, including perception, memory, judgment, etc." (Webster's New World Dictionary, 1980). Cognitive Psychology, Neisser's (1967) landmark book, claimed that cognition "refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used [including] terms such as sensation, perception, imagery, retention, recall, problem solving, and thinking" (p. 4). For the present, we will use a definition that is somewhat easier to remember, but just as broad: cognition is the collection of mental processes and activities used in perceiving, remembering, and thinking, and the act of using those processes.

While our definition of the term memory is relatively specific, notice that the definition of cognition is still somewhat slippery. A term such as thinking in a scientific definition virtually begs for clarification, or at least a catalog of examples. You might, in good faith, decide that dreaming is a perfectly valid act of cognition, according to the definition. You would then be puzzled that cognitive psychology generally excludes dreaming from the content to be discussed (but see G. Mandler, 1984). What rationale do we have for including some mental acts, but excluding others?

One purpose of the examples in the previous section was to suggest that cognitive psychology is largely, though not exclusively, interested in what might be termed everyday, ordinary mental processes. The processes by which we read and understand, for instance, are entirely commonplace—not simple by any means, but certainly routine. On the other hand, we should not amend the definition to include only "normal" mental activities. It is true that cognitive psychology generally excludes the "psychologically abnormal," such as the varieties of thought disturbance associated with schizophrenia (but a cognitive approach to those problems is certainly possible). The problem with excluding the "normal" mental processes is that the unusual or rare may also be tossed out. As a consequence, we might lose such topics as creativity or eidetic imagery. Rather than change the definition, we will merely assume that cognition usually refers to those customary, commonplace mental activities that most people engage in as they interact with the world around them. (Some very interesting evidence about cognitive functioning has also been obtained from clearly abnormal individuals, for instance those with various brain disorders and dysfunctions; chapter 13 presents part of this research.)

What you will find in this book is a presentation of cognitive psychology's current interests and activities. As mentioned, a surprisingly large number of topics have been of interest to researchers in this field. Since cognitive psychology is a fairly recent creation, it is probably quite desirable that we cast a rather broad net at the outset as we fish for topics to investigate.

Nonetheless, there are still omissions, sometimes glaring and sometines not. To the distress of some (e.g., Neisser, 1970), most of our research deals with the sense modalities of vision and hearing, and we probably use habits and other sensory ways of knowing the world. More disturbing, probably, is our reliance on seemingly sterile experimental techniques and methods (this is Neisser's more substantive criticism), techniques that are rather simple questions and may therefore yield only simple views aboard the operation of cognitive systems. In Neisser's term, much of our cognitive research lacks ecological validity, meaning that it is not representative of the real-world situations in which people think and act. As a single example, imagine how different your reading and comprehension processes would be if you were shown this paragraph on a television screen, with each word for only a fraction of a second. The method would prevent you from slowing down when your comprehension lagged, from returning you gaze to a previous word or syntax sentence you may have misinterpreted, and so on. And yet, this very method has been used to investigate reading at comprehension.

While Neisser's criticism was sensible, it was also possibly premature. We have and great complexity in cognitive processing, even when simple tasks are performed. At our current level of sophistication, we might be overwhelmed if our tasks were also permitted to be more complex, or if we tried to investigate the full range of a behavior in all its detail and nuance. In other words, at the beginning of an investigation it is reasonable for scientists to take a reductionistic approach to complex events, attempting to understand them by investigating their components. After all, an artificially simple situation can sometimes render much simpler a process, and sometimes we gain insight by prevent from occurring in its regular fashion (see Mok, 1983, for useful discussion of the entire issue of ecological validity). Of course, it is also reasonable to expect that scientists will eventually put the parts back together again and deal with the larger event as a whole. To the extent the research permits, this book will present both the component processes that have been investigated and the larger aspects of cognition built of or of those components. You can judge whether Neisser's decade-old criticism is still valid today.
book will be amplified if you also understand how cognitive research is done, how new knowledge is acquired in the scientific pursuit of cognition. Relatively few of you will become cognitive psychologists yourselves, but presumably most of you who are reading this book have decided to major in psychology (or at least be “close friends”). Since the cognitive approach has come to influence many areas in modern psychology, your mastery of psychology as a whole will be enhanced by an understanding of cognitive psychology.

A final purpose of this book is to illustrate the pervasiveness of cognitive psychology and its potential impact on other fields outside of psychology proper. In many important ways, cognitive psychology is already a multidisciplinary field; the newly coined term cognitive science retains much of the content of cognitive psychology, but adds the related disciplines of linguistics and artificial intelligence. This fusion of disciplines represents the conviction that researchers in linguistics and artificial intelligence 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 these contributions is both obvious and important. We expect that even such diverse fields as medicine and law may incorporate some of cognitive psychology’s findings (some of these contributions, real and potential, are discussed in chapter 13). In a way, we should not be at all surprised that cognitive psychology is relevant to so many other fields—after all, what human endeavor doesn’t involve thought?

\section*{Thinking About Thinking}

Let’s begin to develop an intuitive feel for this topic by considering some examples, coming back later to improve our quick definitions of the terms memory and cognition. For all three of the examples that follow, you should read the question and come up with the answer, but more importantly you should try to be as aware as possible of the thoughts that pass through your head as you consider the question. The first question is easy:

1. How many hands did Aristotle have?\footnote{The Aristotle question is not original; I got it from someone else. My difficulty is that I don’t remember who. I strongly suspect it originated with Allan Collins, who gave a talk on “Reasoning from Incomplete Knowledge” several years ago. On the other hand, knowing that Collins did research on such reasoning processes, I may just be attributing the Aristotle question to him because it makes sense to do so—if ever, he did use several especially compelling examples in his talk. Then again, it may have been someone else; since I’ve used the example in describing Collins’s research, I suppose it’s even possible that I generated the question, then by association have swarmed it to him. In any event, this rather ironic situation is a good example of uncertainty in everyday reasoning and remembering.}\n
For such a ridiculously easy question, we’re of course not particularly interested in the correct answer “two.” We are tremendously interested, however, in the thoughts you had as you considered the question. Most students I’ve tried this demonstration with report a train of thoughts something like this: “Dumb question, of course he had two hands. Wait a minute—why would he 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.”

Let’s attempt a bit of informal cognitive analysis to uncover some of the different activities you engaged in while arriving at your answer. We’ll keep track of the analysis with the listing in Table 1–1; as you read the questions that follow later, refer to Table 1–1 to see whether all of the processes and steps apply to the questions and when new ones need to be added. Bear in mind that Table 1–1 is illustrative of our intuitive analysis only; it does not substitute for the full description of these processes and steps later in the book.

First of all, though you were no doubt totally unaware of it, a large group of perceptually related processes were brought into play to deal with the written words of the question. Highly overlearned visual processes focused your eyes on the printed line, then moved your focus across the line bit by bit, registering that printed material into some kind of memory system. Smoothly and rapidly, another set of processes “looked up” the encoded material in memory, identifying the letters and words for you. Of course, few if any of the readers of a college text need to attend to the nuts and bolts of perceiving and identifying words in a conscious fashion, unless the vocabulary is unfamiliar or the printing is faint. Yet your lack of awareness of these stages doesn’t mean they didn’t happen—ask a grade school teacher about the difficulties children have in learning to identify letters and their sounds and in putting these components together into words. We’ve encountered two important lessons of cognitive psychology already. Mental processes, even those of some complexity, can occur with hardly any conscious awareness at all. This is especially (or maybe only) true of processes that have received a great deal of practice, as in reading skills. Second, these processes can operate very quickly, so quickly that we are no longer aware of them at a conscious level.

As the individual words in the first question were being identified, you were also accessing or “looking up” the meanings of those words and then fitting those meanings together to understand the question. Surely no one was consciously aware of looking up the meaning of the word hands in a mental dictionary. Just as surely, however, you did search for and find that entry in memory, stored with all your other general knowledge about the human body. A small number of students often insist that they wondered whether the question might be referring to a different Aristotle—maybe Aristotle Onassis, for instance—since asking about the philosopher Aristotle’s hands seemed so odd.