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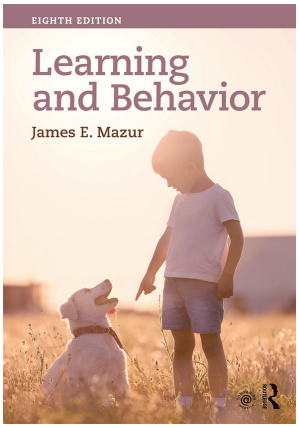

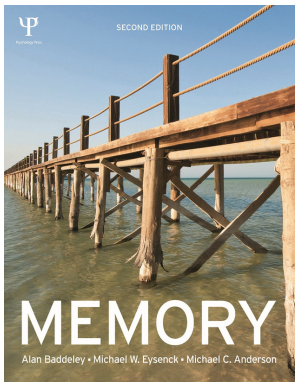

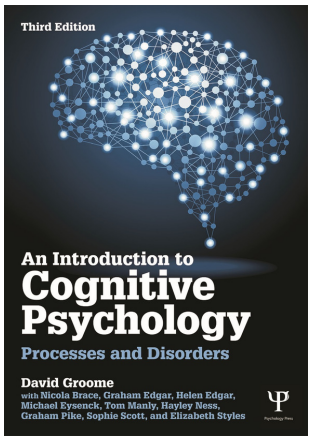

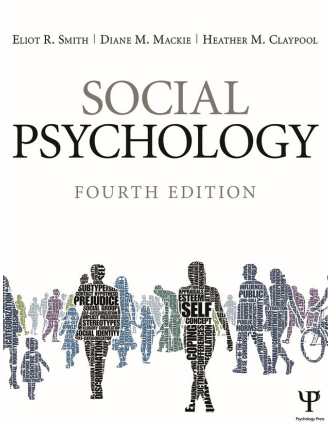

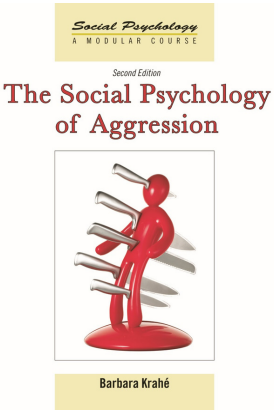

Contents

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CHAPTER 1

History, Background, and Basic Concepts

Learning Objectives

After reading this chapter, you should be able to

- describe the early theories of memory proposed by the Associationists and the early memory studies of Hermann Ebbinghaus
- explain the behavioral and cognitive approaches to studying learning and how they differ
- explain the advantages and disadvantages of using animals in psychological research
- discuss intervening variables and the debate over whether they should be used in psychology
- explain how our sensory receptors respond to "simple sensations" and how feature detectors in the visual system respond to more complex patterns
- list three main types of changes that can take place in the brain as a result of a learning experience, and present evidence for each type

If you know nothing about the branch of psychology called *learning*, you may have some misconceptions about the scope of this field. I can recall browsing through the course catalog as a college freshman and coming across a course offered by the Department of Psychology with the succinct title "Learning." Without bothering to read the course description, I wondered about the contents of this course. Learning, I reasoned, is primarily the occupation of students. Would this course teach students better study habits, better reading, and better note-taking skills? Or did the course examine learning in children, covering such topics as the best ways to teach a child to read, to write, to do arithmetic? Did it deal with children

who have learning disabilities? It was difficult to imagine spending an entire semester on these topics, which sounded fairly narrow and specialized for an introductory-level course.

My conception of the psychology of learning was wrong in several respects. First, a psychology course emphasizing learning in the classroom would probably have a title such as "Educational Psychology" rather than "Learning." My second error was the assumption that the psychology of learning is a narrow field. A moment's reflection reveals that students do not have a monopoly on learning. Children learn a great deal before ever entering a classroom, and adults must continue to adapt to an ever-changing environment. Because learning occurs at all ages, the psychological discipline of learning places no special emphasis on classroom learning. Furthermore, since the human being is only one of thousands of species on this planet that have the capacity to learn, the psychological discipline of learning is by no means restricted to the study of human beings. For reasons to be explained, a large percentage of all psychological experiments on learning have used nonhuman subjects. Though they may have their faults, psychologists in the field of learning are not chauvinistic about the human species.

Although even specialists have difficulty defining the term *learning* precisely, most would agree that it is a process of change that occurs as a result of an individual's experience. Psychologists who study learning are interested in this process wherever it occurs—in adults, school children, other mammals, reptiles, and even insects. This may sound like a large subject, but the field of learning is even broader than this because psychologists study not only the *process* of learning but also the *product* of learning—the long-term changes in one's behavior that result from a learning experience.

An example may help to clarify the distinction between process and product. Suppose you glance out the window and see a raccoon near some garbage cans in the backyard. As you watch, the raccoon gradually manages to knock over a garbage can, remove the lid, and tear open the garbage bag inside. If we wanted to study this raccoon's behavior, many different questions would probably come to mind. Some questions might deal with the learning process itself: Did the animal open the can purely by accident, or was it guided by some "plan of action"? What factors determine how long the raccoon will persist in manipulating the garbage can if it is not immediately successful in obtaining something to eat? These questions deal with what might be called the **acquisition** phase, or the period in which the animal is acquiring a new skill.

Once the raccoon has become skillful at opening garbage cans, we can ask questions about its long-term performance. How frequently will the raccoon visit a given backyard, and how will the animal's success or failure affect the frequency of its visits? Will its visits occur at the most advantageous times of the day or week? Such questions concern the end product of the learning process, the raccoon's new behavior patterns. This text is entitled *Learning and Behavior*, rather than simply *Learning*, to reflect the fact that the psychology of learning encompasses both the acquisition process and the long-term behavior that results.

THE SEARCH FOR GENERAL PRINCIPLES OF LEARNING

Because the psychology of learning deals with all types of learning and learned behaviors in all types of creatures, its scope is broad indeed. Think, for a moment, of the different behaviors you performed in the first hour or two after rising this morning. How many of

those behaviors would not have been possible without prior learning? In most cases, the decision is easy to make. Getting dressed, washing your face, making your bed, and going to the dining room for breakfast are all examples of behaviors that depend mostly or entirely on previous learning experiences. The behavior of eating breakfast depends on several different types of learning, including the selection of appropriate types and quantities of food, the proper use of utensils, and the development of coordinated hand, eye, and mouth movements. It is hard to think of human behaviors that do not depend on prior learning.

Considering all of the behaviors of humans and other creatures that involve learning, the scope of this branch of psychology may seem hopelessly broad. How can any single discipline hope to make any useful statements about all these different instances of learning? It would make no sense to study, one by one, every different example of learning that a person might come across, and this is not the approach of most researchers who study learning. Instead, their strategy has been to select a relatively small number of learning situations, study them in detail, and then try to generalize from these situations to other instances of learning. Therefore, the goal of much of the research on learning has been to develop general principles that are applicable across a wide range of species and learning situations.

B. F. Skinner, one of the most influential figures in the history of psychology, made his belief in this strategy explicit in his first major work, *The Behavior of Organisms* (1938). In his initial studies, Skinner chose white rats as subjects and lever pressing as a response. An individual rat would be placed in a small experimental chamber containing little more than a lever and a tray into which food was occasionally presented after the rat pressed the lever. A modern version of such a chamber is shown in Figure 1.1. In studying the behavior of

Figure 1.1 An experimental chamber in which a rat can receive food pellets by pressing a lever.

rats in such a sparse environment, Skinner felt that he could discover principles that govern the behavior of many animals, including human beings, in the more complex environments found outside the psychological laboratory. The work of Skinner and his students will be examined in depth beginning in Chapter 5, so you will have the opportunity to decide for yourself whether Skinner's strategy has proven to be successful.

Attempts to discover principles or laws with wide applicability are a part of most scientific endeavors. For example, a general principle in physics is the law of gravity, which predicts, among other things, the distance a freely falling object will drop in a given period of time. If an object starts from a stationary position and falls for t seconds, the equation $d = 16t^2$ predicts the distance (in feet) that the object will fall. The law of gravity is certainly a general principle because in theory it applies to any falling object, whether a rock, a baseball, or a skydiver. Nevertheless, the law of gravity has its limitations. As with most scientific principles, it is applicable only when certain criteria are met. Two restrictions on the equation are that it applies (1) only to objects close to the earth's surface and (2) only as long as no other force, such as air resistance, plays a role. Therefore, the law of gravity can be more accurately studied in the laboratory, where the role of air resistance can be minimized through the use of a vacuum chamber. For similar reasons, principles of learning and behavior are often best studied in a laboratory environment. Every chapter in this book will introduce several new principles of learning and behavior, nearly all of which have been investigated in laboratory settings. To demonstrate that these principles have applicability to more natural settings, each chapter will also describe real-world situations in which these principles play an important role.

Within the field of psychology, researchers have studied the topic of learning in several different ways. The remainder of this chapter gives an overview of these different approaches, plus a brief history of the field and some background information that will help you to understand the topics covered in later chapters. We will begin with some of the earliest recorded thoughts about learning and memory, and then we will examine and compare two modern approaches to learning—the behavioral and cognitive approaches. Finally, this chapter will introduce a third approach to studying learning—the neuroscience approach—which examines what happens in the brain and in individual nerve cells when we learn.

THE ASSOCIATIONISTS

Aristotle

The Greek philosopher Aristotle (c. 350 B.C.) is generally acknowledged to be the first **Associationist**. He proposed three principles of association that can be viewed as an elementary theory of memory. Aristotle suggested that these principles describe how one thought leads to another. Before reading about Aristotle's principles, you can try something Aristotle never did: You can conduct a simple experiment to test these principles. Before reading further, take a few moments to try the demonstration in Box 1.1.

Aristotle's first principle of association was **contiguity**: The more closely together (contiguous) in space or time two items occur, the more likely will the thought of one item lead to the thought of the other. For example, the response *chair* to the word *table* illustrates association by spatial contiguity since the two items are often found close together. The

BOX 1.1 APPLYING THE RESEARCH

A Demonstration of Free Association

This exercise, which should take only a minute or two, can be called a study of free association. Take a piece of paper and a pencil, and write numbers 1 through 12 in a column down the left side of the paper. Below is a list of words also numbered 1 through 12. Reading one word at a time, write down the first one or two words that come to mind.

1. apple
2. night
3. thunder
4. bread
5. chair
6. bat
7. girl
8. dentist
9. quiet
10. sunset
11. elephant
12. blue

Once you have your list of responses to the 12 words, look over your answers and try to develop some rules that describe how you came up with your responses. Can you guess any of Aristotle's three principles?

response *lightning* to the word *thunder* is an example of association by temporal contiguity. Other examples of association by contiguity are *bread-butter* and *dentist-pain*.

Aristotle's other two principles of association were **similarity** and **contrast**. He stated that the thought of one concept often leads to the thought of similar concepts. Examples of association by similarity are *apple-orange* or *blue-green*. By the principle of contrast, Aristotle meant that an item often leads to the thought of its opposite (e.g., *night-day*, *girl-boy*, *sunset-sunrise*). Most people who try this simple free-association experiment conclude that Aristotle's principles of association have both strengths and weaknesses. His list of factors that affect the train of thought seems incomplete, but it is not bad as a first step in the development of a theory about the relationship between experience and memory.

The British Associationists: Simple and Complex Ideas

For some philosophers who wrote about Associationism several centuries after Aristotle, this topic assumed a much greater significance: Associationism was seen as a theory of all knowledge. The **British Associationists** included John Locke (1690), James Mill (1829), and

John Stuart Mill (1843). These writers are also called Empiricists because of their belief that every person acquires all knowledge empirically, that is, through experience. This viewpoint is typified by John Locke's statement that the mind of a newborn child is a *tabula rasa* (a blank slate) onto which experiences make their marks. The Empiricists believed that every memory, every idea, and every concept a person has is based on previous experiences.

The opposite of **Empiricism** is **Nativism**, or the position that some ideas are innate and do not depend on an individual's past experience. For instance, Immanuel Kant (1781) believed that the concepts of space and time are inborn and that through experience new concepts are built on the foundation of these original, innate concepts. As we will see many times throughout this book, modern research has uncovered numerous examples that support Nativism and contradict the extreme Empiricist position that all knowledge is learned through experience. Nevertheless, we can grant that some concepts are innate, but many concepts are developed through experience.

The British Empiricists offered some hypotheses both about how old concepts become associated in memory and about how new concepts are formed. According to the Associationists, there is a direct correspondence between experience and memory. Experience consists of sensations, and memory consists of ideas. Furthermore, any sensory experience can be broken down into simple sensations. For instance, if a person observes a red box-shaped object, this might be broken down into two simple sensations: *red* and *rectangular*. Later, the person's memory of this experience would consist of the two corresponding simple ideas of *red* and *rectangular* (see Figure 1.2a). A simple idea was said to be a sort of faint replica of the simple sensation from which it arose.

Now suppose that the person repeatedly encounters such a red box-shaped object. Through the principle of contiguity, an association should develop between the ideas of *red* and *rectangle*, as shown in Figure 1.2b. Once such an association is formed, if the person experiences the color red, this will not only invoke the idea of red, but by virtue of the association the idea of rectangular will be invoked as well (Figure 1.2c).

Of course, the Associationists realized that many of our concepts are more complex than the simple ideas of *red*, *rectangular*, *thunder*, and *lightning*. In an attempt to come to grips with the full range of memories and knowledge that all people have, some Associationists speculated about the formation of complex ideas. James Mill (1829) proposed that if two or more simple sensations are repeatedly presented together, a product of their union may be a **complex idea**. For instance, if the sensations *red* and *rectangular* occur together repeatedly, a new, complex idea of *brick* may form. Figure 1.2d shows one way to depict Mill's hypothesis graphically. Once such a complex idea is formed, it can also be evoked by the process of association when the sensation of either *red* or *rectangle* occurs. Mill went on to say that complex ideas could themselves combine to form larger **duplex ideas**. In the following passage, Mill (1829) describes the formation of a hierarchy of ideas of increasing complexity:

> Some of the most familiar objects with which we are acquainted furnish instances of these unions of complex and duplex ideas. Brick is one complex idea, mortar is another complex idea; these ideas, with ideas of position and quantity, compose my idea of a wall. . . . In the same manner my complex idea of glass, and wood, and others, compose my duplex idea of a window; and these duplex ideas, united together, compose my idea of a house, which is made up of various duplex ideas.
>
> (pp. 114–116)

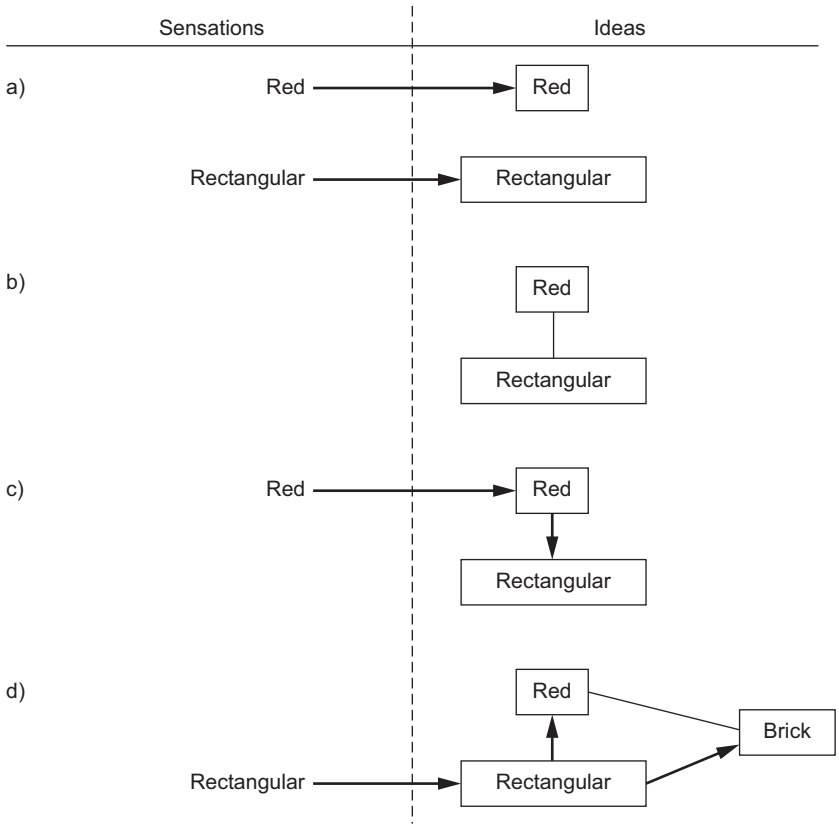


Figure 1.2 Some principles of Associationism. (a) One-to-one correspondence between simple sensations and simple ideas. (b) After repeated pairings of the two sensations, an association forms between their respective ideas. (c) Once an association is formed, presenting one stimulus will activate the ideas of both. (d) With enough pairings of two simple ideas, a complex idea encompassing both simple ideas is formed. The complex idea may now be evoked if either of the simple stimuli is presented.

There are both strengths and weaknesses in this hypothesis. Some types of learning do seem to progress from simple to complex concepts. For example, only after children understand the concepts of *addition* and *repetition* are they taught the more complex concept of *multiplication*, and it is often introduced as a procedure for performing repeated additions. However, other concepts do not seem to follow as nicely from Mill's theory, including his own example of the concept of *house*. A 2-year-old may know the word *house* and use it appropriately without knowing the "simpler" concepts of *mortar*, *ceiling*, or *rafter*. With *house* and many other complex concepts, people seem to develop at least a crude idea of the entire concept before learning all of the components of the concept, although according to Mill's theory this should not be possible. Thus, although it appears to have validity in some cases, Mill's theory is at best incomplete.

Another Associationist, Thomas Brown (1820), tried to expand Aristotle's list by adding some additional principles. For example, he proposed that the *length of time* two sensations

coexist determines the strength of the association, and the *liveliness* or vividness of the sensations also affects the strength of the association. According to Brown, intense stimuli or emotional events will be more easily associated and better remembered. He also proposed that a stronger association will also occur if the two sensations have been paired *frequently* or if they have been paired *recently.*

The ideas of the Associationists can be called the earliest theories of learning, for they attempted to explain how people change as a result of their experiences. However, the Associationists never conducted any experiments to test their ideas. In retrospect, it is remarkable that despite an interest in principles of learning spanning some 2,000 years, no systematic experiments on learning were conducted until the end of the nineteenth century. This absence of research of learning was not a result of technological deficiencies because the first experiments on learning were so simple that they could have been performed centuries earlier.

Ebbinghaus's Experiments on Memory

Hermann Ebbinghaus (1885) was the first to put the Associationists' principles to an experimental test. In his memory experiments, Ebbinghaus served as his own subject. This is not an acceptable arrangement by modern standards because his performance could have been biased by his expectations. Yet despite this potential problem, all of his major findings have been replicated by later researchers using modern research procedures.

To avoid using stimuli that had preexisting associations (such as *coffee-hot*), Ebbinghaus invented the *nonsense syllable*—a meaningless syllable consisting of two consonants separated by a vowel (e.g., HAQ, PIF, ZOD). He would read a list of nonsense syllables out loud at a steady pace, over and over. Periodically, he would test his memory by trying to recite the list by heart, and he would record the number of repetitions needed for one perfect recitation. He then might allow some time to pass and then try to learn the list to perfection a second time, again recording how many repetitions were needed. He could then calculate his *savings*—the decrease in the number of repetitions needed to relearn the list. For example, if he needed 20 repetitions to learn a list the first time, but only 15 repetitions to relearn the list at a later time, this was a savings of 5 repetitions, or 25%.

A few examples will show how Ebbinghaus tested the Associationists' principles. One of Thomas Brown's principles was that the frequency of pairings affects the strength of an association. Obviously, this principle is supported by the simple fact that with enough repetitions Ebbinghaus could learn even long lists of nonsense syllables. However, one of Ebbinghaus's findings provided additional support for the frequency principle. If he continued to study a list beyond the point of one perfect recitation (e.g., for an additional 10 or 20 repetitions), his savings after 24 hours increased substantially. In other words, even after he appeared to have perfectly mastered a list, additional study produced better performance in a delayed test. Continuing to practice after performance is apparently perfect is called **overlearning**, and Ebbinghaus demonstrated that Brown's principle of frequency applies to periods of overlearning as well as to periods in which there is visible improvement during practice.

Another of Thomas Brown's principles was recency: The more recently two items have been paired, the stronger will be the association between them. Ebbinghaus tested this principle by varying the length of time that elapsed between his study and test periods. As shown

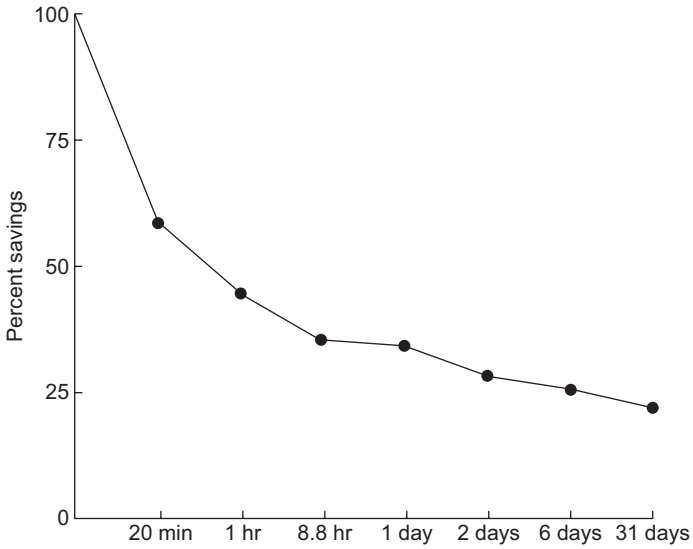


Figure 1.3 Ebbinghaus's forgetting curve. The percentage savings is shown for various time intervals between his initial learning and relearning of lists of nonsense syllables. (After Ebbinghaus, 1885)

in Figure 1.3, he examined intervals as short as 20 minutes and as long as 1 month. This graph is an example of a **forgetting curve**, for it shows how the passage of time has a detrimental effect on performance in a memory task. The curve shows that forgetting is rapid immediately after a study period, but the rate of additional forgetting slows as more time passes. The shape of this curve is similar to the forgetting curves obtained by later researchers in numerous experiments with both humans and animals, although the time scale on the x-axis varies greatly, depending on the nature of the task and the species of the subjects. Forgetting curves of this type provide strong confirmation of Brown's principle of recency.

A final example will show how Ebbinghaus tested Aristotle's principle of contiguity. He reasoned the strongest associations in his lists should be between adjacent syllables, but there should also be measurable (though weaker) associations between nonadjacent items. He devised an ingenious method for testing this idea, which involved rearranging the items in a list after they were memorized and then learning the rearranged list. His technique is illustrated in Table 1.1.

The designations I1 through I16 refer to the 16 items as they were ordered in the original list (List 0). Once this list is memorized, there should be a strong association between I1 and I2, a somewhat weaker association between I1 and I3 (since these were separated by one item in the original list), a still weaker association between I1 and I4, and so on. There should be similar gradations in strength of association between every other item and its neighbors.

The rearranged list, called List 1 in Table 1.1, was used to test for associations between items one syllable apart. Notice that every adjacent item in List 1 was separated by one syllable in the original list. If there is any association between I1 and I3, between I3 and I5, and so on, then List 1 should be easier to learn than a totally new list. In a similar fashion, List 2

Table 1.1 Ebbinghaus's rearranged list experiment. An original list of 16 nonsense syllables (represented here by the symbols I1 through I16) was rearranged to test for possible associations between items separated by one syllable (List 1) or associations between items separated by two syllables (List 2).

List 0 (Original list)	*List 1 (1 item skipped)*	*List 2 (2 items skipped)*
I1	I1	I1
I2	I3	I4
I3	I5	I7
I4	I7	I10
I5	I9	I13
I6	I11	I16
I7	I13	I2
I8	I15	I5
I9	I2	I8
I10	I4	I11
I11	I6	I14
I12	I8	I3
I13	I10	I6
I14	I12	I9
I15	I14	I12
I16	I16	I15

tests for associations between items that were two syllables apart in the original list. Ebbinghaus found that if List 0 was simply relearned after 24 hours, the savings amounted to about 33%. In comparison, he found an average savings of 11% if List 1 was studied 24 hours after List 0 and a savings of 7% if List 2 was used. Although the amount of savings with these rearranged lists was not large, the pattern of results was orderly: As the number of skipped syllables increased in the rearranged lists, the amount of savings was diminished. These results therefore support the principle of contiguity because they show that the strength of an association between two items depends on their proximity in the original list.

The Influence of the Associationists and Ebbinghaus

Several themes from the Associationists and Ebbinghaus can still be seen in the work of present-day psychologists. During the twentieth century, two major approaches to the study of learning arose—the behavioral and cognitive approaches. Many researchers from both the behavioral and cognitive traditions have adopted the idea that learning involves the formation of associations, as the next several chapters will show. Both behavioral and cognitive psychologists continue to be interested in how factors such as contiguity, similarity among stimuli, repetition, and the passage of time affect what we learn and what we remember. They continue to investigate how people (and animals) learn complex concepts and novel ideas. Now that we have surveyed the contributions of these early thinkers, we can turn to the modern-day learning researchers who followed them.

BEHAVIORAL AND COGNITIVE APPROACHES TO LEARNING

The field of learning is frequently associated with a general approach to psychology called **behaviorism**, which was the dominant approach to the investigation of learning for the first half of the twentieth century. During the 1960s, however, a new approach called **cognitive psychology** began to develop, and one of the reasons for its appearance was that its proponents were dissatisfied with the behavioral approach. This book considers both perspectives, but it places more emphasis on the behavioral approach. Two of the most notable characteristics of the behavioral approach are (1) a heavy reliance on animal subjects and (2) an emphasis on external events (environmental stimuli and overt behaviors) and a reluctance to speculate about processes inside the organism that cannot be seen.

The Use of Animal Subjects

A large proportion of the studies described in this text used animals as subjects, especially pigeons, rats, and rabbits. Researchers in this field frequently choose to conduct their experiments with nonhuman subjects for a number of reasons. First, in research with humans, subject effects can sometimes pose serious problems. A **subject effect** occurs when those who are participating in an experiment change their behavior because they know they are being observed. Whereas people may change the way they behave when they know a psychologist is watching, subject effects are unlikely to occur with animal subjects. Most studies with animal subjects are conducted in such a way that the animal does not know its behavior is being monitored and recorded. Furthermore, it is unlikely that an animal subject will be motivated to either please or displease the experimenter.

A second reason for using animal subjects is convenience. The species most commonly used are easy and inexpensive to care for, and animals of a specific age and sex can be obtained in the quantities the experimenter needs. Once animal subjects are obtained, their participation is as regular as the experimenter's: Animal subjects never fail to show up for their appointments, which is unfortunately not the case with human participants.

Probably the biggest advantage of domesticated animal subjects is that their environment can be controlled to a much greater extent than is possible with either wild animals or human subjects. This is especially important in experiments on learning, where previous experience can have a large effect on a subject's performance in a new learning situation. When a person tries to solve a brainteaser as part of a learning experiment, the experimenter cannot be sure how many similar problems the subject has encountered in his or her lifetime. When animals are bred and raised in the laboratory, however, their environments can be constructed to ensure they have no contact with objects or events similar to those they will encounter in the experiment.

A final reason for using animal subjects is that of comparative simplicity. Just as a child trying to learn about electricity is better off starting with a flashlight than a cell phone, researchers may have a better chance of discovering the basic principles of learning by examining creatures that are less intelligent and less complex than human beings. The assumption here is that although human beings differ from other animals in some respects, they are also similar in some respects, and it is these similarities that can be investigated with animal subjects.

One disadvantage of research with animals is that many of the most advanced human abilities cannot be studied with animals. Although there has been some research with animals on skills such as language and problem solving (see Chapter 10), most behavioral psychologists would agree that some complex abilities are unique to human beings. The difference between behavioral psychologists and cognitive psychologists seems to be only that cognitive psychologists are especially interested in those complex abilities that only human beings possess, whereas behavioral psychologists are typically more interested in learning abilities that are shared by many species. This is nothing more than a difference in interests, and it is pointless to argue about it.

A second argument against the use of animal subjects is that human beings are so different from all other animals that it is not possible to generalize from animal behavior to human behavior. This is not an issue that can be settled by debate; it can only be decided by collecting the appropriate data. As will be shown throughout this book, there is abundant evidence that research on learning with animal subjects produces findings that are also applicable to human behavior.

A third concern about the use of animals as research subjects is an ethical one. Is it right to use animals in research and, if so, under what conditions? This complex and controversial issue is discussed in the next section.

Ethical Issues and Animal Research

In recent years there has been considerable debate about the use of animals as research subjects. Viewpoints on this matter vary tremendously. At one extreme, some of the most radical animal rights advocates believe that animals should have the same rights as people and that no animals should be used in any type of research whatsoever (Regan, 1983). Others, both animal welfare advocates and members of the general public, take less extreme positions but believe that steps should be taken to minimize and eventually phase out the use of animals in research.

In response to such arguments, scientists have emphasized that many of the advances in medicine, including vaccines, surgical techniques, and prescription drugs, would not have been possible without research on animals. They warn that if research with animals were to stop, it would severely impede progress in medical research and hamper efforts to improve the health of the world population. In psychology, researchers have documented the many benefits that have resulted from animal research in the treatment of disorders ranging from anxiety and depression to drug addictions and memory loss (N. E. Miller, 1985). They argue that progress in dealing with mental health problems would be jeopardized if animals were no longer used as subjects in psychological research (Baldwin, 1993; Brennan, Clark, & Mock, 2014).

Because of ethical concerns, many new regulations have been put in place in an effort to improve the well-being of animal subjects. In the United States, most colleges, universities, and research centers that use animal subjects are required to have an Institutional Animal Care and Use Committee (IACUC) to oversee all research projects involving animals. The IACUC must review each project with animal subjects before it begins to ensure that all governmental regulations are met and that the animals are well cared for. Any pain or discomfort to the animals must be minimized to the extent possible. For example, if an animal

undergoes surgery, appropriate anesthesia must be used. Regulations also require that all research animals have adequate food and water; clean and well-maintained living environments with appropriate temperature, humidity, and lighting conditions; and the continual availability of veterinary care.

It should be clear that recent research has been governed by increasingly strict regulations designed to ensure the humane treatment of animal subjects. Older studies were conducted during times when there were fewer regulations about animal research. Nevertheless, it is probably safe to say that even before the advent of tighter regulations, the vast majority of the experiments were done by researchers who took very good care of their animals because they realized that one of the best ways to obtain good research results is to have subjects that are healthy and well treated.

The Emphasis on External Events

The term *behaviorism* was coined by John B. Watson (1919), who is often called the first behaviorist. Watson criticized the research techniques that prevailed in the field of psychology at that time. A popular research method was introspection, which involves reflecting on, reporting, and analyzing one's own mental processes. Thus, a psychologist might attempt to examine and describe his thoughts and emotions while looking at a picture or performing some other specific task. A problem with introspection was that it required considerable practice to master this skill, and, even then, two experienced psychologists might report different thoughts and emotions when performing the same task. Watson recognized this weakness, and he argued that verbal reports of private events (sensations, feelings, states of consciousness) should have no place in the field of psychology.

Watson's logic can be summarized as follows: (1) We want psychology to be a science; (2) sciences deal only with events everyone can observe; therefore, (3) psychology must deal only with observable events. According to Watson, the observable events in psychology are the stimuli that a person senses and the responses a person makes; they are certainly not the subjective reports of trained introspectionists.

Whereas Watson argued against the use of unobservable events as psychological data, B. F. Skinner criticized the use of unobservable events in psychological theories. Skinner (1950) asserted that it is both dangerous and unnecessary to point to some unobservable event, or **intervening variable**, as the cause of behavior. Consider an experiment in which a rat is kept without water for a certain number of hours and is then placed in a chamber where it can obtain water by pressing a lever. We would probably find an orderly relationship between the independent variable, the number of hours of water deprivation, and the dependent variable, the rate of lever pressing. The rule that described this relationship is represented by the arrow in Figure 1.4a.

Skinner has pointed out that many psychologists would prefer to go further, however, and postulate an intervening variable such as *thirst*, which is presumably controlled by the hours of deprivation and which in turn controls the rate of lever pressing (see Figure 1.4b). According to Skinner, this intervening variable is unnecessary because it does not improve our ability to predict the rat's behavior—we can do just as well simply by knowing the hours of deprivation. The addition of the intervening variable needlessly complicates our theory. Now our theory must describe two relationships: the relationship between hours of deprivation and thirst, and that between thirst and lever pressing.

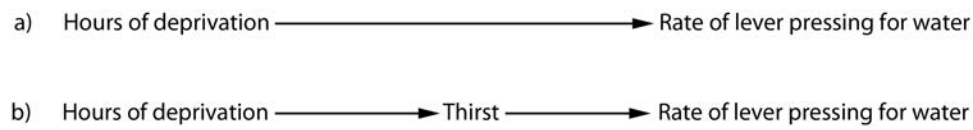


Figure 1.4 (a) A schematic diagram of a simple theory of behavior with no intervening variables. (b) The same theory with an intervening variable added. In this example, the intervening variable, thirst, is unnecessary, for it only complicates the theory. (From N.E. Miller, 1959, Liberalization of basic S-R concepts, in S. Koch, *Psychology: The study of a science,* Vol. 2. © McGraw-Hill Education. Reprinted by permission.)

Skinner also argued that the use of an intervening variable such as thirst is dangerous because we can easily fool ourselves into thinking we have found the cause of a behavior when we are actually talking about a hypothetical and unobservable entity. Suppose that when a father is asked why his son does not do his homework, he answers, "Because he is lazy." In this case, laziness, an unobservable entity, is offered as an explanation, and accepting this explanation could prematurely curtail any efforts to improve the problem behavior. After all, if the cause of a behavior is inside the person, how can we control it? However, Skinner proposed that the causes of many behaviors can be traced back to the external environment, and by changing the environment, we can change the behavior. Perhaps the boy spends all afternoon playing video games, eats dinner with the family at a fairly late hour, and then is too tired to do his assignments. If so, the parents might be able to change the boy's behavior by requiring him to complete his homework before playing any video games. In short, the potential for controlling a behavior may be recognized if an intervening variable such as laziness is rejected and an external cause of the behavior is sought.

Neal Miller (1959), another behavioral psychologist, disagreed with Skinner's position that intervening variables are always undesirable. Miller suggested that intervening variables are often useful when several independent and dependent variables are involved. As shown in Figure 1.5, he noted that besides hours of water deprivation, two other independent variables that could affect the rat's lever pressing might also increase if it were fed dry food or if it were given an injection of a saline solution. Furthermore, the rate of lever pressing is only one of many dependent variables that might be affected by water deprivation, dry food, or a saline injection. Two other dependent variables are the volume of water consumed and the amount of quinine (which would give the water a bitter taste) that would have to be added to make the rat stop drinking.

Miller argued that once these additional independent and dependent variables are considered, to account for the rat's behavior we would need a theory with nine cause-and-effect relationships, as symbolized by the nine crossing arrows in Figure 1.5a. This fairly complicated theory could be simplified by including the intervening variable, thirst. We can assume that each of the three independent variables affects an animal's thirst, and thirst controls each of the three dependent variables. Figure 1.5b shows that once the intervening variable, thirst, is included in this way, only six cause-and-effect relationships (represented by the six arrows in the figure) have to be described. In other words, when there are multiple independent and dependent variables to consider, the theory with the intervening variable is actually simpler (because there are fewer cause-and-effect relationships to account for).

Some psychologists have also pointed out that intervening variables are commonplace in other, firmly established sciences. For instance, many familiar concepts from physics

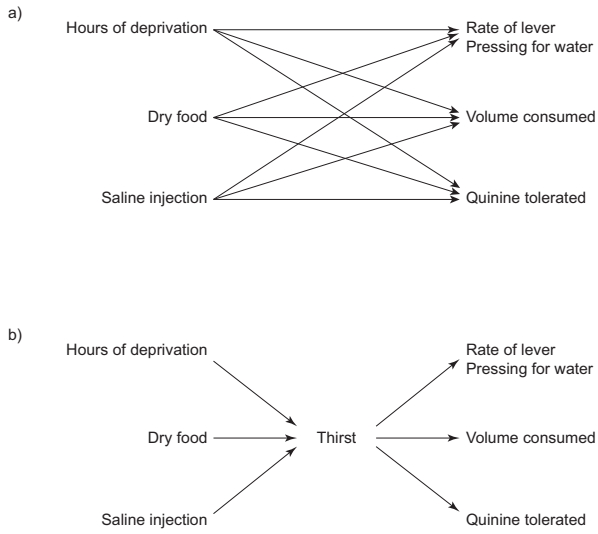


Figure 1.5 (a) The arrows represent the nine relationships between independent and dependent variables that must be defined by a theory without intervening variables. (b) The arrows represent the six relationships the theory must define if it includes the intervening variable of thirst. Neal Miller argued that the second theory is superior because it is more parsimonious. (From N.E. Miller, 1959, Liberalization of basic S-R concepts, in S. Koch, *Psychology: The study of a science,* Vol. 2. © McGraw-Hill Education. Reprinted by permission.)

(gravity, magnetism, force) are intervening variables since they are not directly observable. Some psychologists have therefore reasoned that progress in psychology would be needlessly restricted if the use of intervening variables were disallowed (Nicholas, 1984).

As Miller's position shows, it is not correct to say that all behaviorists avoid using intervening variables. As a general rule, however, cognitive psychologists tend to use intervening variables more freely and more prolifically than do behavioral psychologists. The debate over the use of intervening variables has gone on for decades, and we will not settle it here. My own position (though hardly original) is that the ultimate test of a psychological theory is its ability to predict behavior. If a theory can make accurate predictions about behaviors that were previously unpredictable, then the theory is useful, regardless of whether it contains any intervening variables. In this book, we will encounter many useful theories of each type.

Practice Quiz 1: Chapter 1

1. Aristotle's three principles of association were _____, _____, and _____.
2. Ebbinghaus's forgetting curve shows that the rate of forgetting in the first few minutes after studying is _____ than the rate of forgetting a week later.
3. Animals have been used as research subjects more often by _____ psychologists than by _____ psychologists.
4. According to John B. Watson, if psychology is to be a science it must focus on observable events, namely _____ and _____.
5. According to B. F. Skinner, theories in psychology should not include _____.

Answers

1. contiguity, similarity, contrast 2. faster 3. behavioral, cognitive 4. stimuli, responses 5. intervening variables

BRAIN AND BEHAVIOR

What happens in the nervous system when two stimuli are repeatedly paired and a person begins to associate the two? How do our sensory systems allow it to recognize complex stimuli such as bricks, automobiles, or people's faces? Neuroscientists, who study the brain and nervous system, have attempted to answer these questions and many others like them, with varying degrees of progress so far. The rest of this chapter gives a brief overview of some of this research. To understand this material you need to have some understanding of how neurons (nerve cells) function, so the following section provides a short summary of the basic points.

The Basic Characteristics of Neurons

The nervous systems of all creatures on earth are composed of specialized cells called neurons, whose major function is to transmit information. The human brain contains many billions of neurons, and there are many additional neurons throughout the rest of the body. Although they vary greatly in size and shape, the basic components of all neurons, and the functions of those components, are quite similar.

Figure 1.6 shows the structure of a typical neuron. The three main components are the **cell body**, the **dendrites**, and the **axons**. The cell body contains the nucleus, which regulates the basic metabolic functions of the cell, such as the intake of oxygen and the release of carbon dioxide. In the transmission of information, the dendrites and the cell body are on the receptive side; that is, they are sensitive to certain chemicals called **transmitters** that are released by other neurons. When its dendrites and cell body receive sufficient stimulation, a neuron is said to "fire"—it exhibits a sudden change in electrical potential lasting only a few milliseconds (thousandths of a second). The more stimulation a neuron receives, the more rapidly it fires: It may fire only a few dozen times a second with low stimulation but several hundred times a second with high stimulation. The axons are involved on the transmission side. Each time a neuron fires, enlarged structures at the ends of the axons, the axon terminals, release a transmitter that may stimulate the dendrites of other neurons. Therefore, within a single neuron, the flow of activity typically begins

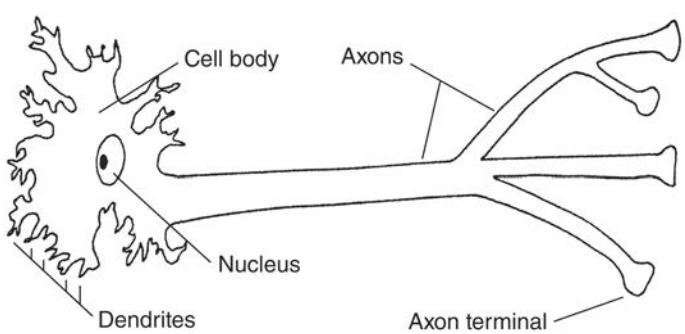


Figure 1.6 A schematic diagram of a neuron.

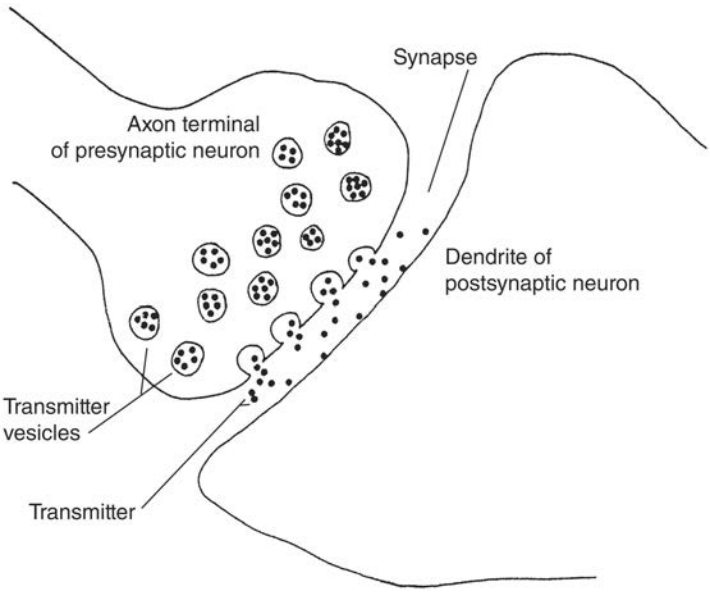


Figure 1.7 A schematic diagram of a synapse between two neurons. The chemical transmitter released by the axon terminal of the presynaptic neuron causes changes in the dendrite of the postsynaptic neuron that makes the neuron more likely to fire (in an excitatory synapse) or less likely to fire (in an inhibitory synapse).

with the dendrites, travels down the axons, and ends with release of transmitter by the axon terminals.

The term **synapse** refers to a small gap between the axon terminal of one neuron (called the *presynaptic neuron*) and the dendrite of another neuron (called the *postsynaptic neuron*). As Figure 1.7 shows, the presynaptic neuron releases its transmitter into the synapse. This transmitter can affect the postsynaptic neuron in one of two ways. In an *excitatory synapse*, the release of transmitter makes the postsynaptic neuron more likely to fire. In an *inhibitory synapse*, the release of transmitter makes the postsynaptic neuron less likely to fire. A single neuron may receive inputs, some excitatory and some inhibitory, from thousands of other neurons. At any moment, a neuron's firing rate reflects the combined influence of all its excitatory and inhibitory inputs.

Simple Sensations

One theme of the Associationists that has been uniformly supported by subsequent brain research is the hypothesis that our sensory systems analyze the complex stimulus environment that surrounds us by breaking it down into "simple sensations." The nervous system's only contact with the stimuli of the external environment comes through a variety of specialized neurons called **receptors**. Instead of dendrites that are sensitive to the transmitters of other neurons, receptors have structures that are sensitive to

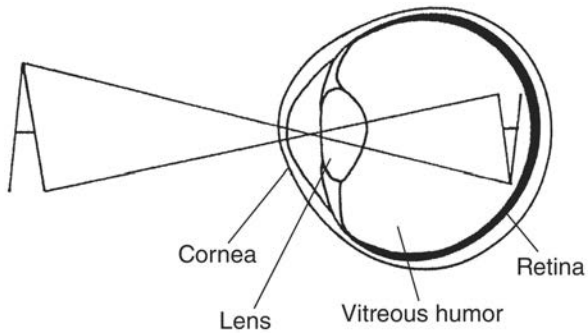


Figure 1.8 How light from an object in the environment enters the eye and is focused on the retina as an inverted image.

specific types of external stimuli. In the visual system, for example, receptors sensitive to light are located on the retina. As shown in Figure 1.8, light entering the eye is focused by the cornea and lens and is projected onto the retina. A miniature inverted image of the visual world is focused on the retina, which lines the inside surface of the eyeball. Some of the receptors on the retina are called cones (because of their shape), and different cones are especially sensitive to different colors in the spectrum of visible light. In the normal human eye, there are three classes of cones, which are most effectively stimulated by light in the red, green, and blue regions of the spectrum, respectively. A red-sensitive cone, for example, is most responsive to red light, but it will also exhibit a weaker response when stimulated by other colors in the red region of the spectrum, such as orange, violet, and yellow. Although we have only three types of cones, we can distinguish many subtle differences in color because they produce different patterns of activity in the three types of cones. A particular shade of yellow, for example, will produce a unique pattern of activity: The red and green cones may be activated to approximately the same extent, and the blue cones will exhibit very little activity. Since no other color will produce exactly the same pattern of activity in the cones, this pattern is the visual system's method of encoding the presence of a particular shade of yellow. We can think of the cones as receptors that decompose the complex visual world into what the Associationists called "simple sensations."

Similarly, all of our other senses have specialized receptors that are activated by simple features. The skin contains a variety of tactile receptors, some sensitive to pressure, some to pain, some to warmth, and some to cold. In the auditory system, single neurons are tuned to particular sound frequencies so that one neuron might be most sensitive to a tone with a frequency of 1,000 cycles/second. This neuron would be less sensitive to tones of higher or lower pitches. Regarding the sense of taste, most experts believe that all gustatory sensations can be decomposed into four simple tastes: sour, salty, bitter, and sweet (and possibly a fifth, savory). Some very exacting experiments by von Bekesy (1964, 1966) showed that individual taste receptors on the tongue are responsive to one and only one of these simple tastes. In summary, the evidence from sensory physiology is clear: All sensory systems begin by breaking down incoming stimuli into simple sensations.

Feature Detectors

Whereas our visual systems start by detecting the basic features of a stimulus—color, brightness, and location—each of us can recognize complex visual patterns, such as the face of a friend or a written word. The same is true of our other senses. We do not simply hear sounds of different pitches and intensities; we can perceive spoken sentences, automobile engines, and symphonies. When we eat, we do not just detect the basic tastes; we perceive the complex tastes of a pepperoni pizza or a strawberry sundae. How do our nervous systems start with simple sensations and arrive at these much more complex perceptions?

In their groundbreaking research, Hubel and Wiesel (1965, 1979) found neurons in the brain that can be called **feature detectors** because each neuron responded to a specific visual stimulus. Using an anesthetized monkey or cat, Hubel and Wiesel would isolate a single neuron somewhere in the visual system and record its electrical activity while presenting a wide range of visual stimuli (varying in color, size, shape, and location in the visual field) to the animal. The question Hubel and Wiesel wanted to answer was simple: What type of feature detector is this neuron? That is, what type of visual stimuli will make the neuron fire most rapidly?

Hubel and Wiesel found several different types of feature detectors in the visual cortex, an area in the back of the head, just beneath the skull. One class of cells, which they called **simple cells**, fired most rapidly when the visual stimulus was a line of a specific orientation, presented in a specific part of the visual field. For example, one simple cell might fire most rapidly in response to a line at a 45-degree angle from the horizontal. If the orientation of the line were changed to 30 or 60 degrees, the cell would fire less rapidly, and with further deviations from 45 degrees, the cell would respond less and less. Other simple cells responded to lines of other orientations.

It is not hard to imagine how neural signals from the rods and cones on the retina could combine to produce a line detector. Imagine that a simple cell in the cortex receives (through a chain of intervening neurons) excitatory inputs from individual receptors that are positioned in a row on the surface of the retina. A line of just the right angle will stimulate this entire row of retinal cells, and so there will be a very strong input to the simple cell in the visual cortex. Lines of other orientations will only stimulate a few of the retinal cells, so there will be less stimulation (and less response) of the simple cell in the visual cortex. So far, no one has actually managed to trace the "wiring diagram" for a simple cell, but it is clear from Hubel and Wiesel's results that some such integration of information must occur between the retina and the line-detecting cells in the visual cortex. Hubel and Wiesel also found more complex feature detectors in the visual cortex. Some cells responded only to shapes with two edges intersecting at a specific angle. For instance, one cell might respond to the corner of a rectangle—two edges forming a 90-degree angle. Another cell might be most responsive to part of a triangle—two edges forming an angle of, say, 45 degrees.

When Hubel and Wiesel (1963) examined cells in the visual cortex of newborn kittens with no previous visual experience, they found feature detectors similar to those found in adult cats (though the neurons of kittens were more sluggish in their response). This shows that individual neurons in a kitten's visual cortex are prewired to respond to specific visual features (lines, angles) before the kitten has seen any visual patterns whatsoever. A Nativist might call this an example of "innate knowledge": The newborn kitten already knows how to extract information from the visual world. However, feature detectors are also affected

by experience. Blakemore and Cooper (1970) found that kittens raised in an environment with large vertical stripes on the walls had more vertical line detectors as adult cats, and those raised in an environment with horizontal lines had more horizontal line detectors. Therefore, both heredity and environment contribute to the types of visual feature detectors found in the adult animal.

The most complex visual detectors ever reported are cortical neurons in macaque monkeys that could be called "hand detectors" and "face detectors" (Desimone, Albright, Gross, & Bruce, 1984). For instance, the face detectors responded vigorously to human or monkey faces, whereas a variety of other stimuli (shapes, textures, pictures of other objects) evoked little or no response. Extrapolating from these remarkable findings, does this mean that the brain has individual neurons in the visual system for every complex stimulus one can recognize, such as the face of a friend or a 2010 Porsche? Current research suggests that the answer is "no." From studies on human visual perception, there is evidence from both infants and adults that large parts of the visual cortex are activated when people perceive human faces, and it is the entire pattern of brain activity that allows us to recognize a face (Nichols, Betts, & Wilson, 2010). And although human face perception may be different in some ways from other types of object perception, many different areas of the brain are involved when we perceive other objects as well (Konen & Kastner, 2008). Yet even with modern brain-imaging technology and extensive research on this topic, there is much that neuroscientists still do not understand about what takes place in the brain when a person recognizes a familiar object.

The Neuroscience of Learning

There are several possible ways in which the brain might change during learning. One possibility is that learning involves chemical changes at the level of individual synapses that alter flow of communication among neurons. A second possibility is that neurons may grow new axons and/or new dendrites as a result of a learning experience so that new synaptic connections are formed. A third possibility is that completely new neurons are grown during a learning experience. Let us examine each of these possibilities.

Chemical Changes

There is now plenty of evidence that some changes in the brain do not depend on the growth of new synapses but rather on chemical changes in already existing synapses. For example, say the neurons in a slice of rat brain tissue are given a brief burst of electrical stimulation; this action can produce long-lasting increases in the strength of existing connections between neurons. The increase in the strength of excitatory synapses as a result of electrical stimulation is called **long-term potentiation**, and the effect can last for weeks or months (Bliss & Lomo, 1973). Long-term potentiation has also been observed in human brain tissue removed during the course of surgical procedures (Chen et al., 1996) and even in the intact brains of humans (Heidegger, Krakow, & Ziemann, 2010). Long-term potentiation has been demonstrated in brain areas that are implicated in the storage of long-term memories, such as the hippocampus and the cerebral cortex. For this reason, some investigators believe that long-term potentiation may be a basic process through which the brain can

change as a result of a learning experience. There is growing evidence that it may play a role in the learning of new associations (Wang & Morris, 2010).

What type of chemical changes could cause an increase in the strength of a synaptic connection? One possibility is that as a result of a learning experience, the axon terminal of the presynaptic neuron develops the capacity to release more transmitter. Another possibility is that the cell membrane of the postsynaptic neuron becomes more sensitive to the transmitter, so its response to the same amount of transmitter is greater. In experiments on long-term potentiation, researchers have found evidence that both presynaptic and postsynaptic changes may be involved (Bourne, Chirillo, & Harris, 2013; Meis, Endres, & Lessmann, 2012). It seems that the mammalian brain has at its disposal a number of different chemical mechanisms for altering the strengths of the connections between neurons.

Growth of New Synapses

There is now abundant evidence that learning experiences can lead to the growth of new synaptic connections between neurons. Some of the earliest evidence for the hypothesis that new synapses are developed as a result of experience came from studies in which animals were exposed to enriched living environments. Rosenzweig and his colleagues (Rosenzweig, 1966; Rosenzweig, Mollgaard, Diamond, & Bennet, 1972) placed young rats in two different environments to determine how early experience influences the development of the brain. Some rats were placed in an environment rich in stimuli and in possible learning experiences. These animals lived in groups of 10 to 12, and their cages contained many objects to play with and explore—ladders, wheels, platforms, mazes, and the like. Other rats were raised in a much more impoverished environment. Each animal lived in a separate, empty cage, and it could not see or touch other rats. These rats certainly had far fewer sensory and learning experiences. After the rats spent 80 days in these environments, Rosenzweig and colleagues found that the brains of the enriched rats were significantly heavier than those of impoverished rats. Differences in weight were especially pronounced in the cerebral cortex, which is thought to play an important role in the learning process. Many recent studies have found evidence that growth in specific parts of the cerebral cortex and other brain areas can result from a variety of different learning experiences, ranging from rats learning mazes (Lerch et al., 2011) to people learning to juggle (Draganski et al., 2004). It seems clear that learning experiences can produce growth in brain tissue.

What types of changes at the cellular level accompany these differences in overall brain size? Microscopic examinations have revealed a variety of changes in the brain tissue of rats exposed to enriched environments, including more branching of dendrites (indicating more synaptic connections between axons and dendrites) and synapses with larger surfaces. Other studies have found that exactly where neural changes take place in the brain depends on what the learning task involved. Spinelli, Jensen, and DiPrisco (1980) trained young kittens to flex one foreleg to avoid a shock to that leg. After a few brief sessions with this procedure, there was a substantial increase in the amount of dendritic branching in the area of the cortex that controlled the movement of that foreleg. Studies like this provide compelling evidence that relatively brief learning experiences can produce significant increases in the number, size, and complexity of synaptic connections.

Many neuroscientists believe that the growth of new dendrites and synaptic connections underlies the formation of long-term memories (Kolb & Gibb, 2008). In humans, studies have shown that dramatic arborization, or the branching of dendrites, occurs in the months before birth and in the first year of life. At the same time, other connections between neurons disappear. It is not clear how much of this change is due to maturation and how much to the infant's learning experiences. It appears, however, that as a child grows and learns, numerous new synaptic connections are formed and other unneeded connections are eliminated. These neural changes continue at least until the adolescent years (Huttenlocher, 1990).

Growth of New Neurons

In the past, it was generally believed that except before birth and possibly during early infancy, no new neurons can grow in the brains of animals. According to this view, all learning takes the form of changes in existing neurons (through chemical changes or synaptic growth), and any neurons that are lost due to illness or injury cannot be replaced. Today, however, there is convincing evidence that this traditional view of neural growth is incorrect and that new neurons continue to appear in the brains of adult mammals (Fuchs & Flügge, 2014). For example, research with adult macaque monkeys has found new neurons developing in several areas of the cerebral cortex (Gould, Reeves, Graziano, & Gross, 1999). The growth of new neurons, called **neurogenesis**, has also been observed in other species, and in some cases this growth appears to be related to learning experiences. For instance, in one experiment, some rats learned tasks that are known to involve the hippocampus, and other rats learned tasks that do not involve the hippocampus. For the first group of rats, after the learning period, new neurons were found in a nearby area of the brain that receives inputs from the hippocampus. For the second group of rats, no new neurons were found in this area. These results suggest that new neurons can grow during a learning experience and that exactly where they grow may depend on the specific type of learning that is involved (Gould, Beylin, Tanapat, Reeves, & Shors, 1999).

Studies of adult humans have shown that their brains also continue to produce new neurons and that neurogenesis may play an important part in the functioning of the adult brain. If a person's level of neurogenesis is unusually low, this may be related to various types of psychological disorders. Adults suffering from clinical depression have decreased levels of neurogenesis, and antidepressant medications appear to increase neurogenesis (Boldrini et al., 2013). After a brain injury, neurogenesis may help restore some level of brain functioning in the damaged area. There is evidence that after such an injury, new brain cells grow through mitosis (cell division), and they appear to develop some of the same physical characteristics and neural connections as the neurons that were damaged (Kokaia & Lindvall, 2003).

Where Are "Complex Ideas" Stored in the Brain?

Before concluding this brief survey of the physiological approach to learning, let us take one final look at James Mill's concept of complex ideas. What happens in the brain when a child learns the concept *house* or when a kitten learns to recognize and respond appropriately to

a snake? Although the answer to this question is not yet known, a number of different possibilities have been proposed.

One hypothesis is that every learning experience produces neural changes that are distributed diffusely over many sections of the brain. This hypothesis was supported by some classic experiments by Karl Lashley (1950). After training rats to run through a maze, Lashley removed sections of the cerebral cortex (different sections for different rats) to see whether he could remove the memories of the maze. If he could, this would show where the memories about the maze were stored. However, Lashley's efforts to find the location of these memories were unsuccessful. When a small section of cortex was removed, this had no effect on a rat's maze performance, no matter which section was removed. When a larger section of cortex was removed, this caused a rat's performance in the maze to deteriorate, no matter which section was removed. Lashley concluded that memories are stored diffusely throughout the brain and that removing small sections of the brain will not remove the memory. Many later studies have also provided support for the view that large sections of the brain undergo change during simple learning experiences and that many brain regions are also involved when these learning experiences are remembered at a later time (Shimamura, 2014; Tomie, Grimes, & Pohorecky, 2008).

A very different hypothesis is that the information about individual concepts or ideas is localized, or stored in small, specific sections of the brain. For example, some psychologists have suggested that the cerebral cortex may contain many unused or dormant neurons. Through an animal's learning experiences, one (or a few) of these dormant neurons might come to respond selectively to a particular complex object (Konorski, 1967). To take a simple example, after an animal has had experience with a complex object such as an apple, some cortical neuron might develop excitatory inputs from detectors responsive to the apple's red color, roughly spherical shape, specific odor, and other characteristics. In this way, an animal that at birth had no complex idea of an apple might develop the ability to recognize apples as a result of its experience.

Some evidence supporting this idea came from the pioneering research of Penfield (1959), who electrically stimulated areas of the cerebral cortex of human patients during brain surgery. When Penfield stimulated small areas of the cortex, his patients, who were anesthetized but awake, reported a variety of vivid sensations, such as hearing a specific piece of music or experiencing the sights and sounds of a circus. Although it might be tempting to conclude that the electrical stimulation had triggered a site where specific memories of the past were stored, Penfield's findings can be interpreted in many ways, and their significance is not clear.

Better evidence for localized memories comes from reports of people who suffered damage to small sections of the brain as a result of an accident or stroke. Brain injury can, of course, produce a wide range of psychological or physical problems, but in a few individuals the result was a loss of very specific information. For example, one man had difficulty naming any fruit or vegetable, whereas he had no trouble identifying any other types of objects (Hart, Berndt, & Caramazza, 1985). Another person could not name objects typically found in a room, such as furniture and walls (Yamadori & Albert, 1973). Another could no longer remember the names of well-known celebrities, but he had no problem with the names of other famous people, such as historical and literary figures (Lucchelli, Muggia, & Spinnler, 1997). There is also evidence from brain-imaging studies that specific

but different areas of the brain are activated when people look at pictures of animals versus pictures of tools (Chouinard & Goodale, 2010). These findings suggest that specific concepts are stored in specific areas of the brain and that concepts belonging to a single category are stored close together.

The debate over whether the neural representation of complex ideas is localized or distributed has gone on for many years, and it has not yet been resolved. It is possible that both hypotheses are partially correct, with some types of learning producing changes in fairly specific parts of the brain and others producing changes over large portions of the brain. Modern-day neuroscientists continue to investigate the question asked by James Mill over a century and a half ago: What are complex ideas, and how does the human brain acquire them and retain them? If and when neuroscientists eventually discover exactly how the brain stores information about complex concepts and ideas, this will be a milestone in the psychology of learning.

Practice Quiz 2: Chapter 1

1. In communication between neurons, a chemical transmitter is released by the _____ of one neuron and received by the _____ of another neuron.
2. There are three types of cones in the human retina that respond to three different types of stimuli: _____, _____, and _____.
3. The "simple cells" in the visual cortex found by Hubel and Wiesel respond specifically to _____.
4. Three main types of changes that can occur in the brain as a result of a learning experience are _____, _____, and _____.
5. By removing different parts of the brains of rats after they learned a maze, Lashley concluded that memories are stored _____.

Answers

1. axon terminals, dendrites 2. red, green, and blue 3. lines of specific orientations 4. chemical changes, growth of new synapses, growth of new neurons 5. diffusely throughout the brain

SUMMARY

The field of learning is concerned with both how people and animals learn and how their long-term behavior changes as a result of this learning. The earliest ideas about learning were developed by the Associationists, who proposed principles about how the brain forms associations between different thoughts and ideas. Aristotle proposed the principles of contiguity, similarity, and contrast. James Mill developed a theory of how two or more simple ideas can be combined to form more complex ideas. Hermann Ebbinghaus conducted some of the first studies on learning and memory using lists of nonsense syllables as his stimuli and repeating the lists to himself until he memorized them. He demonstrated several basic principles of learning, including contiguity, recency, and overlearning.

Two main approaches to studying learning are the behavioral and cognitive approaches. Behavioral psychologists have often used animal subjects because they are interested in general principles of learning that are shared by many species, because animals are less complex than human subjects, and because animal environments can be controlled to a greater degree. Critics of animal research have questioned whether we can generalize from animals to people, and they have raised ethical concerns about the use of animal subjects. Behaviorists

have argued that psychology should deal only with observable events, whereas cognitive psychologists regularly use intervening variables such as hunger, memory, and attention. B. F. Skinner argued that intervening variables make scientific theories more complex than necessary. However, Neal Miller showed that if a theory includes many independent variables and many dependent variables, then using intervening variables can actually simplify a theory.

Specialized sensory neurons in the eyes, ears, and other sense organs respond to very simple sensory properties, much as the Associationists suggested. Neurons in the eye respond to specific colors, and neurons in the ear respond to specific pitches of sound. In the brain, the inputs from many sensory neurons are often combined, so that individual neurons may respond to features such as edges, angles, and corners of a visual stimulus. How the nervous system combines all this information so that we can perceive and identify objects in our environments is still not well understood, but there is evidence that object recognition involves patterns of brain activity across large sections of the brain.

Neuroscientists assume that whenever an individual learns something new, there is a physical change somewhere in the brain or nervous system. Some axon terminals may begin to produce neurotransmitters in greater quantities, some dendrites may become more sensitive to existing neurotransmitters, new synapses may form between neurons, and completely new neurons may grow. There is solid evidence for each of these different types of changes. Lashley's early research with rats suggested that many different sections of the brain are changed during a simple learning experience. However, research on humans with brain injuries suggests that some types of information may be stored in fairly small, specific areas of the brain.

Review Questions

1. Describe Aristotle's three principles of association and some of the additional principles proposed by Brown. Illustrate these principles by giving some examples from your own life of words or concepts that you tend to associate.
2. What procedure did Ebbinghaus use to study memory? How did his results offer evidence for the principles of frequency, recency, and contiguity?
3. What are some of the advantages and disadvantages to using animals as subjects in research on learning?
4. Why did B. F. Skinner believe that intervening variables should not be used in psychological theories? In your opinion, what is the biggest disadvantage of using intervening variables? What do you consider the biggest advantage?
5. Describe some research results that provide evidence that learning can result in chemical changes in the brain, the growth of new synaptic connections, and the growth of new neurons.

REFERENCES

Aristotle. (ca. 350 B.C.). De memoria et reminiscentia. In J.A. Smith (Trans.) & W.D. Ross (Ed.), *The works of Aristotle* (Vol. 3). Oxford: Clarendon Press. (English translation published 1931.).

Baldwin, E. (1993). The case for animal research in psychology. *Journal of Social Issues, 49*, 121–131.

Blakemore, C., & Cooper, G.F. (1970). Development of the brain depends on the visual environment. *Nature, 228*, 477–478.

Bliss, T.V.P., & Lomo, T. (1973). Long-lasting potentiation of synaptic transmission in the dentate area of the anaesthetized rabbit following stimulation of the perforant path. *Journal of Physiology, 232*, 331–356.

Boldrini, M., Santiago, A.N., Hen, R., Dwork, A.J., Rosoklija, G.B., Tamir, H., & . . . Mann, J.J. (2013). Hippocampal granule neuron number and denate gyrus volume in antidepressant-treated and untreated major depression. *Neuropsychopharmacology, 38*, 1068–1077.

Bourne, J.N., Chirillo, M.A., & Harris, K.M. (2013). Presynaptic ultrastructural plasticity along CA3→CA1 axons during long-term potentiation in mature hippocampus. *The Journal of Comparative Neurology, 521*, 3898–3912.

Brennan, P., Clark, R., & Mock, D. (2014). Time to step up: Defending basic science and animal behaviour. *Animal Behaviour, 94*, 101–105.

Brown, T. (1820). *Lectures on the philosophy of the human mind* (Vols. 1 and 2). Edinburgh, UK: James Ballantyne.

Chen, W.R., Lee, S.H., Kato, K., Spencer, D.D., Shepherd, G.M., & Williamson, A. (1996). Long-term modifications of synaptic efficacy in the human inferior and middle temporal cortex. *Proceedings of the National Academy of Sciences, 93*, 8011–8015.

Chouinard, P.A., & Goodale, M.A. (2010). Category specific neural processing for naming pictures of animals and naming pictures of tools: An ALE meta-analysis. *Neuropsychologia, 48*, 409–418.

Desimone, R., Albright, T.D., Gross, C.G., & Bruce, C. (1984). Stimulus-selective properties of inferior temporal neurons in the macaque. *Journal of Neuroscience, 4*, 2051–2062.

Draganski, B., Gaser, C., Busch, V., Schuierer, G., Bogdahn, U., & May, A. (2004). Neuroplasticity: Changes in grey matter induced by training. *Nature, 427*, 311–312.

Ebbinghaus, H. (1885). *Memory*. Leipzig, Germany: Duncker.

Fuchs, E., & Flügge, G. (2014). Adult neuroplasticity: More than 40 years of research. *Neural Plasticity*, Article ID 541870.

Gould, E., Beylin, A., Tanapat, P., Reeves, A., & Shors, T.J. (1999). Learning enhances adult neurogenesis in the hippocampal formation. *Nature Neuroscience, 2*, 260–265.

Gould, E., Reeves, A.J., Graziano, M.S., & Gross, C.G. (1999). Neurogenesis in the neocortex of adult primates. *Science, 286*, 548–552.

Hart, J., Berndt, R.S., & Caramazza, A. (1985). Category-specific naming deficit following cerebral infarction. *Nature, 316*, 439–440.

Heidegger, T., Krakow, K., & Ziemann, U. (2010). Effects of antiepileptic drugs on associative LTP-like plasticity in human motor cortex. *European Journal of Neuroscience, 32*, 1215–1222.

Hubel, D.H., & Wiesel, T.N. (1963). Receptive fields of cells in striate cortex of very young, visually inexperienced kittens. *Journal of Neurophysiology, 26*, 994–1002.

Hubel, D.H., & Wiesel, T.N. (1965). Binocular interaction in striate cortex of kittens reared with artificial squint. *Journal of Neurophysiology, 28*, 1041–1059.

Hubel, D.H., & Wiesel, T.N. (1979). Brain mechanisms in vision. *Scientific American, 241*, 150–162.

Huttenlocher, P.R. (1990). Morphometric study of human cerebral cortex development. *Neuropsychologia, 28*, 517–527.

Kant, I. (1781/1881). *Kritik der reinen Vernunft.* Riga [*Critique of pure reason*]. (F. Max Muller, Trans.). London: Henry G. Bohn.

Kokaia, Z., & Lindvall, O. (2003). Neurogenesis after ischaemic brain insults. *Current Opinion in Neurobiology, 13*, 127–132.

Kolb, B., & Gibb, R. (2008). Principles of neuroplasticity and behavior. In D.T. Stuss, G. Winocur, & I.H. Robertson (Eds.), *Cognitive neurorehabilitation: Evidence and application* (2nd ed., pp. 6–21). New York: Cambridge University Press.

Konen, C.S., & Kastner, S. (2008). Two hierarchically organized neural systems for object information in human visual cortex. *Nature Neuroscience, 11*, 224–231.

Konorski, J. (1967). *Integrative activity of the brain: An interdisciplinary approach.* Chicago, IL: University of Chicago Press.

Lashley, K.S. (1950). In search of the engram: Physiological mechanisms in animal behavior. In J.F. Danielli & R. Brown (Eds.), *Symposium of the Society for Experimental Biology* (pp. 454–482). Cambridge, MA: Cambridge University Press.

Lerch, J.P., Yiu, A.P., Martinez-Canabal, A., Pekar, T., Bohbot, V.D., Frankland, P.W., & . . . Sled, J.G. (2011). Maze training in mice induces MRI-detectable brain shape changes specific to the type of learning. *NeuroImage, 54*, 2086–2095.

Locke, J. (1690). *An essay concerning humane understanding: In four books.* London: Thomas Bassett.

Lucchelli, F., Muggia, S., & Spinnler, H. (1997). Selective proper name anomia: A case involving only contemporary celebrities. *Cognitive Neuropsychology, 14*, 881–900.

Meis, S., Endres, T., & Lessmann, V. (2012). Postsynaptic BDNF signalling regulates long-term potentiation at thalamo-amygdala afferents. *Journal of Physiology, 590*, 193–208.

Mill, J. (1829). *Analysis of the phenomena of the human mind.* London: Baldwin & Cradock.

Mill, J.S. (1843). *A system of logic, ratiocinative and inductive, being a connected view of the principles of evidence, and the methods of scientific investigation.* London: J. W. Parker.

Miller, N.E. (1959). Liberalization of basic S-R concepts: Extensions to conflict behavior, motivation, and social learning. In S. Koch (Ed.), *Psychology: A study of a science* (Vol. 2, pp. 196–292). New York: McGraw-Hill.

Miller, N.E. (1985). The value of behavioral research with animals. *American Psychologist, 40*, 423–440.

Nicholas, J.M. (1984). Lessons from the history of science. *Behavioral and Brain Sciences,* 7, 530–531.

Nichols, D.F., Betts, L.R., & Wilson, H.R. (2010). Decoding of faces and face components in face-sensitive human visual cortex. *Frontiers in Perception Science, 1*(29), 1–13.

Penfield, W. (1959). The interpretive cortex. *Science, 129*, 1719–1725.

Regan, T. (1983). *The case for animal rights.* Berkeley, CA: University of California Press.

Rosenzweig, M.R. (1966). Environmental complexity, cerebral change, and behavior. *American Psychologist, 21*, 321–332.

Rosenzweig, M.R., Mollgaard, K., Diamond, M.C., & Bennet, T.E.L. (1972). Negative as well as positive synaptic changes may store memory. *Psychological Review, 79*, 93–96.

Shimamura, A.P. (2014). Remembering the past: Neural substrates underlying episodic encoding and retrieval. *Current Directions in Psychological Science, 23*, 257–263.

Skinner, B.F. (1938). *The behavior of organisms.* New York: Appleton-Century-Crofts.

Skinner, B.F. (1950). Are theories of learning necessary? *Psychological Review, 57*, 193–216.

Spinelli, D.H., Jensen, F.E., & DiPrisco, G.V. (1980). Early experience effect on dendritic branching in normally reared kittens. *Experimental Neurology, 62*, 1–11.

Tomie, A., Grimes, K.L., & Pohorecky, L.A. (2008). Behavioral characteristics and neurobiological substrates shared by Pavlovian sign-tracking and drug abuse. *Brain Research Reviews, 58*, 121–135.

von Bekesy, G. (1964). Sweetness produced electrically on the tongue and its relation to taste theories. *Journal of Applied Physiology, 19*, 1105–1113.

von Bekesy, G. (1966). Taste theories and the chemical stimulation of single papillae. *Journal of Applied Physiology, 21*, 1–9.

Wang, S.H., & Morris, R.G.M. (2010). Hippocampal-neocortical interactions in memory formation, consolidation, and reconsolidation. *Annual Review of Psychology, 61*, 49–79.

Watson, J.B. (1919). *Psychology from the standpoint of a behaviorist*. Philadelphia, PA: Lippincott.

Yamadori, A., & Albert, M.L. (1973). Word category aphasia. *Cortex, 9*, 112–125.

Chapter 4

Contents

Disorders of perception and attention

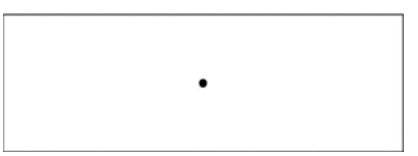
4

Tom Manly and Hayley Ness

4.1 INTRODUCTION

In the previous chapters we described the processes involved in perception and attention, and described how we construct an internal representation of the world around us. Given the complexity of these processes, it is not surprising that brain damage can disrupt perception and attention. These can have devastating consequences for peoples' everyday lives. Examining the range and nature of these impairments can also give us useful clues as to the beautiful computational complexity and efficiency of the unimpaired system. To adapt a well-used analogy, a television that is in perfect working order tells you little about *how* it works. When it malfunctions, however, it emits clues as to its underlying structure; if you can hear the sound but not see the picture you know immediately that, at some level, these two functions are handled differently within the system. The hope is that by studying disorders of perception that we can better understand normal function and find better ways to help patients cope with impairments. The emphasis in this chapter is to study the pattern of disorders with relatively little emphasis on the location of functions within particular brain regions. We have taken the view that it is more important to know *how* we perceive than *where* we perceive.

Before we proceed, we would like you to try a demonstration that you may well have done before. In the box below is a dot. Close your left eye and hold the book about 5 cm from your face and look straight



at the dot. Then, *without moving your eyes to track the dot*, move the page slowly to the right (to the left if using your left eye).

At some point, the dot will disappear. You have found your blind-spot where your retina meets the optic nerve and is insensitive to light. Now, still with one eye, look back at the complex world around you. Where is the blind spot? How does the world look so complete? One of the most startling perspective shifts we undergo in studying the brain is knowing that all that is 'out there' (from a visual perspective) is light of different intensities and wavelengths bombarding the retina at 299,792,458 metres per second. The world of objects and people and faces and colours and textures that we see are actually reconstructions, or perhaps more accurately, *predictions* by the brain of objects that the light has bounced off on its journey to the retina, based on its knowledge of the world. The section on visual illusions in Chapter 2 provides other good examples.

Most of the disorders discussed in this chapter result from brain injury, which leaves the affected individual with a noticeable deficit. However, the first 'condition' we will consider is a little different. This is the extraordinary case of **synaesthesia**. Whilst it can begin following an injury to the brain (Fornazzari *et al.*, 2011), many people with synaesthesia have had it for as long as they can remember and regard it as a gift rather than a disability. For the remainder of the chapter we will study other syndromes which have an increasingly specific impact on perception and attention. We will first consider disorders which prevent conscious perception or distort attention, then we will consider disorders which affect the ability to recognise objects, and finally we will discuss disorders which appear to affect the ability to recognise one particular category of object or the ability to encode one particular type of information.

Key Term

Synaesthesia
A condition in which individuals presented with sensory input of one modality consistently and automatically experience a sensory event in a different modality (for example seeing colour on hearing musical notes).

4.2 SYNAESTHESIA

What colour is Monday? How about the number 7? What does blue taste like? For most of us these are ludicrous questions. For a minority of you reading this chapter they will make perfect sense. These readers show synaesthesia, which literally means 'to perceive together'. When presented with a particular stimulus, a person with synaesthesia (**synaesthete**) will consistently and automatically experience another sensory event, sometimes in the same modality (e.g. both in vision), sometimes in another sense. The most common form is to experience a colour on seeing or hearing a letter, number or word. The triggers of synaesthetic experience are called inducers. Hence, Monday might be yellow, and 7 might be red. Other examples include linking colours with familiar faces, days, or weeks, but also feeling sounds, seeing musical notes, seeing tastes and tasting colours (Baron-Cohen *et al.*, 1996; Carpenter, 2001; Ward, 2013). Many synaesthetes also report that inducers which follow a reliable sequence (e.g. letters of the alphabet, days of the week, months of the year) are experienced in a particular spatial arrangement, for example as segments in an arc projected around the body (Figure 4.1).

Key Term

Synaesthete
A person who has the condition synaesthesia.

The first known report of synaesthesia was in the 1812 dissertation of an Austrian doctor, George Sachs, who described his own colour sensations when exposed to letters and numbers (Jewanski *et al.*, 2009). Although

brought to greater prominence by Galton in the latter years of that century (Galton, 1883), with the rise of behaviourism and its scepticism about subjective reports, it largely fell from scientific favour. In the 1980s a landmark paper by Baron-Cohen *et al.* (1987) brought the topic back into mainstream cognitive psychology. Baron-Cohen responded to an advertisement placed in a psychology journal by a synaesthete called EP who described herself as 'an artist who has experienced the life-long condition of hearing words and sounds in colour'. First, they tested the replicability (reliability) of EP's synaesthetic experiences. She was asked to describe her response to 100 aurally presented words, letters, names and numbers, and a selection of non-words. Ten weeks later and without warning she was retested on the same list. In every case her description matched that on the first test. This 100 per cent replication contrasted with just 17 per cent in a non-synaesthete asked to remember her random responses over just a two-week period. EP's remarkable consistency was achieved despite the fact that the descriptions she provided were much more elaborate than those offered by the control participant (Figure 4.1). For many synaesthetes, the colour induced by the first letter determines the apparent colour of a word. However, when EP was presented with word-like letter strings (called pseudo-words, e.g. "bralbic") her synaesthetic experience was a mix of the colours induced by each letter.

Inducing Item	Description of the induced synaesthetic experience
Moscow	darkish grey with spinach-green, and a pale blue in places
Fear	Mottled light grey, with a touch of soft green and purple
Daniel	deep purple, blue and red, and is shiny
Maria	deep violet blue
Huk (non-word)	The combination of the colours of the component letters; dark red (H), yellow (U), and purple (K)
H	Dark red
M	Blue-black
Q	Greeny yellow

Part (a)
Some examples of the very consistent colour descriptions offered by synaesthete EP in response to the sound of words, names, non-words and letters.

```
A B  C  D  E
 F G
 H
 I
 J
 K  L  M N
              O
            P
         Q
     R
 S
 T
 U
 V
   W
        X Y Z
```

Part (b) The spatial arrangement of the letters of the alphabet as perceived by EP

Figure 4.1 Baron-Cohen's investigation of EP's synaesthesia.

Source: After Baron-Cohen *et al.* (1987).

THE NATURE OF SYNAESTHESIA

This high level of consistency over time is not unique to EP. In fact Mattingley *et al.* (2001) reported accuracy levels of 80-100 per cent in a group of fifteen synaesthetes compared with 30-50 per cent in fifteen non-synaesthete controls. The synaesthetes' reports were significantly more consistent over a three-month test–retest interval than were the controls after a delay of just one month. For some classes of items, such as Arabic numerals, the synaesthetes achieved a mean consistency of more than 90 per cent compared with less than 30 per cent consistency in the control participants.

Synaesthesia is usually a unidirectional process; the letter A may give rise to the perception of red but not vice versa. For most synaesthetes, simply imagining the inducer can be enough to produce the response. Synaesthetic experiences are limited to fairly low-level percepts such as colour or spatial location rather than the appearance of a face or an object (Grossenbacher and Lovelace, 2001). Curiously, a high number of inducers seem to be things that we learn as children, such as letters, numbers, or days, where the relationships between the perceptual form and the entity that it represents is arbitrary but fixed within a culture.

An interesting study (Witthoft and Winawer, 2013) linked consistent colour–letter associations in eleven synaesthetes to a specific Fisher-Price coloured letter set that had been manufactured between 1972 and 1990 (which all but one of the participants then reported being able to recall from their childhood). This result does not mean that all synaesthesia is based on such developmental experiences, but it is important in suggesting that learning can play a role.

Most synaesthetes regard their condition as a good thing (Carpenter, 2001). However, Baron-Cohen *et al.* (1996) describe one individual, JR, who experienced particularly strong colour and sound associations working in both directions. Each colour in a scene triggered a different musical note, each sound a different colour. Understandably, this was rather overwhelming and JR restricted her lifestyle to avoid excessive stimulation.

Steven and Blakemore (2004) reported the details of six synaesthetes who experienced seeing colours on hearing or thinking about letters or numbers, despite being blind for many years. All had experienced letter–colour synaesthesia for as long as they could remember and the condition persisted after they became blind. One of the six had been blind for thirty-five years. Another experienced colour when he touched the raised dots of Braille characters even though he had been without colour vision for ten years. As Steven and Blakemore comment, this suggests that synaesthesia 'persists for very long periods with little or no natural experience in the referred modality' (2004: 855).

There is a great deal of commonality to the subjective reports provided by synaesthetes. Almost all report that they have had the condition for as long as they can remember (Baron-Cohen *et al.*, 1993) and many have strong memories of the moment at which they discovered that they were different to other people (see Box 4.1). However, Dixon *et al.* (2004) distinguish two forms of synaesthetic experience.

Box 4.1 Discovering one is a synaesthete: A case history

Synaesthete Patricia Duffy provides a vivid account of the moment she first realised that her experience of coloured letters was unusual. Duffy recounts a conversation she had at age 16 in which she reminisced with her father about learning to write the letters of the alphabet (Duffy, 2001):

> I said to my father, 'I realized that to make an "R", all I had to do was first write a "P" and then draw a line down from its loop. And I was so surprised that I could turn a yellow letter into an orange letter just by adding a line.'
>
> 'Yellow letter? Orange letter?' my father said. 'What do you mean?'
>
> 'Well, you know,' I said. ' "P" is a yellow letter, but "R" is an orange letter. You know – the colors of the letters.'
>
> 'The colors of the letters?' my father said.

It had never come up in any conversation before. I had never thought to mention it to anyone. For as long as I could remember, each letter of the alphabet had a different color. Each word had a different color too (generally, the same color as the first letter) and so did each number. The colors of letters, words and numbers were as intrinsic a part of them as their shapes, and like the shapes, the colors never changed. They appeared automatically whenever I saw or thought about letters or words, and I couldn't alter them.

I had taken it for granted that the whole world shared these perceptions with me, so my father's perplexed reaction was totally unexpected. From my point of view, I felt as if I'd made a statement as ordinary as 'apples are red' and 'leaves are green' and had elicited a thoroughly bewildered response.

They differentiate between 'projectors', who experience the colour as if it were 'out there' in the physical world superimposed on the stimulus, and 'associators', who see the colour in their 'mind's eye'. Dixon *et al.* report that about 90 per cent of synaesthetes in their sample were associators. We will return to this distinction later.

INCIDENCE AND FAMILIARITY

Based on response rates to newspaper adverts, Baron-Cohen *et al.* (1996) estimated the incidence of synaesthesia at about 1 in 2,000, with about 80 per cent being female. There are of course many problems with this sampling method, including how representative the readership are, the likelihood of responses from people who believe they are synaesthetic and those who do not, and possibly different propensities of men and women to respond. More reliable methods include screening with checks on the test–retest consistency of the subjective reports. Reviewing these studies, Ward (2013) cites prevalence rates from 0.2 per cent of the population for taste–shape synaesthetes, 1.4 per cent for letter/number–colour, and up to 20 per cent for those who image sequences into spatial arrays. These studies suggest that an approximately equal number of men and women have synaesthetic experiences.

In Baron-Cohen's newspaper survey, about one-third of synaesthete respondents reported having a relative who also had synaesthesia. This

is higher than you would expect based on the general frequency in the population, and subsequent studies suggest a genetic component, though it is always important to keep in mind the possible influence of shared environment. Any genetic component is now thought to involve multiple genes and not a specific sex-linked (X-chromosome) component, as first suggested by Baron-Cohen (Smilek *et al.*, 2005; Asher *et al.*, 2009; Tomson *et al.*, 2011). What appears to be shared in families is not the precise manifestation in terms of particular inducer–modality pairings but rather a more general predisposition (Ward *et al.*, 2007). Even when family members do share, say, letter–colour synaesthesia, they are no more likely to agree on the colour of any particular letter than unrelated synaesthetes (Barnett *et al.*, 2008). A general predisposition account would also help explain why the majority of synaesthetes report more than one type of synaesthetic experience (Baron-Cohen *et al.*, 1996). We return to the idea of a predisposition to synaesthesia in the brief discussion of candidate neural mechanisms below. Before that we turn to what experimental psychology methods can tell us about this phenomenon.

EXPERIMENTAL INVESTIGATIONS OF SYNAESTHESIA

Several researchers (e.g. Mills *et al.*, 1999; Mattingley *et al.*, 2001) have used versions of the Stroop test (Stroop, 1935) to investigate synaesthesia (see Chapter 3 for details of the Stroop task). In these tasks, a synaesthete is asked to identify the actual colour of a series of stimuli, some of which are inducers and some not. It turns out that when the inducer colour matches the synaesthetic colour (is *congruent*), responses are significantly faster than on neutral, non-inducer, trials. When an inducer has a different (*incongruent*) colour, it interferes with performance and responses are significantly slower than neutral trials. Even when it is interfering with the task, therefore, it appears that synaesthesia cannot be 'switched off'; hence the responses are termed *mandatory* or *automatic*.

Mattingley *et al.* (2001) modified the Stroop technique to investigate whether conscious processing of an inducer is necessary for a synaesthetic response. Inducers were presented very briefly followed by a visual mask (visual masks are a scramble of lines etc. that disrupt the representation preserved after a picture has disappeared, reducing the time available to 'see' the image). We know that such brief, masked presentations are registered in the brain at some level because they can influence (or 'prime') responses to subsequent related material. However, this technique prevents conscious awareness, and neither the synaesthetes nor the control participants were able to report what they had seen. Under these conditions, no synaesthetic Stroop interference was found. It appears that conscious awareness is therefore necessary for synaesthetic responses to occur. This idea is supported by studies that used visual search paradigms. If you are asked to look out for the red letter F amongst lots of other red letters, the more other letters there are, the longer you will take to find it. If, however, you are asked to look for the red F amongst

blue letters, the number of these extra distractors makes little difference; the distinctive red letter 'pops out' and can be detected at a glance (see Chapter 3). So, if synaesthetes cannot help but experience, say, a blue F as red, do they have a built-in advantage in separating it out from blue distractors? No such advantage was found (Edquist *et al.*, 2006) again suggesting that conscious attention to the inducer is necessary before the synaesthetic experience will occur.

Conscious attention to the inducer may be necessary but does the inducer actually need to be present? Dixon *et al.* (2000) worked with a number–colour synaesthete called C who completed a Stroop task. Each trial had the sequence: number, arithmetic operator (+, {min} etc.), number, colour patch (e.g. 2 . . . + . . . 5. . . [green]). C was asked to name the colour as quickly as possible. It turned out that when the colour patch was congruent with the colour induced in C by the *answer* to the sum (7), she was significantly faster than when it was incongruent, despite it never being presented. A similar conclusion follows from Myles *et al.* (2003). An ambiguous grapheme like 2 can appear as a number or letter depending on context (e.g. 1234, 2ebra). This enabled the researchers to use the same stimulus in both congruent and incongruent trials in a Stroop task. The results demonstrated that it was the synaesthete's *interpretation* rather than the physical properties of the stimulus, which predicted the synaesthesia.

Taken together, these careful experiments show that synaesthetic experiences are reliable over time, appear mandatory or automatic, occur whether the inducer is physically present or in the mind, but require conscious attention to the inducer.

BRAIN-IMAGING STUDIES OF SYNAESTHESIA

Functional brain-imaging techniques, such as **functional magnetic resonance imaging (fMRI)**, allow researchers to examine changes in measures of brain function as volunteers perform different sorts of tasks, think different thoughts, remember different things and so on. It is important to remember that these techniques all have some limitations. fMRI, for example, takes advantage of detecting changes in the oxygen level of blood in different parts of the brain (the blood oxygen response level, or BOLD, signal). Areas that are working harder during a given task require more oxygen and this arrives via the blood a few seconds after the work is done and takes a few more seconds to dissipate. When we are looking at fMRI patterns, therefore, we are not looking directly at brain function but a map that is somewhat blurred, both spatially and in time, in a brain where blood is flowing in many directions for different reasons, creating a noisy signal.

Electroencephalography (EEG) records minute changes in voltage detectable from electrodes harmlessly resting on the scalp. These measures are very sensitive to millisecond-by-millisecond changes but give us only a crude idea about which parts of the brain (or combinations of parts) the signals are coming from. Very occasionally, it is possible to directly record electrical activity from a small group of brain cells, for example, when a volunteer is being prepared for essential brain

Key Term

Functional magnetic resonance imaging (fMRI)
A medical imaging technology that uses very strong magnetic fields to measure changes in the oxygenation of the blood in the brain and thus map levels of activity in the brain. It produces anatomical images of extremely high resolution.

Electroencephalo graphy (EEG)
Recording the brain's electrical activity via electrodes placed against the scalp. Can be used to continuously record rhythmic patterns in brain function or particular responses to events (**event-related potentials**).

Key Term

Event-related potentials (ERP)
Systematic changes in the brain's electrical responses linked to the presentation of a stimulus. Typically the stimulus is presented numerous times with the EEG signals time-locked to its occurrence then being averaged to separate the signal from noise.

Transcranial magnetic stimulation (TMS)
This technique uses an electrical coil placed near the surface of the head to induce a rapid change in the magnetic field, which, in turn, produces a weak electrical current in underlying brain tissue. This can cause depolarisation or hyperpolarisation. The technique can use single bursts or repetitive stimulation. It can be used to support inferences about the role of that brain region in a particular task (e.g. by showing that repetitive stimulation slows responses in task *a* but not task *b*, that the region is involved in task *a*).

surgery. This gives you a very precise picture of the response to a given stimulus etc. *in that area* but no way of knowing how this links to what is happening in the rest of the brain. The methods described so far are observational-correlational, as an area may respond under certain conditions but we do not know exactly what it is doing or how it contributes to a behavioural response.

Transcranial magnetic stimulation (TMS) is a method that allows some inference about the *functional* involvement of a brain area in a process. In TMS an electromagnetic coil near the scalp is used to induce an electrical pulse in the underlying cortical region. This can cause excitation or, with repeated stimulation, a period of under-excitability, a little bit like a temporary brain lesion in that area. If inhibition worsens performance on a task, for example, it suggests that brain area was contributing to good performance. A limitation of this technique is that it is only really effective near to the cortical surface.

Understanding the limitations of these techniques is important, because the last few decades have seen many examples, particularly in the press, of the logical fallacy ('neurorealism') that something that has a detectable 'brain signal' is more real than something that does not. In the case of synaesthesia, it would be wrong to conclude that the synaesthesia is real because it was associated with activity in regions that are also sensitive to colour – perhaps simply imagining colour could have the same effect, or perhaps these regions are involved in some other way such as anticipating colour judgements. Similarly, it would be very dangerous to conclude that a synaesthetic experience was not real just because your method could not detect a reliable signal in a particular brain region. There are many ways of failing to discriminate real activity!

Functional imaging generally requires multiple participants to make generalised claims and most studies of synaesthesia have accordingly focused on the most frequently seen word–colour form. Nunn *et al.* (2002), using fMRI, reported that synaesthetes showed increased activity in V4, a region of the brain linked with colour perception, when listening to inducer compared with non-inducer words. This signal was not detectable in non-synaesthete control participants who had been asked to associate colours and words. Consistent findings were reported by Hubbard and Ramachandran (2005). These results were exciting because they suggested that synaesthetic colour was represented in exactly the same system as that based on 'real' colour. However, other studies have failed to detect this activity (Rouw *et al.*, 2011; Hupe *et al.*, 2012), and there are suggestions that different forms of synaesthesia may be associated with different patterns (Van Leeuwen *et al.*, 2011). Currently the brain regions most commonly activated in the critical synaesthesia response study conditions lie in the frontal and parietal lobes, particularly in a fold in the brain in this region called the intra-parietal sulcus (IPS). For the IPS in particular there is developing (and reassuring) convergence across different methods; it is more active in fMRI comparisons, differences in brain structure in this region (grey matter volume) between synaesthetes and control groups have been reported, and TMS to the area influences behavioural measures of synaesthesia effects (Weiss *et al.*, 2005; Weiss

and Fink, 2009). It is also interesting because this region has been implicated in functional imaging and neuropsychological studies in integrating across multimodal sensory information.

MECHANISMS UNDERLYING SYNAESTHESIA

In some ways synaesthesia is less surprising than it first appears. We know from many sources that the brain integrates information from across modalities to develop a working, *useful* model of the world around us. We know that what we can see can influence what we hear and vice versa (Driver and Spence, 1998). We know that sensory feedback from muscles or from the vestibular (balance) system can influence how the world appears to us (Bottini *et al.*, 2001; Schmida *et al.*, 2005), and that priming and memory cues activate representations across modalities (think of an apple and you will get a shape, a colour, a smell, a taste, a crunching sound etc.). Perhaps the curious thing is that the associations are so strong for some people that the presence (or thought) of an inducer is enough to trigger a full perceptual experience in the same or different sensory modality, whilst for most of us it may activate related mental content, but not sufficiently to produce a percept.

Neural spiking is the brain's common currency. From the brain's point of view the colour red is a level of activity in and across particular neurons and, if this occurs, the brain cannot tell if this is due to an external or internal event (without other clues, at least). Most neural accounts of synaesthesia are based on the idea that regions related to the perception of the inducer (e.g. letter reading) become linked to regions related to the experience (e.g. colour perception) such that the occurrence of the former automatically activates the latter. Variants of this argument, which in truth do not tell us much more than the descriptions of synaesthesia presented above, are that these connections exist for everyone but they are functionally more active in synaesthetes or inhibited for the majority of the population who are non-synaesthetes.

An interesting theory is that we were all synaesthetes once but that the neural connections that supported this are usually pruned out in early childhood (the infant's brain has massively more connections than the adult's). By this account, a small group maintain enough of these connections to become adult synaesthetes (Maurer and Mondloch, 2006). Ramachandran and Hubbard (2002) note that brain areas involved in colour perception (V4 in the fusiform gyrus) are immediately adjacent to the areas active during letter reading. 'Can it be a coincidence', they comment, 'that the most common form of synaesthesia involves graphemes and colours and the brain areas corresponding to these are right next to each other?' (p. 9). It certainly could be coincidental and others have argued that there is no necessary argument for either local or long-range extra neural connections in synaesthesia. Grossenbacher and Lovelace (2001), for example, put forward a 'disinhibited-feedback' theory. This suggests that connections between different sensory pathways exist in 'normal' brains, but that the activity of these pathways is usually inhibited to

Key Term

Disinhibition
The removal or reduction of a control process that previously prevented activity (inhibition). In the brain, a neuron's activity may be inhibited by other processes. If those processes are switched off, the neuron is disinhibited. Disinhibition can also refer to a person's behaviour, for example, if they have problems in preventing inappropriate or habitual responses.

prevent unadaptive cross-talk between sensory modalities. They point out that certain hallucinogenic drugs such as LSD can induce temporary synaesthetic experiences in non-synaesthetes, suggesting that the pathways connecting the different sensory modules exist in normal brains. The action of LSD could plausibly involve the **disinhibition** of existing pathways but is not likely to induce the 'growth' of new pathways. Interesting functional imaging evidence supporting disinhibition theory has been reported. Neufeld *et al.* (2012) found no difference between fourteen auditory–visual synaesthetes and non-synaesthete fMRI participants in terms of the functional connectivity (both being active) between auditory and visual areas but greater connectivity between sensory areas and the IPS in the synaesthetic group, suggesting that it may be links via this integration area that are supressed in non-synaesthetes.

SYNAESTHESIA – ADVANTAGE OR DISADVANTAGE?

We have seen that unbidden synaesthetic experiences were so overwhelming for JR that they had a detrimental effect on her quality of life (Baron-Cohen *et al.*, 1996). Survival and reproductive fitness will often depend on making quick, accurate decisions on what is 'out there' (can I eat it or will it eat me?). Interference with accurate perception from synaesthetic content, as we saw with the Stroop tasks, can impede rapid judgements. However, we have also seen how, in surveys, most synaesthetes do not view their condition as an impediment and there is growing evidence that synaesthesia may result in or stem from (or both) enhanced general perceptual skills in the relevant domain (Yaro and Ward, 2007). There is evidence too that some synaesthetes can use their elaborated representation of inducers to enhance memory and mathematical manipulations and that a disproportionate number may be drawn towards the creative arts (Ward, 2013). Synaesthesia may therefore form a useful example of the idea of 'neurodiversity' – individual differences in brain function that have advantages in some settings, disadvantages in others. There is a good argument that applying that idea to other characteristics currently seen as 'developmental disabilities' may have positive results.

CONCLUSIONS

Synaesthesia is an interesting example of the historical progress of cognitive psychology. As an inherently subjective state it received relatively little scientific interest at first. The application of appropriate scientific method to this area over the last 30 years has shown it to be both a 'real' phenomenon and one that offers a number of insights into normal cognition and perception, and human diversity. From the fraction of studies reviewed here we know that it takes many forms; it runs in families; it reflects an underlying propensity with many synaesthetes showing a number of manifestations; it is automatic but requires conscious awareness of the inducer; it may confer advantages in some circumstances; and it may be reflected in relative patterns of

neural feedback on connections between inducer and synaesthetic response brain areas.

4.3 BLINDSIGHT

The striate cortex, or area V1 as it is now known, is central to visual perception. Damage to the left striate cortex will result in blindness in the right *visual field* of both eyes and damage to the right striate cortex will result in blindness in the left visual field of both eyes. These areas of blindness are called *scotomata* (plural of **scotoma**). In order to imagine the effect of such damage, look straight ahead, and cover the left half of each eye. The very restricted visual field you now experience is similar to that which you would experience following damage to your right striate cortex. To see anything to your left side you need to turn your head (the patient would be able to turn their eyes).

Key Term

Scotoma
A blind area within the visual field, resulting from damage to the visual system (plural = scotomata).

Now imagine that you were asked to point to a flash of light that had occurred somewhere to your 'blind' left side. If persuaded to take part in this puzzling experiment you would expect to perform at chance levels, sometimes guessing the correct location but more often being wrong. Poppel *et al.* (1973) studied a group of ex-servicemen who suffered visual field deficits as a result of gunshot wounds to the striate cortex, and asked the participants to make just such judgements. Lights were flashed in the defective area of the visual field of each participant. Because the servicemen could not see the flashes, the light was paired with the sound of a buzzer, and on hearing the buzzer the servicemen were asked to move their eyes in the direction of the light source. The servicemen found this a difficult task, but to their surprise, all were able to direct their gaze towards the light which they could not see.

In the following year, Weiskrantz *et al.* (1974) described a patient DB who seemed to demonstrate the same remarkable ability. DB was blind in his lower-left visual field following surgery to remove part of his right striate cortex to relieve very severe migraine headaches. What was remarkable about DB was the extent to which he could report details of objects appearing in the blind areas of his visual field despite having no conscious experience of seeing them. Weiskrantz coined the term 'blindsight' to describe this phenomenon.

In a series of experiments covering many years (see Weiskrantz, 1986), Weiskrantz and colleagues were able to systematically investigate the perceptual abilities preserved in the 'blind' areas of DB's visual field. DB was able to detect the presence of an object, and indicate its location in space by pointing. He could discriminate between moving and stationary objects, and between horizontal and vertical lines, and he could distinguish the letter X from the letter O. However, he was unable to distinguish between X and a triangle, suggesting that the ability to distinguish between X and O was dependent on some low-level characteristic of these stimuli rather than any residual ability to discriminate form. DB's inability to discriminate form is further demonstrated by his failure to distinguish between rectangles of various sizes or between straight- and curved-sided triangles.

BLINDSIGHT – A SCEPTICAL PERSPECTIVE

Some scientists have questioned the existence of blindsight, arguing that there are several possible explanations which need to be considered carefully. Cowey (2004) summarised the arguments put forward by sceptics such as Campion *et al.* (1983). Three of these arguments are summarised below.

The stray light hypothesis

Campion *et al.* (1983) favoured the stray light explanation of blindsight, suggesting that blindsight patients were responding to light which was reflected from the object onto the functioning areas of the visual field (remember that patients such as DB are only partially blind, and can see normally in large areas of their visual field). Campion *et al.* described one patient who reported that he was using such a strategy to distinguish between vertical and horizontal bars presented to the blind areas of his visual field. This patient claimed that he could see a faint glow in the preserved areas of his visual field and used this cue to undertake the task. Campion *et al.* also demonstrated that such a strategy could lead to the accurate localisation of a light in a 'blind' area of the visual field of normal subjects whose vision had been masked. However, it is difficult to see how this stray light could explain DB's ability to distinguish letters such as X and O or two different spatial frequency gratings with the same average brightness. In addition, DB could locate objects even against a bright background, whereas Campion *et al.*'s normal subjects could only locate a light source against a low level of background illumination.

Paradoxically, the best evidence against the stray light explanation came from DB's *inability* to respond accurately to objects whose image fell onto his blindspot. The blindspot, where the optic nerve passes through the retina, is devoid of receptor cells so we are blind to images falling on this part of the retina. If DB's blindsight was explained by stray light, then we would expect him to perform equally well whether the image of the object fell on the blindspot or in the scotoma. In fact, DB showed no evidence of being able to detect the presence of objects or lights presented at his blindspot, yet could accurately detect objects or events occurring within the scotoma immediately adjacent to the blindspot (Figure 4.2).

More recently, some evidence has emerged to suggest that one form of the 'stray light' hypothesis might help to account for some reports of unexpected abilities in blindsight patients. Cowey (2004) noted that most research with blindsight patients uses 'raster displays' (television screens or computer monitors) to present the visual stimuli. Cowey demonstrated that a pattern displayed on one side of such a screen will often give rise to a faint 'ghost' image on the other side of the screen. Cowey and Azzopardi (2001) showed that in a display that included this artefact a normal participant could determine whether a grating presented in the masked area of the visual field was drifting up or down. However, once the display was modified to remove the artefact, this ability disappeared. Similarly, when the unmodified display

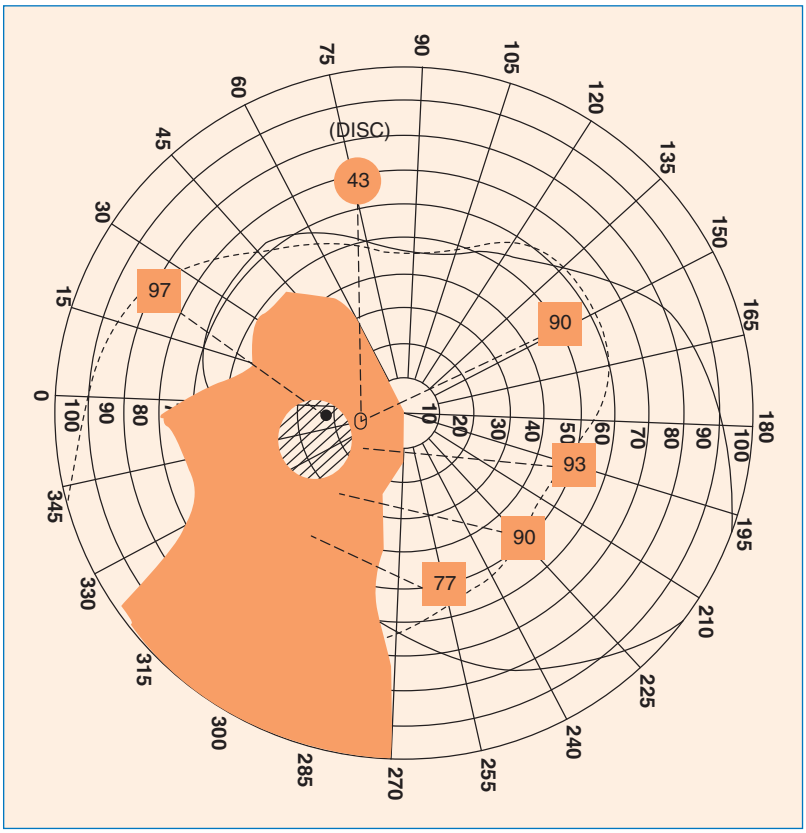


Figure 4.2 Weiskrantz's investigation of DB's blindsight.

Note: The dark area indicates the 'blind' area of DB's visual field. The hashed area indicates that region in which DB had some partial awareness of the presence of the light. When the light occurred at his blindspot (marked DISC) DB performed at chance level, correctly reporting the presence of the light on less than 50 per cent of occasions. However, performance at all other locations was well above chance. The stray light hypothesis would predict that performance at the blindspot should be well above chance.

Source: Weiskrantz (1986), reproduced by permission of Oxford University Press.

was used, three blindsight patients could detect both the presence of a moving pattern and the direction of movement, but once the artefact was removed they were sensitive to the presence of movement but not its direction. Thus, it seems that some, but not all of the apparent abilities of blindsight patients might be attributed to the presence of these artefacts.

Spared islands of residual vision

Wessinger *et al.* (1997) suggested that blindsight was attributable to small areas or 'islands' in the scotoma within which vision is spared, and that blindsight may be mediated by what is left of the primary visual pathway rather than other secondary pathways. This suggestion was tested by Kentridge *et al.* (1997) who looked for scattered regions of spared vision in one patient using a procedure which ensured that the effects of eye movements were abolished. Under these stringent testing conditions, Kentridge *et al.* noted that blindsight did not extend across the whole of the area of the scotoma, but was evident in some areas even after eye movements had been eliminated, leading to the conclusion that although there may be some spared islands within the scotoma, these cannot account for all blindsight. Furthermore, Cowey (2004) notes that the results of MRI scanning of several blindsight

patients has shown 'not a shred of evidence' of any sparing of the striate cortex in the area of the scotoma.

A change in criterion to report the presence of the stimulus?

Another explanation offered by sceptics is that blindsight represents a change in response criterion but not in sensitivity, such that blindsight patients are equally sensitive to the presence of a stimulus but less willing to report conscious awareness than a normal subject. Cowey and Azzopardi (2001) employed a signal detection approach to determine whether performance in a two-alternative-forced-choice task (such as determining in which of two time intervals a stimulus has been presented) was determined by a change in sensitivity or a change in criterion. The results suggest that the performance of blindsight patients tested was characterised not only by a change in response criterion, but also by a different mode of processing. That is, blindsight is qualitatively and not just quantitatively different from normal vision. However, Cowey (2004) notes that we should not ignore the possibility that changes in response criteria might partially account for some aspects of the performance of blindsight patients. This is an area of continuing research interest.

THE SENSATION OF BLINDSIGHT

It is very difficult to imagine what a patient such as DB experiences when a stimulus is presented within the 'blind' regions of his visual field. It is clear that the experience is very different from that of normal vision. Weiskrantz records DB as saying that he 'felt' movement rather than saw it. As far as we can tell, blindsight patients are learning to respond to very subtle experiences which have little in common with the normal perceptual experience. As Cowey (2004) observes, it is important not to think of blindsight as 'normal vision stripped of conscious visual experience' (p. 588). Blindsight is a very poor substitute for normal vision with very significantly reduced sensitivity to fundamental aspects of the scene.

So how can we imagine the experience of blindsight? Suppose you are sitting reading this book when suddenly, in your peripheral vision ('out of the corner of your eye'), a spider scuttles across the floor. Before you are conscious of the motion, you move your head and eyes towards the spider. You did not 'see' the spider but your visual system was able to guide you towards it. Perhaps this is a reasonable analogy to the experience of blindsight. Patients such as DB do not have any conscious experience of perception, yet, at some level below that accessible to introspection, the visual system does have access to information about the outside world.

THE IMPLICATIONS OF BLINDSIGHT: ONE VISUAL SYSTEM OR TWO?

The most widely accepted explanation for blindsight is that we have two separate visual systems, one primitive non-striate system and a

more advanced striate system. The primitive non-striate system might be sensitive to movement, speed, and other potentially important characteristics of a stimulus without giving rise to conscious perception. A frog can catch a fly because it can locate its position in space very accurately, but it is unlikely that the frog consciously perceives the fly. Perhaps blindsight represents the working of this primitive visual system whose functioning is normally masked by the conscious perception which results from the action of the striate visual system.

A slightly different explanation would be to see the striate and non-striate systems as having evolved to fulfil different roles. One possibility would be that the striate system has evolved to allow the identification of an object, whereas the non-striate system has evolved to allow the localisation of that object in space. There is some evidence from non-human animal studies to support this view. Based on a series of lesion studies in hamsters, Schneider (1969) suggested that there were two separate visual pathways: one responsible for the identification of objects, and the other for the location of objects in space.

Goodale and Milner (1992, 2004) suggested that the distinction might be between a system responsible for the recognition of objects and one responsible for the control of actions such as picking up an object. Goodale and Milner (1992) suggested that object recognition and the control of action might be mediated by different and mutually incompatible types of representation. In this case, they reasoned, it might be *necessary* to separate these two pathways and only allow one of them to have access to consciousness.

4.4 UNILATERAL SPATIAL NEGLECT

As we saw in the previous section, patients with blindsight are able to respond to a stimulus they cannot see. In **unilateral spatial neglect** the opposite seems to be true – patients fail to respond to stimuli which they can see. A patient may have normal vision yet fail to react to objects or events to one side of space – hence the terms *unilateral* (one-sided) *neglect* (ignoring rather than being blind to). The condition has a number of other names including *hemi-inattention, contralateral neglect* and simply *spatial neglect*. These represent terminological preferences rather than different conditions.

The main cause of unilateral spatial neglect (USN) is stroke, an interruption to the brain's blood supply. Because of its organisation, this interruption will primarily affect one or other hemisphere. Although USN may seem like an exotic neuropsychological phenomenon it is extremely common. Up to 84 per cent of patients with damage to the right hemisphere (RH) of the brain from stroke will show evidence on ignoring information on their left (the side opposite the lesion often called *contralateral* or *contralesional*). Similarly, up to 64 per cent of patients with left hemisphere damage can show the opposite pattern, ignoring information on their right (Stone *et al.*, 1993). One of the most robust and mysterious findings in neuropsychology is, however,

Key Term

Unilateral spatial neglect
A difficulty in noticing or acting on information from one side of space typically caused by a brain lesion to the opposite hemisphere (e.g. right-hemisphere damage producing lack of awareness for information on the left). Also called hemispatial neglect or hemispatial inattention.

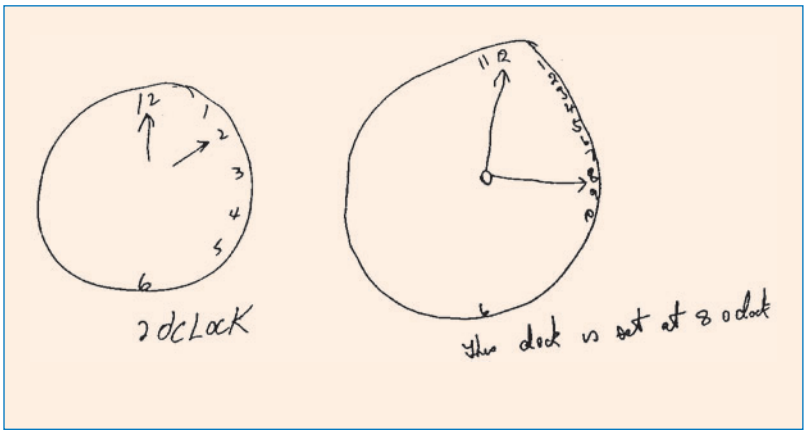


Figure 4.3 Examples of drawings of clock faces produced by patients with unilateral visual neglect.

Source: Halligan and Marshall (1993), by permission of Psychology Press Limited, Hove, UK.

that this fairly balanced picture is seen only very early on after the stroke. For some reason, left neglect following right hemisphere lesion is markedly more severe and persistent than its right neglect/left hemisphere equivalent (Bowen *et al.*, 1999). For that reason we will generally be talking about left-sided neglect in this chapter.

Patients with USN may fail to notice object in 'clear view' on the left, ignore people approaching from the left, eat food only from the right side of the plate, or wash and dress only the right side of their own body. A classic demonstration is to ask a patient to draw a clock face. USN patients will often omit the numbers between 7 and 11, or will try to squeeze these numbers onto the right side of the clock (Figure 4.3).

USN impacts upon many activities of daily living, can exclude people from rehabilitation and is associated with longer hospital stays and dependence on others. It is a serious clinical problem for patients and families. For science it also offers fascinating insights into the nature of awareness, consciousness, vision–action links and attention. A hope, as with other disorders, is that these insights will feed back into better targeted rehabilitation for the disorder.

A DISORDER OF ATTENTION?

A definition of USN is that it is a failure of or difficulty in responding to information on one side of space that we cannot explain by basic sensory loss. As we have seen, damage to primary visual areas can produce blindness for one half or portion of space. How does this differ from USN? This is an important question both because many patients with USN also have some loss of vision on the affected side (*hemianopia*) and because the rehabilitation implications of the two disorders may differ (Zihl, 1994).

The most obvious difference between USN and visual field loss is that the former can exert an influence across modalities whilst the later is restricted to vision. USN has been reported in audition (De Renzi *et al.*, 1989), tactile exploration, touch and body sensation (*haptic* and *somatosensory* perception (Vallar *et al.*, 1993; McIntosh *et al.*, 2002) imagery (Bisiach and Luzzatti, 1978; see below) and even smell! (Bellas *et al.*,

1988). However, many dissociations between modalities have been reported (meaning that a patient may show spatial bias in one modality but not the other). Assessment in non-visual modalities can be complex, and it is difficult to rule out non-visual sensory loss from stroke. Even in the visual domain, however, there are fundamental differences between visual field loss and USN, to which we now turn.

Visual field losses are strictly retinotopic – the blind area will move with the eyes. USN in contrast varies in different spatial frameworks, it may occur for objects to the left side of the body (*egocentric* space) or for objects on the left side of *something* (like a page or room) regardless of where this is in relation to the person (*allocentric* space). USN may occur for the left side of each object *within* a scene (Driver and Halligan, 1991). Marshall and Halligan (1993) for example, asked patients to copy pictures of plants. Bizarrely, a patient may miss leaves and petals on the left side of one plant and then go on to draw the right side of the next plant, which lies further into their neglected side. Perhaps the best way to think about this difference between visual field disorders and USN is to imagine looking around your room through a cardboard tube. At any given moment your view is greatly restricted and you will miss things happening outside of this narrow window. By scanning the tube around the room, however, you can see everything. With the important exception that you are consciously aware of the restricting tube, this is like visual field loss. Now imagine instead limiting your scans only to the left side of the room or the left side of each object in the room. This is more like neglect.

Another astonishing example of neglect was reported by Driver and Halligan (1991). To imagine this effect, hold this book upright and look at the words at the top-left side of the page. Driver and Halligan found, unsurprisingly, that USN led to insensitivity to differences between two stimuli in details at this location. Now rotate the book, but not your head, 45° to the right (sorry if this makes it difficult to read). Now the top-left words are on the 'right' side of the stimulus. Would this spare them from being neglected? No, remarkably, the neglect appeared to rotate with the page! It is as if the left side of *something* is first identified and then ignored.

So USN is different from basic visual loss, but is it a disorder of *attention*? This depends on quite what you mean by this notoriously difficult-to-define term. A key idea in lay uses of 'attention' is that you *could have* noticed something had you remembered to, or if it was pointed out to you. Both appear to be true in neglect. Patients *can* attend to the left if cued to do so or if particularly salient events draw attention there, although this often drifts quickly back to the right (Riddoch and Humphreys, 1983). In cognitive neuroscience the idea of *competition* is central to the study of attention; we have limited capacity resources, and objects, events etc. compete for access. If an object gains access, another is inevitably ignored, at least partially (Desimone and Duncan, 1995). This too seems to fit USN. A stimulus that appears in isolation in the neglected field will often be detected. When the same stimulus appears in competition with a rival on the good side,

however, it is more likely to be missed (this is called *extinction* and is commonly assessed at the bedside by *confrontation testing* – the examiner wiggles one, other or both of two fingers in the patient's line or sight and asks what was seen). Another characteristic of attention, illustrated already in the cueing and extinction examples, is *variability*. It is tempting to think of USN as reflecting a clear border between left and right. Instead there is much more of a gradient stretching from the left to the right affecting the probability that a stimulus will be detected (Karnath, 1997). Patients' performance on spatial tasks can show a very high level of trial-to-trial variability (Anderson, B. *et al.*, 2000). We have seen a patient show severe USN on a clinical test and then perform the *same test* without obvious impairment moments later. Such volatility in a symptom, as we shall discuss, can be very useful in suggesting the potential for rehabilitation.

Attention can be to external stimuli or internal content (e.g. day-dreaming). A fascinating example of USN was reported by Bisiach and Luzzatti (1978). They asked two USN patients to describe a famous square in their native Milan (the *Piazza del Duomo*) from memory. When the patients imagined themselves at one end, looking into the square, they showed a marked tendency to report landmarks that would be to their right. When asked to now imagine themselves at the other end looking back, the previously neglected left landmarks, now on their imagined right, re-entered consciousness. We have observed similar striking effects in asking a man with USN to describe his house to us from the front- and back-garden perspectives. Again his access to memories of entire rooms was peculiarly determined by where he imagined himself to be with respect to them. Arguably, omissions in patients' drawings of clocks, flowers etc. from memory also reflect distorted mental imagery, although in these cases, concurrent perception and even motor neglect is hard to rule out.

With due caution regarding blindsight and the heterogeneity of USN, a further fascinating difference with a purely visual field loss concerns the level to which neglected stimuli may be processed. Marshall and Halligan (1988) showed a USN patient pairs of drawings of a house. The patient failed to notice when the house on the left was on fire, but was above chance in choosing the non-burning building when asked which would be preferable to live in. Berti and Rizzolatti (1992) showed that presenting a brief stimulus in USN's patients 'bad' left field primed subsequent responses to related information in the good field, despite patients reporting no conscious awareness of the prime. Manly *et al.* (2002) asked USN patients to perform a common clinical test in which they had to find and cross out small stars scattered over a page amid distractors (a *cancellation* test). Under normal conditions, in addition to missing many targets on the left the patients showed a strong tendency cross out the same targets on the right of the sheet over and over again (this tendency to repeat actions without obvious cause is called *perseveration* and is a noted feature of neglect (Na *et al.*, 1999; Manly *et al.*, 2002) and some other neurological conditions (Joseph, 1999). When, however, the ignored targets on the left

of the sheet were replaced by non-targets, this re-marking of targets on the right dramatically declined. This suggests that on the standard version of the task the patients were aware, at some level, of the missing targets and this drove them to repeatedly cancel those on the right. Taken together the results suggest that neglected stimuli may be processed to quite a high level and yet fail to reach conscious awareness.

DO WE ALL SHOW NEGLECT?

A common clinical observation is that patients with persistent (chronic) left neglect tend to be drowsy and appear to have difficulty remaining focused on all sorts of tasks. This impression has been supported by research showing that such patients indeed tend to perform very poorly on non-spatial sustained attention measures (Robertson *et al.*, 1997; Samuelsson *et al.,* 1998). By itself this could reflect two independent consequences of overall stroke severity. However, Robertson *et al.* (1998b) showed that alerting patients with a loud tone temporarily but dramatically reduced or reversed their neglect, even when the tone was to their right. Subsequent studies have shown that stimulating medication (Malhotra *et al.*, 2006) or thoughts (George *et al.*, 2008) can cause similar gains.

If levels of alertness influence spatial biases in patients with USN, might this relationship also occur in other groups? A number of studies have now shown that some children with a diagnosis of attention deficit hyperactivity disorder (ADHD), who struggle to sustain their attention, can show a marked pattern of omissions reliably from one side of space. So far, this has always been the left (Voeller and Heilman, 1988; Manly *et al.*, 1997; Shepard *et al.*, 1999; Dobler *et al.*, 2003; George *et al.*, 2005). Healthy volunteers show significant rightward shifts in spatial attention after sleep deprivation (Manly *et al.*, 2005), when awake but sleepy in the early hours of the morning (Fimm *et al.*, 2006) and after long periods of repetitive task performance (Dobler *et al.*, 2005; Manly *et al.*, 2005; Dodds *et al.*, 2008). Whilst these biases are not generally as marked as in USN, they provide potential insights into why left neglect in particular may be so persistent.

REHABILITATION FOR UNILATERAL SPATIAL NEGLECT

USN is an area in which the results of studies primarily aimed at improving the outcome of patients have had direct relevance for our understanding of the disorder. This is perhaps because the most obvious form of rehabilitation, encouraging and training patients to look towards and be aware of the left, often produces rather disappointing results at practicable durations (Lawson, 1962; Weinberg *et al.*, 1977). An interesting example of a more positive effect came from Robertson *et al.*'s work (Robertson *et al.*, 1998a; Robertson and Hawkins, 1999; Robertson *et al.*, 2002). This showed that movements of the patients' left arm/hand could generally enhance visual awareness of the left, even if those movements occurred out of sight.

As we saw in the discussion of synaesthesia, parts of the brain integrate information from across the senses to form a coherent model of the world. Because this system is intolerant of discrepancy (you cannot be facing one way and another!) you can use input to one modality to bias perception in another. In caloric vestibular stimulation, for example, pouring cold water into one ear (and sometimes hot water into the other) disturbs the vestibular balance system and can produce involuntary eye movements to the left (and, of course, wet ears). Similarly, tricking the *proprioceptive* (body sense) system into believing that the trunk of one's body is rotated by mechanical vibration of the muscles can produce reflexive re-orienting to the left (Karnath *et al.*, 1993). These are not just interesting experimental effects. Fifteen sessions of 80 Hz neck muscle stimulation was linked with lasting improvements across a range of spatial tasks in USN patients (compared with a similar period of just practising tasks) (Schindler *et al.*, 2002). Training in adapting to rightward deviating prism lenses (that causes a rebound effect to the left) has also produced positive results (Rossetti *et al.*, 1998; Frassinetti *et al.*, 2002). Do these effects help us explain USN?

EXPLAINING UNILATERAL SPATIAL NEGLECT

As we have seen, USN occurs at a remarkably high frequency following stroke. It has also been reported following damage to a wide variety of brain areas including the parietal, temporal and frontal lobes and a good number of subcortical areas (Mort *et al.*, 2003). This has led to the idea that normal spatial attention may reflect a dynamic – and easily disrupted – competitive balance between the widely distributed networks in the hemispheres (Mesulam, 1999). In this view, the left hemisphere is pushing attention into right space and the right hemisphere pushing back to the left. In USN we are not seeing simply the effect of the lesioned hemisphere (which may have much residual function) but its exaggeration due to the supressing effects of its undamaged rival (Sprague, 1966; Kinsbourne, 1977).

We discussed how the idea of information 'competing' to gain access to limited capacity processing was useful in thinking about attention. This competition may occur at all sorts of cognitive/perceptual levels and in different modalities. However, it has been argued that, for coherent goal-directed action, this competition is integrated so that, for example, rather than being aware primarily of one event in the visual modality, another in audition, and thinking about a memory of the third – in general the levels will try to converge at any one time on a single target. An important factor influencing whether a given stimulus will win the competition for conscious awareness is therefore the state of activity relevant to that stimulus across all levels of the system (Desimone and Duncan, 1995; Driver and Spence, 1998; Duncan, 2006). Within this framework it is easier to see how unilateral brain damage could have cascading effects reducing the likely awareness of different sorts of information in contralesional space (be this based in egocentric, allocentric, object-based or imagery-based space). It also makes more sense of why a rather diverse set of rehabilitation

interventions and experimental manipulations (in as much as these potentiate the representation of the left) appear to work.

4.5 VISUAL AGNOSIA

Agnosia is an ancient Greek word which means 'non-knowledge'. So visual agnosia roughly translates to 'not knowing through vision' and it refers to an impairment in the ability to visually recognise objects. Patients with visual agnosia aren't blind. In fact, sensory processes are usually intact. Patients can move around without bumping into things and they can reach for and pick up objects which they are unable to recognise. Generally, patients with visual agnosia can also recognise objects through touch, so they haven't lost their knowledge about objects; they just can't recognise them visually.

Key Term

Agnosia
The failure to recognise or interpret stimuli despite adequate sensory function. It is usually classified by sensory modality, so visual agnosia is the failure to recognise objects that are seen.

APPERCEPTIVE AND ASSOCIATIVE AGNOSIA

This observation that people can be impaired in their ability to recognise objects without other sensory or global cognitive impairment was first discussed by Lissauer in 1890. In fact, Lissauer was one of the first people to study visual agnosia systematically and identified two broad patterns of impairment, which were termed *apperceptive* and *associative* agnosia. Someone suffering from apperceptive agnosia was thought to have normal visual acuity with an inability to draw an object (Figure 4.4), to say whether two similar objects were the same or different, or even to describe the component parts of an object. Someone suffering from associative agnosia *would* be able to draw an object, to match similar objects *and* be able to describe the component parts *but* they would be unable to recognise the objects they had just seen or drawn.

Lissauer proposed that these two stages were serial and hierarchical. So in the apperceptive stage the elements or components of the object

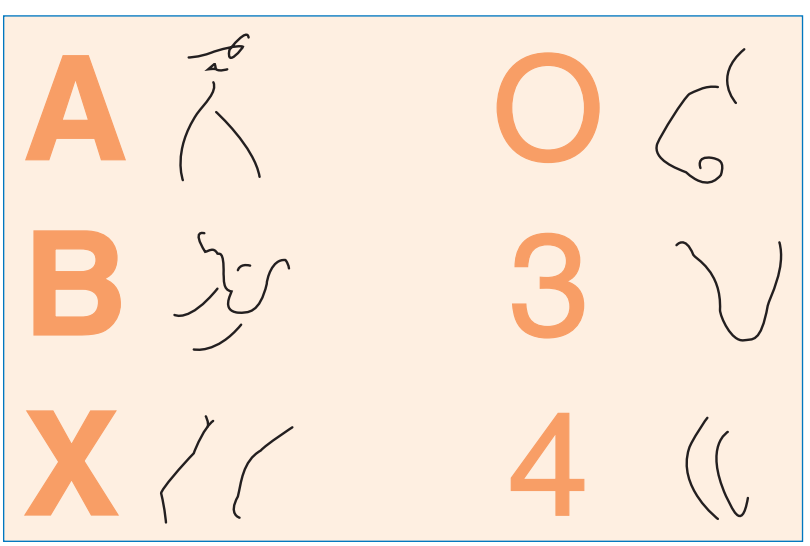


Figure 4.4 The attempts of a patient with apperceptive agnosia to copy six simple figures.

Source: Farah (1990), reproduced by permission of MIT Press.

are established, and then in the associative stage these elements are integrated into a representation of the whole object which is then linked to a store of object knowledge which enables recognition and identification. This means that patients with pure apperceptive agnosia have an intact store of knowledge about objects, but as they are unable to distinguish the shape of objects, they are unable to identify objects visually. In contrast, patients with pure associative agnosia are able to perceive objects but are often unable to identify them. In practical terms, the decision to categorise a patient as apperceptive or associative was often based on their ability to copy a drawing. If a patient could not copy a drawing, they would be classified as having apperceptive agnosia. If they could copy them but failed to recognise the objects in the drawings, they would be diagnosed as having associative agnosia.

Lissauer's broad classification of the impairments that are observed in visual agnosia are still useful today. However, research over the last 20 years has highlighted the difficulty in identifying and diagnosing 'pure' cases of visual agnosia. Furthermore, different sub-types of impairment have been identified which means that both Lissauer's original classification of visual agnosia and the processes that are involved in recognising objects have become fractionated (see Humphreys and Riddoch, 2006, for a review).

Key Term

Form agnosia
This is now the generally accepted term for patients who are unable to discriminate between objects and are unable to copy line drawings of objects (this was previously termed apperceptive agnosia).

Integrative agnosia
This is the generally accepted term for associative agnosia. It refers to patients who can perceive the individual shapes and elements of objects but are unable to integrate these into a representation of the whole object.

FORM AND INTEGRATIVE AGNOSIA

Form agnosia is now the generally accepted term for patients who are unable to discriminate between objects and are unable to copy line drawings of objects (apperceptive agnosia) (Farah, 2004). Similarly, **integrative agnosia** is the generally accepted term for associative agnosia as it more accurately reflects the processing difficulties that patients experience. So, it refers to patients who can perceive the individual shapes and elements of objects but are unable to integrate these into a representation of the whole object. Carbon monoxide poisoning seems to be a particularly common cause of form agnosia (for example patient 'Dee' described by Goodale and Milner, 2004), although other rarer incidents such as assault and cardiac events have been reported. In contrast, integrative agnosia has been reported with incidents of stroke, brain trauma and Alzheimer's disease where there are often bilateral lesions. In addition, patients with integrative agnosia appear to have more medial ventral lesions than patients with form agnosia (Riddoch *et al.*, 2008a).

LIVING WITH VISUAL AGNOSIA

It is very difficult to imagine just what it is like to suffer from a visual agnosia, and the experience must vary greatly with the type of agnosia. In order to gain a small insight into the difficulties that these two types of visual agnosia have on everyday functioning, it is helpful to draw on case studies. One such case study is patient HJA, who has integrative agnosia and has been studied extensively by Humphreys and Riddoch. In a captivating account of their work with HJA, Humphreys and Riddoch (1987) provide a valuable insight into the life of an individual with visual agnosia (Box 4.2).

Box 4.2 HJA: Living with visual integrative agnosia

After an operation, HJA suffered a stroke which caused damage to both of his occipital lobes and affected his posterior cerebral artery. When HJA first woke up in hospital he was unable to recognise his surroundings and he assumed that it must have been caused by a 'bang on the head' or a 'hangover'. While some improvement was observed over the following weeks, HJA was still unable to recognise many familiar objects. After a formal assessment, it was found that HJA was blind in the top half of both visual fields. However, this couldn't explain his inability to identify objects because the lower half of each visual field was undamaged, so a simple movement of the object or head would reveal aspects that were previously hidden by his visual field deficit. HJA could negotiate his environment well. He could walk around without bumping into objects and he could also reach for objects and pick them up. However, he had considerable difficulty in naming objects on the basis of their appearance alone. While he could recognise some objects, many were a mystery to him and he had particular difficulty in making within-category judgements (e.g. distinguishing between two types of animal or plant). This problem is illustrated by the fact that HJA could trim the garden hedge with shears, but he couldn't differentiate between the hedge and the roses, so he would decapitate them.

HJA's difficulties were not caused by memory difficulties. When he was given names of objects, he could eloquently describe their appearance and functions. However, when HJA was shown the same objects that he had just described he was unable to identify them (Figure 4.5). This pattern of spared and impaired processing suggests that while HJA could form a representation of the major elements of an object and extract shape and textural information from drawings, he was unable to integrate this information into a representation of the whole object. This means that as HJA doesn't know what the whole object is when he sees it, he is unable to 'match' it to his memory store of common objects and identify it. Importantly, when HJA was blindfolded and asked to identify objects by touch, he was able to name many objects which he could not identify by sight. This demonstrated that his impairment was not a form of anomia (loss of memory for the names of objects).

HJA offered the following definition of a carrot:

'A carrot is a root vegetable cultivated and eaten as human consumption world wide. Grown from seed as an annual crop, the carrot produces long thin leaves growing from a root head; this is deep growing and large in comparison with the leaf growth, some times gaining a length of 12 inches under a leaf top of similar height when grown in good soil. Carrots may be eaten raw or cooked and can be harvested during any size or state of growth. The general shape of a carrot root is an elongated cone and its colour ranges between red and yellow.' (p. 64)

However, HJA was unable to identify a line drawing of a carrot, saying:

'I have not even the glimmerings of an idea. The bottom point seems solid, and the other bits are feathery. It does not seem to be logical unless it is some sort of a brush.' (p. 59)

Figure 4.5 HJA's definition of the word 'carrot' and his attempt to recognise a line drawing of a carrot (as recorded by Humphreys and Riddoch, 1987).

HJA spoke eloquently and insightfully about his processing difficulties. For example, while he could describe a favourite etching of London which had hung on his living room wall for many years, and he was still able to pick out some distinctive aspects (such as the dome of St Paul's cathedral), he commented:

> But now it does not 'fit' my memory of the picture nor of the reality. Knowing that I should be able to identify the general design of the

> dome-headed, high circular central tower covering a particularly cruciform building, I can point out the expected detail but cannot recognise the whole structure. On the other hand, I am sure I could draw a reasonable copy of the picture.
>
> (Humphreys and Riddoch, 1987: 33)

Figure 4.6 HJA's copy of his favourite etching showing St Paul's Cathedral, London, which took six hours to complete by a laborious process of line-by-line reproduction.

Source: Humphreys and Riddoch (1987), reproduced by permission of Psychology Press, Hove, UK.

HJA also described a visit to an aircraft museum. During the war he had served in the RAF and at the museum he was able to describe the shape of his bomber to his friends, and was able to recount various stories and describe technical aspects of the aircraft. It is clear that he had a detailed memory for the aircraft and its appearance; however, HJA stated that 'in all honesty, I did not recognise the "whole"'.

When asked to copy a picture, such as the etching of London described above, HJA could produce a reasonable likeness (Figure 4.6), but this image took six hours to complete by a laborious process of line-by-line reproduction which did not seem to be guided by any knowledge of the form of the object. It was as if he was being set the task of copying a complex pattern of random lines. However, when drawing from memory rather than attempting to copy, HJA produced very recognisable and detailed drawings (Figure 4.7) indicating that he retained a good visual memory for the objects which he could no longer recognise. He stated:

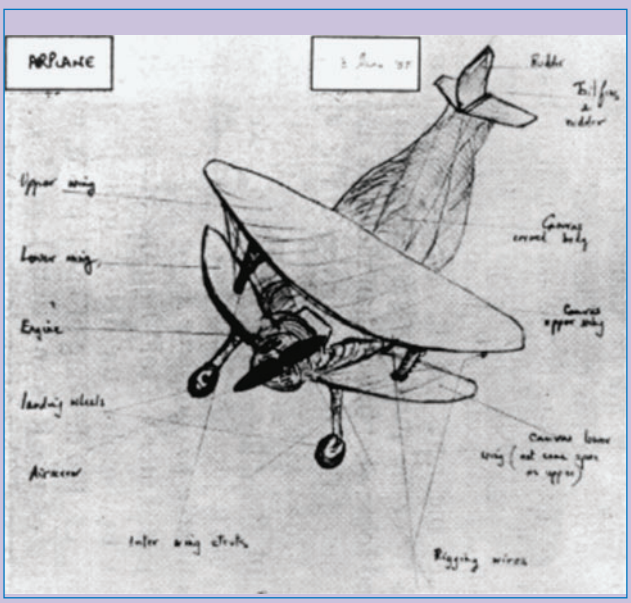


Figure 4.7 An example of one of HJA's drawings from memory.

Source: Humphreys and Riddoch (1987), reproduced by permission of Psychology Press, Hove, UK.

> I don't find [drawing from memory] too difficult, bearing in mind that I never had much drawing ability .... My mind knows very clearly what I should like to draw and I can comprehend enough of my own handiwork to know if it is a reasonable representation of what I had in mind.

Patients with visual form agnosia experience a very confused and distorted visual world in which almost nothing seems familiar and even basic forms are indistinguishable from each other. Perhaps the best analogy would be to imagine looking at the world through a very powerful microscope. To look at an object you would have to scan the microscope around the object, trying to remember what each view of the object has revealed. To form a representation of the whole object you would need to assemble a mental picture of the overall structure of the object by piecing together the independent microscopic views. In this way, despite being able to see the component details of the object accurately you would find it very difficult to recognise the whole, and the more complex the local detail the harder the recognition task would become. These difficulties are evident with patient Dee (see Goodale and Milner, 2004, for a powerful description of the problems faced by Dee). She has severe visual form agnosia as a result of carbon monoxide poisoning which resulted in bilateral damage to her occipitotemporal visual system. Despite being unable to recognise objects or their shape, she can perceive the surface characteristics (texture and colour) and uses them as cues to help her to recognise the object. She can also identify familiar objects through touch. However, Dee cannot copy line drawings of objects or simple shapes. Interestingly, when Dee is asked to show how wide an object is (using her fingers) she is unable to. However, when she is asked to pick up an object that she cannot identify, Dee makes the correct hand movements. Furthermore when walking, Dee is able to negotiate her environment and can step over objects, even though she can't say what the objects are (Goodale, 2008). Dee can also move around her own home freely and she can undertake tasks such as making a cup of tea without help.

PERCEPTION AND ACTION

From Dee's pattern of spared and impaired processing we can see that she has retained her 'action' abilities (e.g. reaching, grasping and stepping over objects) but her recognition ability is impaired. Goodale and Milner (1992, 2004) suggested that these two unconscious processes might be facilitated by different brain areas. As the parietal cortex provides information about the orientation and structure of objects in order to help guide movement and the temporal lobe provides visual information, they suggested that these different types of information might give rise to different representations. This led Goodale and Milner (1992) to develop their two-streams account of visual processing as explained in Chapter 2 (see also Milner and Goodale, 1995, 2006). They suggested that visual information follows two main streams or routes; the ventral stream (sometimes informally called the 'what' pathway) travels to the temporal lobe and is thought not only to be responsible for identifying objects and events but also to help attach meaning and significance to them (along with other cognitive structures). The dorsal stream (sometimes informally called the 'where' pathway) travels to the parietal lobe and it does not involve visual information. Instead, it processes spatial information and works with the sensorimotor system to help

generate skilled movements (Goodale, 2008). This provides a clear account of Dee's pattern of spared and impaired processing; her dorsal stream is intact (Dee can negotiate her environment well) but she cannot recognise objects visually, so her ventral stream is evidently damaged. While the two-streams account is a highly influential and widely accepted account, some researchers have questioned the nature of the dissociation between the two streams (e.g. Franz *et al.*, 2000). These issues and more are considered fully in an excellent review by Milner and Goodale (2008).

COMPARING FORM AND INTEGRATIVE AGNOSIA

While there are many benefits to examining the pattern of spared and impaired processing using patient case studies, it is often very difficult to make direct comparisons and draw conclusions from case studies for a number of reasons. One particular difficulty is that researchers often use different tests, stimuli and methods to assess the level of spared and impaired processing and these methodological differences can make direct comparisons very difficult. To help remedy this, Riddoch *et al.* (2008a) directly compared HJA (who has integrative agnosia) with another patient SA (who has form agnosia) using an extensive array of tests. Both patients had bilateral occipital lesions, though they involved the dorsal route (action) with SA and the ventral route (recognition) with HJA. The results provide evidence for qualitatively different types of processing in the two types of agnosia. In particular, it was found that patient SA tended to process more at a local level, while HJA processed at a more global level. This led Riddoch *et al.* (2008a) to propose that successful object recognition depends on the ability to code the global aspects of an object's shape with the fine, local detail at the same time. So, as HJA processed more globally, he could match shapes well, whereas SA was impaired at this task. Similarly, while HJA could copy drawings, SA's drawings often contained errors. Therefore, HJA's pattern of impairment clearly fits integrative agnosia. He can code the shapes of objects, but he is impaired in the ability to segment parts of objects and group them into a whole, whereas SA's pattern of impairment fits clearly with form agnosia.

RECOGNISING LIVING AND NON-LIVING OBJECTS

SA was much better at identifying animate objects rather than inanimate ones, whereas HJA showed the opposite pattern, as he was better at identifying inanimate rather than animate objects. This finding that identification varies depending on the category of object has also been reported by other researchers. For example, JBR could name drawings of many non-living objects (such as a spade or hairbrush), but he couldn't name drawings of living things (such as dog or fly), or musical instruments (such as a trumpet), according to Warrington and Shallice (1984). Researchers have also reported that other patients have difficulty in identifying living things (e.g. Farah *et al.*, 1989, patient LH; Farah *et al.*, 1991, patient MB; Stewart *et al.*, 1992, patient HO).

One of the difficulties in interpreting results such as these is that the distinction between living and non-living things is not perfect. For example, JBR also had difficulty naming musical instruments (as did HO). One possibility is that the living and non-living things used to demonstrate this effect may also differ in other characteristics. Stewart *et al.* (1992) pointed out that although the living and non-living pictures used to demonstrate this effect were matched for the familiarity of the object names, they were not matched for the familiarity of the pictures themselves. Furthermore they observed that there is a tendency for line drawings of living things to be more complex than drawings of non-living things. When Stewart *et al.* (1992) retested their patient HO with a new set of materials which were matched for familiarity of both name and picture as well as image complexity, they found that he no longer demonstrated a category-specific agnosia, and when Funnell and Sheridan (1992) retested Warrington and Shallice's patient JBR using materials which controlled for item familiarity, there was no evidence of the category-specific naming deficit that Warrington and Shallice had originally observed.

One additional difficulty of using line drawings is that they don't contain important surface characteristics (e.g. colour, texture and 3-D shape information) which are useful cues to aid identification. As Hiraoka *et al.* (2009) state, it is common in studies of visual agnosia to find an identification superiority for real objects over line drawings as they only contain basic 2-D shape information. Interestingly, Peru and Avesani (2008) reported that patient FB couldn't name most of the black-and-white line drawings that she was shown. However, she could identify more objects when the drawings were in colour. FB also couldn't identify coloured pictures of living things but she recognised 70 per cent of non-living things.

Farah and McClelland (1991) argue that this difference between identifying living versus non-living things may in fact be an artefact. They state that in most cases where there is impaired knowledge of perceptual attributes compared with intact knowledge of functional properties, there is also an impairment for inanimate objects. They suggest that this is because perceptual attributes (colour, size, shape etc.) are crucial for identifying animate objects, whereas the identification of inanimate objects relies mainly on functional attributes (e.g. a kettle is used to boil water). However, there is evidence that knowledge of perceptual attributes can be distinguished from functional attributes in semantic memory (Riddoch and Humphreys, 1987). Furthermore, while FB has impaired knowledge of object form, her knowledge of object colour remains relatively intact. Indeed, the findings from FB led Peru and Avesani (2008) to tentatively suggest that different properties may be stored discretely in semantic memory. What is clear is that while there are clearly methodological issues with the stimuli that have been used to assess the levels of impairment in visual agnosia, the finding that HJA and SA showed a converse pattern in their ability to identify animate and inanimate objects (Riddoch *et al.,* 2008a) using the *same* stimuli, suggests that this effect cannot be attributed to an artefact of the stimulus materials. Research in this area continues.

4.6 DISORDERS OF FACE PROCESSING

Prosopagnosia is a form of agnosia that relates to faces. As you read in the previous section, agnosia is an ancient Greek word which means 'non-knowledge'. The 'prosop' part of the term comes from another ancient Greek word 'prosopon' which means 'face'. The term prosopagnosia was first used by Bodamer (1947); he examined three patients who, he believed, showed a face-specific deficit, as they were apparently able to recognise non-face objects normally. So prosopagnosia roughly translates to 'not knowing' faces, or rather the inability to recognise faces. People with severe prosopagnosia cannot recognise family members, friends and even themselves in the mirror, and this cannot be explained by visual or sensory impairment. However, individuals with prosopagnosia are often able to use other cues such as voice to recognise familiar people. This means that identity and semantic information hasn't been lost. They still know who the people are, it's just that they can no longer recognise their faces. Bruce and Young (1986) used evidence gained from studying individuals with face processing deficits and from studies of normal individuals to propose a model of face processing (Figure 4.8). This model suggests that the recognition of identity, expression and facial speech analysis (e.g. lip reading) are independent processes, and subsequent evidence from brain-damaged patients largely supports this view.

Given that face recognition is one of the most demanding and sophisticated tasks that our visual system undertakes, it is unsurprising that an impairment in this ability can be acquired through brain damage. Faces are remarkably similar in appearance. They have the same first-order global configuration (eyes above nose above mouth etc.) and facial features are remarkably similar. Despite this, we are able to recognise thousands of faces with apparent ease. It is important to note that brain damage rarely leads to the complete destruction of this ability. Instead, research has demonstrated that there is considerable variation in the severity of the impairment, the associated deficits and types of face processing skills as well as in the location of and type of lesions that result in acquired prosopagnosia (Barton, 2008). Furthermore, prosopagnosia may present alongside other associated deficits and disorders such as autism or Alzheimer's disease, and recent research has demonstrated that it may be present in childhood. This part of the chapter focuses primarily on the evidence for prosopagnosia that has been acquired in adulthood but **developmental** and **congenital** prosopagnosia will be considered at the end of the chapter.

Key Term

Prosopagnosia
An inability to recognise faces despite adequate visual acuity.

Developmental prosopagnosia
This is thought to be a result of early neurological trauma that might be caused by accident or injury.

Congenital prosopagnosia
This is thought to be present from birth and is thought to occur without any apparent brain injury.

LIVING WITH PROSOPAGNOSIA

While the variation of spared and impaired processing in prosopagnosia may help to tell us a great deal about face processing and its underlying mechanisms, it tells us very little about what it is like to live with prosopagnosia. Our ability to communicate socially and professionally depends to a large extent on our ability to be able to converse

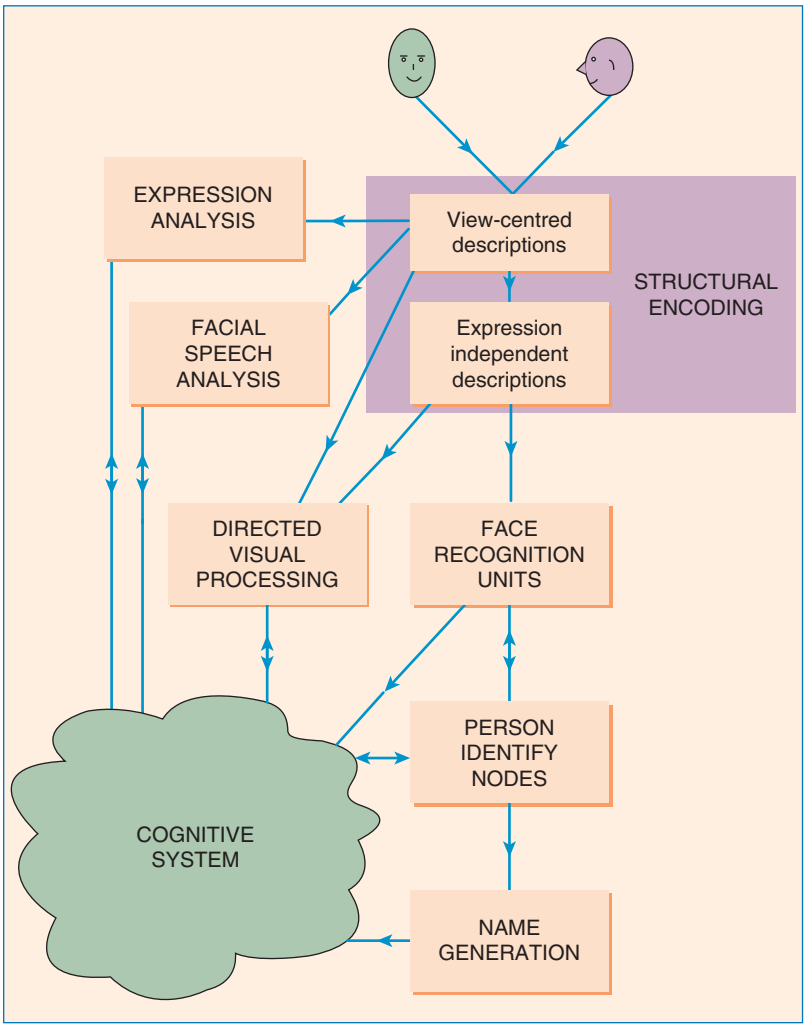


Figure 4.8 Bruce and Young's model of face processing showing independent pathways for face recognition, expression analysis and speech analysis.

Source: Bruce and Young (1986), reproduced by permission of the British Psychological Society.

and interact with our family, friends and colleagues. So what is it like to live with prosopagnosia? The material in Box 4.3 has been kindly provided by Jeff Hunt. I met Jeff while he was a cognitive psychology student with the Open University. Despite having prosopagnosia, Jeff was able to hold down jobs as both a lecturer and an IT manager for a large college. Here he provides just a few examples of how prosopagnosia impacts on his daily life.

WHAT KIND OF DAMAGE CAUSES ACQUIRED PROSOPAGNOSIA?

There is considerable variation in the type and location of lesion that results in prosopagnosia. Early autopsy studies (e.g. Damasio *et al.*, 1982) reported that prosopagnosia was caused by bilateral lesions in the occipito-temporal cortex. More recent reports have supported this

Box 4.3 Jeff: Living with prosopagnosia

Example 1

One day I was at home and the front door opened unexpectedly and a strange lady walked straight into my hall. I stared at her wondering what to do and what to say, especially as I was just dressed in a pair of boxer shorts. She said 'Oh you don't like it; I can tell by the way you are staring!' It was only when she spoke that I realised that it was my wife. She had been to the hairdressers and had her hair cut and dyed. I simply had not recognised her. The only reason I was staring was because I was trying to work out why this woman was in my hallway!

Example 2

The only lecturing incident that I clearly got wrong was when my lecture was moved from one lecture room to another. I was not told but the students were. So I went into my lecture and started talking about artificial intelligence and John Searle and his Chinese Room problem. After about 20 minutes another lecturer came in and asked me if I had his students – he was a geography lecturer. The students had decided not to say anything as they found my lecture interesting, which I guess is a compliment but I felt rather cross with myself that I had thought that I had recognised some of them.

Example 3

My youngest daughter was shopping with me and we have a lifelong habit of playing jokes on each other. She wanted to go and look at the chocolates so I let her wander while I found a few bits I needed. I went to find her and saw her looking at the sweets. She looked at me watching up the aisle and then pretended to ignore me and look away. So I crept around the other end of the aisle and ran up behind her and tickled her in the ribs. At that moment she turned round and to my horror it was not my daughter! To nicely compound my humiliation, her mum came up and tried to find out what was going on. Thankfully, as I was trying to explain, my daughter came along and I politely pointed out that her hair was similar to the child I'd tickled in the ribs. The mum very reluctantly accepted it.

Prosopagnosia also affects Jeff's life in other not so obvious ways. One is that it is very difficult for him to watch television and films. This is because actors often change clothing and hair styles during a film. The consequence of this is that Jeff can get the actors confused with each other, or it seems that a new character has been introduced when it is just an existing character with a new hairstyle. Jeff writes that 'the film *Fifth Element* is great for me as all of the characters look completely different'. With television though, 'I do struggle to believe that the character Brian Potter in *Phoenix Nights* is Peter Kay, the comedian.'

by showing that patients with prosopagnosia have bilateral lesions (e.g. Boutsen and Humphreys, 2002; Sorger *et al.*, 2007), suggesting that both hemispheres play an important role in face processing. However, in rarer cases it can also be caused by unilateral damage in

the right hemisphere (De Renzi *et al.,* 1994; Barton, 2008) and even rarer still, by left-hemisphere lesions (Mattson *et al.,* 2000).

Data from imaging studies has also demonstrated that most cases of prosopagnosia have damage in the fusiform and lingual gyri, although there are also cases of damage in more anterior temporal areas (e.g. Gainotti *et al.,* 2003). The fusiform area has been shown to be a key structure in face and object processing, and numerous studies have shown that the fusiform gyrus contains an area dedicated to face processing called the **fusiform face area (FFA)** (e.g. Haxby *et al.,* 1994; Kanwisher *et al.,* 1997; McCarthy *et al.,* 1997). There is variability, however, in the location of the FFA across individuals, and this may help to explain why prosopagnosia sometimes seems to occur with damage in only one hemisphere (Bruce and Young, 2012). Given this individual variability, many imaging studies have adopted what has been termed a 'functional localiser' approach. Kanwisher *et al.* (1997) developed this technique by identifying functional areas of interest for each individual. Multiple tests are then performed and the activity within this pre-defined area is examined. Doing this allows for the fact that people's brains and brain structures are of different sizes, so it allows precise comparison across the same brain area in different people, without mistakenly measuring activity in a different brain area. Using this technique, it is possible to identify activity in structures such as the FFA.

Key Term

Fusiform face area (FFA)
An area in the fusiform gyrus dedicated to face processing.

While the FFA plays a key role in face processing, there is still variability in the type of brain damage that can result in prosopagnosia. This variation is consistent with current thinking regarding face processing – there is no single area in the brain that is responsible for processing faces. Instead, this highly developed and demanding process is underpinned by a distributed neural network that is made up of many bilateral regions (Haxby *et al.*, 2000). So how does this variability impact on the type of face-processing impairments that are observed in prosopagnosia? Barton (2008) examined this by reviewing the data from ten patients. It was reported that the most severe impairments were found in patients who had bilateral occipito-temporal lesions, involving the fusiform gyri. In particular, bilateral lesions in this area resulted in severe impairments in the ability to form an image of a face, to perceive and integrate configural information and also resulted in the lowest levels of familiarity to famous faces. This led Barton to conclude that the right fusiform gyrus was involved in configurational processing and that memory for faces was more severely disrupted when these bilateral lesions also included right anterior temporal lobe damage.

PROSOPAGNOSIA – A FACE-SPECIFIC DISORDER?

Riddoch *et al.* (2008b) studied FB and found that she was unable to identify faces of famous people that she was previously familiar with. She was also poor at saying whether two faces were the same or different when they were in different views. FB could, however, make age, sex

and expression judgements. She could learn object names faster than controls, and she scored within the normal range on an object-naming task. FB was also faster to respond to parts of faces than whole faces. This dissociation between FB's ability to process objects and faces indicates that her deficit is in the ability to perceive facial information. As the results provide support for face-specific processes, it indicates that FB demonstrates a relatively 'pure' form of prosopagnosia.

Does this mean that prosopagnosia is specific to faces? While there is clearly evidence for face-specificity (e.g. De Renzi and Pellegrino, 1998; Wada and Yakamoto, 2001; Riddoch *et al.,* 2008b) some people with prosopagnosia also have difficulty in processing objects (e.g. Farah *et al.,* 1995). One of the major difficulties in trying to draw conclusions regarding face specificity is that there are methodological issues surrounding the assessment of face and object processing. The main difficulty is that face recognition requires what is called a within-category judgement. That is, in order to successfully recognise a face, we have to recognise it from our 'pool' of all of the other faces that we know. So we need to be able to discriminate between a whole host of similar-looking faces – a remarkable feat which we generally perform with ease. In contrast, we rarely have to recognise an individual object amongst a whole host of other similar objects. Imagine that you had to select a Braeburn apple from a crate that also contained Cortland, McIntosh and Gala apples (they're all red ones!). This would seem to be an almost impossible task, unless you were an apple expert. Now, imagine that you are given a specific Braeburn apple to inspect, which is then put into the crate with all of the other apples. The task now requires you to identify and select the *same* apple that you originally inspected. This seems like an impossible task and yet we achieve it every day when we recognise an individual face. This difference in process between making a within-category judgement (as has just been described) and making a between-category judgement (recognising an apple in a crate of oranges, melons and plums) is what makes face recognition special. It is all about **individuation**, and we need to be able to recognise many individual faces in order to function successfully in society. The challenge for researchers is that in order to be able to clearly demonstrate whether prosopagnosia is face-specific or not, similar tasks need to be employed to examine object and face processing. So, this means comparing a face recognition task with an object recognition task where the set of stimuli are as similar to one another as the faces are to each other. Some researchers have used sets of similar manufactured items such as eyeglasses or cars (De Renzi *et al.*, 1991; Sergent and Signoret, 1992; Farah *et al.*, 1995; Tippett *et al.*, 2000) and on the whole these studies find that prosopagnosic patients are significantly more impaired with faces than these other non-face items. However, unlike faces, cars or eyeglasses are not natural biological objects, and for this reason some researchers have also attempted to study performance on tasks which require patients to identify individual members of non-human species, including cows and sheep. Bruyer *et al.* (1983) reported that Mr W, a prosopagnosic farmer, was still able

Key Term

Individuation
Recognising one specific item from other members of that class of item (e.g. recognising the face of a particular individual).

to recognise his cows. This is in contrast to the report by Bornstein *et al.* (1969) who described a prosopagnosic farmer who could not recognise either humans or his cows, and Assal *et al.* (1984) who describe a farmer who was initially unable to recognise either humans or cows but after six months recovered the ability to recognise human faces but not to individuate cows. Thus, almost unbelievably, we have evidence of a double dissociation between the ability to individuate humans and animals following brain injury. McNeil and Warrington (1993) describe the case of WJ, who took up farming after becoming prosopagnosic and remarkably showed evidence of being able to recognise his sheep, despite remaining profoundly prosopagnosic for human faces. This is an important case because it demonstrates that it is possible to learn to distinguish between very similar biological forms (sheep) despite being prosopagnosic and unable to identify even highly familiar human faces. This is in contrast to the patient described by Tippett *et al.* (2000) who could recognise faces and non-faces he had learned prior to his injury, and could learn new non-face objects but could not learn to identify new faces.

While there are clear dissociations in the literature, Duchaine and Garrido (2008) argue that dissociations are not enough to provide support for face specificity. They state that 'A network of areas is involved in face processing, but the role of these areas and their interactions remain poorly understood' (p. 767). Therefore, it is still unclear what conclusions should be drawn concerning the degree of face specificity in prosopagnosia. In part the problem lies with the fact that as faces are, in one sense at least, special – it is difficult to find suitable non-face control stimuli which can be individuated as well as faces by normal subjects.

Figure 4.9 Would you recognise this cow if you saw her again?

Source: Shutterstock.

COVERT RECOGNITION IN PROSOPAGNOSIA

Some, but not all prosopagnosic patients show evidence of covert recognition (Bruyer, 1991), that is, an indication that at some level their brains are discriminating between faces. Some of these patients demonstrate covert familiarity – for example showing differences in neural electrical responses (evoked potentials) produced by viewing familiar and unfamiliar faces (Renault *et al.*, 1989). In other cases it has been possible to demonstrate some retained knowledge about the person shown in a photograph, such as occupation or name. Interestingly, Bruyer *et al.* (1983) found that it was easier to teach a prosopagnosic patient to associate faces with their real names than with randomly assigned names,

and de Haan *et al.* (1987) showed that this was true even for people that their patient (PH) had met after he had become prosopagnosic, suggesting that he continued to learn the names and faces of people he met despite having no conscious awareness of recognition.

Simon *et al.* (2011) examined covert processing of faces with patient PS. EEG and fMRI data were collected while PS performed a gender discrimination task for both familiar and unfamiliar faces. The results from both the EEG and fMRI data revealed that PS had different patterns of activity for faces that were previously known to PS compared with unfamiliar and famous faces, even though PS could not identify any of the faces and had no conscious feeling of familiarity. In particular, there was increased activation in the FFA for previously familiar faces, compared with unfamiliar faces. This difference wasn't found for famous faces and provides evidence that the FFA is involved in covert processing as well as in individuating faces.

There are different explanations for why covert recognition may occur. Bauer (1984) linked face processing to the two streams of processing proposed by Goodale and Milner (1992), suggesting that conscious, overt face recognition is facilitated by the ventral pathway, whereas covert recognition is mediated by the dorsal pathway. As the ventral route is damaged in acquired prosopagnosia, whereas the dorsal route is intact, this may explain why people with acquired prosopagnosia often show covert recognition but are unable to overtly recognise a face. Others, however, have suggested that the difference between overt and covert recognition in acquired prosopagnosia arises from a disconnection. De Haan *et al.* (1992) suggested that this disconnection occurs between an intact face-processing system and a higher system that facilitates conscious awareness. Burton and colleagues (Burton *et al.,* 1991), however, explain the disconnection in terms of connection weights. They developed the IAC (independent activation and competition) model of face recognition, which was based on the earlier Bruce and Young (1986) model and found that this model could simulate some of the covert recognition behaviours that have been observed in the literature. In this connectionist model, different units (e.g. face recognition units (FRUs); person identity nodes (PINS)) are linked together with bidirectional weighted connection links, and it was found that covert recognition could be simulated by halving the weight (or strength) of these links (Burton *et al.,* 1991; Young and Burton, 1999). This means that activation can still occur within the face recognition system, but this activation doesn't reach the level that is required for overt recognition. Bruce and Young (2012: 343) state that one implication of this is that 'covert recognition will not be an "all or none" phenomenon – effects will be graded according to the functional locus and severity of damage'.

CAN PROSOPAGNOSIA OCCUR WITHOUT BRAIN DAMAGE?

While the early literature on prosopagnosia described cases where it had been 'acquired' as a result of brain trauma in adulthood, more recently, it has been reported that prosopagnosia can occur much

earlier and in some cases without acquired brain trauma. These cases have been called 'congenital' or 'developmental' prosopagnosia, and while these terms are often used interchangeably in the literature, they are quite different. Congenital prosopagnosia is thought to be present from birth and was traditionally thought to occur without any apparent brain injury. In contrast, developmental prosopagnosia is thought to be a result of early neurological trauma that might be caused by accident or injury (Avidan and Behrman, 2008). Recent MRI studies have, however, questioned the lack of brain abnormality in congenital prosopagnosia. While some have reported no brain abnormalities (e.g. Patient GA in Barton *et al.,* 2003) others have reported a range of abnormalities. For example, Behrmann *et al.* (2007) reported that the fusiform gyrus was smaller and that there was a relationship between size and impairment: the smaller the fusiform gyrus, the more severe the impairment. Therefore, the nature of the impairment in congenital prosopagnosia is at present, far from clear.

One of the reasons why the terms 'developmental' and 'congenital' prosopagnosia are often used interchangeably is that it is often extremely difficult to be sure if there has been early childhood injury or if the condition has been present from birth. For example, Duchaine *et al.* (2006) examined face processing in Edward, who was thought to have developmental prosopagnosia. However, the authors state that Edward's impairment has been lifelong and he is not aware of any childhood trauma, so he may in fact have congenital prosopagnosia. While tests have been developed to aid diagnosis of these two forms of prosopagnosia there are issues with them (see Bowles *et al.,* 2009, for a discussion), so at present diagnosing these two different types of prosopagnosia is extremely difficult.

TYPES OF IMPAIRMENT IN DEVELOPMENTAL AND CONGENITAL PROSOPAGNOSIA

Individuals with developmental prosopagnosia sometimes have impairments in the ability to process facial emotion (e.g. Duchaine, 2000) and the ability to make gender judgements (e.g. de Haan and Campbell, 1991). Furthermore, while many cases of developmental prosopagnosia seem to have impairments that are consistent with autism spectrum disorder (ASD) (Wilson *et al.,* 2010), developmental prosopagnosia does occur without ASD. For example, Wilson *et al.* (2010) examined six children between the ages of four and eight years who were thought to display prosopagnosic symptoms. Using a range of face-processing and cognitive tasks they found that four of the six children did not display any sign of ASD but they did exhibit a range of difficulties in processing faces and objects.

Patients with congenital prosopagnosia show considerable variability in face-processing impairment. However, it does seem that most have an associative or integrative impairment. That is, they can perceive a face as a face but are unable to link it to their stored representation of known faces. For example, Bentin *et al.* (2007) examined the face-processing abilities of KW who was unable to identify faces, had

a bias towards local feature processing and had difficulty processing holistically, not just for faces. This suggested that KW had congenital integrative prosopagnosia.

Many patients with congenital prosopagnosia also show evidence of covert recognition, similar to acquired prosopagnosia (Avidan and Behrmann, 2008; Bate *et al.*, 2008). This finding is extremely interesting because it was traditionally thought that patients with congenital prosopagnosia could *not* show evidence of covert recognition because it is associated with patients who had previously been able to recognise faces and as such would have a store of intact face representations (Barton *et al.*, 2001). This questions many of the functional models of face processing and much more research is needed in order to fully understand the nature of covert processing in congenital prosopagnosia.

Key Term

Modular system
A system in which different types of processing are carried out by separate and relatively independent sub-systems.

SUMMARY

- Damage to different brain regions can result in a variety of perceptual and attention disorders which display a surprising degree of specificity.
- The pattern of disorders observed suggests a highly **modular system** in which a series of independent processes each contribute towards the goal of perception.
- Synaesthesia is a phenomenon which seems to result from a breakdown in this modularity.
- Blindsight provides an example of this dissociation between conscious experience and the ability to respond appropriately to a stimulus.
- Prosopagnosia also provides evidence of this dissociation, as does unilateral neglect, where some patients show evidence of partial insight into the nature of neglected objects.
- There is some evidence that the nature of the representation formed might be dependent on the task to be performed, and in particular there may be an important distinction between the perceptual processes that mediate action and those which result in recognition.
- Two broad patterns of impairment in visual agnosia have been identified and these were originally termed *apperceptive agnosia* (now generally known as *form agnosia)* and *associative* agnosia (now known as *integrative agnosia*).
- In *form agnosia* patients are unable to discriminate between objects and cannot copy line drawings. *Integrative agnosia* is characterised by an ability to perceive the individual shapes and elements of objects with an inability to integrate these elements into a representation of the whole object.
- *Prosopagnosia* involves an impairment of face processing. It can be acquired or it can be developmental or congenital. In all forms of prosopagnosia there is considerable variation in the severity

of impairment, associated deficits and types of face processing skills.

- In acquired prosopagnosia there is variability in the location and type of lesion, although impairment in areas such as the fusiform face area seems to be particularly important.
- Some patients with prosopagnosia show evidence of covert recognition even when the disorder appears to have been present from birth (congenital prosopagnosia). This finding challenges many functional models of face processing, and research in this area continues.

FURTHER READING

- Bruce, V. and Young, A. (2012) *Face Perception.* Hove: Psychology Press. A comprehensive and extremely accessible text covering all aspects of face perception.
- De Gelder, B., de Haan, E. H. F. and Heywood, C.A. (2001). *Out of Mind: Varieties of Unconscious Processes.* Oxford: Oxford University Press. This edited collection of papers examine the nature of blindsight and related conditions.
- Farah, M. J. (2004). *Visual Agnosia* (2nd edn). Cambridge, MA: MIT Press. A very readable account of disorders in object recognition written by one of the leading researchers in the field.
- Goodale, M. and Milner, D. (2004). *Sight Unseen*. Oxford: Oxford University Press. In this book Goodale and Milner provide a fascinating account of their work with patient 'Dee'.
- Harrison, J. (2001). *Synaesthesia: The Strangest Thing.* Oxford: Oxford University Press. This book provides a very accessible account of synaesthesia.
- Hole, G. and Bourne, V. (2010). *Face Processing: Psychological, Neuropsychological and Applied Perspectives.* Oxford: Oxford University Press. An extremely accessible text that contains several easy to read chapters on the neuropsychology of face processing.
- Karnath, H. O., Milner, A. D. and Vallar, G. (2002). *The Cognitive and Neural Bases of Spatial Neglect*. Oxford: Oxford University Press. This edited volume brings together some of the leading researchers in the field.
- Young, A. W. (ed.) (1998) *Face and Mind*. Oxford: Oxford University Press. Provides a fuller description of prosopagnosia, and related conditions including some not covered in this chapter.

CHAPTER 1

WHAT IS MEMORY?

Alan Baddeley

Memory is something we complain about. Why? Why are we quite happy to claim "I have a terrible memory!" but not to assert that "I am amazingly stupid"? Of course, we do forget; we do sometimes forget appointments and fail to recognize people we have met in the past, and rather more frequently we forget their names. We do not, however, often forget important events; if the bridegroom failed to turn up for his wedding he would not be believed if he claimed to have forgotten. Consequently, failing to recognize an old acquaintance suggests that the person was perhaps not of great importance to us. The obvious excuse is to blame one's terrible memory.

In the chapters that follow, we will try to convince you that your memory is in fact remarkably good, although fallible. We agree with Schacter (2001) who, having described what he refers to as the seven sins of memory, accepts that the sins are in fact the necessary consequences of the virtues that make our memories so rich and flexible. Our memories might be less reliable than those of the average computer but they are just as capacious, much more flexible, and a good deal more user friendly. Let us begin by considering the case of Clive Wearing who has the misfortune to have had much of his memory capacity destroyed by disease (Wilson, Baddeley, & Kapur, 1995).

WHY DO WE NEED MEMORY?

Clive is an extremely talented musician, an expert on early music who was master of a major London choir. He himself sang and was asked to perform before the Pope during a papal visit to London. In 1985, he had the misfortune to suffer a brain infection from the herpes simplex virus, a virus that exists in a large proportion of the population, typically leading to nothing worse than cold sores but very occasionally breaking through the blood–brain barrier to cause encephalitis, an inflammation of the brain that can prove fatal. In recent years, treatment has improved, with the result that patients are more likely to survive, although often having suffered from extensive brain damage, typically in areas responsible for memory.

When he eventually recovered consciousness, Clive was densely amnesic and appeared to be unable to store information for periods longer than seconds. His interpretation of his plight was to assume that he had just recovered consciousness, something that he would announce to any visitor, and something that he repeatedly recorded in a notebook, each time crossing out the previous line and writing "I have now recovered consciousness" or "consciousness has now finally been recovered," an activity that continued for many, many years.

Clive knew who he was and could talk about the broad outlines of his early life, although the detail was very sparse. He knew he had spent 4 years at Cambridge University, but could not recognize a photograph of his college. He could remember, although somewhat vaguely, important events in his life such as directing and conducting the first modern performance of Handel's *Messiah* using original instruments in an appropriate period setting, and could talk intelligently about the historical development of the role of the musical conductor. However, even this selected knowledge was sketchy; he had written a book on the early composer Lassus, but could not recall any of the content. Asked who had written *Romeo and Juliet*, Clive did not know. He had remarried, but could not remember this. However, he did greet his new wife with enormous enthusiasm every time she appeared, even though she might only have been out of the room for a few minutes; every time he declared that he had just recovered consciousness.

Clive was totally incapacitated by his amnesia. He could not read a book or follow a television program because he immediately forgot what had gone before. If he left his hospital room, he was immediately lost. He was locked into a permanent present, something he described as "hell on earth." "It's like being dead—all the bloody time!"

However, there was one aspect of Clive's memory that appeared to be unimpaired, that part concerned with music. When his choir visited him, he found that he could conduct them just as before. He was able to read the score of a song and accompany himself on the keyboard while singing it. For a brief moment he appeared to return to his old self, only to feel wretched when he stopped playing. Over 20 years later, Clive is still just as densely amnesic but now appears to have come to terms with his terrible affliction and is calmer and less distressed.

ONE MEMORY OR MANY?

Although Clive's case makes the point that memory is crucial for daily life, it does not tell us much about the nature of memory. Clive was unfortunate in having damage to a range of brain areas, with the result that he has problems that extend beyond his amnesia. Furthermore, the fact that Clive's musical memory and skills are unimpaired suggests that memory is not a single simple system. Other studies have shown that densely amnesic patients can repeat back a telephone number, suggesting preserved immediate memory, and that they can learn motor skills at a normal rate. As we will see later, amnesic patients are capable of a number of types of learning, demonstrating this by improved performance, even though they do not remember the learning experience and typically deny having encountered the situation before. The evidence suggests, therefore, that rather than having a single global memory system, the picture is more complex. The first few chapters of this book will try to unpack some of this complexity, providing a basis for later chapters that are concerned with the way in which these systems influence our lives, how memory changes as we move through childhood to adulthood and old age, and what happens when our memory systems break down.

In giving our account of memory, we are of course presenting a range of psychological theories. Theories develop and change, and different people will hold different theories to explain the same data. As a glance at any current memory journal will indicate, this is certainly the case for the study of memory. Fortunately, there is a great deal of general agreement between different groups studying the psychology of memory, even though they tend to use somewhat different terminology. At this point, it might be useful to say a little bit about the concept of theory that underpins our own approach.

THEORIES, MAPS, AND MODELS

What should a psychological theory look like? In the 1950s, many people thought they should look like theories from physics. Clark Hull studied the learning behavior of white rats and attempted to use his results to build a rather grand general theory of learning in which the

learning behavior of both rats and people was predicted using a series of postulates and equations that were explicitly modeled on the example set by Isaac Newton (Hull, 1943).

By contrast, Hull's great rival, Edward Tolman (1948), thought of rats as forming "cognitive maps," internal representations of their environment that were acquired as a result of active exploration. The controversy rumbled on from the 1930s to the 1950s, and then was abandoned quite suddenly. Both sides found that they had to assume some kind of representation that went beyond the simple association between stimuli impinging on the rat and its learned behavior, but neither seemed to have a solution to the problem of how these could be investigated.

The broad view of theory that we shall take is that theories are essentially like maps. They summarize our knowledge in a simple and structured way that helps us to understand what is known. A good theory will help us to ask new questions and that in turn will help us find out more about the topic we are mapping. The nature of the theory will depend on the questions we want to answer, just as in the case of maps of a city. The map that will help you travel by underground around London or New York looks very different from the sort of map that you would need if you wanted to walk, with neither being a direct representation of what you would see if you stood at a given location. That does not of course mean that they are bad maps, quite the opposite, because each map is designed to serve a different purpose.

In the case of psychological theories, different theories will operate at different levels of explanation and focus on different issues. An argument between a shopkeeper and customer, for example, would be explained in very different ways by a sociologist, who might emphasize the economic and social pressures, a social psychologist interested in interpersonal relationships, a cognitive psychologist interested in language and a physiological psychologist who might be interested in the emotional responses of the two disputants and how these are reflected in the brain. All of these explanations are relevant and in principle should be relatable to each other, but none is the single "correct" interpretation.

This is a view that contrasts with what is sometimes called **reductionism**. This assumes that the aim of science is to reduce each explanation to the level below: Social psychology to cognitive psychology, which in turn should be explained physiologically, with the physiology then being interpreted biochemically and ultimately in terms of physics. Although it is clearly valuable to be able to explain phenomena at different but related levels, this is ultimately no more sensible than for a physicist to demand that we should attempt to design bridges on the basis of subatomic particle physics, rather than Newtonian mechanics.

The aim of the present book is to outline what we know of the *psychology* of memory. We believe that an account at the psychological level will prove valuable in throwing light on accounts of human behavior at the interpersonal and social level, and will play an important role in our capacity to understand the neurobiological factors that underpin the various types of memory. We suggest that the psychology of memory is sufficiently understood to begin to interface very fruitfully with questions at both of these levels, and hope to illustrate this over the subsequent chapters.

HOW CAN WE STUDY MEMORY?

The case of Clive Wearing demonstrates how important memory is, and how complex, but leaves open the question of how it can best be studied. The attempt to understand human memory extends at least as far back as Aristotle, and forms one of the classic questions within the philosophy of mind, although without reaching any firm conclusions. This was vividly illustrated by a lecture on memory by the eminent philosopher

KEY TERM

Reductionism: The view that all scientific explanations should aim to be based on a lower level of analysis: psychology in terms of physiology, physiology in terms of chemistry, and chemistry in terms of physics.

A. J. Ayer that I attended as a student. He began, rather unpromisingly, by declaring that memory was not a very interesting philosophical question. He seems to have demonstrated this pretty effectively as I can remember none of the lecture, apart from his statement that his memory was totally devoid of imagery, prompting a skeptical questioner to ask "If I tell you that the band of the grenadier guards is marching past the end of the street, banners flying and trumpets sounding, do you not hear or see anything?" "No" replied the philosopher; "I don't believe you!" said the questioner and sat down crossly.

This point illustrates a limitation of a purely philosophical approach to the understanding of memory in particular, and to mind in general, namely its reliance on introspection, the capacity to reflect and report our on-going thoughts. These are not unimportant, but are not a reliable indication of the way our minds work for two principal reasons. The first of these, as our example shows, is that, people differ in what they appear to experience in a given situation; does memory depend on visual imagery, and if not, why do some of us experience it? Second, and even more importantly, we are only consciously aware of a relatively small proportion of the mechanisms underpinning our mental life, and as we will see, the tip of the mental iceberg that is available to conscious awareness is not necessarily a good guide to what lies beneath.

While there are still important issues addressed by the philosophy of mind, it is now generally acknowledged these can best be pursued in collaboration with a scientific approach based on empirical evidence. To return to the question of imagery, as I suspect Ayer knew, in the late nineteenth century, Sir Francis Galton had asked a number of "eminent men" to reflect on their breakfast table from that morning and describe the vividness of the resulting memory, finding a huge range of responses. What was not known by Galton is that these huge differences are not reflected in how accurate our memories are, suggesting that accuracy depends on some nonconscious process. Could it be that different people have the same experience but just describe it differently? Or do they have different memory systems? Or perhaps they have the same basic system but have a different strategy for using it? Hence, although they are interesting, subjective reports do not provide a very solid basis for understanding how our memory works.

So how can we move beyond introspection?

An answer to this started to develop in Germany in the latter half of the nineteenth century. It was concerned initially with the discipline of *psychophysics*, an attempt to systematically map the relationship between physical stimuli such as brightness and loudness onto their perceived magnitude. Despite success in linking physical stimuli to the psychological experience of participants, capacities such as learning and memory were initially regarded as unsuitable for experimental study. This view was dramatically overturned by a German philosopher, Herman Ebbinghaus, who conducted an intensive series of experiments on himself over a 2-year period, showing that it was indeed possible to plot systematic relationships between the conditions of learning and the amount learned. Having published this, the first classic book on the science of memory (Ebbinghaus, 1885), he moved on to

Ebbinghaus (1850–1909) was the first person to demonstrate that it was possible to study memory experimentally.

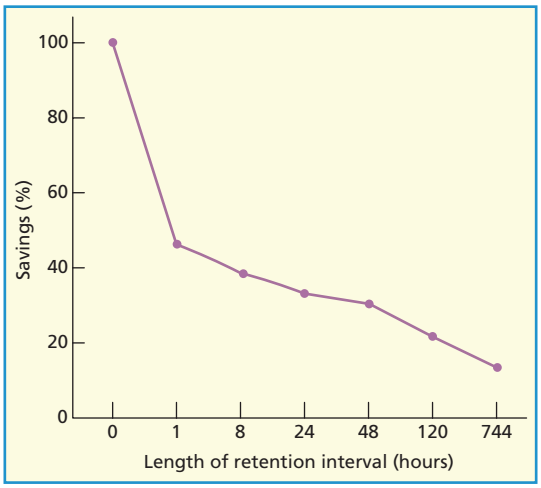


Figure 1.1 Forgetting over time as indexed by reduced savings during relearning. Data from Ebbinghaus (1885/1913).

study color vision, intelligence and a range of other questions in the newly developing field of experimental psychology.

So what did Ebbinghaus do? He began by simplifying the experimental situation, attempting to develop material that was devoid of meaning but was verbally learnable and reportable, inventing what has become known as the nonsense syllable, consonant–vowel–consonant items such as *zug*, *pij*, and *tev*. He served as his own subject, always holding constant the room in which he learned, the time of day and the rate of presentation, which was rapid, so as to avoid any temptation to attempt to find meaning in the stimuli. Ebbinghaus established some of the basic principles of learning that will discussed in Chapter 5 and the classic forgetting curve shown in Figure 1.1 that forms the basis of all subsequent work in this area (see Chapter 9).

The Ebbinghaus tradition was subsequently most strongly developed in the US, focusing particularly on the factors and conditions surrounding the important question of how new learning interacted with what was already known. Results were interpreted in terms of associations that were assumed to be formed between stimuli and responses, using a limited range of methods that typically involved remembering lists of nonsense syllables or words (McGeoch & Irion, 1952). This is often referred to as the **verbal learning** approach. It developed from the 1930s to the 1960s, particularly in mid-Western laboratories, and emphasized the careful mapping of phenomena rather than the ambitious building of grand theories such as that proposed by Clark Hull. When the grand theories appeared to collapse, however, the more staid approach that had previously been disparagingly discounted by its critics as "dust bowl empiricism" began to attract a broader range of investigators interested in studying learning and memory. This led to the founding of a new journal *The Journal of Verbal Learning and Verbal Behavior*, which, when the term "verbal learning" later became unfashionable, became *The Journal of Memory and Language*.

A second development that occurred at this point had its roots in both Europe and North America. In the 1930s, a German approach known as **Gestalt psychology** began attempting to apply ideas developed in the study of perception to the understanding of human memory. Unlike the behaviorist approaches, *Gestalt* psychologists tended to emphasize the importance of internal representations rather than observable stimuli and responses, and to stress the active role of the rememberer. Gestalt psychology suffered badly from Nazi persecution, but enough Gestalt psychologists moved to North America to sow the seeds of an alternative approach to verbal learning; an approach that placed much more emphasis on the activity of the learner in organizing material. This approach was typified by two investigators who had grown up in Europe but had then emigrated and been trained in North America: George Mandler and Endel Tulving.

KEY TERM

Verbal learning: A term applied to an approach to memory that relies principally on the learning of lists of words and nonsense syllables.

Gestalt psychology: An approach to psychology that was strong in Germany in the 1930s and that attempted to use perceptual principles to understand memory and reasoning.

In Britain, a third approach to memory developed, based on Frederick Bartlett's (1932) book *Remembering*. Bartlett explicitly rejected the learning of meaningless material as an appropriate way to study memory, using instead complex material such as folk tales from other cultures, reflecting his interest in social psychology and stressing the importance of the rememberer's "effort after meaning." This approach emphasized the study of the memory errors that people made, explaining them in terms of the participants' cultural assumptions about the world. Bartlett proposed that these depended on internal representations that he referred to as **schemas**. His approach differed radically from the Ebbinghaus tradition, relying on quite complex tasks but, as was the case with the later followers of Tolman and Hull, Bartlett was left with the problem of how to study these elusive inner representations of the world.

A possible answer to this problem evolved gradually during the Second World War with the development of computers. Mathematicians such as Weiner (1950) in the US, and physiologists such as Gray Walter (1953) in the UK described machines that were able to demonstrate a degree of control that resembled purposive behavior. During the 1940s, a Scottish psychologist, Kenneth Craik (1943), working with Bartlett in Cambridge produced a brief but influential book entitled *The Nature of Explanation*. Here he proposed the idea of representing theories as **models**, and using the computer to develop such models. He carried out what were probably the first psychological experiments based on this idea, using analog computers (digital computers were still being invented) and applying his computer-based theoretical model to the practical problem of gun-aiming in tanks. Tragically, in 1945 he was killed in a traffic accident while still a young man.

Fortunately, the new approach to psychology, based on the computer metaphor, was being taken up by a range of young investigators, and in the years following the war, this information-processing approach to psychology became increasingly influential. Two books were particularly important. Donald Broadbent's *Perception and Communication* (1958) developed and applied Craik's seminal ideas to a range of work carried out at the Medical Research Council Applied Psychology Unit in Cambridge, England, much of it stimulated by practical problems originating during the war. Some 9 years later, this growing field was then brilliantly synthesized and summarized by Ulric Neisser (1967) in a book whose title provided a name for this burgeoning field: *Cognitive Psychology*.

Using the digital computer as an analogy, human memory could be regarded as comprising one or more storage systems. Any memory system—whether physical, electronic, or human—requires three things, the capacity to *encode*, or enter information into the system, the capacity to *store* it, and—subsequently—the capacity to find and *retrieve* it. However, although these three stages serve different functions, they interact: The method of registering material or encoding determines what and how the information is stored, which in turn will limit what can subsequently be retrieved. Consider a simple physical memory device, a shopping list. If it is to work, you need to write legibly in a language the recipient shopper understands. If it were to get wet, the ink would blur (impaired storage) making it less distinct and harder to read (retrieval). Retrieval would be harder if your handwriting was poor (an encoding–retrieval interaction), and if the writing was smudged (a storage–retrieval interaction). The situation is further complicated by the discovery that our memories comprise not one, but several interrelated memory systems.

KEY TERM

Schema: Proposed by Bartlett to explain how our knowledge of the world is structured and influences the way in which new information is stored and subsequently recalled.

Model: A method of expressing a theory more precisely, allowing predictions to made and tested.

HOW MANY KINDS OF MEMORY?

As the influence of the cognitive approach to psychology grew, the balance of opinion moved

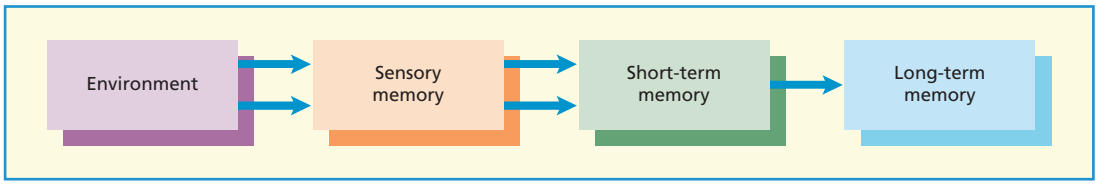


Figure 1.2 An information-processing approach to memory. Information flows from the environment through sensory storage and short-term storage to long-term memory.

from the assumption of a single memory system based on stimulus–response associations towards the idea that two, three or perhaps more memory systems were involved. Figure 1.2 shows the broad view that came to be widely accepted during the 1960s. It assumed that information comes in from the environment and is first processed by a series of sensory memory systems, which could be best regarded as providing an interface between perception and memory. Information is then assumed to be passed on to a temporary short-term memory system, before being registered in long-term memory (LTM). A particularly influential version of this model was proposed by Atkinson and Shiffrin (1968). It was dubbed the **modal model** because it was representative of many similar models of the operation of human memory that were proposed at the time. As we shall see, a number of the assumptions underlying this model were subsequently questioned, causing it to be further elaborated.

The question of how many kinds of memory remains controversial, some theorists object to the very concept of a memory *store* as too static, arguing instead that we should concerned with *processes* (e.g. Nairne, 1990, 2002; Neath & Surprenant, 2003). They point to similarities across a range of very different memory tasks and suggest that these imply common processes, and hence a unitary memory system. Our own view is that we need to think in terms of both structures such as stores and the processes that operate on them, just as an analysis of the brain requires the contribution of both static anatomical features and a more dynamic concern with physiology. We should certainly look for similarities across domains in the way that these systems perform, but the presence of common features should not encourage us to ignore the differences.

Fortunately, regardless of the question of whether one emphasizes similarities or differences, the broad picture remains the same. In what follows, we ourselves use the distinctions between types of memory as a way of organizing and structuring our knowledge of human memory. As discussed below, we assume separate sensory, short-term and long-term memory systems, each of which can be subdivided into separate components. We do not, however, assume the simple flow of information from the environment into long-term memory that is suggested in Figure 1.2, as there is abundant evidence that information flows in both directions. For example, our knowledge of the world, stored in long-term memory, can influence our focus of attention, which will then determine what is fed into the sensory memory systems, how it is processed and whether it is subsequently remembered. Thus a keen football fan watching a game will see and remember particular plays that her less enthusiastic companion will miss.

We begin with a brief account of **sensory memory**. This was an area of considerable activity during the 1960s and provides a good illustration of the general principles of encoding, storage, and retrieval. However, given that it relates more to perception than memory, it will not be covered in the remainder of the book. Our outline continues with introductory accounts of short-term and working memory, before moving to a brief preliminary survey of long-term memory.

KEY TERM

Modal model: A term applied to the model of memory developed by Atkinson and Shiffrin (1968).

SENSORY MEMORY

If you wave your hand while holding a sparkler in a dark room, it leaves a trail, which rapidly fades. The fact that the image persists long enough to draw an apparent line suggests that it is being stored in some way, and the fact that the line rapidly fades implies some simple form of forgetting. This phenomenon forms the basis for movies; a sequence of static images is presented rapidly, with blank intervals in between, but is perceived as a continuous moving image. This occurs because the perceptual system stores the visual information long enough to bridge the gap between the static images, integrating each one with the next, very slightly different, image.

Neisser (1967) referred to this brief visual memory system as **iconic memory**, referring to its auditory counterpart as "echoic memory." In the early 1960s, a number of investigators at Bell Laboratories in the US used the new information-processing approach to analyze this fleeting visual memory system (Sperling, 1960, 1963; Averbach & Sperling, 1961).Sperling (1960) briefly presented a visual array of twelve letters in three rows of four, and then asked for recall (Figure 1.3). People could typically remember four or five items correctly. If you try this task, however, you will have the sensation that you have seen more than four or five, but that they have gone before you can report them. One way of avoiding the problem of forgetting during reporting is to present the same array and reduce the number of items to be reported, but not tell the participant in advance which ones will be selected for recall. Sperling therefore required only one of the three lines to be reported, signaling the line to be recalled by presenting a tone; a high tone for the top line, a medium tone for line two, and a low tone for line three. As he did not tell the participant in advance which line would be cued, the report could be treated as representative of the whole array; multiplying the score by three will thus give an estimate of the total number of letters stored. However, as shown in Figure 1.4, this depends on when the recall tone is presented. When recall is tested immediately, it should provide an estimate of the total capacity of the memory store, with the fall-off in performance as the tone is delayed representing the loss of information. Note that Figure 1.4 shows two curves, one with a bright field before and after the letters, and the other with the letters preceded and followed by a dark visual field. A subsequent experiment (Sperling, 1963) found that the brighter the light during the interval, the poorer the performance, suggesting that the light is interfering with the memory trace in some way, a process known as **masking**.

Later work by Michael Turvey (1973) investigated two separate types of masking operating at different stages. The first of these involves *brightness masking*, with the degree of masking increasing when the mask becomes brighter, or is presented closer in time to the stimulus. This effect only occurs if the mask and the stimulus are presented to the same eye, suggesting that it is operating at a peripheral retinal level. If you were a subject in such an experiment, this type of masking would give rise to experiencing a composite of target and mask, with the brighter the mask the less distinct the target. This is distinct from *pattern masking*, the second type studied, which occurs when targets are followed by a mask comprising broadly similar features to the target, for example jumbled fragments of letters. This type of mask operates even when the target is presented to one eye and the mask to the other. This suggests that it influences a later stage of visual processing that occurs

KEY TERM

Sensory memory: A term applied to the brief storage of information within a specific modality.

Iconic memory: A term applied to the brief storage of visual information.

Masking: A process by which the perception and/or storage of a stimulus is influenced by events occurring immediately before presentation (forward masking) or more commonly after (backward masking).

B C X Y
N F R W
T Z K D

Figure 1.3 Stimulus array used by Sperling. Although twelve letters were presented, participants only had to recall one row, that cued by a high, medium, or low tone.

after information from the two eyes has been combined into a single percept. It is relatively insensitive to brightness and subjectively feels as if a clear image has been disrupted before the information could adequately be read off from it.

What function does iconic memory serve other that of keeping psychologists busy, or as Haber concluded in desperation, reading at night in a thunderstorm? The answer is that its function is probably indirect, forming part of the process of perceiving the world. As we scan the visual world, stimuli of huge complexity will fall on our retina, comprising far more information than it is useful for us to process and store. It seems likely that iconic memory represents two early stages of a process whereby information is read off from the retina, and some of it then fed through to a more durable short-term visual store. It is this that allows us to build up a coherent representation of the visual world and that allows a movie to be perceived, not as a series of static frames with gaps in between, but as a continuous and realistic visual experience. The early stages of iconic memory are probably best regarded as aspects of perception; the subsequent more stable stage will be discussed in the chapter on short-term memory.

The auditory system also involves a brief sensory memory component that Neisser named **echoic memory**. If you are asked to remember a long telephone number, then your pattern of errors will differ depending on whether the number is heard or read. With visual presentation, the likelihood of an error increases systematically from the beginning to the end of the sequence, whereas, as shown

KEY TERM

Echoic memory: A term sometimes applied to auditory sensory memory.

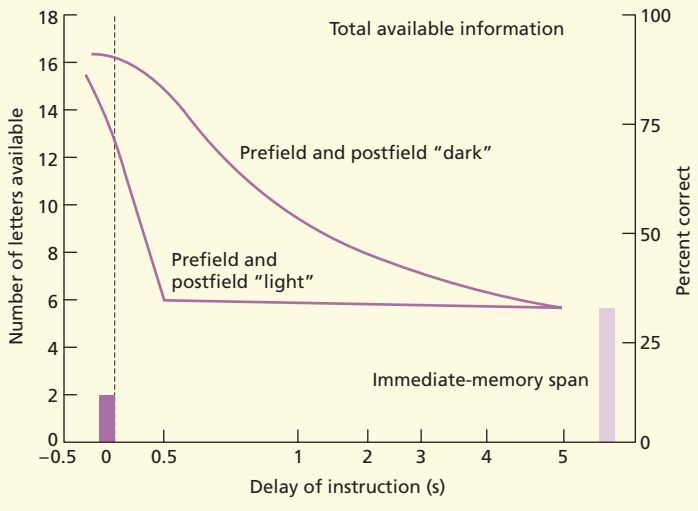


Figure 1.4 Estimated number of letters available using the partial report method, as a function of recall delay. From Sperling (1963). Copyright © 1963 by The Human Factors Society and Ergonomics Society Inc. Reprinted by permission of Sage Publications.

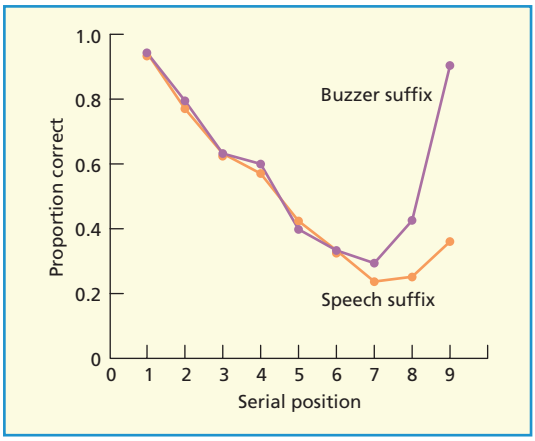


Figure 1.5 Serial recall of a nine-item list when an additional item, the suffix, is either the spoken word *zero* or a sound made by a buzzer. From Crowder (1972). Copyright © 1972 Massachusetts Institute of Technology, by permission of the MIT Press.

in Figure 1.5, with auditory presentation the last one or two items are much more likely to be correct than are items in the middle of the list (Murdock, 1967). This recency advantage can be removed by interposing another spoken item between presentation and recall, even when this item itself does not need to be processed, and is always the same, for example, the instruction "recall." In an extensive series of experiments, Crowder and Morton (1969; Crowder & Raeburn, 1970; Crowder, 1971) showed that the nature of this suffix is critical. A visual or nonspeech-like auditory suffix, such as a buzzer, does not disrupt performance, whereas a spoken suffix does, regardless of its meaning.

Crowder and Morton postulated what they term a precategorical acoustic store as the basis for the auditory recency effect. However, the question of whether the process responsible for the enhanced auditory recency effect is better regarded as a form of memory or an aspect of perception remains controversial (Jones, Hughes, & Macken, 2006; but see also Baddeley & Larsen, 2007). Regardless of its interpretation, the auditory recency component is sufficiently large and robust to play a potentially significant role in studies of verbal short-term memory, and has even been proposed as an alternative to more conventional views of performance on short-term verbal memory tasks (Jones et al., 2006). We will return to this issue when discussing short-term memory. In the meantime, it seems likely that an adequate explanation of echoic memory will need to be fully integrated with a broader theory of speech perception.

SHORT-TERM AND WORKING MEMORY

As this topic, and that of long-term memory, forms a major part of the book, for present purposes we will limit ourselves to a very brief outline. We use the term **short-term memory (STM)** in a theory-neutral way to refer to the temporary storage of small amounts of material over brief delays. This leaves open the question of how this storage is achieved. In most, if not all situations, there is likely to be a contribution to performance from long-term memory that will need to be taken into account in evaluating the role of any more temporary storage systems. Much of the work in this area has used verbal material, and there is no doubt that even when the stimuli are not verbal, people will often use verbal rehearsal to help maintain their level of performance over a brief delay (see Chapter 3). It is important to bear in mind, however, that STM is not limited to verbal material, and has been studied extensively for visual and spatial information, though much less extensively for smell and touch.

The concept of **working memory** is based on the assumption that a system exists for the temporary maintenance and manipulation of information, and that this is helpful in

KEY TERM

Short-term memory (STM): A term applied to the retention of small amounts of material over periods of a few seconds.

Working memory: A memory system that underpins our capacity to "keep things in mind" when performing complex tasks.

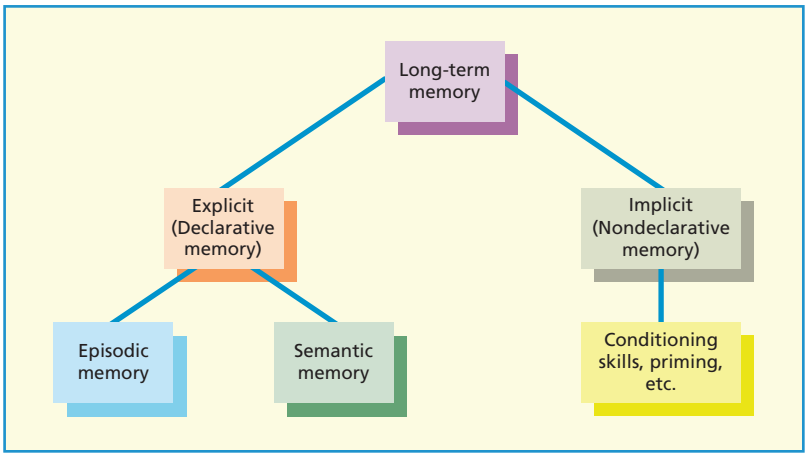


Figure 1.6 Components of long-term memory as proposed by Squire (1992).

performing many complex tasks. A number of different models of working memory have been proposed, with the nature and emphasis of each model tending to depend on the particular area of interest of the theorist, and their theoretical style. However, most assume that working memory acts as a form of mental workspace, providing a basis for thought. It is usually assumed to be linked to attention, and to be able to draw on other resources within short-term and long-term memory (Miyake & Shah, 1999). By no means all approaches, however, emphasize the role of memory rather than attention. One approach that does so is the multicomponent model proposed originally by Baddeley and Hitch in 1974 as a means of linking research on the psychology and neuropsychology of STM to its functional role in performing important cognitive activities such as reasoning, comprehension and learning. This approach has continued to prove productive for over 40 years (Baddeley, 2007) and is the principal focus of Chapter 4, on working memory.

LONG-TERM MEMORY

We shall use the classification of long-term memory proposed by Squire (1992). As shown in Figure 1.6, this classification makes a broad distinction between explicit or declarative memory and implicit or nondeclarative memory. Explicit memory refers to situations that we would generally think of as involving memory, both for specific *events*, such as meeting a friend unexpectedly on holiday last year, and remembering *facts* or information about the world, for example the meaning of the word *testify* or the color of a ripe banana. Implicit memory refers to situations in which some form of learning has occurred, but which is reflected in *performance* rather than through overt remembering, riding a bicycle for example or reading a friend's handwriting more easily because we have encountered it frequently in the past. We will briefly discuss these in turn, leaving a full exploration to subsequent chapters.

KEY TERM

Long-term memory: A system or systems assumed to underpin the capacity to store information over long periods of time.

Explicit/declarative memory: Memory that is open to intentional retrieval, whether based on recollecting personal events (episodic memory) or facts (semantic memory).

Implicit/nondeclarative memory: Retrieval of information from long-term memory through performance rather than explicit conscious recall or recognition.

Explicit memory

As Figure 1.6 shows, this can be divided into two categories, **semantic** and **episodic memory**. During the 1960s, computer scientists attempting to achieve automatic language processing discovered that their computer programs needed to have built into them some kind of knowledge of the world, which could represent the meaning of the words being processed. This led psychologists to attempt to study the way in which humans store such semantic information. At a conference convened to discuss these new developments, a Canadian psychologist, Endel Tulving (1972), proposed a distinction that was immediately adopted and has been used extensively ever since, that between *semantic* and *episodic* memory. Semantic memory refers to knowledge of the world. It goes beyond simply knowing the meaning of words and extends to sensory attributes such as the color of a lemon or the taste of an apple. It also includes general knowledge of how society works, what to do when you enter a restaurant or how to book a theatre seat. It is inherently general in nature, although it can in principle be acquired on a single occasion. If you heard that an old friend had died, this would be likely to become part of your general knowledge of that person, hence part of your semantic memory, although you might well forget where or when you had heard this.

If you subsequently recall the particular occasion when and where you had learned this sad news, then this would be an instance of *episodic memory*, which underpins the capacity to remember specific single episodes or events. Hence, a given event can be registered in both types of memory. Tulving himself (2002) now limits the use of the term "episodic memory" to situations in which you actually re-experience some aspect of the original episode, for example remembering how surprised you were that your informant knew your old friend. Tulving refers to this capacity as **mental time travel** and emphasizes its value, both in allowing us to recollect and "relive" individual events, and to use that information for planning a future action, for example sending a letter of condolence. It is this capacity to acquire and retrieve memories for particular events that tends to be most severely disrupted in amnesic patients, and it is this deficit that has made Clive Wearing's life so unbearably difficult.

How are semantic and episodic memory related? One possibility is that semantic memory is simply the residue of many episodes. For example, I know that Madrid is the capital of Spain, not only because I was told it at school but also because I have encountered this fact in countless news-reels and had it reinforced by visiting Madrid. Consistent with this assumed role of episodic memory in forming semantic memory is the fact that most amnesic patients have difficulty in building up new semantic knowledge. They typically would not know

Semantic memory goes beyond the meaning of words, and extends to sensory attributes such as taste and color; and to general knowledge of how society works, such as how to behave in a supermarket.

KEY TERM

Semantic memory: A system that is assumed to store accumulative knowledge of the world.

Episodic memory: A system that is assumed to underpin the capacity to remember specific events.

Mental time travel: A term coined by Tulving to emphasize the way in which episodic memory allows us to relive the past and use this information to imagine the future.

the name of the current President of the United States of America, or what year it is, or which teams were doing well in their favorite sport. This suggests that although semantic and episodic memory might possibly involve separate systems, they clearly interact (Tulving, 2002).

Implicit memory

Amnesic patients thus tend to show not only grossly disturbed episodic memory, but also a greatly impaired capacity to add to their store of knowledge of the world. There are, however, a number of situations in which they do appear to learn at a normal rate, and the study of these preserved capacities has had an important influence on the development of the concept of implicit or nondeclarative memory.

One preserved form of learning is simple **classical conditioning**. If a tone is followed by a brief puff of air to the eye, amnesic patients will learn to blink in anticipation (Weiskrantz & Warrington, 1979). Despite learning at a normal rate, they do not remember the experience and cannot explain the function of the nozzle that delivers the air puff to their eye. Amnesic patients can also learn motor skills, such as improving with practice the capacity to keep a stylus in contact with a moving spot of light (Brooks & Baddeley, 1976). Warrington and Weiskrantz (1968) demonstrated that word learning was also preserved in densely amnesic patients under certain conditions. They presented their patients with a list of unrelated words and then tested for retention in a number of different ways. When asked to recall the words or recognize which of the subsequent sequence of words had already been presented, the patients performed very poorly. However, when the nature of the test was changed to one in which the task was to "guess" a word when given the first few letters, both patients and normal participants were likely to "guess" a word that had been seen earlier. For example, a patient who had been shown the word "bring" and was later given the letters "BR– – –" would be just as likely as control participants to guess "bring" rather than "bread," but would not remember having just seen that word.. Patients could take full advantage of their prior experience, despite failing to remember that they had even been shown any words earlier, indicating that *something* had been stored. As we shall see, this phenomenon, known as **priming**, is found in a range of perceptual tasks, both visual and auditory, and can also be found in the progressive improvement in more complex activities such as reading mirror writing (Cohen & Squire, 1980) or assembling a jigsaw puzzle (Brooks & Baddeley, 1976).

Given that these are all examples of implicit learning and memory, do they all reflect a single memory system? While attempts continue to be made to account for them all in terms of a single system (see Neath & Surprenant, 2003), our own view is that although they have features in common, they represent a range of different learning systems using different parts of the brain that have evolved for different purposes. They seem to represent a tendency for evolution to develop similar ways of addressing problems across different systems.

MEMORY: BEYOND THE LABORATORY

We have so far discussed the question of how to develop a theoretical understanding of human memory: how it encodes, stores, and retrieves information. However, if our theory is to be useful as well as informative, then it needs to be applicable beyond the confines of the laboratory, to tell about how our memories will work in the world. It must aim to extend beyond the student population, on which much of the research is based, and tell

KEY TERM

Classical conditioning: A learning procedure whereby a neutral stimulus (e.g. a bell) that is paired repeatedly with a response-evoking stimulus (e.g. meat powder), will come to evoke that response (salivation).

Priming: The process whereby presentation of an item influences the processing of a subsequent item, either making it easier to process (positive priming) or more difficult (negative priming).

us about how memory functions in children and the elderly, across different cultures and in health and disease.

It is of course much more difficult to run tightly controlled experiments outside the laboratory, with the result that most of the theoretically focused studies that inform the initial chapters are laboratory based. Some investigators argue that we should confine our research to the laboratory, extending it only when we have a thorough understanding of memory. Others have followed Bartlett in suggesting that this is likely to lead to the neglect of important aspects of memory. In response to this rather conservative view, a group of psychologists in South Wales enthusiastically convened an international conference concerned with practical aspects of memory. It was a great success, with people coming from all over the world to talk about their research on topics ranging from memory for medical information to sex differences in facial memory, and from expert calculators to brain-damaged patients (Gruneberg, Morris, & Sykes, 1978).

Ulric Neisser was invited to give the opening address. In it, he lamented the laboratory-based tradition declaring that "If X is an interesting or socially significant aspect of memory, then psychologists have hardly ever studied X!" (Neisser, 1978, p. 4). He was in fact preaching to an enthusiastic audience of the converted, whose work presented over the next few days was already refuting his claim. However, his address was less well received in other quarters, resulting in a paper complaining of "the bankruptcy of everyday memory" (Banaji & Crowder, 1989). This led to a lively, although rather unfruitful, controversy, given that it was based on the false assumption that psychologists should limit their research to *either* the laboratory *or* the world beyond. Both approaches are valuable. It is certainly easier to develop and test our theories under controlled laboratory conditions, but if they tell us little or nothing about the way in which memory works in the world outside, they are of distinctly limited value.

In general, attempts to generalize our theories have worked well, and have in turn enriched theory. One important application of theory is to the memory performance of particular groups such as children, the elderly, and patients with memory problems. As we will see, these not only demonstrate the robustness and usefulness of cognitive theory, but have also provided ways of testing and enriching theory. A good case in point is the study of

In Medieval times, accurate and precise articulation of the words of the church liturgy was more important than the sound of the music, with errors taken very seriously. The demon Titivillus was believed to take time off from his other task of inducing errors in written manuscripts to collect such omissions and slips of the tongue. Each day a thousand bags of such lapses would be conveyed to his master Satan, written in a book of errors and used against the unfortunate cleric on the Day of Judgement. It appears that in due course the level of accuracy improved to a point at which Titivillus was driven to filling his sack with idle gossip from the congregation, a rather menial task for a respectable demon (Zieman, 2008).

patients with a very dense but pure amnesia, which has told us about the everyday importance of episodic memory, has helped develop tests and rehabilitation techniques for clinical neuropsychologists, and has, at the same time, had a major impact on our theories of memory.

A second major benefit from moving beyond the laboratory comes from a realization that certain very important aspects of memory were not being directly covered by existing theories. Some of these have led to important new theoretical developments. This is the case with the study of semantic memory, which, as mentioned earlier, was initially prompted by the attempt of computer scientists to develop programs that could understand language (Collins & Quillian, 1969). Another area of very active research that was driven by a practical need is that of eyewitness testimony, where it became clear that the failures of the judiciary to understand the limitations of human memory were often leading to potentially very serious miscarriages of justice (Loftus, 1979). Other areas have developed as a result of identifying practical problems that have failed to be addressed by theory. A good example of this is prospective memory, remembering to do things. This use of memory is of great practical importance, but for many years was neglected because it reflects a complex interaction between attention and memory. These broader topics are covered in the latter part of the book, which will illustrate the now widely accepted view that theoretical and practical approaches to memory are allies and not rivals.

The contribution of neuroscience

Both the Ebbinghaus and Bartlett approaches to the study of memory were based on the psychological study of memory performance in normal individuals. In recent years, however, this approach has increasingly been enriched by data from neuroscience, looking at the contribution of the brain to our capacity to learn and remember. Throughout this book, you will come across cases in which the study of memory disorders in patients has thrown light on the normal functioning of human memory. In particular, the problems faced by patients with memory problems can often tell us about the function that our memories serve, and how they can be further investigated. Recent years have seen a rapid development of methods that allow the neuroscientist to observe and record the operation of the brain in healthy people both at rest and while performing complex activities, including those involved in learning and remembering. These will be discussed in the next chapter

SUMMARY

- Although we complain about our memories, they are remarkably efficient and flexible in storing the information we need and discarding what is less important.
- Many of our memory lapses result from this important need to forget nonessentials, if we are to remember efficiently.
- The study of memory began with Ebbinghaus, who greatly simplified the experimental situation, creating a carefully constrained approach that continued in North America into the twentieth century.
- Alternative traditions developed in Germany, where the study of perception influenced the way in which Gestalt psychologists thought about memory, and in Britain, where Bartlett used a richer and more open approach to memory.

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(Continued)

- During the 1950s and 1960s, these ideas, influenced further by the development of the computer, resulted in an approach that became known as cognitive psychology.
- In the case of memory, this emphasized the need to distinguish between encoding or input into memory, memory storage, and memory retrieval, and to the proposal to divide memory into three broad types, sensory memory, short-term memory, and long-term memory.
- The information-processing model is very well illustrated in Sperling's model of visual sensory memory, in which the various stages were ingeniously separated and analyzed.
- These were assumed to lead into a temporary *short-term* or *working memory*. This was initially thought to be largely verbal in nature but other modalities were subsequently shown to be capable of temporary storage.
- The short-term memory system was assumed to feed information into and out of long-term memory.
- Long-term memory was further subdivided into *explicit* or declarative memory, and *implicit* or nondeclarative memory.
- Explicit memory was further divided into two types: The capacity to recollect individual experiences, allowing "mental time travel," became known as *episodic memory*, whereas our stored knowledge of the world was termed *semantic memory*.
- A range of implicit or nondeclarative learning and memory systems were identified, including classical conditioning, the acquisition of motor skills, and various types of priming
- An important development in recent years has been the increased interest in extending theory beyond the laboratory. Although this has led to controversy; it is clear that we need the laboratory to refine and develop our theories, but that we also need to move outside the laboratory to investigate their generality and practical importance.

POINTS FOR DISCUSSION

1. What are the strengths and weaknesses of the approach to memory taken by Ebbinghaus and Bartlett?
2. How did the cognitive approach to memory build on these foundations?
3. Do we need to assume more than one kind of memory? If so, why?

FURTHER READING

Banaji, M. R., & Crowder, R. G. (1989). The bankruptcy of everyday memory. *American Psychologist*, *44*, 1185–1193. A reply to Niesser's challenge.

Craik, K. J. W. (1943). *The nature of explanation*. London: Cambridge University Press. A short but seminal book in cognitive psychology presenting the case for using models to embody theories, an approach that underpins the subsequent cognitive revolution.

Gruneberg, M. M., Morris, P. E., & Sykes, R. N. (1978). *Practical aspects of memory*. London: Academic Press. The proceedings of a classic conference that can be said to have launched the everyday memory moment.

Neisser, U. (1978). Memory: What are the important questions? In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory*. London: Academic Press. An influential paper in the movement to study everyday memory.

Rabbitt, P. (2008). *Inside psychology: A science over 50 years*. New York: Oxford University Press. A series of personal views of the recent history of psychology from individuals who have been involved in a wide range of areas, including memory.

Roediger, H. L., Dudai, Y., & Fitzpatrick, S. M. (2007). *Science of memory: Concepts*. Oxford: Oxford University Press. The proceedings of a conference at which leading figures in learning and memory were invited to summarize their interpretation of the basic concepts underlying the field, and to present their own views. Because available space was limited, this provides a very economical way of accessing current expert views concerning both the psychology and neuroscience of learning and memory.

Sperling, G. (1963). A model for visual memory tasks. *Human Factors*, *5*, 19–31. A very good example of the application of the information-processing approach to the study of sensory memory.

REFERENCES

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 2, pp. 89–195). New York: Academic Press.

Averbach, E., & Sperling, G. (1961). Short-term storage of information in vision. In C. Cherry (Ed.), *Information theory* (pp. 196–211). London: Butterworth.

Baddeley, A. D. (2007). *Working memory, thought and action*. Oxford: Oxford University Press.

Baddeley, A. D., & Larsen, J. D. (2007). The phonological loop unmasked? A comment on the evidence for a "perceptual-gestural" alternative. *Quarterly Journal of Experimental Psychology*, *60*, 497–504.

Banaji, M. R., & Crowder, R. G. (1989). The bankruptcy of everyday memory. *American Psychologist*, *44*, 1185–1193.

Bartlett, F. C. (1932). *Remembering*. Cambridge: Cambridge University Press.

Broadbent, D. E. (1958). *Perception and communication*. London: Pergamon Press.

Brooks, D. N., & Baddeley, A. D. (1976). What can amnesic patients learn? *Neuropsychologia*, *14*, 111–122.

Cohen, N. J., & Squire, L. R. (1980). Preserved learning and retention of pattern-analyzing skill in amnesia: Dissociation of knowing how and knowing that. *Science*, *210*, 207–210.

Collins, A. M., & Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior*, *8*, 432–438.

Craik, K. J. W. (1943). *The nature of explanation*. London: Cambridge University Press.

Crowder, R. G. (1971). Waiting for the stimulus suffix: Decay, delay, rhythm, and readout in immediate memory. *Quarterly Journal of Experimental Psychology*, *23*, 324–340.

Crowder, R. G., & Morton, J. (1969). Precategorical acoustic storage (PAS). *Perception and Psychophysics*, *5*, 365–373.

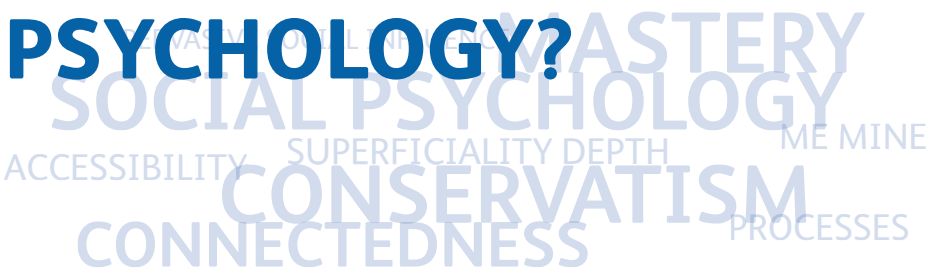
Crowder, R. G., & Raeburn, V. P. (1970). The suffix effect with reversed speech. *Journal of Verbal Learning and Verbal Behavior, 9*, 342–345.

Ebbinghaus, H. (1885). *Über das Gedächtnis*. Leipzig: Dunker.

Gruneberg, M. M., Morris, P. E., & Sykes, R. N. (1978). *Practical aspects of memory*. London: Academic Press.
Hull, C. L. (1943). *The principles of behaviour*. New York: Appleton-Century.
Jones, D., Hughes, R. W., & Macken, W. J. (2006). Perceptual organization masquerading as phonological storage: Further support for a perceptual-gestural view of short-term memory. *Journal of Memory and Language, 54*, 265–281.
Loftus, E. F. (1979). *Eyewitness testimony*. Cambridge, MA: Harvard University Press.
McGeoch, J. A., & Irion, A. L. (1952). *The psychology of human learning*. New York: Longmans.
Miyake, A., & Shah, P. (Eds.). (1999). *Models of working memory: Mechanisms of active maintenance and executive control*. New York: Cambridge University Press.
Murdock Jr., B. B. (1967). Auditory and visual stores in short-term memory. *Acta Psychologica, 27*, 316–324.
Nairne, J. S. (1990). A feature model of immediate memory. *Memory and Cognition, 18*, 251–269.
Nairne, J. S. (2002). Remembering over the short-term: The case against the standard model. *Annual Review of Psychology, 53*, 53–81.
Neath, I., & Surprenant, A. (2003). *Human memory: An introduction to research, data and theory* (2nd edn.). Belmont, CA: Wadsworth.
Neisser, U. (1967). *Cognitive psychology*. New York: Appleton-Century Crofts.
Neisser, U. (1978). Memory: What are the important questions? In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory*. London: Academic Press.
Schacter, D. L. (2001). *The seven sins of memory: How the mind forgets and remembers*. New York: Houghton-Mifflin.
Sperling, G. (1960). The information available in brief visual presentations. *Psychological Monographs: General and Applied, 74*, 1–29.
Sperling, G. (1963). A model for visual memory tasks. *Human Factors, 5*, 19–31.
Squire, L. R. (1992). Declarative and nondeclarative memory: Multiple brain systems supporting learning and memory. *Journal of Cognitive Neuroscience, 4*, 232–243.
Tolman, E. C. (1948). Cognitive maps in rats and men. *Psychological Review, 55*, 189–208.
Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 381–403). New York: Academic Press.
Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology, 53*, 1–25.
Turvey, M. T. (1973). On peripheral and central processes in vision: Inferences from an information processing analysis of masking with patterned stimuli. *Psychological Review, 80*, 1–52.
Walter, W. G. (1953). *The living brain*. London: Norton.
Warrington, E. K., & Weiskrantz, L. (1968). New method of testing long-term retention with special reference to amnesic patients. *Nature, 217*, 972–974.
Weiner, N. (1950). *The human use of human beings*. Boston, MA: Houghton Mifflin.
Weiskrantz, L., & Warrington, E. K. (1979). Conditioning in amnesic patients. *Neuropsychologia, 8*, 281–288.
Wilson, B. A., Baddeley, A. D., & Kapur, N. (1995). Dense amnesia in a professional musician following Herpes Simplex Virus Encephalitis. *Journal of Clinical and Experimental Neuropsychology, 17*, 668–681.
Zieman, K. (2008). *Singing the new song: Literacy and liturgy in Late Medieval England*. Philadelphia, PA: University of Pennsylvania Press.

1

WHAT IS SOCIAL PSYCHOLOGY?



CHAPTER OVERVIEW

In the fall of 1951, Princeton University's undefeated football team played Dartmouth College in a particularly hard-fought game. The teams were long-term rivals, and the game started rough and went downhill from there. Penalties punctuated the game, and fights left players on both sides with serious injuries before Princeton finally won. One month later, two social psychologists asked Princeton and Dartmouth undergraduates to view a film of the game (Hastorf & Cantril, 1954). The responses were astonishing. Princeton fans and Dartmouth supporters reported seeing events so differently that they might have been watching different games. Princeton students saw a constant barrage of Dartmouth violence and poor sportsmanship, with Princeton players occasionally retaliating in self-defense. Dartmouth students rated the teams as equally aggressive but saw their battered team's infractions as understandable responses to brutal Princeton attacks. One Dartmouth alumnus who watched the film saw so few Dartmouth violations that he concluded he must have been sent an edited copy of the film.

Perhaps these findings are not really so astonishing if you consider that fans of opposing teams hardly ever agree on the impartiality of the umpiring. Similarly, partisan observers of political debates almost always proclaim their own candidate "the winner," and proud parents at the school music contest often disagree with the judges' decision. Yet consider the profound questions that these findings raise. If the world is objectively "out there" for all to see, how can observers reach such different conclusions about what seems to be the same event? Why do we so often end up seeing exactly what we expected to see, and how then can we decide what "really" happened? Can the same innocent feelings of belonging that make us see our team, our candidate, or our child in such positive terms also produce biased judgments, unfair decisions, and unequal treatment of others?

Thirty years after Hastorf and Cantril's study, researchers at Vanderbilt University asked two groups of students to consider the difficult issue of whether convicted criminals should be given probation as an alternative to imprisonment (Axsom, Yates, & Chaiken, 1987). One group of students had a special reason to be concerned with the issue: They had been led to believe that the probation policy might soon be introduced in their area. For the other group, the issue was merely academic—the policy was not

being considered for their community. The researchers told the students that, to help them make up their minds, they would hear a tape of a local candidate speaking in favor of the issue at a political rally. What the students did not know was that the researchers had actually prepared four quite different tapes. On one tape, the candidate put forward compelling evidence in support of probation while an enthusiastic audience warmly applauded his words. On a second, the same effective presentation elicited scattered hisses, boos, and heckling from the audience. A third tape had the candidate giving rambling, specious, and disjointed arguments, which were met with enthusiastic applause from the audience. And on the fourth tape, the weak arguments were greeted by boos and hissing.

When the researchers polled the students whose interest in the probation issue was merely academic, the impact of the audience's taped response was clear. Students in this group who heard the audience greet the candidate's position with enthusiasm adopted the position themselves, and those who heard the audience voice disdain rejected the candidate's position. A completely different pattern of responses emerged among students who expected the issue to affect their community. These students focused on the content of the speech. They were swayed if they heard the candidate give cogent arguments but remained unpersuaded if the arguments were weak—regardless of the applause or hisses of the taped audience. Why were the reactions of other people so compelling to some students and so unimportant to others? Why did some participants "go with the flow" while others considered the issues carefully? Did some students care less than others about being right, or were all of the students trying to take different paths to the "truth?"

Like the Vanderbilt students, we are all bombarded daily by attempts to persuade us: advertising campaigns, paid political messages, even the cajoling of friends and family. Consider the last time you were persuaded by one of these attempts. What approach was used by the person who persuaded you? Did that person present you with the hard facts, or did he or she play on your emotions? If you were told that "everyone else" had already joined the parade, would you be more likely to go along or more likely to rebel? Or would it depend on the issue?

Questions like those raised by these studies lure social psychologists into their labs every day in search of reliable answers. Social psychology offers a special perspective on human behavior, because the social aspects of human behavior—the ways that people's thoughts and actions are affected by other people—can be both powerful and puzzling. Our goal in this book is to give you some insight into how people act, and why they act the way they do, by introducing you to some of the many questions social psychologists ask about social behavior, the ways they go about answering those questions, and the answers they have found. We know that you will find these questions intriguing and hope that the often surprising conclusions will make you want to delve more deeply into these compelling issues.

Our first step will be to provide a definition of social psychology: to chart out the territory we will be covering and to give you a glimpse of what makes the terrain so fascinating. We next describe how social psychology developed its special perspective on human behavior. Like other fields of human inquiry, contemporary social psychology is a product of its own history and of the history of the societies in which it developed. With a quick survey of the past behind us, we then map out the territory ahead. The final part of the chapter provides a sneak preview of the material we cover in the rest of

this book. To help you find your way with confidence, we point out some signposts and landmarks to look for along the route.

A DEFINITION OF SOCIAL PSYCHOLOGY

Social psychology is the scientific study of the effects of social and cognitive processes on the way individuals perceive, influence, and relate to others. Notice that social psychology is defined as a science, that social psychologists are as keenly interested in underlying social and cognitive processes as they are in overt behavior, and that the central concern of social psychology is how people understand and interact with others. Let us consider each of these components in turn.

social psychology
the scientific study of the effects of social and cognitive processes on the way individuals perceive, influence, and relate to others

The Scientific Study . . .

Social psychologists, like other scientists, gather knowledge systematically by means of scientific methods. These methods help to produce knowledge that is less subject to the biases and distortions that often characterize common-sense knowledge.

This blue text is a brief preview of the section that follows. For advice on how you can use it to improve your efficiency in studying the text, turn back to the "To the Student" section in the Preface, pages xxx–xxxi.

Of course, you have been studying social behavior all your life. Everyone uses common sense and "street smarts" to make sense of the social world they inhabit because we all want to make good friends, reach mutually satisfying decisions, raise children properly, hire the best personnel, and live in peace and security rather than in conflict and fear. How does the social psychologist's approach differ from our everyday approaches? The answer is found in methods, not goals. Although scientific researchers and common-sense observers share many goals—both wish to understand, predict, and influence people's thoughts and behavior—their methods for achieving those goals differ greatly.

As common-sense observers, people often reach conclusions about social behavior based on limited samples from their own or others' experiences. Therefore common-sense knowledge is sometimes inconsistent, even contradictory. You may have heard, for example, that "opposites attract," and also the reverse, that "birds of a feather flock together." As scientists, on the other hand, social psychologists study social behavior systematically, seeking to avoid the misconceptions and distortions that so often afflict our common-sense knowledge. Of course, even scientific knowledge is not infallible. The history of science shows that some findings from individual studies cannot be confirmed by further observation, and many conclusions proposed as scientific truths are eventually overturned by new insights. But as you will see in Chapter 2, scientific conclusions are sounder and more resistant to challenge than common-sense knowledge because they are based on systematic methods of gathering information and are constructed with an awareness of the possibility of error.

. . . of the Effects of Social and Cognitive Processes . . .

The presence of other people, the knowledge and opinions they pass on to us, and our feelings about the groups to which we belong all deeply influence us through social processes, whether we are with other people or alone. Our perceptions, memories, emotions, and motives also exert a pervasive influence on us through cognitive processes. Effects of social and cognitive processes are not separate but inextricably intertwined.

A first date, a classroom presentation, a job interview, a problem-solving session with co-workers: What do these situations have in common? Each is a situation in which others observe us or interact with us, influencing our thoughts, feelings, and behavior. We try to make a good impression, to live up to the standards of the people we care about, to cooperate or compete with others as appropriate. These examples show the operation of social processes. **Social processes** are the ways in which our thoughts, feelings, and actions are influenced by the people around us, the groups to which we belong, our personal relationships, the teachings of our parents and culture, and the pressures we experience from others.

social processes
the ways in which input from the people and groups around us affect our thoughts, feelings, and actions

cognitive processes
the ways in which our memories, perceptions, thoughts, emotions, and motives influence our understanding of the world and guide our actions

Cognitive processes, on the other hand, are the ways in which our memories, perceptions, thoughts, emotions, and motives guide our understanding of the world and our actions. Note that emotion and motivation are intrinsic parts of every cognitive process, just as are memory and thought. Modern social psychology rejects the misleading opposition—dating back to ancient Greek philosophers—between pure, "rational" thought and irrational emotions. Cognitive processes affect every aspect of our lives, because the content of our thoughts, the goals toward which we strive, and the feelings we have about people and activities—all the ways we act and react in the social world—are based on what we believe the world is like.

Though we have defined them separately, in reality, social and cognitive processes are inextricably intertwined. To illustrate their intimate connections, consider these two points.

First, social processes affect us even when others are not physically present: We are social creatures even when alone. Faced with an important decision, we often stop to think about the possible reactions of absent friends, relatives, or fellow group members, and these thoughts can also influence us. Even during many of our most private activities—writing a term paper, practicing a musical instrument, exercising, or showering—we are motivated by our concern for what others think of us. Think about the last time you rode an elevator in which you were the only passenger. We bet you stood facing the doors, just as you would have if other people had been physically present. Because our group memberships become part of who we are, they influence us even when other group members are absent. Whether other supporters are present or not, we rise to the defense of our party's political platform and feel elated about our sports team's victory. We react in this way because our party or our team has become a basic part of our identity. In cases like these, by considering the group in the individual, social psychologists examine how people are affected by their knowledge of what is expected of them, that is, by their knowledge about the beliefs, attitudes, and actions that are considered appropriate for members of their group.

Second, the social processes that affect us even when others are physically present depend on how we interpret those others and their actions, and therefore on the operation of cognitive processes. The impact of other people's arguments or comments in a group discussion depends on how we think and feel about those people and their statements: Is the argument strong and compelling, or shaky and questionable? Is the person who makes a particular comment genuinely trying to help the group arrive at the right answer or just seeking to dominate others by belittling their ideas? By studying the individual in the group, researchers gain insights into how people are affected by others who are physically present, whether they offer friendly hugs or scornful glares, provide trustworthy information or try to deceive, lead by example or wait for someone to follow. But in all these cases, the way others affect us depends on our own thoughts and feelings.

Whether we are alone or together with others, then, both social and cognitive processes operate together to affect everything we think, feel, and do.

Photo 1.1 Group influence far from the group. These soccer players of Moroccan descent are celebrating a goal scored in a 2012 match in Germany. Although engaged in a sporting competition, and away from their homeland, they so thoroughly accept their Muslim faith that they stop and pray after the goal. For all of us, beliefs, attitudes, and practices endorsed by the groups to which we belong strongly affect our thoughts, feelings, and actions, even when we are far away from other group members.

. . . on the Way Individuals Perceive, Influence, and Relate to Others

Social psychology focuses on the effects of social and cognitive processes on the way individuals perceive, influence, and relate to others. Understanding these processes can help us comprehend why people act the way they do and may also help solve important social problems.

Social psychology seeks to understand the social behavior of individuals, a focus that distinguishes it from sociology, political science, and other social sciences. The cognitive and social processes we have just described affect individuals as they perceive, influence, and relate to others. Consequently, these processes shape all forms of social behavior, including some that are significant concerns in today's world. Here are some examples of social behaviors that are important concerns and some questions social psychologists might ask about them.

- ***Why do many marriages end in divorce?*** A social psychologist might study divorce as an outcome of the social and cognitive processes of conflict in marriages. The research might focus on questions like the following: How do couples interpret events that put the relationship under stress? What alternatives to the relationship do they believe they have? What types of actions in the course of an argument determine whether one partner storms angrily out of the house or allow the couple

to kiss and make up after a fight? Whereas sociologists might study the effects of unemployment on divorce rates in a society, social psychologists might instead examine the ways that being unemployed causes conflict and divorce, by affecting how the partners think about their relationship or how they try to influence one another.

- ***How do salespeople sell products?*** Have you ever found yourself leaving a store carrying an item that was different from what you entered the store to buy, wondering how you were manipulated into purchasing it? A social psychologist would be interested in knowing the social and cognitive processes that induced you to make the purchase. For example, how can a sales pitch expertly play on the consumer's needs, desires, or feelings of guilt or obligation? Did the salesperson subtly hint that the product you asked about was unfashionable or outdated, while pushing a newer (and more expensive) item instead? In contrast, an economist might study whether TV advertisements or in-store promotions produce more total sales.
- ***What causes outbreaks of ethnic violence?*** An historian or journalist might document the unique events that sparked a particular conflict. To the social psychologist, however, intergroup hostility stems from fundamental aspects of the ways people think about and interact with members of different groups. These include both competition for concrete resources (like jobs and political clout) and people's attitudes, emotions, and actions toward their own and other social groups. Social psychologists would ask whether the ways people categorize individuals into groups, the stereotypes they form about others, their preferences for people "just like them," or their feelings of power or powerlessness contribute to intergroup hostility.

Thus, social psychology seeks an understanding of the reasons people act the way they do in social situations. Such an understanding helps us explain events in our own lives: that disastrous first date, the successful job interview, the loneliness of being the new kid on the block, the hesitation we feel before making a major decision. It also helps us comprehend the factors that contribute to the complex events of our times: crime and violence, ethnic unrest and civil war, the spread of pandemic diseases, the destruction of the global environment. And if we understand how people are influenced by social and cognitive processes, we can begin developing solutions for such pressing social problems (Walton, 2014). For example, knowing that stereotypes and prejudice about members of other religious groups may have contributed to violent conflict in the Middle East or Northern Ireland suggests that changing those beliefs might help to prevent recurrences. In fact, social-psychological research has been instrumental in exposing workplace discrimination (Fiske, Bersoff, Borgida, Deaux, & Heilman, 1991) and investigating why innocent people sometimes confess to crimes they did not commit (Kassin & Gudjonsson, 2004). It has suggested policies to increase people's feelings of security and self-worth in their close relationships (Marigold, Holmes, & Ross, 2010) and to improve classroom environments and performance for minority students (Walton & Cohen, 2011). It has also been influential in developing programs to reduce tensions in situations of intense intergroup conflict (Gross, Halperin, & Porat, 2013). Thus the social-psychological perspective invites us not only to understand but also to act on that understanding.

HISTORICAL TRENDS AND CURRENT THEMES IN SOCIAL PSYCHOLOGY

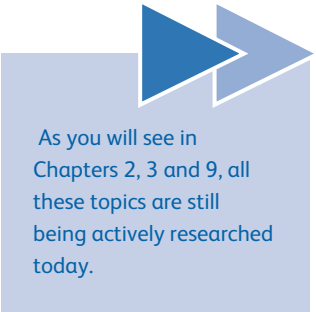
How did social psychology come to develop its particular point of view? Like any field of knowledge, social psychology is a product of its past. The current focus of its research reflects historical events of the 20th and 21st centuries, changing societal concerns, and developments in other scientific fields, as well as changes in the techniques social psychologists have used in their research. This brief survey of the field's history will place the field in context and serve as a partial explanation for where social psychology stands today.

Social Psychology Becomes an Empirical Science

Soon after the emergence of scientific psychology in the late 19th century, researchers began considering questions about social influences on human thought and action.

From the time of the ancient Greeks, the study of the human condition was considered to be the domain of philosophy. Like social psychologists today, early philosophers recognized the impact that other people can have on individual behavior. Plato, for example, speculated about the "crowd mind," arguing that even the wisest individuals, if assembled into a crowd, might be transformed into an irrational mob. Through the ages, philosophers continued to theorize about the workings of the human mind—and they still do—but the development of social psychology had to await the emergence of its parent discipline, the science of psychology. This new field was born in the late 19th century, when a few researchers in Germany, impressed by laboratory methods being used by physiologists, began to employ experimental techniques to understand mental processes like sensation, memory, and judgment.

The experimental investigation of social-psychological issues began soon afterward, as researchers in North America, Britain, and France began systematically measuring how behavior is influenced by the presence of others. A study published in 1898 by an American researcher, Norman Triplett, is sometimes cited as the first research study in social psychology (G. W. Allport, 1954a). Triplett, having noticed that swimmers and cyclists performed better when competing against their rivals than when practicing by themselves, wondered whether the presence of other people has a generally beneficial effect on performance. To find out, he asked school children to wind fishing line onto reels as quickly as possible, with and without others present. Sure enough, the children's performance improved in the presence of others. This interesting finding, however, appeared to contradict a conclusion that Max Ringelmann, a French agricultural engineer, had reached in an even earlier study conducted in the 1880s. Ringelmann found that when people worked together to pull on a rope or push on a cart, they put less effort into the task than when they worked alone (Ringelmann, 1913). The study of group effects on performance still continues today, and we now know that Ringelmann's and Triplett's results are not necessarily inconsistent. As you will see in Chapter 11, the presence of others often facilitates performance when individual contributions are easily identified, but it reduces performance when people are "lost in a crowd."



For the first social psychologists, this puzzle was just one among many questions about how people influence one another. Early researchers also tackled questions about how facial expressions and body movements reveal people's feelings, how people conform to the suggestions of others, and the role that experimenters might play in influencing the outcomes of research (Haines & Vaughan, 1979). The first two textbooks bearing the name Social Psychology both appeared in 1908. One of these, by psychologist William McDougall, argued that all social behavior stems from innate tendencies or instincts, an idea that was popular throughout psychology at the time. The other, by sociologist E. A. Ross, took up the theme that was soon to become social psychology's central concern: that people are heavily influenced by others, whether those others are physically present or not.

Social Psychology Splits from General Psychology Over What Causes Behavior

Throughout much of the 20th century, North American psychology was dominated by behaviorism, but social psychologists maintained an emphasis on the important effects of thoughts and feelings on behavior.

Although it arrived on the coattails of general psychology, social psychology soon developed an identity distinct from that of its parent discipline. Early in the 20th century, North American psychology as a whole became dominated by the behaviorist viewpoint. This perspective, exemplified by the work of John B. Watson and B. F. Skinner, denied the scientific validity of explanations for behavior that invoke mental events like thoughts, feelings, and emotions. For radical behaviorists, a legitimate science of human activity could be based only on the study of observable behavior as influenced by observable environmental stimuli.

Most social psychologists, however, resisted the behaviorist view that thoughts and feelings had no place in scientific explanations. They accepted the behaviorists' argument that the ultimate goal of science is to explain behavior, but their studies showed that behavior could not be explained without taking into account people's thoughts and feelings. Social psychologists learned that individuals often hold divergent views of, and react in different ways to, the same object or idea, be it a football game, a political candidate, or capitalism. Such findings could be explained only by differences in individuals' attitudes, personality traits, impressions of others, group identifications, emotions, goals, and so forth (F. H. Allport, 1924). Behaviorists were certainly right in their belief that external stimuli can influence behavior. However, social psychologists maintained that the effect of any stimulus depends on how individuals and groups interpret it. Right from the start, then, social psychology was distinctive in its conviction that understanding and measuring people's perceptions, beliefs, and feelings are essential to understanding their overt behavior (E. E. Jones, 1985).

The Rise of Nazism Shapes the Development of Social Psychology

In the 1930s and 1940s, many European social psychologists fled to North America, where they had a major influence on the field's direction. Significant questions generated by the rise of Nazism and the Second World War shaped research interests during this period.

It has been said that the one person who has had the most impact on the development of social psychology in North America is Adolf Hitler (Cartwright, 1979). Ironic though this observation is, it contains important elements of truth. In fact, both the events that precipitated the Second World War and the war itself had a dramatic and lasting impact on social psychology.

As Nazi domination spread across Europe in the 1930s, a number of psychologists fled their homelands to continue distinguished scientific careers in North America. One result was that the major growth in social psychology was concentrated in North America for the next few decades. In addition, this influx of European researchers consolidated social psychology's special emphasis on how people interpret the world and how they are influenced by others. Most European researchers were trained not in the behaviorist tradition that was prominent in North America but in Gestalt theory, which sought to understand the rules underlying the organization of perception. This school of thought took for granted the role cognitive processes play in our interpretations of the social world. Around the same time, researchers became increasingly impressed by anthropologists' accounts of the pervasiveness of cultural influences on people's thoughts and behavior. It fell to social psychologists to identify the mechanisms by which such influences occurred, and they soon developed techniques to perform realistic studies of complex social influences in the laboratory. Muzafer Sherif's (1936) elegant experiments, for example, showed that a social group can influence even a person's perception and interpretation of physical reality, as you will see in Chapter 9.

But the war's effect on social psychology went beyond bringing a new group of skilled researchers to North America. Revelations of Nazi genocide led a horrified world to ask questions about the roots of prejudice (Adorno, Frenkel-Brunswik, Levinson, & Sanford, 1950). How could people feel and act on such murderous hatred for Jews, homosexuals, and members of other groups? These questions still resonate today as the world contemplates ethnic conflicts in Rwanda, Iraq, Sri Lanka, and Syria, and "gay bashing" on streets around the world.

Conditions created by the Second World War also drew social psychologists to the search for solutions to immediate practical problems. With food in short supply and rationing in full swing, the U.S. government asked social psychologists how to convince civilians to change their eating habits: to eat less steak and more kidneys and liver, to drink more milk, and to feed their babies cod-liver oil and orange juice (Lewin, 1947). Social psychologists were also called on to help the military maintain troop morale, improve the performance of aircraft and tank crews (Stouffer, 1949), and teach troops to resist enemy propaganda—and even to brush their teeth regularly (Hovland, Janis, & Kelley, 1953).

Social psychologists flocked to applied research willingly, realizing that they would be able to develop and test general theories of behavior even as they solved practical problems. As we will see in Chapter 10, Kurt Lewin (1947) found that active participation

in discussion groups, by establishing behavior in a social context, was more effective in changing what women fed their families than passive listening to lectures on the topic. Lewin's findings are still successfully applied in support groups like Weight Watchers, Gamblers Anonymous, and many other organizations. Samuel Stouffer's (1949) research on American soldiers' morale showed that it depended more on the soldiers' interpretations of how they were doing compared to other enlisted men than on how well they were actually doing. Satisfaction with the rate of promotion, for example, was sometimes lower in units with higher-than-average promotion rates. Stouffer suggested that in these units the soldiers' expectations of promotion were high, setting them up for disappointment if others were promoted but they were not. The importance of comparisons with others and ways comparisons can lead to feelings of relative deprivation are still important topics in current social-psychological research. And, though we may be amused by Carl Hovland's assignment of devising ways to persuade soldiers to brush their teeth regularly, current theories of persuasion build on his original demonstrations that persuasion depends on who delivers the message, who receives the message, and how the message is processed (Hovland and others, 1953).

During this crucial period of research and theory building, the work of one social psychologist in particular embodied the themes that characterized the young discipline. Kurt Lewin, one of the scientists who had fled Hitler, held that all behavior depends on the individual's life space, which he defined as a subjective map of the individual's current goals and his or her social environment (Lewin, 1936). Perhaps you can see how Lewin's ideas sum up two of social psychology's enduring themes: that people's subjective interpretation of reality is the key determinant of their beliefs and behaviors, and that social influences structure those interpretations and behaviors. Lewin's work also reflected the close link between research aimed at understanding the underlying social and cognitive causes of behavior and research aimed at solving important social problems, a link that will receive considerable attention throughout this book. Lewin had a gift for conducting research that combined the testing of theories with the solving of problems. As he put it, "There is nothing so practical as a good theory" (Lewin, 1951, p. 169).

Growth and Integration

Since the 1950s and 1960s, social psychology has grown and flourished, moving toward an integrated theoretical understanding of social and cognitive processes and toward further applications of social-psychological theory to important applied problems.

Both basic and applied social psychology flourished in the United States during the prosperous 1950s and 1960s. Backed by expanding university enrollments and generous government grants, researchers addressed a great variety of topics central to understanding social behavior. Research contributions during this period laid the foundations of what we now know about self-esteem, prejudice and stereotyping, conformity, persuasion and attitude change, impression formation, interpersonal attraction and intimate relationships, and intergroup relations, all still key topics within social psychology today.

During the same period, as Europe recovered and rebuilt from the destruction of the war, social psychologists in several countries developed theoretical and research approaches to a wide range of topics, particularly those involving group memberships, influence within groups, and the often-competitive relationships between groups (Doise, 1978; Moscovici, 1980; Tajfel, 1978). These emphases dated back to a European tradition of research on the psychology of the crowd (LeBon, 1895/1947) and "folk psychology" or the study of common products of human groups such as culture and religion (Wundt, 1916). By the 1970s, social psychology on both sides of the Atlantic had developed a set of reliable and repeatable findings, which is a mark of scientific maturity. The time was ripe for both internal integration, the melding of various specific topic areas into broader explanations of behavior, and external integration, increasing attention to neighboring scientific fields and to significant social concerns. And so the movement toward integration began.

Integration of Cognitive and Social Processes. The study of cognitive processes became a natural framework for integration both within and outside social psychology. As the tight grip of behaviorism on North American psychology was finally broken, a cognitive revolution got under way in the 1960s (Neisser, 1967). Cognitive themes and theories swiftly gained attention in experimental, developmental, personality, and even clinical psychology. Of course, the cognitive revolution was no revolution for social psychology. Cognitive themes such as the importance of people's interpretations in shaping their reactions to events were familiar to social psychologists because their foundations had been laid decades earlier in Allport's, Sherif's, and Lewin's work in the 1930s and in Stouffer's and Hovland's studies in the 1940s. Concepts such as attitudes, norms, and beliefs, already common currency in social psychology, began to be applied to new areas of study: personal relationships, aggression and altruism, stereotyping and discrimination. These applications were greatly facilitated during the 1970s and 1980s by the adoption of research techniques that had been found to be valuable by cognitive psychologists studying perception and memory. Thus, theoretical concerns and proven experimental methods converged as researchers in many areas of social psychology focused on the study of cognitive processes (E. E. Jones, 1985).

Concern with cognitive processes is only one side of the coin, however. Social psychologists have always been aware that social processes, including personal and group relationships and social influence, also impinge on everything people do. True, our behavior is a function of our perceptions and interpretations and our attitudes and beliefs, but those factors in turn are fundamentally shaped by our relationships to others, our thoughts about their reactions, and the group memberships that help us define who we are (Markus, Kitayama, & Heiman, 1996). Scientific understanding of the way social and cognitive processes work together to mold all social behavior has benefited from the increasing integration of North American social psychology with European social psychology, where the impact of social group memberships had long been a dominant theme. Today, researchers in all domains of social psychology are weaving together the effects of cognitive and social processes to provide explanations of people's experience and behavior.

Integration with Other Research Trends. As the world became more interconnected in the late 20th century and as social psychological research spread to many more regions

of the globe, researchers were confronted with findings showing that even what had been regarded as "basic" processes differed strikingly in different nations and cultures (Henrich, Heine, & Norenzayan, 2010). For example, North Americans tend to explain behaviors by referring to characteristics of the actor, and this had been considered to be a fundamental human tendency. However, Chinese and other East Asians usually give explanations based on other people's social expectations (Morris & Peng, 1994). Even seemingly basic visual processes such as susceptibility to optical illusions can differ substantially from one culture to another (Henrich, 2008). Researchers have now advanced beyond merely cataloging such cultural differences in cognitive and social processes, to developing theories of when and why the differences occur (Kitayama & Uskul, 2011). As you will see at many points throughout the book, social psychologists are now integrating these theories with the principles of their own science to arrive at a fuller understanding of what aspects of social behavior are especially sensitive to cultural contexts, as well as why.

Other newer theoretical trends are also becoming incorporated into social psychological thinking (Kaschak & Maner, 2009). Evolutionary psychology emphasizes that humans as well as other animals have evolved processes for solving specific problems that have recurred over evolutionary timespans. These processes still affect our thoughts, feelings, and behaviors today, as we, for example, cooperate or compete in groups (Wilson, Van Vugt, & O'Gorman, 2008) or choose dating and mating partners (Todd, Penke, Fasolo, & Lenton, 2007). The embodiment perspective argues that people's thoughts and judgments are deeply intertwined with sensory experiences and bodily movements, rather than being based just on abstract knowledge. For example, researchers have found that when we perceive other people's emotional facial expressions, we subtly mimic those expressions with our own face—and if such mimicry is blocked, accuracy in perceiving the other's emotion decreases (Niedenthal, 2007). In other words, we use our own bodies in the process of perceiving others. A recent explosion of research on neuroscience has led to the development of powerful research methods yielding new insights into how our brains represent and process social information (Cacioppo, Berntson, & Decety, 2011). The future is likely to bring even more integration of social psychological theory with cultural psychology, evolutionary principles, embodiment, and neuroscience as well as other emerging perspectives.

Integration of Basic Science and Social Problems. Can technological advancement by itself offer solutions to such global threats as resource depletion, environmental pollution, war and ethnic conflict, and overpopulation? Many people believe the answer to that question is no. Instead, solving such massive problems requires profound changes in human behavior.

Social psychologists are attacking these and other crucial social problems, and this attack will require their best theoretical efforts. In this regard, social psychologists are lucky. Scientists in many other fields have to choose whether they will work on purely theoretical issues or apply their theoretical knowledge to practical problems. A materials scientist, for example, may seek to understand the nature of the molecular bonds that produce stronger materials, but it is the engineer who will use the new materials to design an improved wind-turbine blade. Social psychologists do not have to make this kind of choice. It is difficult to think of a single area of social-psychological research that does

not have some application to significant social issues. Whether social psychologists are looking at close relationships or divorce, altruism or aggression, attitude change or the effectiveness of advertising, intergroup conflict or its resolution, they simultaneously address the basic theoretical questions that spur pure scientific curiosity and the important phenomena that affect our daily lives.

Traditionally, many psychologists have thought of basic and applied research as distinct, even opposite, areas, with applied research taking a back seat to basic research. This stance is foreign to contemporary social psychology. Because virtually all social-psychological research is relevant to significant social issues, it is simultaneously basic and applied. The same underlying social and cognitive processes operate wherever people perceive, influence, and interact with each other, both inside the research laboratory and outside it, in schools, factories, courtrooms, playgrounds, boardrooms, and neighborhoods. For this reason, as we describe theories and research areas throughout this text, we will also discuss their applied implications. As you will see, talented researchers are studying social-psychological processes in many applied settings, with a particular focus on major issues relevant to health, education, law, the environment, and business. We have created special section headings to help you locate discussions of particularly important applications to areas such as the following.

Photo 1.2 Social psychology helps society. Social psychology is relevant to many important problems facing society. It can inform policy on issues related to health, environmental conservation, intergroup conflict, prejudice and discrimination, etc. Research conducted by social psychologists has even been used in important cases before the U.S. Supreme Court on issues including racial segregation in schools and overcrowding in prisons.

- ***Health***. Good health is just a matter of good diet, regular exercise, and lucky genes, right? Wrong. The emotions we experience, the amount of stress we encounter from daily hassles, our ability to find love and acceptance in close relationships, and even the way we feel about ourselves can influence our bodies as well as our minds. When public health officials promote exercise and fight drug abuse, when hospitals allow patients more control over their treatments, and when support groups speed recovery from illness, addiction, and grief, social-psychological processes are playing a part in producing sound minds in sound bodies.
- ***Education***. As teachers teach and students learn, more is being communicated than just Spanish and geography. Teachers' expectations can shape their pupils' self-esteem, self-confidence, and even their actual performance. Classroom activities can encourage competition or cooperation and can eliminate or exacerbate ethnic and gender stereotypes. No wonder that for some the classroom is an open field of opportunity, whereas for others it is a minefield of adversity and disappointment.
- ***Law***. How do the police extract confessions? Do lie detectors really work? Is a defendant in suit and tie more credible to a jury than one in prison fatigues? How

might leading questions and inadmissible evidence influence a juror's thinking? Does the minority opinion of a dissenting juror ever sway jury verdicts? From crime to conviction, social-psychological processes are at work as police enforce laws, juries weigh evidence, and societies try to distribute justice.

- *Environment*. Japanese commuters buy whiffs of oxygen from coin-operated machines in subways, yields of Atlantic fisheries decline, and American motorists waste hours in traffic jams. These human dimensions of environmental change are among those motivating social psychologists to discover how individuals can be encouraged to conserve energy or to recycle used materials. Others are working hard to determine the ways groups can be convinced to cooperate in harvesting renewable resources instead of overexploiting and destroying them.
- *Business*. From advertising and sales techniques to the pitfalls of managerial decision making and diversity in the workplace, social-psychological processes are the gears that drive the wheels of business. Consider, for example, the way effective leadership can mold diverse individuals into a smoothly functioning work team, whereas ineffective leadership generates only conflict, dissatisfaction, and low productivity.

In social psychology, the everyday world is not just a place to test discoveries made during laboratory research. Instead, social psychologists regard issues that are important outside the laboratory, such as those listed here, as both a source of theoretical ideas and a target for solutions (Walton, 2014).

HOW THE APPROACH OF THIS BOOK REFLECTS AN INTEGRATIVE PERSPECTIVE

Not surprisingly, given the way social psychology has developed, our conception of social psychology is an integrated one. In this text we share with you our view of social psychology as a field that integrates not only the cognitive and the social but also basic theory and applied research. We believe that all the diversity and richness of human social behavior can be understood in terms of a few fundamental social-psychological processes. These processes flow from eight principles: two fundamental axioms, three motivational principles, and three processing principles.

As the chapters in this book describe specific topics like attraction, aggression, altruism, and attitude change, we will show you how all these forms of social behavior flow from the interaction of these same fundamental principles. At the same time, seeing these principles at work in different settings, producing apparently different forms of social behavior, will enhance your understanding of their meanings and implications. Here we give you just a quick introduction to these basic principles and the processes that flow from them.

Two Fundamental Axioms of Social Psychology

Two fundamental axioms of social psychology are that people construct their own reality and that social influences are pervasive.

Two fundamental axioms, or most important principles, integrate all the topics in this text. The first is that people construct their own reality. The second is that social influence pervades all social life.

Construction of Reality. At first glance, studying social behavior may seem to be an exercise in the obvious. As we go through our daily routines, we trust that we are seeing the world around us as it is—that an objective reality exists "out there" for all to see. When we join friends to watch a ball game or to eat dinner in a restaurant, we assume that we all see the same game and hear the same enjoyable dinnertime conversation. When we meet someone new, we quickly form an impression of what he or she "is like." And when we see someone raise a fist, furrow a brow, or slump in a chair, we know what the behavior means because "actions speak louder than words." Because we assume that our impressions are accurate and true, we usually expect anyone else who meets the same person, goes on the same date, or sees the same action to share those impressions.

Photo 1.3 Who is this man? Is Vladimir Putin a greedy, power-hungry dictator or a patriotic president who simply wants the best for his country? An enemy of human rights or a concerned leader looking out for his own citizens? Or is he none of these? The answer depends on who is doing the perceiving—the Russian military, Ukrainians, gay and lesbian Russian citizens, or Putin himself. What seems real to us is socially constructed and, like beauty, is in the eye of the beholder.

Every now and then, however, we are forced to think twice. Discovering how different the reactions of others can be to the "same" social event overturns our usual lack of awareness of the extent to which we construct our own reality. Try reminiscing with one of your parents about what happened on your first day of school, and you may discover that your memories of the details of that milestone in your lives are quite different. Or, if you are a sports fan, compare your recollection of an important game with the view of the opposing team's fans and see if you agree about what happened. At such times we discover that we do not, in fact, share the same experience. A fist can be raised in intimidation or triumph, and a furrowed brow can indicate depression or concentration. What is real for each of us is a **construction of reality**, shaped in part by cognitive processes (the way our minds work) and in part by social processes (input from others who are actually present or whose presence we imagine).

construction of reality the axiom that each person's view of reality is a construction, shaped both by cognitive processes (the ways our minds work) and by social processes (input from others either actually present or imagined)

Cognitive processes operate as we piece together fragments of information, draw inferences from them, and try to weave them into a coherent whole. We may hear a speaker deliver a series of arguments, note the audience's response, draw inferences about how others feel, and decide whether the message is worth our close consideration. In this sense, a person's view of the world is certainly in the eye—or the ear—of the beholder.

Social processes enable us to influence and be influenced by the views of others as we pursue agreement about the nature of reality. Within the groups that are important to us, agreement is our standard for interpreting and responding to events. For example,

most members of Western societies enjoy kissing, although the meaning of the kiss varies, depending on whom we kiss and how. But when the Thonga of southeast Africa first saw Europeans kissing, they were disgusted by what they regarded as "eating each other's saliva and dirt" (Hyde, 1979, p. 18). Whether we are Thonga cattle herders or German university students, we tune in to others' interpretations—our parent's views about kisses or the cheers or boos of an audience listening to a speech—and we use those interpretations as the basis for our own responses. In this sense, a person's view of the world is at least in part a reflection of what is seen in the eyes of others.

Pervasiveness of Social Influence. We could probably all agree that other people influence our public behavior and that our actions in turn can influence what others say and do. Having supporters at our back gives us a bit more courage to speak out; face-to-face confrontations with detractors may frighten us into silence.

pervasiveness of social influence the axiom that other people influence virtually all of our thoughts, feelings, and behavior, whether those others are physically present or not

Recall, however, that we said earlier that others can influence us even when we are alone. The **pervasiveness of social influence** means that other people influence virtually all of our thoughts, feelings, and behavior, whether those others are physically present or not. Our thoughts about others' reactions and our identification with social groups mold our innermost perceptions, thoughts, feelings, motives, and even our sense of self. Do you proudly think of yourself as an Ajax fan, a member of your temple, a citizen of Canada? Our allegiances may be small-scale, such as membership in families, teams, and committees, or large-scale, including affiliations based on race, ethnicity, religion, gender, or the society and culture in which we live. But whether the group is large or small, our membership in it provides a frame and a filter through which we view social events. The Dartmouth–Princeton game described at the beginning of the chapter had a particular meaning for students from each school and a quite different meaning for people who felt no allegiance to either team. Even among those on the same side, the game meant different things to the team members and their fans.

We sometimes experience social influence as social pressure, as when we encounter an aggressive salesperson or are given the cold shoulder or ridiculed for holding a political opinion that differs from our friends. But social influence is most profound when it is least evident: when it shapes our most fundamental assumptions and beliefs about the world without our realizing it. The reactions of the Princeton and Dartmouth fans were certainly shaped and biased by their school allegiances, but were the fans aware of that influence? Probably not. We would not expect anyone to think, "I'd better interpret that tackle as vicious because my friends will reject me if I don't." Social influences have surrounded us since infancy, and it is therefore no surprise that we usually are unaware of their impact. Does the fish know it swims in water? Sometimes it takes a shift in perspective to make us aware of the impact of social influence. Such shifts are familiar to all of us: A rebellious teenager becomes a parent and imposes a curfew on his own teenagers; a die-hard Braves fan moves from Atlanta to Toronto and eventually joins with her new co-workers to support the local Blue Jays. Even then, such changes often seem so natural that we attribute them not to social influence but to simple reality, for example, the self-evident fact that the Blue Jays are just the best team. Throughout this text, you will see evidence of the powerful effect social influence has in molding the reality we construct for ourselves—and therefore our thoughts, feelings, and actions—whether we are together with others or alone with our thoughts.

Three Motivational Principles

As they construct reality and influence and are influenced by others, people have three basic motives: to strive for mastery, to seek connectedness with others, and to value themselves and others connected to them.

As individuals and groups construct reality while influencing and being influenced by others, they direct their thoughts, feelings, and behaviors toward three important goals.

People Strive for Mastery. Mastery refers to understanding ourselves and the world around us and applying that understanding to help us control outcomes and gain rewards in our lives. Each of us is **striving for mastery**: We seek to understand and predict events in the social world in order to obtain many types of rewards. Achieving mastery is an important incentive in our attempt to form and hold accurate opinions and beliefs about the world, because accurate beliefs can guide us to effective and satisfying actions. For example, if you want the last available part-time job at the campus bookstore, forming an accurate impression of the manager's needs and knowing yourself well enough to give a convincing account of your qualifications may help you get the job. Similarly, insightfully diagnosing business problems and successfully understanding students' and faculty members' needs may help you keep such a job. Our desire for long-term rewards can also show itself in seeking ways to enhance our skills and knowledge and to improve ourselves in other ways. In many everyday decisions, individuals and groups choose to act in ways that appear likely to lead to the most rewarding results, guided by the most reliable and accurate information we can muster.

striving for mastery
the motivational principle that people seek to understand and predict events in the social world in order to obtain rewards

People Seek Connectedness. In **seeking connectedness**, each person attempts to create and maintain feelings of mutual support, liking, and acceptance from those they care about and value. For members of groups in bitter conflict, such as Israelis and Palestinians, actions that benefit their group often seem even more important than civil peace and an end to conflict. Conforming to group standards, even standards that have destructive consequences for people outside the group, fulfills a need for belonging and connectedness. Fulfilling such needs does not always bring about destructive consequences, of course. This same fundamental motive cements the relationships that bring joy and meaning to our lives, linking us to our teammates, families, friends, and lovers.

seeking connectedness
the motivational principle that people seek support, liking, and acceptance from the people and groups they care about and value

People Value "Me and Mine." The motivational principle of **valuing "me and mine"** means that we are motivated to see ourselves and anything or anyone connected to us, such as our families, teams, nations, or even possessions, in a positive light. Even people with life-threatening illnesses can maintain a positive view of themselves by comparing themselves with others who are even worse off. Our biased views of those who are connected to us often explain why members of different groups see the same events in very different ways. A Princeton fan may view the Dartmouth quarterback's broken leg as an accident—unfortunate, but part of the game of football and certainly not something that reflects badly on the Princeton team. A Dartmouth supporter might blame the injury on a viciously dirty tackle, clear evidence that the Princeton team is incapable of good sportsmanship. Little wonder that these fans came away from the game with very

valuing "me and mine"
the motivational principle that people desire to see themselves, and other people and groups connected to themselves, in a positive light

different views of it, views that emphasized the positive characteristics of their own teams and let them feel good about themselves.

Three Processing Principles

The operation of social and cognitive processes is described by three processing principles: Established views are slow to change, accessible information has the most impact, and processing is sometimes superficial but at other times goes into great depth.

In seeking rewards and connectedness and in valuing me and mine, people and groups gather and interpret information about the world in which they live. Three principles govern the cognitive and social processes that operate as we construct a picture of reality, influence other people, and are influenced by them.

conservatism principle
the processing principle that individuals' and groups' views of the world are slow to change and prone to perpetuate themselves

Conservatism: Established Views Are Slow to Change. The **conservatism principle** states that individuals' and groups' views of the world are slow to change and prone to perpetuate themselves. The Princeton supporters, convinced that their Tigers were the better team, interpreted what they saw through the filter of their beliefs. Their selective perceptions thus supported their views of reality, as did the influence of their group, the equally biased fans around them. Examples of conservatism are almost endless: the first impressions we form of job applicants, the stereotypes we harbor about other groups, or preferences we nurture for the brand of peanut butter Mom always bought. In all these cases and more, the principle is the same: established knowledge tends to perpetuate itself. In the chapters to come you will see why prior beliefs, expectations, and preferences are so hard to change, and you will become more aware of the consequences of their resiliency. You will also appreciate the enormous amount of effort needed to budge them at all.

accessibility principle
the processing principle that the information that is most readily available generally has the most impact on thoughts, feelings, and behavior

Accessibility: Accessible Information Has the Most Impact. From football games to political debates, every social situation provides an incredibly rich array of information—so rich that we could not consider all its details. Consequently, we are likely to consider, remember, and use only a tiny fraction of the potentially relevant information when we make judgments or decisions. The **accessibility principle** states that whatever information is most readily available to us usually has the most impact on our thoughts, feelings, and behavior. In many situations, what comes most easily to mind is what we were already thinking. So, to return to the football example, Dartmouth stalwarts used their conviction that their team is good as a basis for their judgments of what happened. In other situations, we base our judgments on the information that is most easily noticed and interpreted. For many of the students who listened to the probation speech without expecting to be personally affected, enthusiastic applause or disapproving whistles were the most noticeable and had the most impact on their judgments.

Superficiality Versus Depth: People Can Process Superficially or In Depth. Much of the time, people seem to operate on automatic pilot, putting little effort into forming a superficial picture of reality and relying heavily on whatever information is most

accessible. But sometimes, particularly when we notice that events fail to match our expectations or when our important goals are threatened, we take the time and trouble to process information more extensively. These are examples of the principle of **superficiality versus depth**. Confronted with an opposing point of view—one that clearly contradicted their own—students who cared about probation reconsidered their positions. They reviewed the arguments and based their opinions on the content of the speeches rather than on the circumstances of their presentation. Disagreement or rejection challenges not only our sense of mastery and understanding but also our feelings of connectedness, triggering anxiety and uncertainty. Threats to any of our important goals may motivate us to consider information in more depth and to think hard about our own beliefs and actions.

superficiality versus depth the processing principle that people ordinarily put little effort into dealing with information, but at times are motivated to consider information in more depth

The interrelationships among the eight basic principles of social psychology are summarized in Figure 1.1.

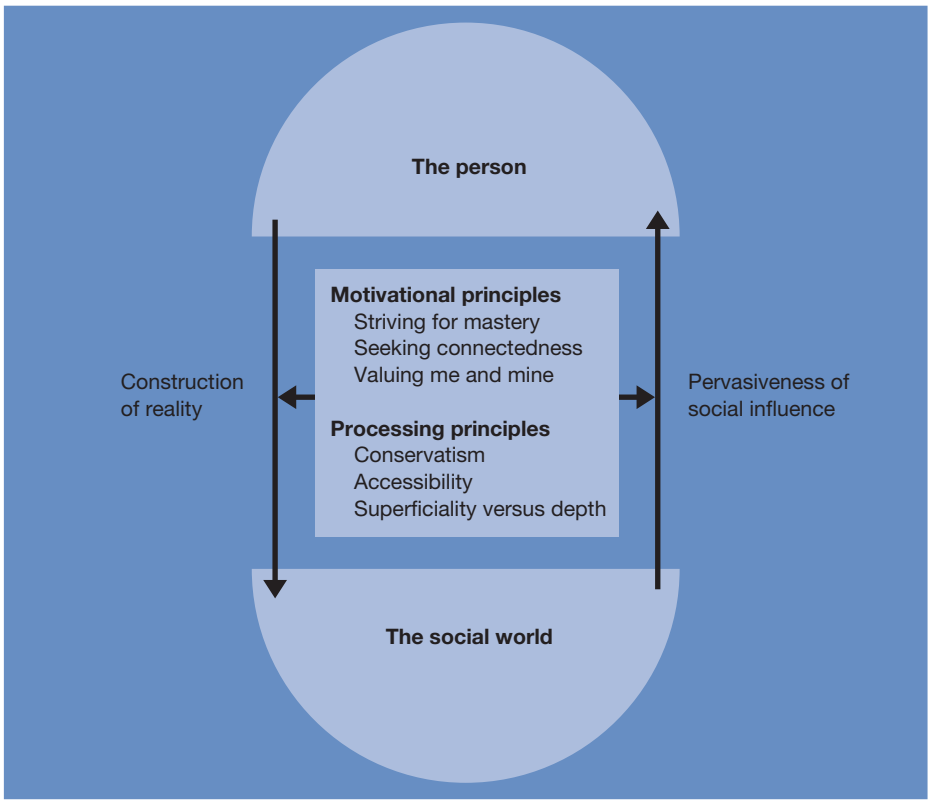


Figure 1.1 Interrelations among the eight basic principles of social psychology
Two fundamental axioms link the individual person to the social world. Each person constructs his or her own picture of social reality, which then guides all thoughts, feelings, and actions. At the same time, the pervasiveness of social influence also affects the person's thoughts, feelings, and behavior. Three motivational principles and three processing principles determine both the nature of the constructed reality and the nature of the social influence.

Common Processes, Diverse Behaviors

In combination, these eight principles account for all types of social behavior, including thoughts and actions that are useful and valuable as well as those that are misleading and destructive.

In combination, then, these eight principles account for all types of social behavior. This includes not only desirable outcomes such as accurate decisions, successful social interactions, and harmonious relationships between groups, but also more problematic and negative forms of behavior. As our examples demonstrate, exactly the same processes that produce useful and valuable outcomes in some situations produce misleading and destructive outcomes in others. Our ability to construct reality allows us to see our world as a coherent and meaningful place, but it also opens the door to bias and misinterpretation. Social influences sometimes provide us with safety in numbers, but they also may lead us like lambs to the slaughter. The drive for connectedness and the value we place on me and mine can give us the warm glow of belonging, but it can also prompt us to reject, devalue, and exclude others not in our chosen circle. Basing decisions on accessible information often produces extremely efficient decision making but sometimes leads to bad decisions. Even when we contemplate information as thoughtfully as possible, we are not always guaranteed an accurate decision. Sometimes the very act of thinking about things can slant our interpretations and introduce mistakes without our being aware of the problem.

Human behavior is not always as simple as it seems, but neither is it impenetrable to scientific inquiry or impossible to understand systematically. In fact, although social behavior is incredibly diverse, this diversity results from the operation of these same few processes. Thus, as you work through chapter by chapter in this text, watch for these principles at work. We offer some help by calling attention to the principles and general themes of the book. In addition, we make special efforts to present theories and research findings as interrelated sets of ideas by placing cross-references to related ideas in the margins. We know that disconnected items of information are hard to remember and do not contribute much to a real understanding of social behavior. We would like you to see this text as an integrated story of (1) the fundamental social and cognitive processes that operate as human beings perceive, influence, and interact with others; and (2) the way social psychologists learn about these processes, both in the laboratory and in the world of everyday life. It is a fascinating story, and we hope you will learn much about yourself and others as you follow it through the text.

PLAN OF THE BOOK

The first two chapters of this text are an introduction to social psychology, covering the "Why?" and the "How?" of our science. The remainder of the book explores the "What?" of social psychology—the topic areas that make up the discipline. In this chapter we have tried to convey why social psychologists ask the questions they do. Chapter 2 tells more about how they seek answers.

- ***Asking and Answering Research Questions.*** Have we convinced you already that people's interpretive processes and social surroundings may bias what they know? Scientists are no exception. Chapter 2 describes the logical checks and balances built into the structure of science that help researchers guard against subjectivity and bias.

Chapters 3 through 14 explore what social psychologists study. Following our definition of social psychology, we deal in turn with how individuals perceive others (Chapters 3–6), influence others (Chapters 7–10), and relate to others (Chapters 11–14). Chapters 3 through 6 focus on social perception, the way we come to know and understand the basic elements of our social world: individuals and social groups.

- ***Perceiving Individuals.*** From fleeting impressions of passing strangers to the intimate familiarity of our best friend, Chapter 3 deals with knowing and understanding other people.
- ***The Self.*** What person is probably most important, most near and dear to each of us? Chapter 4 describes how we understand the self.
- ***Perceiving Groups***. In Chapter 5, we investigate the beliefs and feelings people develop about social groups like working women, Russians, schoolteachers, or Muslims.
- ***Social Identity.*** Chapter 6 brings the topics of Chapters 4 and 5 together in a discussion of how we come to see ourselves as members of a social group and how a group can become part of the self.

Social influence is the impact each of us has on others, and it is the topic of Chapters 7 through 10. The elements of social psychology do not occur in isolation: Each of us is constantly influencing and being influenced by others. Others affect us whether they are in our face, like an aggressive salesperson, or on our minds even when we are alone.

- ***Attitudes and Attitude Change.*** Advertisements aim at our pocketbooks, political campaigns play on our fears, debates appeal to our reason. Do they change our minds? If so, how? Chapter 7 gives some answers to questions like these.
- ***Attitudes and Behavior.*** Under the right circumstances, attitudes both reflect and guide behaviors. Chapter 8 tells a tale of the mutual influence of attitudes and behaviors.
- ***Norms and Conformity.*** A different kind of mutual influence is the focus of Chapter 9. Here we examine how groups reach agreement and why that agreement has such compelling effects on group members.
- ***Norms and Behavior.*** Chapter 10 describes the effects of groups on what people do, not just on what they think. Bringing all the chapters of this section together, we describe how attitudes and group influences combine to affect behavior.

In the final four chapters we concentrate on social relations, the bonds that link us one to another, as individuals and as groups. Whether we are bound by attraction or cooperation, or shackled by aggression and conflict, our relations with others can pull us together or drive us apart.

- ***Interaction and Performance in Groups.*** Small groups—management committees, paramedic teams, juries, and others—do most of society's work. Chapter 11's main topics are how we interact with others in small groups and how groups work to accomplish shared tasks.
- ***Attraction, Relationships, and Love.*** Chapter 12 takes a close look at feelings of attraction to other people and the formation and development of close and loving relationships. We also review what social psychology can tell us about why relationships flourish or wither.
- ***Aggression and Conflict.*** Who can watch the evening news without being struck by the many conflicts that pit person against person or group against group? In Chapter 13 we analyze the path of such conflicts: how they can arise, escalate, and, sometimes, be resolved.
- ***Helping and Cooperation.*** Dramatic incidents of selfless heroism or more commonplace acts of cooperation that benefit others: Why do they occur? Chapter 14 examines the conditions under which we help other people and our reasons for doing so.
- ***Epilogue.*** The text ends with an epilogue, a brief concluding comment that summarizes the major themes and reflects on some of their interrelationships and applications.

As you read this book, we invite you to join us in seeing social-psychological principles at work in people's actions and interactions. Seeing events around you in this framework is the first and most essential step toward becoming a social psychologist, having the fun of doing research that advances our knowledge of how social-psychological principles work, and of applying the principles to real and important problems. But you do not have to do research to use your new knowledge to understand why your friends act as they do, how other people influence you, or what accounts for group conflicts around the world. We hope you will come to appreciate both the usefulness and the excitement of social psychology.

SUMMARY

A Definition of Social Psychology. **Social psychology** is the scientific study of the effects of social and cognitive processes on the way individuals perceive, influence, and relate to others. Like other scientists, social psychologists gather knowledge systematically by means of scientific methods. These methods help produce knowledge that is less subject to the biases and distortions that often characterize common-sense knowledge.

The physical presence of other people, the knowledge and opinions that they pass on to us, and our feelings about the groups to which we belong all deeply influence us through **social processes**, whether we are with other people or alone. Our perceptions, memories, emotions, and motives also influence us through **cognitive processes**. Effects of social and cognitive processes are not separate but are inextricably intertwined.

All types of social behavior, including individuals' perceptions of, influences on, and relationships with others, reflect the operation of social and cognitive processes.

1 Defining and measuring aggression

Everybody knows and uses the word "aggression." Entering it as a search term into Google returns about 50 million entries. It derives from the Latin verb "aggredi", which means "to approach" or "to go to," and has found its way from Latin into a wide range of different languages. But what exactly do we mean when we talk about aggression? Is aggression always a bad thing or can it also be good? Should people refrain from it altogether or is there something like a "healthy" level of aggression that enables people to stand up for themselves in different domains of life? How can we explain why people engage in aggressive behaviour and why some individuals seem to be more aggressive than others? Why is it that a person may be calm and composed in one situation but fly off the handle in another?

Just try and raise these questions with your friends, and you are bound to discover that there is considerable diversity in how people think and feel about aggression, including the question of whether a specific behaviour is an act of aggression or not. Is it aggression to spread rumours about an unfriendly colleague or is this just common workplace behaviour? Is it aggression to smack a child on its bottom or is this just part of normal child-rearing? Is it a form of sexual abuse for a father to take a bath with his 6-year-old daughter, and what if the daughter is not 6, but 13 years old? And is there such a thing as "positive aggression" in the sense of being assertive and forceful?

These questions show that when we talk about aggression, we are talking about a social construction. What is – or is not – considered aggression is determined on the basis of shared values and normative beliefs that vary not only between societies but also over time. As we shall see, corporal punishment was considered a legitimate way of disciplining children until fairly recently, and is still seen and practiced as such by many parents across the world. Similarly, questioning a husband's right to force his wife to have sex with him at his convenience, and calling it sexual aggression instead, is a relatively recent development in the western world, and is a view that is by no means universally shared around the globe.

Given the variety of views about aggression as they are voiced in everyday discourse, it is necessary to begin by taking a close look at the meaning of our key concept as it is commonly used and understood in social psychological research on aggression. To evaluate the research presented in this volume, it is important to be aware of the

understanding of aggression on which this work is based. We need to establish a consensus about the basic criteria for deciding whether or not a given behaviour should be classified as aggressive, and to think about ways of categorising different forms of aggression so as to gain an understanding of the multiplicity of forms in which aggressive behaviour presents itself.

In addition to dealing with the definition of aggression, a closer look at the available methods and data sources for measuring it is required to facilitate a critical appraisal of the current body of knowledge. Among psychologists, it is commonplace to state that research findings cannot be properly understood without considering the methods by which they were obtained. However, in the public debate about aggression, conclusions about causes and consequences of aggression are typically traded without much concern for their methodological foundations. A case in point is the controversy about the detrimental effects of exposure to media violence, in which each side refers to research results selected to corroborate their views without acknowledging that differences in conclusion often result from differences in methodology. Therefore it seems appropriate that a review of the scholarly literature on aggression should start by looking at the definitions and methodological strategies adopted in this body of research.

What is aggression?

The term "aggression" is as firmly established in ordinary language as it is in the vocabulary of social psychologists. Unfortunately, using the same term does not necessarily imply agreement about what exactly it is supposed to mean, and this is clearly the case with aggression. For example, when prompted for their understanding of aggression, laypersons often talk about "good" or "healthy" aggression as opposed to "bad" aggression. However, most social psychologists have focused on aggression as a negative form of social behaviour that causes problems between individuals, groups, and societies.

Beyond the basic consensus about conceptualising aggression as a form of negative or antisocial behaviour, more precise definitions are needed to lay down the criteria for a specific behaviour to be categorised as "aggressive." A classic definition was proposed by Buss (1961, p. 1), who characterised aggression as "a response that delivers noxious stimuli to another organism." However, this purely behaviourist definition is too broad in some ways and too narrow in others. It is too broad because it includes many forms of behaviour that should not be categorised as aggression, such as accidental infliction of harm. At the same time, it is too narrow because it excludes all non-behavioural processes, such as thoughts and feelings, and behaviours that are intended to cause harm but which, for whatever reason, fail to achieve their objective.

Additional aspects were subsequently included to address the limitations of a purely behaviourist definition (for a comprehensive discussion, see also Tedeschi & Felson, 1994, Chapter 6). For a person's behaviour to qualify as aggression, the behaviour must be carried out with the *intention* of inflicting harm on the target, which in turn presupposes the *anticipation* that the action will produce a particular outcome. Introducing these additional

criteria means that *excluded* from the definition are behaviours that result in unintended harm or injury (e.g., by accident or through lack of foresight). At the same time, the definition *includes* behaviours that are aimed at harming another person but which, for whatever reason, do not have the intended consequences. According to this criterion, a gunshot that misses its target represents an aggressive act even though not a hair on the target's head may have been harmed. Focusing on the person's intention to harm also allows non-action, such as the deliberate withholding of care or failure to help a person in need, to be classified as aggressive. A further specification refers to the desire of the target person to *avoid* the harmful treatment. This is to exclude cases of harm inflicted with the target person's consent, such as painful medical procedures or injury inflicted in the context of sadomasochistic sexual practices.

A concise definition that takes these considerations into account was offered by Baron and Richardson (1994, p. 7). They suggested that the term "aggression" should be used to describe "*any form of behavior directed toward the goal of harming or injuring another living being who is motivated to avoid such treatment.*" Their definition is widely accepted (Parrott & Giancola, 2007), and it has also been adopted in the present volume. Broadly speaking, "harm" denotes any form of treatment that is not wanted by the target persons, such as causing them physical injury, hurting their feelings, damaging their social relationships by spreading rumours about them, or taking away or destroying their cherished possessions. It is important to add that, of course, individuals may act aggressively against themselves up to the point of taking their own life. However, this form of self-inflicted harm does not fall within the above definition, as it does not involve harming "another person who is motivated to avoid such treatment." Therefore self-harm is outside the focus of the social psychological perspective on aggression adopted in this volume.

In terms of distinguishing aggression from other forms of social behaviour, the definition offered by Baron and Richardson (1994) has three important implications:

(1) Aggressive behaviour is characterised by its underlying motivation (to harm or injure another living being), *not* by its consequences (whether or not harm or injury actually occurs). This means that a behaviour is regarded as aggressive if it was guided by the intention to harm, even if no damage was done to the target. As noted above, a shot fired from a gun may miss its target, but if it was intended to hit the target, pulling the trigger is nonetheless an aggressive act.
(2) A necessary feature of the intention to harm is the actor's understanding that the behaviour in question has the potential to cause harm or injury to the target. If one person's actions lead to harm or injury of another, but the actor could not have anticipated that the behaviour could lead to those adverse effects, they do not represent instances of aggression. They could be due to carelessness or incompetence, but they do not reflect an intention to harm.
(3) Defining aggression as behaviour that the target would want to avoid means that actions that may cause harm but which are performed with the target's consent, such as painful medical treatment, do not represent instances of aggression.

Aggression can take a great variety of specific forms. Rather than presenting a long and necessarily incomplete list of behaviours that are categorised as aggressive, it is useful to try to identify aspects by which different manifestations of aggression may be distinguished. There are different taxonomies proposed in the literature (e.g., Parrott & Giancola, 2007), each highlighting different aspects. A list of the many faces of aggressive behaviour that is considered useful for capturing the research presented in this volume is presented in Table 1.1.

As with any typology, some forms of aggression may fit into more than one category. This is true, for example, for relational aggression, which is often treated as a response modality that is distinguished from physical aggression, but it is also seen as a form of indirect aggression because it involves acting against other people behind their back (Archer & Coyne, 2005). Furthermore, the different aspects are not mutually exclusive, and indeed they need to be considered in conjunction to properly understand specific forms of aggression.

Table 1.1 The many faces of aggressive behaviour

Aspect	*Examples*
Response modality	
Verbal	• Shouting or swearing at someone
Physical	• Hitting or shooting someone
Postural	• Making threatening gestures
Relational	• Giving someone "the silent treatment"
Immediacy	
Direct	• Punching someone in the face
Indirect	• Spreading rumours about someone behind their back
Response quality	
Action	• Making another person engage in unwanted sexual acts
Failure to act	• Withholding important information from a colleague at work
Visibility	
Overt	• Humiliating someone in front of others
Covert	• Sending threatening text messages to a classmate
Instigation	
Proactive/unprovoked	• Grabbing a toy from another child
Reactive/retaliative	• Yelling at someone after having been physically attacked
Goal direction	
Hostile	• Hitting someone out of anger or frustration
Instrumental	• Taking a hostage to secure a ransom
Type of harm	
Physical	• Broken bones
Psychological	• Fears and nightmares
Duration of effects	
Transient	• Minor bruises
Lasting	• Long-term inability to form relationships
Social units involved	
Individuals	• Intimate partner violence
Groups	• Riots and wars

For example, aggression can be driven by primarily hostile rather than instrumental motives, expressed overtly, in physical terms, and reactively as a response to a preceding provocation.

Although most of the distinctions in Table 1.1 are self-explanatory, some of them require further comment. In the last ten years or so, much emphasis has been placed on the distinction between *direct* and *indirect* aggression. Direct aggression involves a face-to-face confrontation between the aggressor and the target, whereas indirect aggression is aimed at harming other people behind their back by spreading rumours about them or otherwise damaging their peer relationships (Björkqvist, Lagerspetz, & Österman, 1992). As noted above, the term *relational aggression* is also used by some authors instead of indirect aggression to denote aggression aimed at damaging the target person's social relationships (Crick & Grotpeter, 1995). Because indirect/relational aggression can be inflicted covertly, without the target being aware of the aggressor's identity, it represents an alternative strategy for harming another person when the costs of engaging in direct forms of aggression would be high (see also Chapter 3 for a detailed discussion of direct and indirect aggression in the context of gender differences).

The distinction between hostile and instrumental aggression refers to the psychological *function* of the aggressive behaviour for the actor. The primary motive for aggressive behaviour may be either the desire to harm another person as an expression of negative feelings, as in *hostile* aggression, or the aim of achieving an intended goal by means of the aggressive act, as in *instrumental* aggression. The two types of motivation for aggressive behaviour frequently coexist. Nevertheless, we shall see when discussing theories of aggressive behaviour that it makes sense to look at them separately, because different psychological processes may be involved (however, for a critical analysis of the instrumental/hostile distinction, see Bushman & Anderson, 2001).

An additional feature to be considered when defining aggression refers to the normative appraisal of the behaviour in question. There has been some controversy as to whether or not the aspect of *norm violation* should be included among the defining features of aggression, which is why it was not listed in Table 1.1. Disciplinary measures used by teachers and acts of physical self-defence are examples of behaviours that satisfy the criteria of intention, expectancy, and the target's desire to avoid them, and should accordingly be classified as aggressive. Yet they are covered by social norms that turn them into accepted forms of social behaviour. Therefore it has been argued that behaviour should only be considered aggressive if it involves the violation of a social norm. However, as Berkowitz (1993) has pointed out, defining aggression in terms of norm-violating or socially unacceptable behaviour has the problem that the normative evaluation of a behaviour frequently differs depending on the perspectives of the parties involved. For example, some people regard corporal punishment as an acceptable and effective child-rearing practice, while others consider it to be an unacceptable form of aggression.

A similar point can be made with regard to the distinction between *legitimate* and *illegitimate* aggression. Capital punishment, for example, satisfies all elements in the definition by Baron and Richardson (1994). Actions are carried out with the intention and expectancy of inflicting harm on the convicted person, who is motivated to avoid such

treatment. However, these actions are legitimised in the laws of many countries. Is it therefore appropriate to regard them as aggression, provided that the legal procedures are properly conducted? Although many people will reject this idea, others may have a different view. In the absence of explicit legal regulations, the question of legitimacy becomes even more difficult. Are violent acts committed by separatist movements or marginalised minorities legitimate or illegitimate forms of aggression? It is obvious that the answer to this question will depend to a large extent on the position a person takes in the underlying controversy. Therefore, although issues of norm violation and legitimacy are highly relevant, for example, when analysing dynamics of intergroup encounters or justifications for aggressive behaviour, they are problematic to accommodate as critical features in a basic definition of aggression.

Before turning from the definition to the measurement of aggressive behaviour, we should briefly look at the meanings of three related terms, namely antisocial behaviour, coercion, and violence. *Antisocial behaviour* denotes behaviour that violates social norms of appropriate conduct (DeWall & Anderson, 2011). It is a broader construct than aggression in that it includes behaviours that are not intended to harm other people, such as vandalism or lying. *Coercion* is defined by Tedeschi and Felson (1994, p. 168) as "an action taken with the intention of imposing harm on another person or forcing compliance." Defined in this way, coercion can be seen as a form of instrumental aggression. Coercive action can take the form of threats, punishments, or bodily force, and it is directed as much at gaining compliance as at causing harm. Coercion is seen as a form of social influence, which highlights the social nature of this type of behaviour and brings it conceptually closer to processes of communication and interaction not previously examined in the context of aggression.

In contrast to antisocial behaviour and coercion, which are broader constructs than aggression, the term *violence* is more narrow in meaning and is restricted to behaviours carried out with the intention of causing serious harm that involve the use or threat of *physical force*, such as hitting someone over the head, or – in the ultimate form – taking another person's life. Thus not all instances of aggression involve violence (e.g., shouting at someone would be described as aggressive, but not violent), but all acts of violence qualify as aggression. Violence is defined by social psychologists as "the infliction of intense force upon persons or property for the purposes of destruction, punishment, or control" (Geen, 1995, p. 669), or as "physically damaging assaults which are not socially legitimised in any way" (Archer & Browne, 1989, p. 11). These definitions by psychologists are in line with the definition proposed by the World Health Organization, which describes violence as "the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation" (Krug et al., 2002, p. 4). A functional typology of violence has been presented by Mattaini, Twyman, Chin, and Lee (1996), who identified six potential functions of violent behaviour: (1) change of, or escape from, aversive situations; (2) positive reinforcement (i.e., attainment of a particular goal); (3) release of negative affective arousal; (4) resolution of conflict; (5) gaining of respect; and (6) attack on a culturally defined "enemy," (i.e., a member of a devalued out-group).

A special form of violence has been termed structural violence and denotes societal conditions that entail harmful consequences for certain social groups. Structural violence is seen as a latent feature of social systems that leads to social inequality and injustice – for example, by institutionalising a power hierarchy between men and women which leaves women largely unprotected against male sexual coercion (Lubek, 1995). In the present analysis, the focus will be on violence between individuals and social groups, but issues of structural violence will also be touched upon in several places in the course of this volume.

How to measure aggression

Obtaining measures of aggressive behaviour poses particular challenges for researchers due to its potentially harmful nature. When studying prosocial behaviour, creating situations in which research participants may give help to others is not problematic from an ethical point of view. By contrast, it would be highly unethical to set up experimental situations in which research participants are given the opportunity to inflict genuine harm on another person, to make them targets of other participants' aggressive behaviour, or to expose them to treatments that are expected to increase the likelihood of subsequent aggression. With regard to studying aggression in real life outside the laboratory, other problems arise. With the exception of unusual circumstances, such as war or civil unrest, acts of severe aggression are relatively rare in everyday life, and are therefore hard to measure in natural contexts. Therefore the methodological toolbox available to aggression researchers is quite limited. Table 1.2 presents an overview of the different methods used by social psychologists to study aggressive behaviour as well as aggressive thoughts and feelings.

Broadly, measures of aggression rely either on observation or on reporting. Observational methods enable researchers to gain first-hand evidence of aggressive behaviour in a given situation, either in the laboratory or in the field. Measures based on reporting provide them

Table 1.2 Summary of methods for studying aggression

Observing behaviour in natural contexts	• Naturalistic observation • Field experiments
Observing behaviour in the laboratory	• Essay evaluation paradigm • Teacher–learner paradigm • Competitive reaction time paradigm • Hot sauce paradigm • Cold water paradigm
Collecting reports of aggressive behaviour, thoughts, and feelings	• Self-reports of aggressive behaviour • Parent or teacher reports • Peer nominations • Measures of anger and hostility • Implicit Association Text • Projective techniques
Using official records	• Crime statistics • Archival data

with second-hand accounts of aggressive behaviour that can cover longer periods of time and a wider spectrum of situations. The approaches in each group have both strengths and limitations, as will become evident in the following discussion.

Observing aggressive behaviour in natural contexts

Observing aggression "in the field" (i.e., under natural conditions) is a good strategy because information can be collected in an unobtrusive way without people realising that their behaviour is being observed and recorded. With a behaviour such as aggression that everybody knows to be socially undesirable, this is a particular asset because it avoids the problem of measurement *reactivity* (i.e., people's tendency to change their usual patterns of behaviour because they are aware that they are under observation). At the same, the fact that people are not made aware that they are being observed – and therefore have no chance to opt out – poses particularly strict ethical constraints on this type of method. Observational measures in natural contexts mainly come in two forms: *naturalistic observation* in which the researcher records behaviour as it unfolds naturally without manipulating the situation in any way, and *field experiments* that involve a systematic yet unobtrusive manipulation of certain variables to observe the effects of that manipulation on the likelihood of aggressive behaviour.

Naturalistic observation

One aim of observation in natural contexts is to obtain a picture of the various forms of aggression in a particular setting, and the frequency with which they occur. For example, Graham and Wells (2001) conducted an observational study in 12 bars in Ontario, Canada, to record the frequency of aggressive incidents among young adults. Aggressive incidents were defined as involving "personal violation (verbal insults, unwanted physical contact), behavior that was offensive according to the norms of the place, or a dispute in which the participants had personal investment" (p. 197). Trained observers were positioned in different parts of the bar and recorded each aggressive incident. They observed, for example, that 77.8% of the incidents involved men only, 3.4% of them involved women only, and the remaining incidents involved both men and women. In a third of all incidents, severe physical aggression (e.g., kicking, punching, brawling) took place.

The use of naturalistic observation with children is illustrated by a study by Ostrov and Keating (2004). Trained observers watched preschool children during a free play situation and recorded their behaviour as physical aggression (e.g., hitting, pushing, punching), verbal aggression (e.g., antagonistic teasing, calling mean names), or relational aggression (e.g., excluding from playgroup, ignoring a peer). Frequency counts of behaviours in each category were summed up to yield physical, verbal, and relational aggressiveness scores for each child.

In this type of research, the natural flow of behaviour is first recorded, then broken down into more fine-grained units of analysis, and finally assigned to the pre-defined categories.

Questions of when and where to sample behaviour and how to define the basic units of analysis are central to this methodological approach (e.g., Wehby & Symons, 1996). Moreover, it is important to check how reliably the units can be assigned to the different categories by examining the correspondence achieved by independent coders.

Field experiments

Another line of research using observation in natural contexts is directed at exploiting inconspicuous everyday situations to examine the link between certain antecedent conditions and subsequent aggressive responses. Unlike naturalistic observation, where there is no interference with the situation itself, field experiments involve the unobtrusive variation of one or more variables in order to assess their impact on aggressive behaviour as the dependent variable. For example, to test the prediction that de-individuation (not being personally identifiable; see Chapter 9) would lower the threshold for aggression, Rehm, Steinleitner, and Lilli (1987) asked a group of fifth-grade students to dress in identical T-shirts for their sports lessons, ostensibly so that a new teacher would find it easier to tell them apart from members of the opposing team who wore their own clothes. The number of aggressive acts during the ensuing handball game was recorded by two independent observers who were unaware of the experimental hypotheses. Students who were wearing the uniform T-shirts committed more aggressive acts than students who were wearing their own clothes, supporting the prediction that anonymity increases the likelihood of aggressive behaviour.

As another example of a field experiment, Baron (1976) studied behaviour in a common traffic situation to test the hypothesis that drivers would show more aggressive behaviour when they were frustrated. Frustration was manipulated by the time that a confederate took to move his car when the traffic lights turned green (Baron, 1976). The dependent variable was drivers' aggressive behaviour, defined in terms of latency and duration of horn honking. In support of his prediction, Baron showed that the drivers, who were unaware that they were taking part in an experimental study, honked faster and longer when the confederate took longer to move his car. Similarly, a field experiment by Harris (1974) showed that people waiting in a queue responded more aggressively if a confederate jumped in close to the head of the queue (high frustration) than when he jumped in closer to the end of the queue (low frustration).

Despite their advantages in terms of allowing the analysis of naturally occurring behaviour uncontaminated by social desirability concerns, many additional variables may operate in field situations which are not under the experimenter's control. Suppose, for example, that the queue-jumping approach was to be used to study the aggressive responses of people waiting for a bus. There would be a problem if, in some of the trials, the bus for which people were waiting was 15 minutes late at the time of the experimental intervention, creating an additional and powerful source of frustration that might contaminate the effects of the queue-jumping manipulation. In addition, a key feature of experimental research, namely the random allocation of participants to experimental conditions, is often not possible in natural contexts without making people aware that they are part of an experiment.

Observing aggressive behaviour in the laboratory

The lack of control over so-called "third variables" that might interfere with the experimental variations and problems with the assignment of respondents to experimental treatments are the main reasons why the vast majority of observational studies on aggressive behaviour have been conducted as *laboratory experiments*. In this setting, situations can be created by the investigator to meet three essential criteria:

(1) that respondents are exposed to an experimental manipulation aimed at influencing their aggressive response tendencies
(2) that they can be randomly assigned to the experimental and control conditions
(3) that many factors which might influence participants' behaviour over and above the experimental treatment can be controlled.

Experimental studies of aggression need to resort to paradigms in which participants can show behaviour *intended* to harm another person without actually allowing real harm to be inflicted on anyone. Several experimental paradigms have been developed to address this challenge by creating situations in which participants are given the opportunity to deliver a range of different aversive stimuli to another person without actually causing them any harm (Ritter & Eslea, 2005). Each paradigm uses a somewhat different cover story to disguise the true purpose of the measure.

(1) The *teacher–learner* paradigm. This paradigm uses the set-up of an alleged learning experiment in which one person adopts the role of a teacher and presents a word association learning task to another person, the learner. In the first round, pairs of words are presented to the learner. In the second round, only the first word of each pair is presented, and the learner has to correctly remember the second word of the pair. Errors made by the learner are punished by the teacher through administering aversive stimuli. Unbeknownst to the participants, assignment to the two roles is rigged so that the participant always ends up as the teacher, and the learner is a confederate of the experimenter. The participant's choice of punishment intensity represents the measure of aggressive behaviour. In the original version of this paradigm, punishments are delivered in the form of electric shocks, the strength of which is determined by the teacher. This procedure, which is probably better known from the famous study of obedience by Milgram (1974) than from the context of aggression research, was pioneered by Buss (1961). He developed an "aggression machine" that enabled respondents to choose the *intensity* and the *duration* of electric shocks which they thought would be delivered to the learner whenever he made a mistake (no shocks were actually delivered, but respondents received mild shocks in a trial run to convince them that the device was genuine). In later studies, electric shocks were replaced by other aversive stimuli, such as loud noise (e.g., Edguer & Janisse, 1994) or air blasts to the throat (Verona & Sullivan, 2008), and the intensity and duration chosen by the participant

were used as measures of aggressive behaviour. The teacher–learner paradigm provides an experimental framework in which the effects of a variety of independent variables on aggression may be studied (Baron & Richardson, 1994). Differences in aggressive responding may be examined, for example, as a function of respondents' group membership (male vs. female; prisoners vs. students) or situational manipulations (different degrees of frustration or physiological arousal). However, a criticism of the teacher–learner paradigm has been that if they accept the cover story, participants may be motivated by prosocial concerns in that they want to help the alleged learner to improve his task performance, rather than show aggressive behaviour. In addition, it can only measure proactive/unprovoked aggression, as the learner has no opportunity to retaliate. These problems were addressed, at least to some extent, in other paradigms.

(2) The *essay evaluation* paradigm. In this paradigm, the aggressive behaviour consists of delivering negative evaluations of an essay purportedly written by the target person. This paradigm has been used to investigate aggressive behaviour in response to preceding frustration or provocation, and was first introduced by Berkowitz (1962). Participants are told that they are to provide a written solution to a problem-solving task which will then be evaluated by a fellow participant, who is in fact a confederate of the experimenter. They are also informed that the evaluation will be expressed in terms of the number of electric shocks delivered by the evaluator, with one shock indicating the best possible and ten shocks indicating the worst possible evaluation. Irrespective of the quality of their solution, participants then receive either few or many shocks, depending on whether they are in the provocation or control condition. In the second and main phase of the experiment, the roles are reversed and the participant gets the chance to evaluate the solution provided by the other person. The number of shocks administered indicates the strength of the aggressive response. Typically, more shocks are administered to a target person who is seen as responsible for a negative evaluation of the actor in the first round of the experiment, supporting the hypothesis that provocation leads to aggression. The essay evaluation paradigm has been modified by later studies that replaced electric shocks with other aversive stimuli, such as the level of negative verbal feedback in the essay evaluation (e.g., Krahé & Bieneck, 2012). Vasquez, Denson, Pedersen, Stenstrom, and Miller (2005) adapted the paradigm to use feedback about participants' performance on an anagram task rather than an essay, and used the length of time for which participants made the target persons submerge their hands in unpleasantly cold water as a measure of aggression. Beyond addressing the role of anger or provocation, this experimental set-up allows researchers to examine additional variables moderating the effects on aggression. A case in point is Berkowitz and LePage's (1967) well-known study on the so-called "weapons effect", which will be examined in more detail in Chapter 2. They showed that when participants were angered they showed more aggression towards the person who was the source of the anger in the presence of an aggression-related cue (such as a revolver) than in the presence of a neutral object (such as a badminton racket).

(3) The *competitive reaction time (CRT)* paradigm. Using a different cover story, this widely used paradigm leads participants to believe that they are engaging in a competitive reaction time task against another participant. It is also referred to as the Taylor Aggression Paradigm (TAP), as it was first introduced by Taylor (1967). When a visual cue appears on a screen, the participants have to press a button, and the person who presses the button first is the winner of that trial. Before each trial, the participants have to set the intensity of the aversive stimulus delivered to their opponent in case they win, which represents the measure of aggressive behaviour. In the original version developed by Taylor (1967), electric shocks were used as aversive stimuli. Because success and failure of the naive participants are in fact predetermined by the experimenter, each genuine participant receives, as well as delivers, a set number of shocks in the course of the task. In order to make sure that participants perceive the shocks to be aversive but not painful, each participant's threshold of unpleasantness is established in a pilot phase. As the naive participants are always programmed to win the first trial, the intensity they set for the first trial yields a measure of proactive or unprovoked aggression. After the first trial that they lost and in which they received a shock from their alleged opponent, participants' subsequent intensity levels reflect the strength of their reactive or retaliative aggression. Rather than delivering electric shocks, recent studies have used other aversive stimuli, such as unpleasantly loud noise (Bartholow & Anderson, 2002), and measured the intensity and duration chosen by the participant as a measure of aggressive behaviour. Yet other studies have replaced the electric shocks with points deducted from an opponent so as to reduce the other person's reward (e.g., Stadler, Rohrmann, Steuber, & Poustka, 2006).

As noted by Giancola and Parrott (2008), there is ample evidence for the validity of the CRT as a measure of aggressive behaviour. Several studies have shown that the extent to which participants deliver aversive stimuli was significantly correlated with trait measures of aggression (see, however, Ferguson & Ruda, 2009, for disconfirming evidence) and also differentiated between individuals with and without a history of violence. In their own study, Giancola and Parrott (2008) showed that the intensity of electric shocks was more closely related to trait measures of physical aggression than to trait measures of verbal aggression, anger, or hostility, as one would expect from a measure intended to inflict physical harm. A criticism raised about the standard format of the CRT concerns the absence of a non-aggressive response option. Participants can only choose to deliver more or less aversive shocks or noise blasts, the procedure does not allow them to refrain from delivering aversive stimuli altogether. To address this criticism, modifications have been proposed to include non-aggressive response options (Bushman, 2002; Reidy, Shirk, Sloan, & Zeichner, 2009).

(4) The *hot sauce* paradigm. This strategy for measuring aggression also consists of delivering unpleasant stimuli to a target person, this time in the form of setting the amount of hot spicy sauce to be consumed by a target person who allegedly dislikes this kind of food (Lieberman, Solomon, Greenberg, & McGregor, 1999; McGregor et al., 1998). Participants are first made to taste the sauce themselves before being given the

chance to allocate a portion to a person whom they believe strongly dislikes spicy food. The selected quantity of sauce is weighed and constitutes the measure of aggressive behaviour. Using this method, Ayduk, Gyurak, and Luerssen (2008), found that participants allocated more hot sauce to a target person who rejected them as a potential partner in the experiment than to a target person who chosen them as a partner. Meier and Hinsz (2004) showed that participants allocated more hot sauce to a target person when they were in a group than when they acted individually and gave more hot sauce to each target when targets were in a group rather than encountered as individuals. Barlett, Branch, Rodeheffer, and Harris (2009) extended the method by giving their participants a choice of sauces that differed in their degree of hotness. Using a combined index of the hotness of the sauce selected and the quantity assigned to the target person, they were able to show that participants who had played a violent video game subsequently showed more aggressive behaviour than those who had played a non-violent video game. The hot sauce measure yields an easily quantifiable index of aggressive behaviour. Moreover, it is ethically feasible because it does not lead to any harmful effects other than, perhaps, temporary discomfort in the participants as a result of having to test a small quantity of the sauce themselves.

Each of the paradigms discussed so far uses deception (concealing the true purpose of the experiment) to make participants believe that they are harming another person. In addition to obtaining ethical approval for the chosen procedures beforehand, it is important to stress that participants in these experiments have to be carefully debriefed to explain the true purpose of the experiment, and to reassure them that they did not inflict any real harm on another person.

Critique of laboratory measures of aggressive behaviour

Although the experimental procedures discussed in this section have generated a strong body of knowledge on aggressive behaviour, their prominence has not been uncontroversial. The main challenge refers to their validity – that is, the extent to which they (a) represent the underlying theoretical construct of aggression (construct validity), and (b) can explain aggressive behaviour occurring outside the laboratory in the "real world" (external validity). In terms of construct validity, the criticism has been raised that the different approaches are potentially susceptible to alternative interpretations of what is taken to be aggressive behaviour. In the teacher–learner paradigm, participants may choose high levels of shock because they want to help the learner to accomplish his learning task more effectively. In the essay evaluation paradigm, high shock intensities may similarly reflect compliance with the cover story, namely to provide critical feedback on a person's problem-solving success. In the competitive reaction time paradigm, participants' responses may be motivated by competitiveness rather than by aggression. As far as external validity is concerned, critics have pointed out that the artificial and impoverished nature of many laboratory settings is a far cry from those contexts in which aggression occurs as a social problem in the real world.

Thus it has been questioned whether evidence gained from laboratory studies can contribute to a better understanding of aggression as it occurs in natural contexts. Without being able to review the controversy in detail (see Anderson & Bushman, 1997; Berkowitz, 1993; Ritter & Eslea, 2005 for comprehensive discussions), two main lines of reasoning have been advanced in defence of the use of laboratory experiments in the study of aggression:

(1) Experimental procedures for measuring aggressive behaviour can be said to have high construct validity (i.e., to measure the same underlying construct) if they meet the following requirements. First, a person's responses should be correlated across different indicators of aggression, such as duration and intensity of shocks versus negative verbal feedback or amount of hot sauce. This means that if Person A delivers more intensive electric shocks than Person B, then Person A should also give more negative feedback or allocate more hot sauce compared with Person B. Secondly, the different measures of aggression should be triggered by the same antecedent conditions. This means that if the induction of negative affect is found to elicit higher shock intensities compared with a control condition, it should equally result in higher amounts of hot sauce or more intense noise blasts being administered to a target person. Integrating results from over 100 published studies, Carlson, Marcus-Newhall and Miller (1989) examined these aspects of construct validity, and concluded that "critics have gone too far in rejecting outright the thesis that specific aggression measures typically index a common behavioral disposition" (p. 386).
(2) The second criticism refers to a lack of external validity (i.e., the failure to generalise to aggressive behaviour in the real world). This criticism was tackled by Anderson and Bushman (1997; Bushman & Anderson, 1998). They conducted a meta-analysis including 53 studies of laboratory and real-world aggression to explore the correspondence between the two sources of data across a range of independent variables. Meta-analysis is a statistical procedure in which the results from a number of individual studies are converted to a common metric and then integrated into a quantitative index of effect size, indicating the magnitude of the difference between two variables, such as location of a study in the laboratory versus the real world, across the entire range of studies (Glass, McGaw & Smith, 1981). More specifically, Anderson and Bushman (1997) looked for converging evidence concerning the role of individual difference variables (sex, trait aggressiveness, and type A personality; see Chapter 3) and situational variables (provocation, alcohol, media violence, anonymity, and temperature; see Chapters 4 and 5) as determinants of aggressive behaviour. With the exception of temperature, for which the laboratory evidence was inconsistent both in itself and with field research, they found substantial convergence across the two data sources. In both laboratory and field research, aggression was found to increase as a function of provocation, alcohol consumption, anonymity, and exposure to violent media content. Aggression was also found to be higher in both settings for men (physical aggression only) and for individuals with high trait aggressiveness and type A behaviour patterns. It is worth noting, however, that the magnitude of the effects varied across the two approaches. For example, the effect of violent media content was found to be higher in laboratory

experiments than in field studies, whereas the link between trait aggressiveness and behavioural aggression was stronger in field studies than in the laboratory. As Bushman and Anderson (1998) have pointed out, these differences are conceptually plausible. They argue that the stronger effect size for the impact of trait aggressiveness on aggressive behaviour found in field studies was to be expected, because laboratory studies mostly involve relatively homogeneous samples of college students, whereas variability in trait aggressiveness is greater among the largely unselected samples observed in many field studies. In contrast, the effect of media violence on aggressive behaviour was expected to be stronger in the laboratory, because the time interval between exposure to media violence and measurement of subsequent aggression is typically shorter in laboratory experiments, and extraneous influences that might undermine the impact of the media stimuli can be controlled more effectively in the laboratory.

In conclusion, the analysis by Anderson and Bushman (1997) shows that the unquestionable advantage of laboratory experiments (i.e., their ability to test causal hypotheses in a controlled context) is not necessarily undermined by a lack of external validity (for a similar appraisal, see Berkowitz, 1993). Therefore laboratory studies are of prime importance for testing cause–effect hypotheses and illuminating conceptual links between instigating variables, aggressive behaviour, and its consequences. On the other hand, they do not allow researchers to study severe manifestations of aggressive behaviour which would be unethical to elicit deliberately. Therefore, there is clearly a need for additional methodological tools for studying aggressive behaviour.

Collecting reports of aggressive behaviour

Obtaining behavioural records through direct observation is not always feasible. As noted above, the dangerous and potentially damaging nature of aggressive acts prevents researchers from creating conditions in their laboratories under which such behaviours might be observed. Moreover, many aggressive acts occur without prior warning, or only come to light after they have been performed. This is typically the case for acts of violence, such as physical assault, rape, or homicide. In these cases, researchers have to rely on reports of aggressive behaviours rather than gaining first-hand evidence of their occurrence. In other contexts, research questions may be focused not on behaviours, but on internal variables, such as aggressive thoughts and fantasies, that are not open to observation. An overview of different strategies for collecting reports about aggression is presented in the third part of Table 1.2. Most of these methods are commonly used techniques of data collection that can be applied to the measurement of aggression.

Self-reports of aggressive behaviour

In this approach, participants are asked to provide reports of their own aggressive behaviour. The reports can either refer to general patterns of behaviour that reflect trait aggression, such as how characteristic particular aggressive behaviours are for the person, or they can refer to

the frequency of specific behaviours shown in the past, such as how many times in the last year the person has spread rumours about a colleague at work.

Probably the best-known general measure of dispositional or trait aggression relying on self-reports is the Aggression Questionnaire (AQ) developed by Buss and Perry (1992). Based on the earlier Buss-Durkee Hostility Inventory (Buss & Durkee, 1957), the AQ measures the habitual tendency to engage in physical aggression and verbal aggression. In addition, it contains two scales measuring individual differences in anger and hostility, seen as important affective correlates of aggressive behaviour. Box 1.1 shows the full set of all 29 items of the AQ together with mean scores for men and women in the original study by Buss and Perry (1992). You can assess your trait aggression by completing the items in Box 1.1 and comparing your mean score on each scale with the original sample.

The AQ has been translated into several other languages (e.g., Herzberg, 2003, for a German version; Santisteban, Alvarado, & Recio, 2007, for a Spanish version), and has undergone some extensions (Buss & Warren, 2000) and modifications (Bryant & Smith, 2001). It remains one of the most widely used instruments for measuring trait aggression.

As can be seen from the items in Box 1.1, the behavioural scales of the AQ are limited to the measurement of direct physical and verbal aggression. Other self-report measures have recently been developed to measure individual differences in indirect and relational aggression. The Richardson Conflict Response Questionnaire (RCRQ; Richardson & Green, 2003) contains 10 items that measure direct verbal and physical aggression (e.g., "threw something at them," "yelled or screamed at them") and 10 items that measure indirect, relational aggression (e.g., "gossiped about the person behind their back") as behaviours shown when angry.

Recording self-reports of aggression is not limited to the perpetrator perspective. It is also a viable strategy for collecting evidence on victimisation by aggressive others. For example, Forrest, Eatough, and Shevlin (2005) developed the Indirect Aggression Scales (IAS) that contained the same set of items from the aggressor perspective (e.g., "criticised another person in public") and from the target perspective ("someone criticised me in public").

Another aspect of indirect aggression is captured in the Displaced Aggression Questionnaire (DAQ) by Denson, Pedersen, and Miller (2006). The DAQ was designed to measure individual differences in the tendency to engage in displaced aggression. Displaced aggression is said to occur when people shift their aggressive response to a provocation or frustration away from the original source onto an innocent target (see Chapter 2 for a more detailed discussion). The DAQ was developed to capture stable individual differences in the tendency to displace aggression, and consists of three subscales, addressing Angry Rumination (e.g., "I often find myself thinking over and over about things that have made me angry"), Revenge Planning ("I have long living fantasies of revenge after the conflict is over"), and Displaced Aggression at the behavioural level ("I take my anger out on innocent others").

Each of the measures discussed so far was designed to assess aggressive behaviour in a wide range of contexts. In addition, self-report measures are available that are custom-tailored to specific manifestations of aggressive behaviour in different domains, such as sexual aggression, aggressive driving, or school bullying. In the area of sexual aggression,

BOX 1.1 Items from the Aggression Questionnaire (AQ) by Buss and Perry (1992). (Copyright American Psychological Association. Reprinted with permission)

Where do you stand on trait aggression?
Response scale:

1	2	3	4	5
Extremely uncharacteristic of me				*Extremely characteristic of me*

Physical Aggression
- Once in a while I can't control the urge to strike another person.
- Given enough provocation, I may hit another person.
- If somebody hits me, I hit back.
- I get into fights a little more than the average person.
- If I have to resort to violence to protect my rights, I will.
- There are people who pushed me so far we came to blows.
- I can think of no good reason for ever hitting a person.*
- I have threatened people I know.
- I have become so mad that I have broken things.

Verbal Aggression
- I tell my friends openly when I disagree with them.
- I often find myself disagreeing with people.
- When people annoy me, I may tell them what I think of them.
- I can't help getting into arguments when people disagree with me.
- My friends say that I'm somewhat argumentative.

Anger
- I flare up quickly but get over it quickly.
- When frustrated, I let my irritation show.
- I sometimes feel like a powder keg ready to explode.
- I am an even-tempered person.*
- Some of my friends think I'm a hothead.
- Sometimes I fly off the handle for no good reason.
- I have trouble controlling my temper.

Hostility
- I am sometimes eaten up with jealousy.
- At times I feel I have gotten a raw deal out of life.
- Other people always seem to get the breaks.
- I wonder why sometimes I feel so bitter about things.
- I know that "friends" talk about me behind my back.
- I am suspicious of overly friendly strangers.
- I sometimes feel that people are laughing at me behind my back.
- When people are especially nice, I wonder what they want.

Please give each item a number from 1 to 5 depending on how characteristic it is of you.

Reverse the coding on the items marked with * so that high scores always mean high aggressiveness. Then compute the mean of the items for each scale.

In the Buss and Perry (1992) study, men had significantly higher scores on Physical Aggression, Verbal Aggression, and Hostility, but not on Anger. The sex difference was largest on the Physical Aggression scale.

You can compare your mean score on each scale with the following mean scores derived from Buss and Perry (1992, Table 3), based on U.S. college students:

Scale	*Men (n = 612)*	*Women (n = 641)*
Physical aggression	2.70	1.98
Verbal aggression	3.04	2.70
Anger	2.42	2.38
Hostility	2.66	2.52

one of the most widely used instruments is the Sexual Experiences Survey (SES) developed by Koss et al. (2007). The SES can be used to obtain both self-reports of sexual aggression and, in a parallel format, self-reports of sexual victimisation. In the original version, which was developed in the 1980s (Koss & Oros, 1982; Koss, Gidycz, & Wisniewski, 1987), the scales were phrased to assess men's sexual aggression and women's sexual victimisation. In the revised version by Koss et al. (2007), the items are worded in a gender-neutral manner, so that both men and women can be asked about their experiences as perpetrators as well as victims of sexual aggression. It presents a list of different sexual acts, combined with a list of different coercive strategies, and respondents are asked to indicate how many times since the age of 14 or in the last year they engaged in or experienced each specific combination. An example of the format of the SES is presented in Box 1.2.

The SES is widely used to examine the scale of sexual aggression and to explore risk factors as well as consequences of sexual aggression and victimisation. A discussion of research based on the SES will be presented in Chapter 8.

Self-reports of aggressive behaviour can be combined with other-reports (i.e., reports of another person's behaviour) to examine the dynamics of aggressive interactions and to assess the correspondence between self- and other-reports. This type of approach is prominently represented by the "Conflict Tactics Scales" developed by Straus (1979) to measure intimate partner violence. In the latest version, the Conflict Tactics Scales 2 (CTS2), respondents are asked to indicate which of a list of behaviours representing psychological aggression, physical assault, and sexual coercion they have shown against their partner in the past year (Straus, Hamby, Boney-McCoy, & Sugarman, 1996). In addition, they are asked to indicate, for the same set of behaviours, how many times their partner showed the respective behaviour towards them. This enables researchers to examine the agreement between couples about the behaviour shown by each of the partners and to see whether intimate partner aggression is mutual or just shown by one partner in a relationship. Research based on the CTS will be reviewed in Chapter 7. A similar set of scales addressing aggression in parent–child interactions was developed by Straus, Hamby, Finkelhor, Moore, and Runyan (1998).

One problem with the use of self-reports is that aggression is a socially undesirable behaviour, and respondents are aware that they are being asked to report behaviour that makes them appear in a negative light. This renders self-report measures susceptible to response distortions in the direction of social desirability, resulting in an under-reporting of aggressive behaviour (for a discussion of this point regarding the AQ, see Becker, 2007). In many cases there is no alternative to asking people to report on their aggressive behaviour, as there are no other reliable sources one could consult instead. However, in some contexts it is feasible to rely on information from third parties who can provide information about the aggressive behaviour of research participants.

Parent or teacher reports of aggressive behaviour

In studies measuring aggression in childhood and adolescence, parents and teachers may be recruited as informants. They have first-hand knowledge of a target person's aggressive

BOX 1.2 Example items from the Short Form of the Sexual Experiences Survey
(see Koss et al., 2007, for the full item list)

Item 2 of the Short Form Perpetration (SES-SFP)

Perpetration Item	*How many times in the past 12 months?*				*How many times since age 14?*			
I had oral sex with someone or had someone perform oral sex on me without their consent by:	0	1	2	3+	0	1	2	3+
a. Telling lies, threatening to end the relationship, threatening to spread rumors about them, making promises about the future I knew were untrue, or continually verbally pressuring them after they said they didn't want to.	☐	☐	☐	☐	☐	☐	☐	☐
b. Showing displeasure, criticizing their sexuality or attractiveness, getting angry but not using physical force after they said they didn't want to.	☐	☐	☐	☐	☐	☐	☐	☐
c. Taking advantage when they were too drunk or out of it to stop what was happening.	☐	☐	☐	☐	☐	☐	☐	☐
d. Threatening to physically harm them or someone close to them.	☐	☐	☐	☐	☐	☐	☐	☐
e. Using force, for example holding them down with my body weight, pinning their arms, or having a weapon.	☐	☐	☐	☐	☐	☐	☐	☐

Item 2 of the Short Form Victimization (SES-SFV)

Victimisation Item	*How many times in the past 12 months?*				*How many times since age 14?*			
Someone had oral sex with me or made me have oral sex with them without my consent by:	0	1	2	3+	0	1	2	3+
a. Telling lies, threatening to end the relationship, threatening to spread rumors about me, making promises I knew were untrue, or continually verbally pressuring me after I said I didn't want to.	☐	☐	☐	☐	☐	☐	☐	☐
b. Showing displeasure, criticizing my sexuality or attractiveness, getting angry but not using physical force, after I said I didn't want to.	☐	☐	☐	☐	☐	☐	☐	☐
c. Taking advantage of me when I was too drunk or out of it to stop what was happening.	☐	☐	☐	☐	☐	☐	☐	☐
d. Threatening to physically harm me or someone close to me.	☐	☐	☐	☐	☐	☐	☐	☐
e. Using force, for example holding me down with their body weight, pinning my arms, or having a weapon.	☐	☐	☐	☐	☐	☐	☐	☐

behaviour, and can provide behavioural ratings that can then be examined for their convergence with each other and with the person's self-reports. Parent ratings of aggression are particularly useful for studying aggression in young children. An example is provided by Tremblay et al. (1999), who asked parents to rate their children on a list of 11 items addressing physical aggression, such as" bites," "kicks," and "takes away things from others." Similarly, teachers can provide ratings of a child's aggressive behaviour. For example, the teacher form of the Preschool Social Behavior Scale (PSBS-T) developed by Crick, Casas, and Mosher (1997) consists of 16 items on which preschool teachers are asked to rate the children in their class in terms of relational aggression (e.g., "Tells others not to play with or be a peer's friend") and overt aggression (e.g., "Hurts other children by pinching them"). In a recent study of adolescents, self-reported use of violent media was related to teacher reports of the participant's aggressive behaviour in school to examine the link between media violence use and aggression (Krahé & Möller, 2011).

Peer nominations

Whereas parents and teachers are typically asked to rate research participants on a number of items describing aggressive behaviour, peers are asked to nominate (i.e., select from their group) individual children who fit certain behavioural descriptors. Students in a class might be asked to nominate classmates who, for instance, "attack others without reason," "say nasty things to other children even if they had done nothing wrong" or "take other children's possessions" (Kokko, Pulkkinen, Huesmann, Dubow, & Boxer, 2009). The more nominations participants receive, the higher their aggression score. Peer nominations have also been used to measure indirect forms of aggression, as in the Direct–Indirect–Aggression Scale (DIAS) by Björkqvist et al. (1992), for example to nominate a peer who says unpleasant things behind the person's back. Using this approach, Kokko et al. (2009) demonstrated significant correlations of $r = 0.43$ between peer-nominated aggression at age 8 years and peer-nominated aggression at age 19 years for both boys and girls in an American sample, and a correlation between peer-nominated aggression at age 8 years and peer-nominated aggression at age 14 years of $r = 0.38$ for girls and $r = 0.35$ for boys in a Finnish sample. These correlations are impressive, given that different peers provided the ratings at the two measurements.

Measures of aggressive affect: anger and hostility

In addition to eliciting reports of aggression at the behavioural level, researchers are often interested in studying the affective concomitants of aggressive behaviour, most notably *anger* and *hostility*. Standardised scales have been developed to capture individual differences in the disposition to experience affective states that are relevant to aggressive behaviour. As shown in Box 1.1, Buss and Perry's (1992) "Aggression Questionnaire" contains two such scales, measuring dispositional anger and hostility. Another pertinent measure of anger is the State–Trait Anger Expression Inventory (STAXI) developed by Spielberger (1996). The

STAXI addresses five facets of anger and the way it is characteristically expressed. The State–Anger scale asks participants to describe how they feel at a particular moment in time (e.g., "I feel angry," "I feel irritated"), the Trait–Anger scale addresses the habitual tendency to experience these affective states, the Anger/In and Anger/Out scales refer to individual differences in the tendency to direct anger towards others in the social environment as opposed to directing it towards the self, and the Anger/Control scale measures the extent to which people try to keep their anger under control (Forgyas, Forgyas, & Spielberger, 1997). The STAXI is available in many languages, and has been established as a reliable and valid measure of anger in a variety of domains (for a review, see Eckhardt, Norlander, & Deffenbacher, 2002).

Measure of aggressive cognitions: the Implicit Association Test (IAT)

Given the undesirable nature of aggression, self-reports of aggressive thoughts, feelings, and behaviours are susceptible to the problem of systematic under-reporting. Therefore measures of aggressive cognitions have been developed that cannot be easily distorted in the direction of social desirability. Several studies have adapted the Implicit Association Test (IAT), first developed as a measure of attitudes (Greenwald, McGhee, & Schwartz, 1998), for the measurement of aggressive cognitions and aggression-related self-construals (for a review, see Richetin & Richardson, 2008). The IAT is designed to tap into aggressive cognitions in an unobtrusive way by examining the speed with which aggression-related stimuli are recognised. It is based on the assumption that the strength of the association between a target category (e.g., self vs. other) and an attribute category (e.g., aggressive vs. non-aggressive) can be inferred from the speed with which participants can recognise particular combinations of the target and the attribute category. Participants are presented with a list of words that refer to either the target category (e.g., I, ME vs. THEM, YOU) or the attribute category (e.g., AMBUSH, CHOKE vs. HELP, COMFORT; see Richetin, Richardson, & Mason, 2010). For each word, they are asked to indicate as fast as they can whether it refers to the category in question (e.g., press the left key if it is a word related to "me" and press the right key if it is a word related to "other") or whether it refers to the attribute category in question (e.g., press the right key if it is an aggressive word, press the left key if it is a nonaggressive word). If participants respond faster to aggression-related words when they share the same key as the "me" words than when they share the same key as the "other" words, this is regarded as an indication that "me" and "aggression" are closely related in the person's self-concept.

Scores on the Aggression IAT are interpreted as a measure of stable dispositions towards aggression, and they have been used to predict aggressive behaviour in specific situations. So far, there is some evidence that individual differences in aggressiveness may be used to predict aggressive behaviour in laboratory contexts. For example, Richetin et al. (2010) found that participants' implicit aggression scores on the IAT predicted their negative behaviour towards a target person, but only after a preceding provocation by the same person. A study by Gollwitzer, Banse, Eisenbach, and Naumann (2007) showed that IAT

scores may be useful as unobtrusive outcome measures in the evaluation of interventions designed to reduce aggression. Other studies have shown that the IAT can also detect changes in aggression-related self-concept as a result of situational influences. In research on exposure to media violence, it has been found that playing a violent video game for brief periods of time leads to shorter reaction times for aggressive words associated with the self than playing a non-violent game (Bluemke, Friedrich, & Zumbach, 2010; Uhlmann & Swanson, 2004).

Projective techniques

Another approach for exploring the affective and cognitive correlates of aggressive behaviour involves the use of projective techniques in which participants are presented with ambiguous stimulus material and asked to generate a response. Their responses are then scored for aggressive content by trained raters. The most well-known projective technique for the measurement of aggression is the Picture Frustration Test (PFT) by Rosenzweig (1945). It consists of a set of cartoon drawings, each depicting a situation that involves some mild to moderate form of everyday frustration. An example is shown in Figure 1.1.

The person who caused the frustration (e.g., the driver responsible for splattering the pedestrian) makes a comment that is designed to attenuate or add to the initial frustration. The participant suggests a verbal response from the perspective of the frustrated person in the cartoon, and responses across all cartoons are coded for aggressive content (Rosenzweig, 1976). For example, responses are categorised as "extraggression" if they are directed at the social environment, or as "intraggression" if they are directed towards the self, a distinction similar to the STAXI scales of Anger/in and Anger/out. A children's version of the PFT is also available, and an example situation is "A girl on a swing is telling another girl that she is planning to keep the swing all afternoon" (Rosenzweig, Fleming, & Rosenzweig, 1948).

Apart from the time-consuming task of coding free-response statements into a manageable set of categories, the reliability of such codings (i.e., their consistency across independent raters and across repeated codings by the same rater) has been difficult to achieve (Rosenzweig, Ludwig, & Adelman, 1975). Moreover, responses to the PFT have been found to be affected by social desirability concerns. Taken together, these problems explain why the use of projective techniques is no longer widespread in the social psychological analysis of aggression.

The methods for obtaining records of aggressive behaviour can be used to study aggressive behaviour over time. In addition, self-reports of aggressive thoughts and feelings, such as anger, and measures that assess the accessibility of aggressive thoughts in a person's self-concept can be used to predict aggressive behaviour in the course of an individual's development. *Longitudinal studies* provide an important methodological tool for testing hypotheses about the emergence and change of aggressive behaviour that cannot be addressed in short-term experimental studies. They follow the same group of participants over two or more points in time to examine patterns of change at the intra-individual level and to test

Figure 1.1 Example from the Rosenzweig Picture Frustration Test (PFT). (From Rosenzweig, 1945, p. 4. Copyright John Wiley & Sons, Inc. Reprinted with permission).

hypotheses about the prospective links between certain risk factors and aggression. For example, Ostrov and Godleski (2009) combined teacher ratings and observational data to demonstrate that impulsivity and hyperactivity predicted aggressive behaviour in preschool children over a 4-month period. A Spanish study by Carrasco, Holgado, Rodriguez, and del Barrio (2009) showed that higher levels of parents' hostility predicted more aggressive behaviour in their children over a period of 2 years. In a unique study covering a period of 40 years and including three generations, Huesmann, Dubow, and Boxer (2011) explored the links between parents' and children's aggression at different points in their lives. They found, for example, that parents' aggression measured when they were 8 years of age correlated at $r = 0.24$ with their children's aggressive personality assessed 40 years later, when the parents were 48 years old.

Using official records

Rather than asking individuals about their own behaviour or that of others, researchers can derive information about aggressive behaviour from publicly available databases. These data sources are not compiled for research purposes, and therefore researchers are limited to whatever information has been recorded.

Crime statistics

Official records of reported crime are compiled by most countries, and these figures can be used by aggression researchers who want to study criminal forms of aggression. For example, the Uniform Crime Reporting (UCR) Program in the USA, which was started in 1929, presents detailed information about the rates of different forms of criminal violence, broken down by a range of demographic characteristics, such as perpetrator and victim sex or, age, and also by geographic location (see www.fbi.gov/about-us/cjis/ucr/ucr). For instance, it tells us that 15 241 cases of murder and non-negligent manslaughter were reported in 2009, corresponding to a rate of 5 cases per 100 000 inhabitants. This figure compares with 23 438 cases or a rate of 9.4 per 100 000 inhabitants for the year 1990. Crime statistics can be used to examine changes in crime rate in covariation with legal measures to address research questions about aggression. For example, they can help to answer the question of whether murder rates go up when the death penalty is abolished, or whether the tightening of gun control legislation is followed by a decrease in the number of gun-related homicides. We shall come back to crime statistics when we discuss these questions in later chapters.

A possibly less obvious candidate for the study of aggression is the analysis of meteorological records that provide data on average annual temperatures and comparisons between geographic regions. Meteorological data have been used as an important source for studying the link between temperature and aggression. Historical analyses revealed that riots were more frequent in hotter regions and during hotter periods of the year, and this observation was followed by systematic analyses relating temperature scores and violent crime rates within and across different regions to further explore the link. By relating crime statistics to weather records, Anderson and his colleagues found, for example, that the incidence rates of serious and deadly assault were higher in years with a higher average temperature, whereas robbery figures remained unaffected by temperature (Anderson, Bushman & Groom, 1997, Study 1; for a more detailed discussion of this research, see Chapter 4).

Another example of the use of archival data in the study of aggression comes from the domain of sexual violence. In the USA, such data have been used to demonstrate a link, within different states, between the circulation rate of pornographic magazines and the number of rapes documented in annual crime statistics (e.g., Jaffee & Straus, 1987; Scott & Schwalm, 1988). However, these studies nicely illustrate the problem of inferring causal pathways from associations between frequency data of this kind. It may not be unreasonable to suspect that both the popularity of pornographic magazines and the incidence of rape

could be expressions of a third variable, such as the prevalence of a macho gender stereotype among the male population, which was not captured by the design of the study.

Finally, newspaper reports have been used as another form of archival records by aggression researchers. For example, Mullen (1986) referred to this data source in his analysis of violent behaviour by lynch mobs. Based on newspaper reports of 60 lynchings in the USA between 1899 and 1946, Mullen demonstrated that the larger the mob relative to the number of victims, the more savage the lynch mobs were in their atrocities. Mullen used these data to argue that the larger the mob, the more difficult it is for members to retain self-focused attention that is important for inhibiting violent behaviour. We shall return to this issue in our discussion of intergroup aggression in Chapter 9.

Summary

- This chapter was designed to create a basis for the understanding and critical appraisal of empirical research to be discussed in the course of this volume. A definition of aggression was presented that focuses on three aspects, namely *harmful consequences*, *intention and expectancy of inflicting harm*, and *desire by the target person to avoid the harmful treatment*. Dimensions for classifying aggressive acts were discussed to provide a framework for the systematic description of different forms of aggressive behaviour.
- The research strategies reviewed in this chapter clearly show that a variety of methods are available for the social psychological analysis of aggression. Ethical constraints prevent researchers from setting up situations in which participants are given the opportunity to harm another person. Therefore experimental analogues have been developed that facilitate the study of behaviours intended to harm another person without causing any actual harm. Evidence was presented which shows that findings obtained in contrived laboratory settings correspond in many areas to findings obtained from studies conducted in the real world.
- When first-hand observation is not feasible, a range of methods are available for collecting reports of aggressive behaviour. Self-reports, parent or teacher reports, peer nominations, and projective techniques have a firm place in social psychological aggression research. Archival records such as crime statistics and even weather data provide an additional data source that can be used to establish the rates of different violent offences and to examine covariations of crime rates and a range of other variables.

Tasks to do

(1) Plan the design of an experiment using the *competitive reaction time* paradigm to study the effect of frustration on aggression.
(2) Find out how you score on the Aggression Questionnaire presented in Box 1.1, and compare your score with the Buss and Perry sample at the bottom of the box.

(3) Visit the official crime statistics database in your country, find out the most recent figure available for annual homicide rates, and compare this rate with the figures recorded 10 and 20 years earlier.

Suggested reading

Anderson, C. A., & Bushman, B. J. (1997). External validity of "trivial" experiments: The case of laboratory aggression. *Review of General Psychology, 1*, 19–41.

Carlson, M., Marcus-Newhall, A., & Miller, N. (1989). Evidence for a general construct of aggression. *Personality and Social Psychology Bulletin, 15*, 377–389.

