Erich Hartmen/Magnum Photos

Why don't we see this way? If you're wondering why multiple sensory-memory representations of a scene don't overlap and distort your view of the world, the answer is that each new image from instant to instant overrides the sensory memory of the previous image.

SHORT-TERM MEMORY

Sensory Memory: The Brief Prolongation of Sensory Experience

When lightning flashes on a dark night, you can still see the flash and the objects it illuminated for a split second beyond its actual duration. Somewhat similarly, when a companion says, "You're not listening to me," you can still hear those words, and a few words of the previous sentence, for a brief time after they are spoken. Thus, you can answer (falsely), "I was listening. You said . . ."—and then you can repeat your annoyed companion's last few words even though, in truth, you weren't listening when the words were uttered. These observations demonstrate that some trace of sensory input stays in your information-processing system for a brief period—less than 1 second for sights and up to several seconds for sounds—even when you are not paying attention to the input. This trace and the ability to hold it are called ***sensory memory***.

A separate sensory-memory store is believed to exist for each sensory system (vision, hearing, touch, smell, and taste), but only those for vision and hearing have been studied extensively. Each sensory store is presumed to hold, very briefly, all the sensory input that enters that sensory system, whether or not the person is paying attention to that input. The function of the store, presumably, is to hold on to sensory information, in its original sensory form, long enough for it to be analyzed by unconscious mental processes and for a decision to be made about whether or not to bring that information into the short-term store. Most of the information in our sensory stores does not enter into our consciousness. We become conscious only of those items that are transformed by the selective process of *attention*, into working memory.

2
What is the function of sensory memory?

The Short-Term Store: Conscious Perception and Thought

Information in the sensory store that is attended to moves into the next compartment, which is called the ***short-term store*** (the central compartment in Figure 9.1), a term that calls attention to the relatively fleeting nature of information in this store; each item fades quickly and is lost within seconds when it is no longer actively attended to or thought about. This is conceived of as the major workplace of the mind, and thus sometimes referred to as ***working memory***. More recently, working memory has been used to refer to the process of storing and transforming information being held in the short-term store, and we will examine working memory from this perspective later in this chapter. Short-term store is, among other things, the seat of conscious thought—the place where all conscious perceiving, feeling, comparing, computing, and reasoning take place.

3
What are the basic functions of the short-term store and how is this memory store equated with consciousness? In what way is the short-term store like the central processing unit of a computer?

Lee Foster/Photoshot

The passing moment The flow of thought through working memory is not unlike the flow of scenery past the window of a moving train.

As depicted by the arrows in Figure 9.1, information can enter the short-term store from both the sensory-memory store (representing the present environment) and the long-term-memory store (representing knowledge gained from previous experiences). In this sense, the short-term store is analogous to the central processing unit of a computer. Information can be transmitted into the computer's central processing unit from a keyboard (comparable to input from the mind's sensory store), or it can be entered from the computer's hard drive (comparable to input from the mind's long-term store). The real work of the computer—computation and manipulation of the information—occurs within its central processing unit.

The sensory store and long-term store both contribute to the continuous flow of conscious thought that constitutes the content of the short-term store. *Flow* is an apt metaphor here. The momentary capacity of the short-term store is very small—about seven plus or minus two items (Miller, 1956); only a few items of information can be perceived or thought about at once. Yet the total amount of information that moves through the short-term store over a period of minutes or hours can be enormous, just as a huge amount of water can flow through a narrow channel over time.

Long-Term Memory: The Mind's Library of Information

Once an item has passed from sensory memory into the short-term store, it may or may not then be encoded into ***long-term memory*** (again, see Figure 9.1 on page 322). Long-term memory corresponds most closely to most people's everyday notion of memory. It is the stored representation of all that a person knows. As such, its capacity must be enormous. Long-term memory contains the information that enables us to recognize or recall the taste of an almond, the sound of a banjo, the face of a grade-school friend, the names of the foods eaten at supper last night, the words of a favorite song, and the spelling of the word *song*. We are not conscious of the items of information in our long-term store except when they have been activated and moved into the short-term store. According to the model, the items lie dormant, or relatively so, like books on a library shelf or digital patterns on a computer disk, until they are called into the short-term store and put to use.

As you can see from our brief description, long-term memory and the short-term store are sharply differentiated. Long-term memory is passive (a repository of information), and the short-term store (working memory) is active (a place where information is thought about). Long-term memory is of long duration (some of its items last a lifetime), whereas the short-term store is of short duration (items disappear within seconds when no longer thought about). Long-term memory has essentially unlimited capacity (all your long-lasting knowledge is in it), and the short-term store has limited capacity (only those items of information that you are currently thinking about are in it).

Control Processes: The Mind's Information Transportation Systems

4

In the information-processing model, what are the functions of attention, encoding, and retrieval?

According to the information-processing model presented in Figure 9.1, the movement of information from one memory store to another is regulated by the control processes of *attention, encoding,* and *retrieval,* all indicated in Figure 9.1 by arrows between the boxes. Control processes can be thought of as strategies for moving information through the system and enhancing performance.

Attention, as the term is used here, is the process that controls the flow of information from the sensory store into the short-term store. Because the capacity

Working Memory: The Active, Conscious Mind

We've used the concept of the short-term store to refer to the metaphorical space in which information is held for brief periods and "worked on." As we mentioned earlier, working memory refers to the process of storing and transforming information being held in the short-term store. Working memory is the center of conscious perception and thought. This is the part of the mind that thinks, makes decisions, and controls such processes as attention and retrieval of information from long-term memory.

"To find out if you're someone who could benefit from our Memory Improvement Seminar, press 1597362225830952170610137."

The most influential psychological model of working memory to date is that developed by Alan Baddeley (1986, 2006), which divides working memory into a number of separate but interacting components. The components include a ***phonological loop,*** responsible for holding verbal information; a ***visuospatial sketchpad,*** responsible for holding visual and spatial information; and a ***central executive,*** responsible for coordinating the mind's activities and for bringing new information into working memory from the sensory and long-term stores. (Baddeley added a fourth component, the episodic buffer, to the model in 2000, but we will not discuss this here.) We have already discussed one function of the central executive—attention—and will discuss some of its other functions later in this chapter and in Chapter 10. Here we'll focus on the phonological loop.

Verbal Working Memory: The Phonological Loop

As a test of one aspect of your own working memory, read the digits at the end of this sentence and then close your eyes and try to keep them in mind for a minute or so: 2 3 8 0 4 9 7. What did you do to keep them in mind? If you are like most people, you repeated the digit names over and over to yourself in the order you read them: *two three eight zero four nine seven.* Some IQ tests (discussed in Chapter 10) include a measure of *digit span,* the number of digits that the person can keep in mind for a brief period and report back accurately. Most people have a digit span of about seven digits. More generally, the number of pronounceable items—such as digits, other words, or nonsense syllables—that a person can keep in mind and report back accurately after a brief delay is called the ***short-term memory span,*** or simply *memory span.* According to Baddeley's model, it might better be called the *span of the phonological loop of working memory.* The phonological loop is the part of working memory that holds on to verbal information by subvocally repeating it.

12

What is some evidence that people keep information in the phonological loop through subvocal repetition?

Research has shown that memory span, measured this way, depends on how rapidly the person can pronounce the items to be remembered (Baddeley, 1986). Generally, people can keep in working memory about as much verbal material as they can state aloud in 2 seconds (Baddeley et al., 1975). Unrehearsed items fade quickly; some of them begin to disappear within about 2 seconds or slightly longer. People who can speak rapidly have larger spans than people who cannot speak so rapidly. The span for single-syllable words is greater than that for multiple-syllable words. Try repeating from memory the following seven-word list, with eyes closed, immediately after reading it: *disentangle appropriation gossamer anti-intellectual preventative foreclosure documentation.* Was that list harder than the list of digits?

Any manipulation that interferes with a person's ability to articulate the words to be remembered interferes with verbal short-term memory (Baddeley, 2003). Try to hold seven digits in mind while repeating over and over, out loud, the word *the.* You probably can't do it; the act of saying *the* interferes with your ability to articulate to yourself the digit names.

Evidence that the time it takes to articulate words influences memory span comes from research examining digit spans for people speaking different languages.

For example, Chinese speakers have longer digit spans than English speakers do, a difference that is apparent as early as 4 years of age and extends into adulthood (Chen & Stevenson, 1988; Geary et al., 1993). This difference is due to differences in the rate with which number words (one, two, and so on) in the two languages are spoken. The digit names in Chinese are all one syllable and can be articulated more quickly than the longer digit words of the English language. A similar pattern has been found between English and Welsh, with digit span being greater for the more rapidly spoken English digits than for the longer Welsh digits. This was true even for subjects whose first language was Welsh (Ellis & Hennelley, 1980).

Richard T. Nowitz/Corbis

An analogy to the phonological loop of working memory Holding several items of information in the phonological loop is a bit like spinning several plates on the ends of sticks. Just as you have to go back to each plate and renew its spin before it falls, you have to go back to each item in the phonological loop and repeat it before it vanishes from working memory.

Keeping a list of memory items in the phonological loop is a bit like a circus performer's keeping a set of plates spinning on the ends of sticks. As the number of plates increases, the performer must work more frantically to get back to each and renew its spinning before it falls. Performers who can move quickly can spin more plates than performers who move slowly. Larger plates take longer to set in motion than smaller ones, so the performer can't spin as many large plates as small ones. If the performer attempts to do another task at the same time that involves his or her arms and hands—such as building a tower of cups and saucers—the number of plates he or she can spin decreases.

Of course, in everyday life we don't normally use our phonological loop to keep nonsensical lists in mind, any more than we use our hands to keep plates spinning. Rather, we use it for useful work. We say words silently to ourselves, and we bring ideas together in the form of words, as we reminisce about our experiences, solve problems, make plans, or in other ways engage in verbal thought. We don't just hold material in working memory; we stream material through it, in an often-logical fashion.

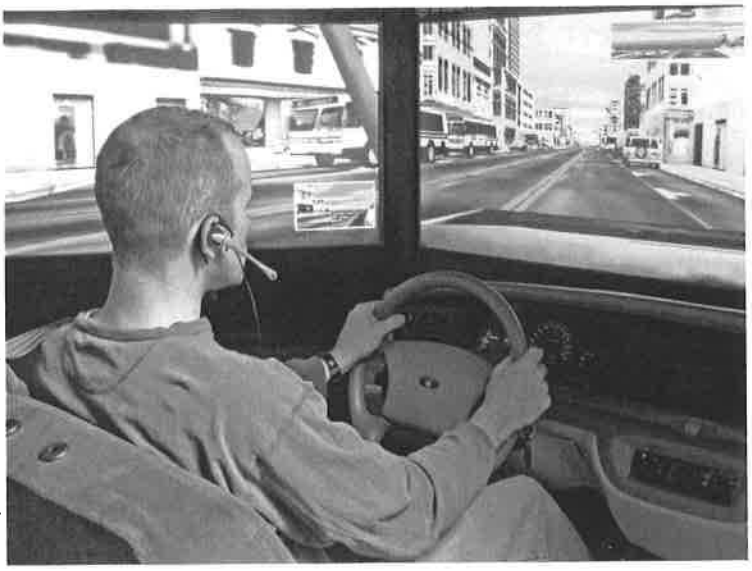
Working-Memory Span

13

Why is working-memory span usually two items less than memory span?

As we said, the capacity of the short-term store is assessed by memory-span tasks, with subjects recalling a series of items in the order they were presented. Many years ago, George Miller (1956) declared that the capacity of the short-term-memory store was seven plus or minus two items. This means that, depending on the information one is working with, an average adult can keep between five and nine items active in consciousness. Memory span, and thus the capacity of short-term memory, increases over childhood (Dempster, 1981) and decreases in old age (Horn & Hofer, 1992).

As useful as memory span is for assessing cognitive performance, in recent years cognitive psychologists have found that an even better measure for assessing cognitive abilities is to examine how many items a person can keep in mind while performing some "work." In *working-memory span* tasks, subjects are asked remember a set of items while doing something with those items. For example, in a reading-span task subjects may be asked to read a set of short sentences (for instance, "In the summer it is very hot"; "The horse jumped over the fence"). After hearing several such sentences, subjects are asked to recall the last word in each sentence, in the order they were presented. Or subjects may be



Simulated driving while talking on hands-free cell phone In their simulated-driving experiments, Strayer and Drews (2007) found that talking on a cell phone created more driving errors, regardless of whether or not the phone was hands free.

given a series of simple arithmetic problems to solve (8 + 1 = ?; 4 + 3 = ?) and asked to remember the sum (9, 7) of each problem, in the order they were presented. Working-memory span is typically about two items shorter than memory span, and also shows improvements over childhood and declines in older adulthood (Cowan & Alloway, 2009; Dykiert et al., 2012). One reason for the increased interest in working-memory span tasks is that, compared to memory-span tasks, they are more strongly associated with (and predictive of) important higher-level abilities, including reading, writing, mathematics, memory strategies, and IQ, among others (Bjorklund, 2013; Kane & Engle, 2002).

One way of demonstrating the importance of working memory on task performance is to examine what happens when someone tries to engage in two tasks at once, or multitasking. Consider, for example, the dual tasks of driving a car and talking on a cell phone. Although both driving and speaking are highly developed and automated skills, they each consume a portion of working memory, and so performing one interferes with performing the other. In a correlational study involving only drivers who sometimes used their cell phones while driving, the accident rate during phone use was four times that for the same group when they did not use their phones (Redelmeier & Tibshirani, 1997). In a simulated-driving experiment in the laboratory, conversing on a phone doubled the number of driving errors made (Strayer & Johnston, 2001). Moreover, it is important to note that in both of these studies, the disruptive effect on driving was as great for hand-free phones as for hand-held phones. The interference is a mental one, involving competing uses of working memory, not a motor one, involving competing uses of the hands. Subsequent simulated-driving experiments showed that drivers whose minds were occupied with phone conversations frequently missed road signs because of inattentional blindness, the same reason that people in the basketball pass-counting experiment missed the gorilla (Strayer & Drews, 2007). Conversations with passengers did not have the deleterious effects that cell phone conversations had. Why? Because passengers, unlike phone partners, experience the driving conditions that the driver experiences, so the conversation becomes synchronized with the driving; when the driving gets difficult, the conversation temporarily stops. The effects of texting while driving may be even more substantial, as this behavior combines cognitive distraction with manual and visual distractions (CDC, 2013). Indeed, as of 2014, 41 states and the District of Columbia had enacted texting bans for all drivers.

SECTION REVIEW

Working memory is the seat of conscious mental activity.

Verbal Components

- The phonological loop maintains verbal information through subvocal repetition and permits verbal thought.
- Working memory quickly loses information without active processing.

Working-Memory Span

- Working-memory span is typically two items less than memory span and is a good predictor of performance on higher-level cognitive tasks.

Elena Elisseeva/Alamy

Although developing expertise in something like driving often permits one to "dual-task"—do two things at once—texting while driving shouldn't be one of them. In a simulation of drivers (17 to 24 years of age) in the United Kingdom, texting while driving reduced the drivers' reaction times by 35 percent. This compares to reductions of 12 percent due to alcohol consumption and 21 percent when smoking marijuana (Reed & Robbins, 2008), making texting a greater accident risk than driving while intoxicated.

Executive Functions

14

What are the three subcomponents of executive functions?

In recent years, cognitive psychologists have seen working memory not as an isolated process but as part of what are termed ***executive functions***—relatively basic and general-purpose information-processing mechanisms that, together, are important in planning, regulating behavior, and performing complex cognitive tasks (Miyake & Friedman, 2012; Miyake et al., 2000). Most researchers agree that executive functions consist of three related components: (a) *working memory*, or *updating*, monitoring, and rapidly adding/deleting the contents of working memory; (b) *switching*, shifting flexibly between different tasks or mind-sets; and (c) *inhibition*, preventing a cognitive or behavioral response, or keeping unwanted information out of mind. Individual differences in executive functions are related to performance on other cognitive tasks, such as IQ, reasoning, and school grades (Friedman et al., 2006; Richland & Burchinal, 2013), as well as important socioemotional phenomena (see Chapter 13, p. 518). The various components of executive function have been assessed by a variety of tasks.

An example of a switching task is the Wisconsin Card Sorting Test (WCST), in which subjects are given sets of cards with different objects on them (such as squares, stars, and circles) that vary in color and number (see **Figure 9.8**). Subjects are asked to sort the cards into specific categories (for example, according to color, number, or shape), which is reinforced by the examiner. After several trials and without notice, the examiner switches reinforcement to another category. For instance, the initial category may be color, in which case subjects would be reinforced for sorting all the green cards in one group, the red ones an another, and so on, regardless of the number or shape of the items on the cards. The examiner may

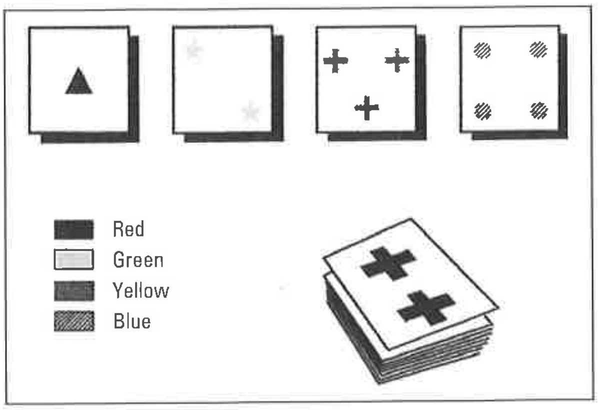


FIGURE 9.8 The Wisconsin Card Sorting Task Subjects start sorting cards by one dimension (color, for instance) then, without notice, they are reinforced for sorting by another dimension (shape, for instance). The number of errors on "switch" trials is a measure of the executive function of switching.

(With permission from E. A. Berg (1948). A simple objective technique for measuring flexibility in thinking. *Journal of General Psychology* 39:15–22. Copyright © 1948. Reproduced by permission of Taylor & Francis Ltd. http://www.tandf.co.uk/journals and Taylor & Francis LLC http://www.tandfonline.com) then switch from color to number, so that all target cards are now to be placed according to number (one, two, three, or four), with color and shape being irrelevant. Subjects are given feedback after a mistake, so they should presumably be able to learn a new classification scheme after only a few trials.

Inhibition has also been assessed by a variety of relatively simple tasks. For example, the Stroop task discussed earlier in this chapter (see Figure 9.6) is used to assess inhibition. To what extent can people inhibit the dominant response (to say the color word "**blue**," for example) and instead identify the color the word is written in (in this case, green)?

Updating, or working memory, is assessed by tasks like those described in the previous section looking at working-memory span, as well as some dual tasks, such as those assessing the effects of talking on the phone and driving.

Four General Conclusions About Executive Functions

15
What four general conclusions can be made about executive functions?

Akira Miyake and Naomi Friedman (2012) have looked at over a decade of research and arrived at four general conclusions about executive functions. First, executive functions show both unity and diversity. This means that performance on the various types of executive functions (updating, switching, and inhibition) all correlate with one another. That is, people who perform well on updating tasks are likely to perform well on switching and inhibition tasks as well. This suggests that the various tasks are tapping some common underlying cognitive ability. However, these correlations are not perfect, indicating that each type of executive function is also assessing some unique abilities. In particular, Miyake and Friedman have determined that updating (working memory) and switching (the ability to shift between tasks) each contributes something beyond the "unity" factor common to all executive functions, whereas inhibition abilities do not add anything to the equation beyond the general, unity factor. This is expressed graphically in **Figure 9.9.**

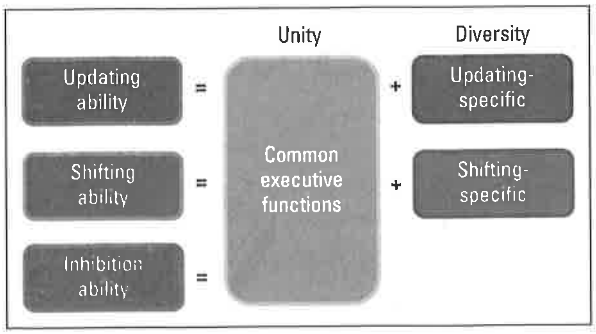
Second, there is a substantial genetic component to executive functions. For example, by looking at performance of different types of executive functions by people with different degrees of genetic relatedness (for instance, identical twins, biological siblings, and adopted siblings), one can get an estimate of the *heritability* of a trait, or the degree to which individual differences in a trait can be attributed to inheritance. Research by Friedman and her colleagues (2008) showed that the heritability of executive functions was quite high—higher than what is typically reported for IQ or personality.

This does not mean that executive functions cannot be altered by experience, however. When people experience different environments (including training environments), the level of a trait can vary even when heritability is high. A number of studies have trained people ranging in age from preschoolers to adults in various aspects of executive functions and have reported significant improvements (Best, 2011; Dahlin et al., 2008; Diamond, 2012; Diamond & Lee, 2011). In fact, physical exercise, especially combined with "character training" as in martial arts (Diamond, 2012), has been shown to relate to executive functions, with people who exercise more having better executive functions (Hillman et al., 2009); and training studies with older adults have demonstrated that increases in physical exercise are associated with corresponding increases in exexuctive finctions (Colcombe & Kramer, 2003). One unexpected environmental influence on executive functions is the number of languages a person speaks. Recent research has shown that bi- and multilingual people have better executive-function abilities than monolinguals (Bialystock, 2010).

Third, executive functions are related to and predictive of important clinical and societal outcomes. For example, externalizing behaviors (where one "acts out" such that one's behavior adversely affects other people, including conduct disorder and opposition defiant disorder), attention-deficit/hyperactivity disorder (ADHD),

FIGURE 9.9 Schematic representation of the unity and diversity of three executive functions (EFs) The various EFs are related to one another, forming a common EFs factor. However, updating (working memory) and switching (shifting) also contribute independently to performance beyond what can be accounted for by the common EFs factor.

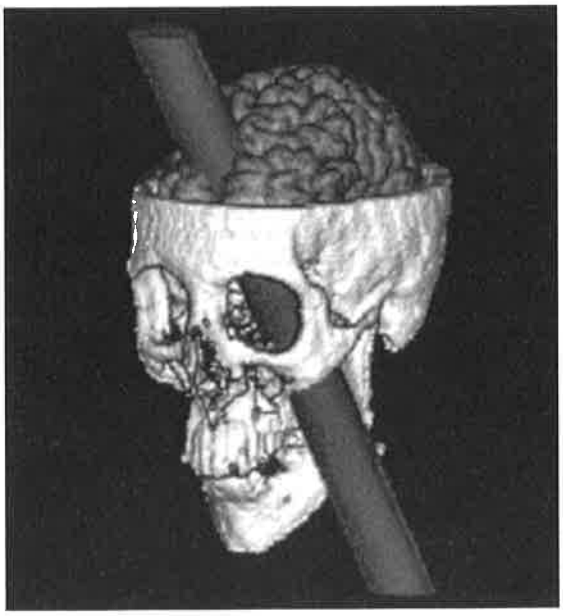
(With permission from Miyake, A. & Friedman, N. P. (2012). The nature and organization of individual differences in executive function: Four general conclusions. *Current Directions in Psychological Science, 21*, 8–14. Copyright © Akira Miyake and Naomi P. Friedman, 2012. SAGE Publications.)



excessive risk taking, and substance abuse are all related to low levels of behavioral inhibition and are associated with executive functions, such that people with better executive functions have fewer behavior problems (Young et al., 2009). More generally, executive functions are related to the ability to regulate one's behavior and emotions (for example, to display self-discipline), beginning in early childhood (Kochanska, Murray, & Harlan, 2000), through adulthood (Pronk et al., 2011), and into old age (von Hippel & Dunlop, 2005).

Fourth, there is substantial developmental stability of executive-function abilities. Although all aspects of executive functions improve over childhood, children (and even infants) who perform well on executive-function tasks tend to develop into adults with high executive-function abilities.

Executive functions can be thought of as a set of low-level cognitive abilities that, in combination, make it possible for people to regulate their thoughts, emotions, and behavior. These abilities improve with age, decline in old age, and at all ages are associated with psychological functioning. Several researchers have speculated that the evolution of executive functions was an important component in the emergence of the modern human mind (Causey & Bjorklund, 2011; Geary, 2005a). The abilities to keep an increasing number of items in mind at one time, resist distractions, inhibit inappropriate behavior, and regulate one's emotions and actions are critical to effective functioning in any social group, as well as for activities such as making tools, hunting, and preparing meals, among many others. These abilities are better developed in humans than in other primates and may be a key to understanding both human cognition and human evolution.



Patrick Landmann/Science Source

FIGURE 9.10 Phineas Gage This reconstruction of the injury suffered by Phineas Gage shows how the metal rod disconnected his frontal lobes from other parts of his brain. Although Gage's intelligence was presumably unchanged after the accident, his personality and ability to plan and make decisions were radically affected.

Neurological Basis of Executive Functions

Research has also found correlates of executive functions with brain function and structure, especially the prefrontal cortex, and we look briefly at some of this research next. There is no single area of the brain that is responsible for the various components of executive functions, but the prefrontal cortex has been identified as a critical area for the control of thought and behavior (Miller & Wallis, 2012). The prefrontal cortex appears to be the neural hub for executive functions (Huey et al., 2006). It is the part of the brain that somehow organizes the efforts of the other portions of the brain and keeps them focused on the task. The prefrontal cortex receives information from the sensory cortex and is connected to structures in the motor system, the limbic system (important in memory, motivation, and emotional expression), and the basal ganglia. It is thus well placed to play a major role in the control of behavior and cognition.

16 How does the case of Phineas Gage show that the prefrontal cortex is related to executive functions?

One of the earliest cases in the medical annals demonstrating the role of the prefrontal cortex in emotional regulation is that of Phineas Gage (Damasio et al., 1994). Gage, a railroad employee, was in the wrong place at the wrong time, when an explosion sent a metal bar through his cheek and out the top of his head (see **Figure 9.10**). The accident destroyed much of his prefrontal cortex, but, surprisingly, he survived and seemed not to have lost any of his intellectual abilities. However, in many other respects, Gage was a changed man. He was unable to plan the work he and his crew needed to accomplish and frequently spoke in a profane, rude, and irreverent manner, all counter to his preinjury personality. In essence, he was unable to control his impulses. Patients with prefrontal lobe damage, like Gage, often lack empathy, show alterations in mood and emotional expressions, have difficulty planning and making decisions, and generally have difficulty inhibiting thoughts and behaviors. For example, patients with frontal lobe damage perform poorly on the Wisconsin Card Sorting Tasks discussed earlier. When the rules change (sort by color, not by number), they are unable to make the switch, but rather continue to sort by the previous rule.

ADHD is associated with delays in the development the frontal cortex. For instance, in one study, development of the frontal cortex of 7- to 13-year-old children with ADHD lagged about 3 years behind those of children without ADHD, whereas their motor areas developed slightly earlier (Shaw et al., 2007). This uneven pattern of brain development may account for the increased fidgeting and restlessness seen in children with ADHD.

17
What general roles does the prefrontal cortex play in working memory?

More specific brain regions can also be identified that are associated with particular aspects of executive functions. For example, working-memory tasks involve the anterior portion of each prefrontal lobe. In neuroimaging studies, increased activity in the prefrontal cortex occurs whenever a person is deliberately holding either verbal or visual information in mind (Nee et al., 2008). In one study, neural activity in the prefrontal cortex was significantly greater on trials in which the person successfully kept the information in mind than in unsuccessful trials (Sakai et al., 2002).

Although the relation of the prefrontal cortex to the regulation of behavior has been known at least since the days of Phineas Gage, new neuroimaging techniques are permitting scientists to get a closer look at important brain/cognition relationships. Moreover, as we learn more about how the brain is involved in the control of our thoughts and behaviors, we're bound to discover interesting individual differences. It's very likely that different people take alternative neural routes to achieve similar goals (Braver et al., 2010).

SECTION REVIEW

Executive functions enable regulation of thoughts, emotions, and behavior.

Executive Functions

- Executive functions involve processes of working memory (updating), switching, and inhibition.
- Executive functions (a) show both unity and diversity, (b) have a substantial genetic component, (c) are related to and predictive of important clinical and societal outcomes, and (d) are developmentally stable.

Neurological Basis of Executive Functions

- The prefrontal cortex serves as the neural hub for executive functions.
- Patients with damage to the prefrontal cortex have difficulty planning and making decisions, regulating emotions, and inhibiting thought and behavior.

Memory as the Representation of Knowledge

Memory, broadly defined from the perspective of cognitive psychology, refers to all of the information in a person's mind and to the mind's capacity to store and retrieve that information. In this section, we examine memory as the *representation of knowledge*. In the next section, we examine memory as the act of remembering.

When we think of "memories" we typically think of things that have happened to us in the past. In fact, it's not too much of a stretch to say that "we are what we remember." Our memories tell us who we are, who we love, our entire life history. These are all available to consciousness, or self-awareness, and are autobiographical in nature.

But there is more to "memories" than this. Some aspects of our memories are available to consciousness but are not related to our personal histories. Your knowledge of the language you speak, the rules of arithmetic and multiplication, and perhaps basic facts about how the world works (for example, objects fall when they are dropped) are also "memories" of a sort, and although you may remember being taught how to multiply in third grade, your knowledge of the rules is represented differently from your recollection of being instructed in the process. Many of your