Physical and Cognitive Development in Later Adulthood

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Important Terms and Concepts
Most of us assume we will reach old age, even if that life stage seems distant to people in their 20s, 30s, or 40s. Yet, remarkably, the very existence of old age as a life stage is a relatively new phenomenon in human history. Had you been born 100 years ago, the probability that you would live to old age would have been quite slim. Only recently have large numbers of people in many societies begun to live long enough to reach this life stage. In some parts of the world today, living long enough to reach old age is still a rare experience.

What is it like to be old? Some common beliefs about older people appear in Figure 17.1. Some of these beliefs may be familiar to you, yet it turns out that none of the statements in Figure 17.1 are true. Instead, they are examples of stereotypes that reflect both lack of knowledge about later adulthood as well as ageism. Ageism refers to prejudice and discrimination toward people on the basis of their age alone (Butler, 2001; Bytheway, 2005). Ageism can be directed toward younger age groups, but it is most often directed toward the elderly (Nelson, 2002). Ageist stereotypes can lead people to avoid or react negatively to older adults. They can also cause older adults to experience discrimination in employment opportunities, housing, and other services. Older adults sometimes internalize negative stereotypes about their competence in ways that adversely affect their functioning (Bugental & Hehman, 2007; Hess, 2005; O’Brien & Hummert, 2006).

Later adulthood presents many paradoxes that challenge prevailing stereotypes. For example, declines in physical and cognitive functioning are common, yet socioemotional functioning is well preserved—and may even improve—in later life (Carstensen, Mikels, & Mather, 2006). In addition, the declines that do occur tend not to be so great—at least until very late in life—that they interfere with older adults’ daily lives. Moreover, older adults are adept at finding ways to compensate for many of the declines they experience. It is also important to realize that some age-related declines can be slowed or prevented, and others may be reversed to some extent. Older adults today are generally healthier and more active than older adults were even a few decades ago (Carstensen & Charles, 2003). So, it seems that later life is not the bleak life stage implied by the statements in Figure 17.1.

Yet at the same time we have to acknowledge that age-related losses and declines do accumulate over time, and by very advanced old age they can seriously challenge older adults’ biological and psychological adaptability (Baltes & Smith, 2003). Age itself is a key source of variability in later life, and the health and functioning of the young-old (those ages 65 to 79) often differs from that of the old-old (those age 80 or older; Neugarten, 1974; Suzman, Willis, & Manton, 1992). It is often not until people are in their 80s or older that age-related physical and cognitive changes begin to take a significant toll.
part eight

Chapter 17  Physical and Cognitive Development in Later Adulthood

Human aging, therefore, has two faces: gains and losses (Baltes & Smith, 2003). We will examine both gains and losses that occur with age as we explore physical and cognitive development in later adulthood in this chapter and socioemotional development in the next chapter. We begin, though, by looking at how later adulthood emerged as an expected life period.

LATER ADULTHOOD: THE NEWEST LIFE PERIOD

To set the stage, imagine traveling back in time to ancient Rome when Julius Caesar was in power, about 45 B.C. Had you been alive during that time, how long do you think you might have lived? Now travel forward to the Middle Ages, about 1250. Had you been born in that era, how long do you think you might have lived? And now jump to the year 1900. Had you had been born then, how long might you have lived?

Life Expectancy

To compare your figures with researchers’ estimates of life expectancy in different historical eras, look at Figure 17.2. Life expectancy refers to the average number of years that a person born in a particular year can expect to live. In Figure 17.2, you can see that life expectancy in ancient Rome was extremely short—only about 20 years. Zooming forward over 1,000 years to the Middle Ages, life expectancy had increased to only
33 years. It changed little until the twentieth century, when something rather extraordinary began to happen. As you can see in Figure 17.2, life expectancy in the United States was only 48 years in 1900 (American Administration on Aging, 2009; He, Sengupta, Velkoff, & DeBarros, 2005). By 1970, however, life expectancy had increased to 71 years (He et al., 2005). In just the 70-year period from 1900 to 1970, gains in life expectancy far exceeded the gains that had occurred in the preceding 2,000 years. In 1900, only 4 percent of Americans lived to age 65 or older; by 1970, this figure had more than doubled, to 10 percent (He et al., 2005).

The United States does not lead the world in life expectancy. With a life expectancy of just over 78 years, the U.S. ranked 50th in a recent comparison of 224 nations (CIA, 2009). Japan, Singapore, Hong Kong, and Australia have some of the longest life expectancies, at approximately 82 years (CIA, 2009). Nor has the United States experienced the greatest population aging in the world. Population aging refers to an increase in the proportion of people within a population who are elderly (Kinsella, 2000). Italy is the “oldest” country in the world in terms of its age composition, with an estimated 18 percent of the population over age 65 (Kinsella & Velkoff, 2001). In the United States, the population ages 65 and older is just under 13 percent, but this figure is expected to increase to nearly 20 percent by 2030 (American Administration on Aging, 2008b, 2008c; He et al., 2005). The elderly segment of the population in the United States is not only growing but is also becoming more diverse, with particularly large increases expected in the number of older Hispanics and Asian Americans (He et al., 2005).

What explains these remarkable increases in life expectancy? People often assume that breakthroughs in treating the chronic diseases that affect the elderly are primarily responsible. Yet improved control over infectious diseases that once claimed the lives of many children actually played a larger role in extending life expectancy (Hayflick, 2004). Economic development in a society often brings about improvements in nutrition, sanitation, water quality, and the availability of antibiotics and vaccinations. These public health measures reduce the threat of infectious conditions (such as tuberculosis, pneumonia, influenza, diarrhea, and diphtheria) that once caused mortality rates among infants and children to be very high. The main force driving gains in life expectancy in economically developed societies has been the declines in mortality among children, which has allowed more children to survive to old age (Lee, 2003). Only in recent years has progress in treating the chronic, degenerative diseases of later life—such as heart disease and cancer—begun to contribute to further gains in life expectancy (Lee, 2003).

However, not all nations have the economic resources to implement public health programs that reduce deaths from infectious diseases. Life expectancy remains alarmingly low in some parts of the world. People seldom live past age 45 in the poorest countries of Africa and the Middle East (United Nations, 2009). Demographers—researchers who study the characteristics of populations in different societies—predict that life expectancy will increase with economic development in these countries.

Maximum Lifespan

Will further increases in life expectancy as dramatic as those that took place in the 20th century occur in the future? Scientists are hotly debating this question. Some believe that life expectancy cannot increase indefinitely because humans (and other
maximum lifespan The maximum number of years people could live if they managed to avoid all accidents and diseases.

centenarian A person who lives to be at least 100 years old.

supercentenarian A person who lives to be 110 or older.

programmed theories of aging Theories that postulate the existence of a program or built-in clock of some kind that causes us to age and, eventually, die.

Jeanne Calment, the longest living person in recorded history, lived to be 122, very close to what some scientists regard as the maximum human lifespan of 125 years. Aging did not slow her down much. She took up fencing lessons at age 85 and was still riding a bicycle at age 100.

BIOLOGICAL THEORIES OF AGING

Why do we age? This simple question does not have a simple answer. Many different hypotheses and theories have been offered to explain aging, but they can be grouped into three basic categories: programmed theories, evolutionary theories, and random damage theories.

Programmed Theories of Aging

According to programmed theories of aging, a program or built-in clock of some kind causes us to age and, eventually, die (Bergeman, 1997; Cristafalo et al., 1999). One view, for example, is that a genetic code may be written into our DNA that programs cells to die. But while many scientists agree that development is genetically programmed early in life, they do not believe this is true later in life. They dispute the idea that aging and death are genetically programmed. A more widely accepted view is one that integrates evolutionary theories of aging with random damage theories of

INTERIM SUMMARY 17.1

Later Adulthood: The Newest Life Period

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<thead>
<tr>
<th>Life Expectancy</th>
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<tr>
<td>Life expectancy refers to the average number of years a person can expect to live. Life expectancy in the United States has increased in the last 100 years.</td>
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<tr>
<td>The main force driving gains in life expectancy in economically developed societies has been the decline in mortality among infants and children. Progress in treating chronic diseases has begun to contribute more recently to further gains in life expectancy.</td>
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<th>Maximum Lifespan</th>
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<tr>
<td>Some scientists believe that life expectancy cannot increase indefinitely because humans have a maximum lifespan of about 125 years. Other scientists argue that further gains in life expectancy are possible.</td>
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Aging (Hayflick, 2007; Kirkwood, 2008; Olshansky & Hayflick, 2002; Rattan, 2007; Troen, 2003; see Figure 17.3).

**Evolutionary Theories of Aging**

According to **evolutionary theories of aging**, discussed in the first chapter of this book, natural selection favors genes that increase the likelihood that people will live long enough to reproduce and care for their offspring. Genes that contribute to fitness and health through the period of reproductive maturity (typically in the first half of life) are likely to be passed on to future generations. Living beyond the age of reproductive maturity, however, does not benefit survival of the species, and, as a result, genes that would confer fitness and health in the second half of life have not been selected through evolution (Rattan, 2007). Without this genetic advantage, according to evolutionary theories of aging, older adults have less capacity to withstand random damage to genes and other essential cells.

**Random Damage Theories of Aging**

According to **random damage theories of aging**, damage accumulates as people grow older, gradually affecting cells, tissues, organs, and bodily systems (Kirkwood, 2008). Even the body's capacities for maintenance and self-repair experience random molecular damage (including damage to mechanisms of repair) occurring more often in later life. Examples:

- Free radicals
- Telomere shortening and cell aging

**Random Damage**

*Random Damage Theories of Aging*

Random molecular damage (including damage to mechanisms of repair) occurs more often in later life. Examples:

- Free radicals
- Telomere shortening and cell aging

**Manifestations of Aging**

Damage accumulates and becomes evident at multiple levels (cells, tissues, organs, bodily systems).

**Frailty, Disease, Disability**

Damage overwhelms repair mechanisms, contributing to frailty, disease, and disability.

**Death**

**Risk and Protective Factors**

Behavioral and environmental risk factors and protective factors hasten or slow these processes.

**Reserve Capacity**

Reserve capacity affects the body's ability to withstand damage.
damage over time (Hayflick, 2007). When the accumulated damage exceeds the body’s capacities for maintenance and self-repair, age-related declines become evident, contributing to disease, disability, and eventually death (Kirkwood, 2008; Yin & Chen, 2005; see Figure 17.3). Biologist Jay Olshansky and his colleagues summed it up this way: “The living machines we call our bodies deteriorate because they were not designed for extended operation and because we now push them to function long past their warranty period” (Olshansky, Carnes, & Butler, 2003, p. 94).

Where does this random damage come from? Biologists emphasize two broad sources. First, damage can be caused by bodily processes that are inherently unstable (e.g., gene mutations that cause defects) or have harmful side-effects (e.g., metabolism that creates harmful byproducts). Second, damage can be caused by the environment (e.g., excessive ultraviolet radiation, pollution, and hazardous work settings), lifestyle factors (e.g., smoking, poor nutrition, and lack of exercise), or injury. As you can probably imagine, many different forms of damage can occur over a person’s lifetime, contributing to aging and disease. The idea that some damage results from the body’s own processes may be more surprising to you, so let’s consider two well-documented examples of such damage. These examples involve free radicals and telomere shortening.

**Free Radicals** The process of metabolism (i.e., converting food to fuel for the body) produces waste and harmful byproducts, just as a fire produces soot when it burns wood for fuel. The byproducts created by metabolism in the human body are called free radicals. Free radicals are unstable oxygen molecules that can penetrate or collide with other molecules, causing damage to cells (Finkel & Holbrook, 2000; Harman, 2009). Damage from free radicals accumulates with age, contributing to arthritis, cancer, diabetes, and other diseases that become more common as we get older (Hayflick, 2007).

Overeating increases the production of free radicals (Weindruch & Sohal, 1997). This has led some researchers to wonder whether caloric restriction—reducing calorie intake while preserving nutrient intake (e.g., adequate protein, vitamins, and minerals)—could reduce the damage caused by free radicals (Gredilla & Barja, 2005; Yu, 1996). Experimental studies have found that caloric restriction increases the lifespan of flies, worms, fish, and rodents by postponing the onset or slowing the progression of many chronic diseases (Fontana & Klein, 2007; Masoro, 2005). Laboratory rats and mice, for example, live up to 40 percent longer than usual when they are fed a nutrient-rich diet that contains only 70 percent of their normal calorie intake (NIA, 2006).

Experimental studies with humans are scarce, but nonexperimental evidence provides intriguing clues. During World War II, food shortages in some European countries were linked to sharp decreases in rates of cardiovascular disease—rates that later increased after the war ended and food became more plentiful (Fontana & Klein, 2007). Similarly, Okinawa, Japan, has an unusually large number of centenarians, and the Okinawan diet contains fewer calories than average but is highly nutritious (Willcox, Willcox, Todoriki, Curb, & Suzuki, 2006). In fact, a popular Okinawan saying is *hara hachi-bu*, “Eat until you are 80 percent full” (Willcox et al., 2006). Caloric restriction is being investigated as a possible strategy for improving health and longevity (Masoro, 2005), but scientists caution that experimental studies of long-term effects in humans need to be conducted before the benefits and risks can be fully understood (Olshansky et al., 2002).

**Telomere Shortening** When cells in our bodies become defective, they are replaced through the process of cell division. This process helps to replenish the body’s tissues and organs. In the 1960s, however, cell biologist Leonard Hayflick discovered that human cells do not divide and replicate indefinitely, but rather slow down and eventually stop dividing with age. (Stem cells are an exception to this principle.) Hayflick demonstrated that human cells grown in ideal laboratory conditions—with a
steady supply of nutrients, a constant temperature, and protection from environmental hazards—stopped replicating at some point, usually after about 50 divisions (Hayflick, 1965). Many other studies have confirmed the existence of a point at which cells stop dividing and replicating (Campisi, 1997). This point has come to be known as the **Hayflick limit**.

What controls the number of times cells divide? The answer may lie with our **telomeres**, the protective tips on the ends of our chromosomes (a bit like the protective tips on the ends of shoelaces) (see Figure 17.4). These tips become shorter each time cells divide. Eventually, when the telomeres have nearly disappeared, the cells stop dividing, causing the cells to age and deteriorate (Harley, Futcher, & Greider, 1990). You might be inclined to think this means that the body has a built-in clock that controls the length of life by limiting cell reproduction. However, scientists view this process not as a clock, but rather as a mechanism that may have developed through evolution to prevent the growth of tumors early in life (Campisi, 2005). This mechanism would have been beneficial when human life expectancy was short, but it has become costly as life expectancy has increased, because cells that cannot be replenished will age and become defective over time (Troen, 2005).

The rate of telomere shortening, like the production of free radicals, can be influenced by life experience and lifestyle factors. Chronic stress hastens telomere shortening and contributes to premature aging in animals and humans (Epel, 2009). Evidence has begun to link low socioeconomic status to accelerated telomere shortening, even after taking into account obesity, smoking, and exercise (Cherkas et al., 2006). You might think about the role of telomere shortening when you read later about the shorter life expectancies of socially disadvantaged groups.

### Genes and Longevity

Emphasizing random damage (produced by the body’s own internal processes and by external factors) as a fundamental cause of aging does not mean that genes are irrelevant to how long we live. Although genes do not dictate the aging process (as in a genetic program that causes us to age), they do play a role in determining longevity by influencing the reserve capacity of various organ systems (Hayflick, 2004; 2007). **Reserve capacity** refers to an excess physiological capacity built into many

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**FIGURE 17.4**

**Telomere Shortening with Age**

Telomeres, the protective tips on the ends of our chromosomes, become shorter each time cells divide. When the telomeres have nearly disappeared (as shown in the senescent cell), the cells stop dividing, causing the cells to age and deteriorate.

organ systems that allows the body to respond to physical challenges even though age-related declines have begun to occur.

Having larger reserve capacity increases the likelihood of surviving long enough to reproduce and raise offspring. As a result, genes that increase reserve capacity would have been selected through evolution and passed from one generation to another. A fringe benefit of greater reserve capacity is being better able to withstand the effects of the random damage in the second half of life. People whose genes enhance reserve capacity live longer because the random damage that accumulates over time takes longer to cause organs or bodily systems to fail (Hayflick, 2007). Longevity tends to run in families for this reason (Hayflick, 2004, 2007). Genes don’t tell the whole story, but there is some truth to the old expression that if you want to live a long life, you should choose your parents wisely. (For a summary of this section, see “Interim Summary 17.2: Biological Theories of Aging.”)

### INTERIM SUMMARY 17.2

<table>
<thead>
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<th>Biological Theories of Aging</th>
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<td><strong>Programmed Theories of Aging</strong></td>
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<td><strong>Evolutionary Theories of Aging</strong></td>
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<td><strong>Random Damage Theories of Aging</strong></td>
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<tr>
<td><strong>Genes and Longevity</strong></td>
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### PHYSICAL DEVELOPMENT

The various theories of aging help explain why the physical changes that occur in later life can take such varied forms. The effects of random damage to the body’s cells, tissues, organs, and regulatory systems accumulate over time in unique ways for different people. This makes physical development in later adulthood more varied than in any earlier life period, and no two people age in exactly the same way. Try to think of two older adults who are about the same age but whose appearance, physical abilities, and health differ greatly. Now try to think about two infants or children who differ as greatly from each other in their physical development as this pair of older adults. The second task is more difficult, because physical development early in life is genetically programmed, and therefore unfolds in more similar ways across different children. This is not true in later life (Hayflick, 2007).

As you read about the physical changes that occur with age, it is important to keep a few key points in mind. First, these changes often interact with each other to affect
an older person’s functioning, which can magnify their impact. For example, declines in bone density, muscle strength, and the sense of balance can interact in ways that greatly increase the risk of falls and bone fractures in later life (Davison & Marrinan, 2008). Similarly, declines in vision, coupled with a general slowing of reaction times, can affect an older person’s ability to drive an automobile safely (Anstey, Wood, Lord, & Walker, 2005).

Second, as discussed earlier, even when older adults experience physical declines, they can often still carry out their daily activities because many vital organs and bodily systems have a built-in reserve capacity. This reserve capacity is similar to the spare gallon or two of gasoline in a car’s gas tank that allows the car to keep operating even when the tank registers as empty. The extra physiological capacity built into our vital organs and bodily systems allows them to keep functioning even though age-related declines have occurred.

When older people encounter very stressful life circumstances or extreme environmental conditions, however, the demands on their organ systems may overwhelm even this built-in reserve capacity, leading to organ failure. Reserve capacity in the cardiovascular system may be sufficient to allow an elderly person to enjoy daily walks, for example, but not to shovel snow or lift a heavy box, either of which might increase the risk of a heart attack (Rook, Charles, & Heckhausen, 2006). Reserve capacity itself is not a static resource, moreover, but tends to decline with advancing age (Fries, 1980; Rowe & Kahn, 1998). This decline helps to explain why the elderly are affected more severely by, and can even die from, health conditions such as influenza or pneumonia that are rarely lethal at younger ages (Koivula, Sten, & Makela, 1999).

Third, compensation reduces the impact of age-related biological decline. Compensation is an adaptive process of developmental regulation that involves the use of alternative strategies to pursue an important goal when one’s physical capacities or resources decline (Baltes, Lindenberger, & Staudinger, 2006; Freund & Baltes, 2002). Therefore, the body’s own systems sometimes compensate for age-related declines. For example, although the heart’s ability to pump blood rapidly during periods of cardiovascular demand (such as exercise) declines with age, the volume of blood pumped with each heartbeat increases with age. As a result, overall blood flow declines relatively little as we get older (NIA, 2005). The brain is capable of reorganizing its functioning to compensate for age-related declines, as discussed later. In addition, people actively use compensation as a strategy to cope with declines or losses, as emphasized by the theory of selective optimization with compensation (Baltes & Baltes, 1990; Baltes et al., 2006; see Chapter 13).

Developmental researcher Orville Brim once told an interviewer how his father adapted to vision loss late in life—a story that nicely illustrates the strategy of compensation (Cromie, 1997). His father loved working on a small farm after he retired. When this proved to be difficult as he grew older, he focused his attentions on a small garden patch. At age 90 he became blind, but he still pursued his love of gardening by arranging to have a window box installed in his bedroom in which he was could grow flowers.

Finally, some age-related physical declines can be slowed or even reversed, illustrating the plasticity, or malleability, of development (Baltes et al., 2006). For example, in the absence of exercise, muscle mass declines by more than 20 percent for both...

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Compensation is an adaptive process of developmental regulation that involves the use of alternative strategies to pursue an important goal when one’s physical capacities or resources decline.

Plasticity is the idea that development is malleable (like plastic); applied to the brain, plasticity refers to the ability of the brain to reorganize its structure and function.
men and women from age 30 to age 70, but regular exercise helps to preserve muscle strength (NIA, 1996).

**Appearance and Body Build**

The outward signs of aging that begin to become noticeable in midlife—wrinkled skin, grey hair, patches of baldness—continue into later life. Skin becomes drier and more wrinkled, and hair becomes entirely white or, among many men, entirely gone. Fortunately, no one ever died of wrinkles, gray hair, or baldness (Hayflick, 1998), and in some parts of the world, these signs of aging are associated with maturity, wisdom, and nurturance (Han, 1996; Muscarella & Cunningham, 1996).

Declines in bone density that begin in midlife continue into later adulthood, causing gradual loss of height and an increasing risk of osteoporosis (see Figure 17.5). Falls experienced by older people are more likely to cause serious bone fractures, a problem that is compounded by declines in the sense of balance. Fortunately, tai chi and other strength- and balance-training programs appear to be helpful in reducing the risk of falls in the elderly (Kannus, Sievänen, Palvanen, Järvinen, & Parkkari, 2005; Low, Ang, Goh, Chew, 2008; Straus, 2008).

Weight gain is common in midlife, but this trend reverses itself in later life, when unintentional weight loss becomes more common (Alley, Ferrucci, Barbagallo, Studenski, & Harris, 2008). Weight loss in later life is caused by a loss of muscle and bone and by a decline in nutrient intake by older adults (Alley et al., 2008; Chapman, 2007). You might think that such weight loss would be associated with improved health, but in later life it tends to be associated with poor outcomes, including frailty, disability, and even death (Alley et al., 2008). Frailty refers to a state of increased vulnerability to stressors that results from diminished reserve capacity and impaired functioning of multiple bodily systems (Bortz, 2002; Fried, Ferrucci, Darer, Williamson, & Anderson, 2004). Frailty in older adults is characterized by unintentional weight loss (usually 10 or more pounds), general muscular weakness, slow walking speed, low physical activity, and a reduced ability to withstand acute illness and emotional or physical stress (Fried et al., 2001; Gillick, 2001). Relatively few of the young-old,

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**Frailty** A state of increased vulnerability to stressors that results from diminished reserve capacity and impaired functioning of multiple bodily systems.

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![Progression of Bone Thinning with Age](image-url)
but as many as 40 percent of the old-old, are frail (Fried et al., 2004). Frailty tends to worsen over time and is linked to a cascade of problems that include increased risks for falls, injuries, hospitalization, nursing-home placement, and mortality (Fried et al., 2004; Hamerman, 1999).

Exactly what causes frailty in later life is not yet known, but active lifestyles that preserve muscle strength may help to slow the development of frailty (Bortz, 2002). In one study of nearly 3,000 initially healthy people in their 70s, those who engaged in more physical exercise were much less likely to become frail over a 5-year period (Peterson et al., 2009). It’s never too late to exercise. Even among the very old, carefully prescribed physical exercise can improve muscle strength and help to prevent frailty (Heath & Stuart, 2002).

**Mobility and Strength**

Mobility and strength decline gradually as we age. You may have observed elderly relatives walk stiffly or unsteadily. This may reflect declines in muscle strength, coupled with joint pain and stiffness (Ayis, Ebrahim, Williams, Juni, & Dieppe, 2007). Preserving muscle strength—especially lower body strength—is important for retaining independence in later life (Goodpaster et al., 2006; Onder et al., 2005). In one large study, older adults who performed well on tests of lower body strength (e.g., walking a short distance, getting in and out of a chair, standing with one’s feet together) were much less likely to need nursing home care in the next 4 years (Guralnik et al., 1994). “Leg power” may be as important for physicians to monitor in older adults as the standard vital signs of heart rate, breathing, temperature, and blood pressure (Bortz, 2002).

**Sensory Systems**

Declines in sensory systems in later life affect not only vision and hearing but also smell, taste, touch, and balance. For many older adults, these sensory declines cause only minor inconveniences, but for others—especially the very old—sensory declines are more severe and can interfere with their ability to carry out their daily activities safely and effectively (Guralnik & Simonsick, 1993).

**Vision** About 18 percent of people ages 70 and older report impaired vision (blindness in one or both eyes or difficulty seeing even with glasses; Crews & Campbell, 2004). As we discussed in Chapter 15, some vision changes may have begun in midlife, such as difficulty focusing on near objects, seeing well in dimly lit settings or settings with a lot of glare, and adjusting to bright-dark shifts. Other changes emerge in later life. As people grow older, they often see distant objects less clearly and have worse depth perception (NIA, 2007a). As you can imagine, such vision limitations could increase the risk of falls and accidents in the home and elsewhere. Driving a car often becomes more difficult, especially at night (Klein, Klein, Lee, & Cruickshanks, 1998). In fact, vision problems are the most common reasons why older adults limit or give up driving (Freeman, Muñoz, Turano, & West, 2006). Corrective eyewear (eyeglasses, contact lenses) and the use of large-print books or magnifiers can address some vision limitations, although one-third of adults in their mid-80s or older have difficulty seeing even with corrective eyewear (Desai, Pratt, Lentzner, & Robinson, 2001).

Some eye diseases become more common as people age. We discussed glaucoma in Chapter 15 (see also Figure 17.6, top right panel). Even though this largely asymptomatic condition becomes more common with age, it can be managed with medication and surgery if it is detected early enough.

Cataract disease affects as many as half of adults age 65 and older (Desai et al., 2001). **Cataracts** are cloudy areas that form gradually in the lens of the eye, causing blurry, distorted vision, and increasing sensitivity to glare (see Figure 17.6, lower-left panel).
As cataracts grow larger, they can interfere with daily activities, such as reading, watching television, engaging in hobbies, and doing household tasks. Fortunately, cataracts usually can be treated effectively with a short surgical procedure in which the affected lens is removed and a new lens implanted (Desai et al., 2001; National Eye Institute, 2009).

The leading cause of blindness in later life is macular degeneration, an eye disease that causes the center of the retina—the macula—to deteriorate (Jager, Mieler, & Miller, 2008). Central vision is lost as a result (see Figure 17.6, bottom-right panel). This condition is more common in advanced old age, affecting about 15 percent of the old-old (Oneill, Jamison, McCulloch, & Smith, 2001). Unlike cataracts, treatment options for macular degeneration are more limited, but promising medical research suggests that effective treatments may be on the horizon (Oneill et al., 2001).

Hearing problems affect about half of those age 75 and older (Pleis & Lethbridge-Çejku, 2006). Hearing problems can make it difficult for older adults to follow conversations, especially when background noise is present (Weinstein, 1994). Interference with social interaction is an especially troubling aspect of hearing loss, causing some older adults to become hesitant when interacting with others or to avoid interaction altogether (Desai et al., 2001). Problems communicating with a hearing-impaired older person...
can frustrate others or lead them to view the older person as confused or incompetent, reactions that can undermine the older person’s confidence or feelings of self-worth (Kampfe & Smith, 1998). It does not help to shout when communicating with a hearing-impaired older person. Instead, it is best to find a quiet location, face the person directly, and speak just a little louder than usual (National Institute on Aging, 2009a).

Hearing aids can help older adults compensate for hearing loss, even if they do not always completely correct the problem (Schneider & Pichora-Fuller, 2000). Many hearing aids today are small enough that they are not readily visible to others, reducing their stigma. Even so, older people are sometimes reluctant to wear hearing aids for fear of looking old or being perceived as disabled (Erler & Garstecki, 2002; Wallhagen, 2010). Combatting negative stereotypes of older adults may help older adults feel more comfortable using aids that help them in the course of their daily lives.

**Smell and Taste** Some of life’s pleasures, often taken for granted, come from our senses of smell and taste. As we age, small but discernible declines in these senses occur (Murphy, Schubert, Cruickshanks, Klein, Klein, & Nondahl, 2002). The number of taste buds in the tongue does not change much with age, but taste sensitivity declines, possibly due to smoking, exposure to environmental pollutants, medication side effects, and even dentures (which can block taste receptors) (Schiffman, 1997). One consequence is that food sometimes tastes bland to older adults (Hetherington, 1998). Spices and other food seasonings may help to compensate for this loss of taste sensitivity. Our senses of taste and smell also serve safety functions, warning us about spoiled food, gas leaks, or fires. Smoke and gas detectors in the home benefit people of all ages, but may be especially important for older adults (Wysocki & Gilbert, 1989).

**Touch and Pain** Sensitivity to touch declines with age, especially in the hands and feet, due to declines in the functioning of touch receptors in the skin and poorer blood circulation to the body’s extremities (Hayflick, 1994). As a result, it can be harder for older adults to grasp and manipulate objects and to do handiwork (such as needlework or other hobbies).

Does the age-related decline in the sense of touch mean that older adults are less likely to experience pain? The answer is not straightforward, in part because pain is influenced by psychological factors (Turk & Okifuji, 2002). Some people, regardless of age, tolerate pain better or are less inclined to admit their pain. Older people also sometimes mistakenly regard painful symptoms that could be due to disease as inevitable aspects of aging, leading them to forego or delay seeking medical care (George, 2001; Leventhal & Prohaska, 1986; Stoller, 1993). Among older adults who have chronic health problems, however, pain is often a persistent problem that can interfere with their daily activities and even their performance on tests of cognitive functioning (Weiner, Rudy, Morrow, Slaboda, & Lieber, 2006)—something you may have experienced if you have taken an exam on a day when you did not feel well. This is worth bearing in mind when age differences in cognitive performance are discussed later in this chapter.

**Balance** Many people probably fail to appreciate the important role played by the sense of balance until it begins to decline in later life. The sense of balance receives and sends information about the body’s position when a person is standing or walking, so that continual adjustments can be made to prevent falls. With age, declines occur in receptors in the inner ear that monitor the body’s position, and nerves that carry messages from these receptors to the brain decline (Park, Tang, Lopez, & Ishiyama, 2001). Standard tests of balance—such as standing on one foot with eyes closed—that are simple for younger people can be very challenging for people in their 70s or 80s.

Declines in the sense of balance greatly increase the risk of falls in later life (Davison & Marrinan, 2007). This problem is magnified by declines in vision because older adults
may misgauge the depth of stairs or curbs or may not see hazards in the environment that could cause them to trip. Weaker muscles, medication side effects, and cognitive impairment can further increase the risk of falling in later life (Morley, 2002). More than one-third of adults age 65 and older fall annually, with the risk of falls being greatest among the old-old (Centers for Disease Control and Prevention [CDC], 2009). Falls can be very serious for older adults, causing fractures nearly 50 percent of the time (Davison & Marrinan, 2007) and often resulting in disability, hospitalization, nursing-home placement, and death. In fact, falls are the leading cause of death from injury in later life (CDC, 2009). Older women are especially likely to break bones when they fall because they often have osteoporosis, a condition that causes their bones to become brittle (CDC, 2006; see Chapter 15).

Given the severe consequences of falls, it is not surprising that older adults—especially the old-old—sometimes limit their activity for fear of falling (Cumming, Salkeld, Thomas, & Szonyi, 2000). Unfortunately, this lack of activity can make matters worse by contributing to further muscle loss and social isolation (Morley, 2002). Once again, physical exercise is crucial—early and later in life—to preserve bone health and reduce muscle loss (and to achieve other benefits for physical and cognitive health, as discussed later).

Vital Organ Systems

Changes in the body’s vital organ systems that first become evident in midlife often continue into later life, and new changes appear as well. In the cardiovascular system, atherosclerosis continues to lead to the buildup of plaque in the artery walls, increasing the risk of heart attacks and strokes in later life (National Institutes on Health, 2005). Artery walls become less elastic (a process called arteriosclerosis), requiring the heart to pump harder and increasing the risk of hypertension (high blood pressure).

In the respiratory system, lung tissue similarly becomes less elastic, making breathing more effortful and causing older adults to become fatigued more easily during physical activity (National Institute on Aging, 2007; Zeleznik, 2003). This leads some older adults to reduce their physical activity, which only hastens declines in cardiovascular and respiratory function (Cousins, 2000).

Changes in the kidneys cause renal functioning to become less efficient (Tedla & Friedman, 2008). As a result, older adults are less able to excrete medication, causing medications to circulate in the bloodstream longer than usual (Turnheim, 2003). This makes it very important to monitor medication side effects in the elderly.

Changes in the urinary system tend to reduce the volume of urine the bladder can hold (Ouslander, 1997). Urinary incontinence (an inability to control urination) causes embarrassment and declines in older adults’ quality of life, but medication and physical exercises help to reduce the problem (Minassian, Drutz, & Al-Badr, 2003).

Bodily Control Systems

With age, important changes also occur in our bodily control systems, which monitor and regulate the functioning of all organs and systems in the body. These control systems are the nervous system, immune system, and endocrine system. Chapter 15 discussed age-related changes in the endocrine system that trigger hormonal changes. The following discussion, therefore, focuses on the nervous and immune systems.

Nervous System The nervous system—which consists of the brain, the spine, and nerves that fan out to all parts of the body—is responsible for integrating information received from the senses, muscles, and organ systems and for sending commands that regulate functions throughout the body. The nervous system controls many bodily functions outside of our awareness (e.g., respiration and digestion), but it is also the site of all conscious thoughts, emotions, and responses. The nervous system becomes...
less efficient and slows down with age (Salthouse, 1996). Physical coordination declines and cognitive functioning becomes slower as a result. In fact, an age-related slowing of **reaction time**—the length of time needed to respond to a stimulus—is one of the most reliable findings in research on aging (Madden, 2001). This increase in reaction time has been demonstrated in studies in which people of different ages are asked to respond as quickly as they can to experimentally presented stimuli, such as auditory tones or visual symbols.

Why does reaction time become slower with age? One reason is that nerves that conduct information to and from the brain become less efficient, requiring more time for sensory information to reach the brain and for commands from the brain to reach the body’s muscles in order to execute a response (Cerella, 1990; Ball, Edwards, & Ross, 2007). In addition, changes in the brain lengthen the time needed to process and respond to incoming information. The production of neurotransmitters, the chemical messengers that transmit information between neurons, declines with age, and the neurons themselves shrink in size as their connective structures (axons, dendrites, and synapses) are lost (Raz, 2000; Volkow et al., 1998). Brain volume declines with age, although the rate of decline varies across different areas of the brain. The prefrontal cortex and hippocampus (areas that are especially important for memory functioning) show the greatest declines in volume (Raz, 2000). Brain imaging studies also have shown that with aging there is less activation of the prefrontal cortex when memory tasks are being performed (Rajah & D’Esposito, 2005; Reuter-Lorenz, & Lustig, 2005).

Yet the aging brain is adaptive, and as these declines occur, compensatory changes are triggered that help to preserve cognitive and motor functioning (Greenwood, 2007; Hess, 2005; Reuter-Lorenz, & Lustig, 2005). New dendrites grow to improve the connectivity among neurons, and healthy neurons may take over some of the functions previously performed by adjacent neurons that have deteriorated (Greenwood, 2007). A particularly striking example of the brain’s adaptive potential is that both hemispheres of the brain are activated during some cognitive tasks in later adulthood. Only the right hemisphere, in contrast, is typically activated during such tasks in young adulthood (Cabeza et al., 1997; Grady et al., 1995; Grady, Bernstein, Beig, & Siegenthaler, 2002; Reuter-Lorenz et al., 2000). The activation of both hemispheres is associated with improved memory in later life (Morcom, Good, Frackowiak, & Rugg, 2003; Rosen et al., 2002). The apparent plasticity—or malleability—of the aging brain is an important and hopeful discovery, and we return to this theme of plasticity later when we discuss interventions designed to enhance cognitive functioning in later life.

Not everyone experiences age-related declines in the nervous system at the same rate. Factors that can hasten age-related declines in brain structures and functions include hypertension, diabetes, and chronic stress (Raz & Rodrigue, 2006; Waldstein, 1995). Factors that slow the rate of age-related declines, in contrast, include cardiovascular fitness and physical exercise, especially aerobic exercise (Colcombe et al., 2006; Greenwood, 2007; Kramer et al., 2004; Raz & Rodrigue, 2006).

**Immune System** The job of the **immune system** is to detect, isolate, and destroy foreign substances (e.g., viruses, bacteria, and toxins) that might invade the body and cause illness. This is a tall order, because the immune system must be able to...
respond to an unknown variety of foreign substances while managing to distinguish these foreign substances from the body’s own cells (Cacioppo & Bernstein, 2006). The immune system also must not overreact, because the powerful chemicals it releases to combat foreign substances have the potential to harm the body’s own tissues. It must be able to recognize when an infection has ended, so that it can withdraw its immune defenses. A careful balancing act is required for the immune system to do its job properly.

With age, the immune system changes in several ways that, paradoxically, can increase (rather than decrease) susceptibility to illness and disease (Gupta, Agrawal, Agrawal, Su, & Gollapudi, 2006; Licastro et al., 2005). First, some of the specific weapons in the immune system’s arsenal become less effective (Miller, 1996). T cells (so named because they develop in the thymus gland) are immune cells that patrol for foreign substances, lock onto any that are identified, and then either destroy them or mobilize other immune cells to destroy them. T-cell functioning declines progressively with age, making it more difficult for older adults to combat infections and disease (Aw, Silva, & Palmer, 2007; Gupta et al., 2006; Pawelec et al., 2002). Second, the body’s ability to distinguish between foreign substances and its own cells declines with age, increasing the risk of autoimmune diseases. Autoimmune diseases develop when the immune system mistakenly attacks the body’s own cells, damaging or destroying healthy tissues. Autoimmune diseases, such as rheumatoid arthritis, become more common with age (Doran, Pond, Crowson, O’Fallon, & Gabriel, 2002).

Perhaps the most significant age-related change, however, is a tendency for the immune system to be chronically activated, producing chronic inflammation (Finch, 2007; Licastro et al., 2005). Inflammation is part of the immune system’s response to foreign substances. It rushes blood and immune cells to the affected tissues—causing swelling, redness, and heat—all in an attempt to surround and destroy the foreign substances and to initiate healing. The redness and swelling you may have noticed when you have had an insect bite, for example, was your immune system’s effort to isolate and neutralize the toxin from the bite and to help the affected tissues begin to heal.

But prolonged inflammation can damage the body’s tissues. The aging immune system—perhaps because of repeated activation and deactivation over a lifetime or because of damage caused by stress—becomes overactive, causing chronic inflammation (Finch, 2007; Licastro et al., 2005). When the chemicals dispatched by the immune system as part of this chronic inflammatory response circulate persistently throughout the bloodstream, they can cause damage to any tissues and organs in the body. This is why some biologists now believe that chronic inflammation plays a key role in the development of all of the degenerative diseases of later life: cardiovascular disease, diabetes, cancer, Alzheimer’s disease, and sarcopenia (a disease that leads to the loss of muscle mass) (Finch, 2007; Licastro et al., 2005). As one biologist commented, “Age-related diseases are the price we pay for a life-long active immune system” that loses its fine tuning over time (Licastro et al., 2005).

**Sexual Functioning**

The idea of older adults being sexually active sometimes provokes raised eyebrows or uncomfortable squirming. After all, it is widely assumed that the elderly cannot really be interested in or capable of sexual activity. But such ageist views do not match the realities of older adults’ needs and desires. Sexual activity does decline as people age, but many older adults continue to value sexual intimacy, viewing it as an important element of an emotionally close relationship (Gott & Hinchliff, 2003).
Older couples generally maintain a steady level of interest in and satisfaction with their sexual activity (Zeiss & Kasl-Godley, 2001). As an older man commented in one study, “Why should there be a sudden stop [when you] get to 75?...I mean it’s just a natural thing when you love somebody, isn’t it?” (Gott & Hinchliff, 2003, p. 1621). Still, some older adults encounter barriers to sexual intimacy, including the lack of a partner and poor physical health (Ginsberg, Pomerantz, & Kramer-Feely, 2005; Gott & Hinchliff, 2003; Zeiss & Kasl-Godley, 2001). Older participants in one study commented that sex was the last thing on their mind when their health was poor (Gott & Hinchliff, 2003). Cultural stereotypes also present barriers to sexual intimacy in later life (Zeiss & Kasl-Godley, 2001). An investigation of sexual practices in 106 cultures revealed that older adults remained sexually active in cultures in which sexual activity in later life was seen as normal and appropriate. Older adults curtailed their sexual activity, in contrast, in cultures in which sexual activity in later life was viewed negatively (Winn & Newton, 1982).

When older adults describe how they adapt to changes in their sexual functioning, the processes of developmental regulation can be seen at work. For example, although many older adults in one study reported that sex remains important to them, those who lacked a partner and who did not expect to have a partner again in their lifetime reported that sex is unimportant to them (Gott & Hinchliff, 2003). The views of the latter group can be regarded as an example of loss-based selection (see Chapter 16), an adaptive process of developmental regulation in which goals are reprioritized and those perceived to be unattainable are relinquished (Freund & Baltes, 2002).

Similarly, when age-related physiological changes such as decreased erections or vaginal dryness make sexual intercourse more challenging, older adults often adapt by taking a broader view of sexuality, one that encompasses cuddling and touching as expressions of sexual intimacy (Gott & Hinchliff, 2003; Zeiss & Kasl-Godley, 2001). As an older man commented on his reduced capacity to have sexual intercourse, “Obviously, as you get older you act differently and you adjust to your age, but I consider that a cuddle is sex, isn’t it?” (Gott & Hinchliff, 2003, p. 1624). This shift to other expressions of sexual intimacy can be seen as an example of compensation.

Many of the basic physical changes that occur with age, then, call upon older adults’ adaptive capacities to preserve their well-being. Such adaptive capacities help older adults preserve their emotional well-being when they experience changes in sexual functioning, and also help older adults adapt to changes in areas such as mobility, strength, and sensory functioning. As discussed later, older adults’ adaptive capacities also play a role in how they respond to changes in their physical health. (For a summary of this section, see “Interim Summary 17.3: Physical Development.”)
Physical changes in later life often interact with each other, magnifying their impact.

- The impact of physical declines on older adults’ ability to carry out their daily activities is reduced by a reserve capacity in many vital organs and bodily systems and by older adults’ use of compensation.
- Some age-related physical declines can be slowed or even reversed, illustrating the plasticity, or malleability, of development.

Declines in bone density continue into later adulthood, causing loss of height and increased risk of osteoporosis. Unintentional weight loss also becomes more common.

Frailty is characterized by unintentional weight loss, muscular weakness, slow walking speed, low physical activity, and a reduced ability to withstand acute illness and emotional or physical stress.

Mobility decreases in later adulthood as a result of declines in muscle strength, coupled with joint pain and stiffness. Physical exercise can help preserve mobility and muscle strength.

Declines in sensory systems in later life affect vision, hearing, smell, taste, touch, and balance. For some, these declines can interfere with daily living.

In the cardiovascular system, atherosclerosis increases the risk of heart attacks and strokes, and artery walls become less elastic (arteriosclerosis), requiring the heart to pump harder and increasing the risk of hypertension.

In the respiratory system, lung tissue becomes less elastic, making breathing more effortful.

Renal functioning also becomes less efficient, and changes in the urinary system reduce bladder capacity, sometimes leading to urinary incontinence.

Important changes occur in bodily control systems: the nervous, immune, and endocrine systems.

The nervous system becomes slower and less efficient, reducing physical coordination and slowing cognitive functioning. Reaction time also slows as a result of declines in brain efficiency. The aging brain is adaptive, though, and can compensate for some declines in functioning.

The immune system changes in ways that increase susceptibility to illness and disease. T cell functioning declines, the risk of autoimmune diseases increases, and chronic inflammation plays a role in the development of degenerative diseases.

The frequency of sexual activity declines as people age, but many older adults continue to value sexual intimacy.

If physiological changes make sexual intercourse challenging, older adults often adapt by taking a broader view of sexuality (an example of compensation).
PHYSICAL HEALTH

If you are a young or middle-aged adult, good health may be something you tend to take for granted—you may realize its importance only when an illness disrupts your activities and plans. In the first half of life, illnesses tend to be short-lived, allowing people to resume their activities after a brief period of discomfort and inconvenience. What about later life? The previous discussion has explored age-related physical changes and biological processes that contribute to the development of health problems in later life, but what health problems are most common? How do they affect older adults’ daily lives or their views of their health? These questions are explored next (reserving our discussion of older adults’ emotional and mental health for the next chapter).

Common Health Conditions

Older adults experience both acute and chronic health conditions. Acute illnesses—which have a rapid onset and short duration—are less common in later life but often require more bed rest and longer recovery time. Acute illnesses, such as influenza or the common cold, tend to make elderly individuals sicker and can even be fatal because of declines in reserve capacity and weakened immune defenses. Yet chronic illnesses—which have a slow onset, long duration, and a tendency to worsen over time—pose the greatest threat to older adults’ health. Chronic conditions become more common with age, accounting for about half of all disability among older adults in the United States (Merck Institute of Aging/Gerontological Society of America [MIAH/GSA], 2002).

As shown in Figure 17.7, the most common chronic conditions in later life include non-fatal conditions such as arthritis and potentially fatal conditions such as heart disease and cancer. Roughly 80 percent of older adults in the United States have at least one chronic condition (He et al., 2005). Members of ethnic minority groups often experience poorer health in old age. For example, compared with elderly Caucasians, elderly Hispanic Americans and African Americans have higher rates of diabetes, hypertension, strokes, and heart attacks (Cooper et al., 2000).

The likelihood of having multiple chronic conditions increases with age. The percent of adults who have three or more chronic conditions increases from just over 7 percent among people in their mid-40s and mid-50s to 28 percent among people in their mid-60s to mid-70s, and 37 percent among people age 75 and older (National Center for Health Statistics, 2007). Multiple chronic conditions often exacerbate each other (Jaur & Stodard, 1999; Kaplan, Haan, & Wallace, 1999). For example, diabetes increases the risk of heart disease and reduces the likelihood of survival after a heart attack or stroke (Wallace & Lemke, 1991). Similarly, the pain and stiffness caused by arthritis may discourage physical exercise, which can worsen a coexisting condition such as diabetes.

Fortunately, chronic conditions usually do not take a substantial toll on older adults’ daily functioning until relatively advanced old age, as shown in Figure 17.8. The kind of activity limitation matters,
part eight

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though, because some limitations make it difficult for an older person to live independently. Researchers usually assess two kinds of activities when they evaluate an older person’s ability to carry out everyday tasks of living. **Activities of daily living (ADLs)** refer to basic self-care activities, such as eating, bathing, toileting, dressing, and being able to get in and out of a bed or chair. **Instrumental activities of daily living (IADLs)** refer to more complex daily activities, such as shopping, preparing meals, doing household chores, and managing personal finances (Katz, 1983; Nagi, 1965). Older people who can perform ADLs adequately but who have difficulty with some IADLs may be able to continue living at home with the assistance of others (to shop, help with household tasks, etc.). Being unable to perform ADLs, however, is more problematic. A recent review of 77 longitudinal studies revealed that older adults who had difficulty with three or more ADLs were much more likely to be placed in nursing homes (Gaugler, Duval, Anderson, & Kane, 2007). Intervening early to slow the progression of chronic disease is important in order to delay the development of ADL impairment and preserve older adults’ ability to live independently (Gaugler et al., 2007).

### Self-Rated Health

Despite the declines in physiological functioning and increases in chronic illness that occur as people age, older adults’ perception of their health tends to be remarkably positive. In one recent large study, 42 percent of the young-old and even 25 percent of the old-old described their health as “excellent” or “very good” (NIA, 2007b). Older adults may view their health favorably in part because they tend to compare their health to that of other people their age rather than to their own health at a younger age (Robinson-Whelen & Kiecolt-Glaser, 1997). Most older adults do not identify themselves as “old,” and they tend to regard their life circumstances, including their own health, as better than those of same-aged peers (National Council on Aging, 2002; Smith, Shelley, & Dennerstein, 1994). Not all older people, of course, rate their health favorably. In advanced old age, as rates of chronic illness increase, the number of people describing their health as poor increases (NIA, 2007b). Elderly Hispanics and African Americans also tend to rate their health less favorably than elderly Caucasians (NIA, 2007b).
Compared to men, women generally rate their health less favorably and report more restrictions of activity and more days of bed rest when they feel ill. This is because women have more, if less lethal, chronic conditions (Austad, 2006; Verbrugge, 2001). This gender difference in self-rated health exists across the lifespan, leading Verbrugge (1989) to conclude that women feel sicker for more of their lives than men do. Although women tend to live longer than men, one price for greater longevity is more disability (Stuck et al., 1999).

**Mortality**

Mortality rates rise over the course of later adulthood due to the degenerative processes and declines in reserve capacity discussed earlier. In the United States, the leading causes of death among adults ages 65 and older are heart disease, cancer, stroke, chronic obstructive pulmonary disease, pneumonia and influenza, and diabetes (Himes, 2001). Two of these conditions—heart disease and cancer—account for more than half of all deaths among older adults.

The leading causes of death among older adults differ relatively little across demographic groups, but life expectancies are significantly shorter for socially disadvantaged groups, such as some ethnic minority groups and people living in poverty. For example, African Americans have life expectancies that are roughly 5 to 7 years shorter than those of Caucasians (Himes, 2001). In the United States, the poor have life expectancies nearly 20 years shorter than those of the non-poor, even when they have comparable health-risk profiles (such as comparable blood pressure, cholesterol, and body mass index) (Crimmins, Kim, & Seeman, 2009).

Life expectancy also differs for men and women. Throughout the world, women tend to live longer than men (Austad, 2006). In the United States, women live an average of 5 years longer than men (Kung, Hoyert, Xu, & Murphy, 2007). The exact reasons for this sex difference are not clear, but both biological and lifestyle factors (e.g., lower rates of risky behavior among women) are likely to play a role (Austad, 2006; Verbrugge, 1989).

**Quantity Versus Quality of Life**

As we take stock of physical health and functioning in later life, a crucial issue to consider is whether increased life expectancy has brought about gains in the quantity of life without gains in the quality of life. Some critics worry that living longer means that people will be ill for a greater portion of their lives. Ideally, the amount of time during which older adults suffer from chronic illness could be shortened in the future.

Is the **compression of morbidity** in later life—a shortening of the duration of illness and disability—a realistic goal? Some scientists think so. In their view, the key is to postpone the onset of chronic illness to a time in life that approaches the average age of death. If people do not develop a serious illness like cancer until shortly before they die, then the period of illness and suffering would be **compressed** into fewer years (Fries & Crapo, 1981; Rowe, 1997; see Figure 17.9). Scientists who argue that the compression of morbidity is possible believe that the best strategy for postponing chronic illness is to help people modify behavioral risk factors, such as smoking, lack of exercise, obesity, and stress (Fries, 2002; Rowe, 1997). In their view, seeking ways to postpone the onset of chronic disease is a more practical goal for an aging society than trying to find cures for all chronic diseases (Fries & Crapo, 1981).

But can people modify their health behaviors enough to postpone disease onset and compress the period of disability in later life? The evidence is encouraging. The number of older adults reporting activity limitations due to chronic illness has declined in recent decades, as rates of smoking declined—especially among men (Manton et al., 2006; Waidmann & Liu, 2000). The onset of disability in later life also began to be
postponed by 7 to 8 years in the 1990s among people with better health behaviors (Fries, 2002, 2003). These are hopeful signs that compressing morbidity into a smaller portion of the lifespan is feasible.

Yet other trends threaten to undo these health gains. Rates of smoking have increased among women in recent years, which may cause future cohorts of elderly women to experience higher rates of lung cancer and heart disease (NAAS, 1999). Soaring rates of childhood and adult obesity may increase the risk of chronic illness and disability—shortening life expectancy—among future cohorts of older adults (Olshansky et al., 2005). Such trends lead some scientists to worry that Americans may not be able to make the lifestyle changes needed to compress morbidity in later life. In fact, they predict an expansion, rather than a compression, of disability in later life in the future (Verbrugge, 1990).

You may begin to see the relevance of the debate about how much life expectancy may increase in the future. If life expectancy increases substantially without a compression of morbidity, then only years of illness, rather than years of health, will have been added. Everyone agrees that the goal for an aging society is to foster quality of life and not merely quantity of life. The crucial question is what mix of preventive health behaviors, medical interventions, and strategies for controlling environmental health threats will best achieve that goal.

As you have seen, a great deal happens to our bodies, our physical functioning, and our health as we age. Some of the changes are relatively small and easily managed; other changes—especially in advanced old age—are more consequential. Many parallels will surface in the exploration of cognitive development in later life that follows. (For a summary of this section, see “Interim Summary 17.4: Physical Health.”)

COGNITIVE DEVELOPMENT

We use our memory and other cognitive capacities every day, in virtually everything we do—from remembering new people we have met and things on our “to do” list to managing everyday activities like driving a car or completing tasks at work. Effective cognitive functioning is crucial to older adults’ ability to remain productive, to live independently, and to enjoy their lives (Hertzog, Kramer, Wilson, & Lindenberger, 2008). After living 70 to 80 years or more, how well do people still learn and remember things? If changes in cognitive functioning occur in later adulthood, how do they affect older adults’ daily lives and, importantly, how do normal changes differ from pathological changes caused by disease? Our discussion focuses on memory, a key aspect of cognitive functioning. The final section of the chapter explores options for preserving and enhancing cognitive functioning in later life and considers whether life experience helps older adults preserve cognitive strengths, such as wisdom.
INTERIM SUMMARY 17.4

Physical Health

Common Health Conditions
- Acute illnesses (which have a rapid onset and short duration) often require more bed rest and longer recovery time in later adulthood. Chronic illnesses (which have a slow onset, long duration, and tend to worsen over time) pose the greatest threat to older adults’ health.
- Limitations in activities of daily living (ADLs, basic self-care activities, such as eating and bathing) and instrumental activities of daily living (IADLs, more complex activities, such as shopping and managing finances) increase in advanced old age. Older people who can perform ADLs but who have difficulty with IADLs may be able to continue living at home with the assistance of others. Being unable to perform ADLs increases the risk of nursing-home placement.

Self-Rated Health
- Older adults’ perceptions of their health tend to be positive.
- Women generally rate their health less favorably than men and report more restrictions of activity and more days of bed rest when they feel ill because women have more chronic (though less lethal) health conditions.

Mortality
- Mortality rates rise over the course of later adulthood as a result of the degenerative processes and declines in reserve capacity.
- The leading causes of death among older adults differ relatively little across demographic groups, but life expectancies are shorter for socially disadvantaged groups.
- In the United States, women live an average of 5 years longer than men.

Quantity versus Quality of Life
- Some critics worry that living longer means that people will be ill for a greater portion of their lives.
- Some scientists argue that a compression of morbidity in later life—a shortening of the duration of illness and disability—is a realistic goal. The key to attaining this goal, in their view, is to postpone the onset of chronic illness.

Normal Changes in Memory

You may have had the experience of forgetting someone’s name at a party or making a mental shopping list on your way to the grocery store but then forgetting to buy some of the items. Apart from feeling embarrassed or inconvenienced, you probably did not give such memory lapses much thought. In later adulthood, memory lapses become more frequent and often take on a different meaning.

Memory Systems As discussed in earlier chapters, a useful framework for understanding how memory changes in later life is to think of memory as involving three systems, each of which performs different functions as we seek to acquire, manipulate, and retain information (Atkinson & Shiffrin, 1968). The first of these systems, sensory memory, receives information from our senses and holds it just long enough to be perceived. Sensory memory lasts 1 to 2 seconds and then fades, unless the information is attended to and passed on to working memory. When you...
call directory assistance and are given a phone number, the information registers in your sensory memory but it will fade unless you try to retain it, perhaps by repeating it to yourself.

When you repeat information to retain it, as with repeating the phone number you just heard, you are using your working memory. Working memory holds information long enough—usually 15 to 25 seconds—to be used or manipulated. We can hold about seven items of information in working memory (Miller, 1956). (It is no coincidence that local telephone numbers contain seven digits!)

Working memory can store information for long periods, ranging from hours to years. The capacity of long-term memory—how much information can be stored in the brain—is virtually unlimited (Brady, Konkle, Alvarez, & Oliva, 2008). Of course, storing information in long-term memory is not the same as getting it out of storage when you need it. This is the frustration you experience when you have memorized material for an exam but are unable to retrieve it during the exam. Memory, then, depends not only on receiving information but also on our ability to encode (or store) and retrieve information.

Age-Related Changes in Memory

How does aging affect memory? Researchers often investigate this question by presenting people of different ages with visual or auditory stimuli (digits, letters, symbols, sounds, etc.) to see how long it takes to memorize the information and how long it can be retained. To test sensory memory, a research participant might be shown a letter for just a split second, followed by another letter, and then asked to state the letter shown first. Such tests reveal little decline with age in sensory memory. Once older adults detect a stimulus, they retain it in sensory memory for about as long as younger people. Older adults with vision or hearing impairments, however, may need more time to detect sensory input (Baltes & Lindenberger, 1997; Lindenberger & Baltes, 1994). Because such sensory deficits are common in later life, they may be partly responsible for deficits in sensory memory that previously have been attributed to aging (Schneider & Pichora-Fuller, 2000; Wingfield, Tun, & McCoy, 2005).

Working memory might be tested by reading a series of digits aloud (e.g., 731652) and asking the research participant to repeat the digits. Very simple tests of working memory like this also reveal relatively few differences between older and younger adults (Luo & Craik, 2008; Maylor, 2005). The working memory task becomes more challenging if the list of items to be repeated becomes longer (e.g., 40162893) or if the participant has to manipulate the items in some way—for example, by repeating them in reverse order (e.g., 39826104). Challenging tests of working memory are more difficult for people of all age groups, but especially for older adults. In general, the more complex or demanding the cognitive task, the more poorly older adults perform compared to younger people (Luo & Craik, 2008; Park, 2000).

Long-term memory is often tested by presenting research participants with material to be memorized—for example, a series of unrelated words (duck, dish, storm, pencil, etc.). The number of times the list must be presented in order for the research participant to memorize it provides an estimate of the ability to encode information in long-term memory. On such tests, older adults do not perform as well as younger adults (Craik, 2006). One reason may be that older adults are less likely to use strategies that aid encoding (Naveh-Benjamin, 2000). You can try an exercise to understand this point: Look at the objects shown in Figure 17.10 for 2 minutes, and don’t write anything down while you do this. Then close the book and write down as many objects as you can remember.

After completing this task, think about how you approached it. Perhaps you used a strategy to help you remember more items. For example, in looking at Figure 17.10, you might have made up a story that involved the objects shown (e.g., A cat named
Clarence was carrying scissors toward a dog who was chewing a baseball mitt. The dog then spotted a football and dashed toward it, tripping over an apple. The story itself does not matter, of course—it is simply a strategy to help transfer information into memory. Older adults make less spontaneous use of such strategies compared to younger age groups, which partly accounts for their poorer performance on memory tests that involve encoding (Naveh-Benjamin, 2000).

What about retrieval? Retrieval is tested by assessing how much people can remember from previously learned material. Tests of recall involve asking people to produce from memory the information they were asked to learn (e.g., “What words were in the list you memorized?”), whereas tests of recognition involve asking people to indicate whether a particular item was included in the information learned (e.g., “Was bucket in the list of words you memorized?”). Recall is more difficult than recognition (one reason why many students like essay exams less than multiple-choice exams!). Consistent with the general trend for age differences to be greater on more challenging cognitive tasks, the difference between older adults’ and younger adults’ performance is greater for tests of recall than for tests of recognition (Craik, 2006; Luo & Craik, 2008).

Not all long-term memories are the same or show the same rate of decline with age, however. Three different kinds of long-term memory that researchers often distinguish are episodic, semantic, and procedural memory (Tulving, 1985). Episodic memory involves learning and retaining new information (such as lists of words or numbers) or remembering details from one’s daily life (e.g., where one parked the car) or past experiences (e.g., what happened on one’s first day of college). This type of memory is generally more susceptible to decline with age than other types. Semantic memory involves learning and retaining general knowledge about the world (such as the capital of France or the state capital of one’s home state), and procedural memory involves learning and retaining skills (such as how to ride a bike). Semantic memory and procedural memory are generally more resistant to decline with age than episodic memory.
of long-term memory shows the greatest decline with age (Craik, 2000). In contrast, semantic memory refers to the ability to remember the general knowledge one has acquired (e.g., vocabulary, historical facts, cultural customs, etc.). Semantic memory, like crystallized intelligence (discussed in Chapter 15), is relatively well preserved into later adulthood (Craik, 2000, 2006). Procedural memory, the ability to remember how to do things (such as how to ride a bicycle or hum a song), is also well preserved into later life (Craik, 2006; Luo & Craik, 2008).

Explanations for Age-Related Changes in Memory Why do age-related changes in memory occur? Many researchers believe that particular kinds of deficits affect older adults’ cognitive functioning, including their memory (Dennis & Cabeza, 2008). Their explanations most often cite five deficits:

1. According to the speed-deficit explanation, the speed of cognitive processing declines in later life (Salthouse, 1996). If people think more slowly as they age, then some of the material they are trying to retain in working memory may decay before they can use it or transfer it to long-term memory. When processing speed is taken into account statistically, the differences between older and younger adults’ memory performance is smaller (Salthouse, 1996).

2. The processing-resources-deficit explanation suggests that an age-related decline in attentional resources (e.g., being able to attend to two tasks simultaneously or to shift from one task to another) leads older adults to perform worse on challenging cognitive tasks (Craik, 2006; Craik & Byrd, 1982).

3. The sensory-deficit explanation, touched on earlier, suggests that older adults who have a sensory deficit (e.g., vision or hearing impairment) must devote extra effort to recognizing sensory input, which leaves fewer resources for encoding information in memory.

4. The inhibition-deficit explanation suggests that older adults have more difficulty than younger adults inhibiting irrelevant information from working memory, and this mental “clutter” leads to worse performance on memory tests (Hasher & Zacks, 1988; Zacks, Hasher, & Li, 2000).

5. Finally, the recollection-deficit explanation suggests that older adults are less likely than younger people to use encoding and retrieval strategies that create associations between items to be learned (Chalfonte & Johnson, 1996; Naveh-Benjamin, 2000). Such associations aid memory retrieval, as you saw in the demonstration in Figure 17.10 (creating associations between unrelated pictures makes it easier to recall them). When trained in the use of such strategies, older adults’ performance on recall tasks is closer to that of younger adults (e.g., Luo, Hendricks, & Craik, 2007).

Each of these explanations has scientific support, and given the complexity of adult cognition, it is likely that each accounts for some of the differences between older and younger adults’ memory functioning.

Yet age differences in memory functioning may not be due solely to deficits that emerge in later life. Contextual factors may play a role, too. In particular, internalized stereotypes about aging can impair memory performance (Hess, 2005; O’Brien & Hummert, 2006), just as negative stereotypes about minority groups can undermine their academic performance (see Chapter 13). In experimental studies, exposing participants to negative age stereotypes—either explicitly (e.g., by having them read about age-related declines in memory) or implicitly (e.g., by briefly flashing words such as confused, forgets, dementia, and decrepit)—leads to worse memory performance by older adults but does not affect the memory performance of younger adults (Hess, Auman, Colcombe, & Rahhal, 2003; Levy, 1996). Evoking negative age stereotypes may erode older adults’ confidence and arouse anxiety as they seek to complete the memory tasks. A hopeful finding from this research is that evoking positive views of aging—for
example, by presenting words associated with wisdom such as learned, insightful, and sage—enhances older adults’ memory performance (Levy, 1996).

Impact of Age-Related Changes in Memory The changes in memory discussed so far are considered to be normal changes that occur with age, unlike pathological (disease-related) change, which is discussed next. Normal memory changes that occur with age generally do not disrupt older adults’ lives (Park & Reuter-Lorenz, 2009). One reason is that our memory systems tend to have much greater capacity than is needed for survival, so that even with age-related declines, ample capacity remains to function effectively in daily life (Verhaeghen, Marcoen, & Goossens, 1993). Another reason is that much of what we do in the course of our daily lives requires us to draw upon accumulated knowledge rather than to learn and remember new knowledge, and both semantic and procedural memory hold up well in later life (Park, 2000; Salthouse, 2004).

Older adults also find ways to compensate for normal changes in their memory (Park, 2000; Salthouse, 2004). The famous neuropsychologist Donald Hebb observed his own memory beginning to decline as he grew older, and he wrote about the strategies he used to compensate for the decline. He made lists, used Post-It notes and other memory cues (e.g., putting an umbrella by the door rather than trying to remember to take it to work the next day), and developed daily routines so that some tasks become habitual (e.g., taking medication at the same time each day; Hebb, 1978). Most older adults adapt relatively easily to normal memory changes, but some find such changes to be quite distressing, especially if they view such changes as signs of Alzheimer’s disease, one of the most feared diseases of later life (Harris Interactive, 2006).

Pathological Changes in Memory

You may know an older person whose memory seems to be seriously impaired. If so, he or she may have dementia, a chronic brain disorder characterized by irreversible cognitive decline severe enough to impair self-care and daily activities (Gatz, 2007; NIA, 2008). Many types of dementia exist. The following discussion explores the two most common forms of dementia in later life—Alzheimer’s disease and vascular dementia—along with delirium, an acute brain disorder characterized by cognitive impairment that can be reversed if it is treated.

Alzheimer’s Disease  Alzheimer’s disease is the most common form of dementia in later life, accounting for about 70 percent of cases of dementia (Albert, 2008). Although Alzheimer’s disease can affect people in their 40s and 50s, it much more often affects people over age 60. In fact, rates of Alzheimer’s disease rise markedly with age, with fewer than 10 percent of the young-old but as many as 50 percent of the old-old having at least mild symptoms of Alzheimer’s disease (Hebert, Scherr, Bienias, Bennett, & Evans, 2003; NIA, 2009b) (see Figure 17.11). Approximately 5.1 million adults in the United States currently suffer from Alzheimer’s disease (NIA, 2008), but this figure is expected to mushroom as the population continues to age (Hebert et al., 2003). Scientists estimate that 100 million people throughout the world may suffer from Alzheimer’s disease by 2050 (Brookmeyer, Johnson, Ziegler-Graham, & Arrighi, 2007).

**FIGURE 17.11**

Mild, Moderate, and Severe Symptoms of Alzheimer’s Disease Increase Markedly with Age

Alzheimer’s disease develops gradually, and although its course varies across people, cognitive deficits usually appear first, followed by behavioral deficits, and then eventually by motor deficits (Albert, 2008; NIA, 2009b; see Table 17.1). The first signs of the disease nearly always involve memory loss. People may have difficulty remembering where they put things or whether they have paid the bills. They may have trouble organizing their thoughts clearly or expressing themselves as they forget words or names. Signs of impaired judgment (reflected in inappropriate decisions or behavior) and disorientation (uncertainty about where one is or what time of day it is) often appear as well. Depression is common at this stage, as people begin to grasp that they have Alzheimer’s disease (NIA, 2009c).

As the disease progresses over time, cognitive deficits (memory loss, language problems, confusion, disorientation) increase, and behavioral deficits begin to emerge (see Table 17.1, middle stage). People begin to have problems performing basic self-care activities (e.g., bathing, dressing, preparing meals), and concerns for their safety can develop as they begin to wander at night or forget to turn off the stove. During this middle stage, people often become fearful or suspicious of others and, as a result, become anxious, agitated, or even aggressive. As the disease progresses, these cognitive and behavioral deficits worsen and motor deficits appear (NIA, 2009c; see Table 17.1, late stage). People need assistance with all self-care tasks, and they may no longer

### TABLE 17.1 Symptoms of Alzheimer’s Disease in Early, Middle, and Late Stages

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<th>EARLY</th>
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<th>LATE</th>
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<td>Cognitive impairment (affecting memory, language, thinking, judgment, and orientation)</td>
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<td>■ Loss of recent memory</td>
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<td>■ Trouble finding words</td>
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<td>■ Difficulty organizing thoughts and actions</td>
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<td>■ Poor judgment</td>
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<td></td>
<td>■ Loses way going to familiar places; misplaces things</td>
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<td>■ Difficulty remembering new information, recognizing familiar people, and recalling past events</td>
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<td>■ Difficulty communicating; reduced or repetitive speech</td>
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<td>■ Difficulty comprehending information and experiences</td>
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<td>■ Deterioration of judgment, inappropriate behavior or safety concerns possible</td>
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<td>■ Confusion about time and place</td>
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<td>Becomes severe:</td>
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<td>■ Severe loss of memory; inability to recognize self or family members</td>
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<td>■ Loss of ability to understand speech or speak intelligibly</td>
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<td>■ Inability to think clearly or comprehend information</td>
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<td>■ Severe impairment of judgment</td>
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<td>■ Severe confusion about time and place</td>
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| Behavioral and psychiatric impairment | Appears: |
|                                      | ■ Depression, loss of interest in activities  |
|                                      | ■ Withdrawal  |
|                                      | ■ Frustration, anger possible  |
|                                      | Worsens: |
|                                      | ■ Difficulty performing self-care (e.g., bathing, dressing), lack of concern for appearance and hygiene possible  |
|                                      | ■ Anxiety, agitation, sleep disruption, aggression possible  |
|                                      | ■ Paranoia and hallucinations possible  |
|                                      | Becomes severe: |
|                                      | ■ Assistance needed with all self-care tasks  |
|                                      | ■ Signs of distress possible (e.g., moaning, screaming, discomfort when touched)  |
|                                      | ■ Weight loss  |
|                                      | ■ Sleep disturbance  |
|                                      | Appears: |
|                                      | ■ Loss of control over body movements (e.g., walking, standing, swallowing)  |
|                                      | ■ Loss of control over bodily functions (e.g., bladder and bowel functions)  |

remember how to walk or stand. Control over bodily functions (such as bladder and bowel functions) can be lost at this stage of the disease.

This progression of symptoms unfolds over a period of about 10 years, on average (Albert, 2008), although the disease often has been developing for many years before being diagnosed (Marx, 2005; Tierney, Yao, Kiss, & McDowell, 2005). Former President Ronald Reagan is believed to have begun showing signs of cognitive impairment during his second term in office before being diagnosed with Alzheimer’s disease in 1994 (Venneri, Forbes-McKay, & Shanks, 2005). If people do not die of another disease first, Alzheimer’s disease ultimately causes their death.

Abnormalities in the brains of people with Alzheimer’s disease may be responsible for their impaired functioning (see Figure 17.12). **Amyloid plaques**—abnormal deposits of protein—form in the brain, causing inflammation, destroying neurons and synapses, and reducing levels of neurotransmitters (NIA, 2009b). **Neurofibrillary tangles**—tangled fibers that form in the neurons—interfere with connections between the neurons. These abnormalities initially affect regions of the brain that are crucial for memory, such as the hippocampus. Over time, they spread to more areas of the brain, eventually affecting the temporal, parietal, and frontal lobes. This explains why symptoms of the disease expand to affect many domains of functioning over time (Albert, 2008). The motor cortex is affected last, which is why the ability to perform motor tasks typically does not deteriorate until late in the course of the disease (Albert, 2008).

Scientists are still investigating what causes these brain abnormalities, and it is likely that multiple factors are involved (NIA, 2009b). Age itself is a risk factor for developing Alzheimer’s disease, as noted earlier. Women have a greater risk than men, primarily because women live longer than men. Heredity plays a role as well. People with a primary relative (such as a parent) who developed Alzheimer’s disease are 2 to 4 times more likely to develop the disease themselves (Gatz, 2007). A mutation of the gene **apolipoprotein (APOE)** is found in 50 to 60 percent of people with Alzheimer’s disease, compared to 20 to 25 percent of healthy older adults (Salmon, 2000). This genetic risk magnifies other risk factors. For example, a head injury early in life increases the risk of developing Alzheimer’s disease later in life, particularly among people who

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**FIGURE 17.12**

Brain Scans of People with Normal Cognitive Functioning versus Mild Cognitive Impairment versus Alzheimer’s Disease

PET (Positron emission tomography) scans reveal fewer areas of high brain activity (shown in red and yellow) and more areas of low brain activity (shown in blue) in the brains of people with mild cognitive impairment and Alzheimer’s disease as compared with a normal brain.
have the APOE gene mutation (Jellinger 2004)—a clear example of the sort of gene-environment interaction we discussed in Chapter 2. There is little one can do about some of these risk factors, but other risk factors can be modified. For example, exercising (especially aerobic exercise), refraining from smoking, preventing or controlling high blood pressure and high cholesterol (especially “bad cholesterol,” or low-density lipoprotein), engaging in cognitively simulating activity, and being socially engaged with others are under our control and can reduce the risk of Alzheimer’s disease (Haan & Wallace, 2004; Hertzog, Kramer, Wilson, & Lindenberger, 2008).

Alzheimer’s disease has no cure, unfortunately. Drug treatments are being investigated, but most currently offer only modest, short-term benefits for cognitive functioning. Medications can help to alleviate symptoms of depression and anxiety, but they do not slow the rate of cognitive decline (Albert, 2008). As scientists continue to search for effective treatments for Alzheimer’s disease, the best strategy in the interim is to try to prevent or postpone the disease (Marx, 2005; Post, 1999). If the disease could be delayed by even 5 years, the number of cases in the United States could be reduced by half (Brookmeyer, Gray, & Kawas, 1998; Fratiglioni & Wang, 2007). The theme of preventing cognitive decline is revisited in the last section of the chapter.

Alzheimer’s disease affects not only the person with the disease but also family members. The progression of cognitive, behavioral, and motor deficits can be devastating, as family members witness the steady, heartbreaking loss of a loved one’s personality and independence. The impact on family members is physical as well as emotional, as they take up the tasks involved in providing day-to-day care of the ill relative (Pinquart & Soreson, 2003, 2007). Caregiving can become a full-time job and a source of chronic stress, putting family caregivers at risk of depression and health problems of their own (Alspaugh, Stephens, Townsends, Zarit, & Greene, 1999; Schulz, O’Brien, Bookwala, & Fleissner, 1995; Vitaliano, Scanlan, & Zhang, 2003). Yet caregiving also offers psychological rewards. Care providers can experience feelings of usefulness and increased closeness to the care recipient, and the care recipient can experience the feeling of being loved and cared for (Pinquart & Sorensen, 2003; Walker, Martin, & Jones, 1992).

As Alzheimer’s disease progresses, many caregivers eventually find it impossible to care for a loved one with the disease at home. Placing an impaired parent or spouse in an institution, such as a nursing home, is an option to which U.S. families often reluctantly turn after they have exhausted all other options (Merrill, 1997). Research clearly indicates that nursing home placement is a last resort in most cases, contrary to stereotypes that unfairly portray U.S. families as uncaring toward the elderly and quick to turn to institutional care (Shanas, 1979). Nursing home care is expensive, unfortunately, averaging over $75,000 annually in the United States (Houser, 2007), and Medicare and most private insurance programs provide only very limited coverage for long-term care. Finding ways to make long-term care more affordable is a challenge confronting all societies experiencing populataging aging.

Vascular Dementia  

Vascular dementia (sometimes referred to as multi-infarct dementia) accounts for about 10 to 20 percent of all dementias in later life (Gatz, 2007; NIA, 2003). It is caused by a series of strokes that disrupt blood flow to the brain, depriving the brain of oxygen and causing brain tissue to die; accounts for about 10 to 20 percent of dementias in later life.
Delirium  Not all brain disorders in later life are irreversible. As noted earlier, delirium is an acute, rather than a chronic, state of cognitive impairment that develops rapidly over a short period of time (Foreman et al., 1996). It can be caused by medication side effects or interactions, vitamin deficiencies, alcohol intoxication, disease (e.g., a tumor caused by cancer), injury (e.g., a blow to the head), surgical complications, or even a sudden environmental change (such as emergency hospitalization or the sudden death of a loved one; Smyer & Qualls, 1999). If the underlying cause (or causes) can be identified and addressed, cognitive functioning can often recover relatively quickly.

Distinguishing Between Chronic and Acute Brain Disorders  It is crucial for medical practitioners who work with the elderly to be able to distinguish between chronic and acute brain disorders, because the acute disorders can be reversed, if treated. This diagnostic task is not easy, however, because the symptoms of chronic and acute brain disorders overlap considerably. In addition, depression (discussed in the next chapter) can also cause problems with memory and concentration (Alexopoulos et al., 2002). Unfortunately, there are no simple tests, such as a blood test, that allow a physician to easily pinpoint the cause of cognitive impairment in an older person.

Alzheimer’s disease can be confirmed definitively only through a brain autopsy after death. Before then, it is typically diagnosed by exclusion—by carefully evaluating the symptom history and conducting a medical exam and psychological tests to evaluate whether potentially reversible conditions could be causing the cognitive impairment. If those conditions are ruled out, the problem is assumed to be Alzheimer’s disease. The danger is that a potentially reversible cause—such as a vitamin deficiency or recent medication change—could go undetected, and untreated. In fact, general-practice physicians are believed to misdiagnose as many as half of all cases of dementia in older adults (Boise, Camicioli, Morgan, Rose, & Congleton, 1999).

Brain imaging techniques (such as magnetic resonance imaging, or MRI) have begun to improve diagnostic accuracy in recent years, but they are not readily available everywhere. If an older relative exhibits cognitive impairment, it is important for family members to provide as much information as possible about the relative’s medical history, medications, diet, alcohol or other substance use, possible injuries, and any recent life changes. It may also be useful to consider obtaining a second opinion if Alzheimer’s disease is suspected. (For a summary of this section, see “Interim Summary 17.5: Cognitive Development.”)

ENHANCING COGNITIVE FUNCTIONING IN LATER LIFE

Some degree of cognitive decline may be a nearly universal experience in later life, but new research shows that there are things we can do to influence when and how much decline occurs. If cognitive decline can be slowed or postponed until very late in life, its negative impact on older adults’ lives will be greatly reduced. You may recognize this idea as an example of the compression of morbidity; Just as it may be possible to compress the period of physical illness in later life, it may be possible to compress the period of cognitive decline in later life.

Intense research interest is currently focused on how cognitive functioning can be enhanced in later life (Elias & Wagster, 2007; Fratiglioni & Wang, 2007; Hertzog et al., 2008; Mayr, 2008). Two key questions lie at the heart of this research. First, what lifestyle factors help to preserve cognitive functioning in later life? Second, to what extent can declines in cognitive functioning be reversed? As you’ll see, the answers that have begun to emerge are encouraging. You’ll also see that cognitive development in later adulthood does not inevitably entail decline. Some areas of cognitive strength, such as wisdom, may be well preserved in later life.
Lifestyle Factors

Lifestyle factors do appear to play a role in preserving cognitive functioning (Albert, 2008; Fratiglioni & Wang, 2007; Hendrie et al., 2006; Hertzog et al., 2008), and four factors are known to be especially important:

- Stimulating cognitive activity
- Physical activity, especially aerobic exercise
- Reducing cardiovascular risk factors
- Social engagement

Stimulating cognitive activity—reading newspapers and books, doing crossword puzzles, and engaging in other cognitively challenging leisure or work activities—has been linked to better cognitive functioning in many studies (Fratiglioni & Wang, 2007; Hertzog et al., 2008; Stine-Morrow, Parisi, Morrow, Greene, & Park, 2007). For example, in a study of over 4,000 older adults, those who engaged more often in stimulating cognitive activities showed less cognitive decline 6 years later, even after adjusting for health and other
factors that could have influenced their cognitive functioning (Wilson et al., 2003). In another study, older adults who engaged in more cognitively stimulating activities were 33 percent less likely to develop Alzheimer’s disease; importantly, all of the participants began the study free of dementia (Wilson et al., 2002). Engaging in stimulating cognitive activity earlier in life also benefits cognitive functioning later in life. Both education and complex work help to build up a larger cognitive reserve (Fratiglioni & Wang, 2007; Stern, 2006). Among identical twins (who have the same genetic makeup), the twin with greater education is less likely to develop Alzheimer’s disease (Gatz, Prescott, & Pedersen, 2006).

Physical exercise, especially aerobic exercise, contributes to greater brain health and better cognitive performance (Raz & Rodrigue, 2006). In a fitness intervention, sedentary older adults who participated in aerobic exercise (a walking program) for 6 months showed significant increases in brain volume, compared to older adults who participated in non-aerobic exercise (a toning-and-stretching program) (Colcombe et al., 2006). Regular physical exercise substantially reduced the risk of developing Alzheimer’s disease, as well, in another large study of older adults (Larson et al., 2006).

Reducing cardiovascular risk factors—high blood pressure, high cholesterol, obesity, smoking—not only preserves physical health but also slows the development of brain abnormalities in later life, such as amyloid plaques and neurofibrillary tangles (Cotman, Berchtold, & Christie, 2007; Raz, Rodrigue, Kennedy, & Acker, 2007). These brain abnormalities are involved in Alzheimer’s disease, so slowing their growth reduces the risk of Alzheimer’s (Haan & Wallace, 2004; Hamer & Chida, 2008; Marx, 2005).

Social engagement—interacting with friends and family members and being involved in social activities—is also associated with better cognitive functioning and a decreased risk of Alzheimer’s disease in later life (Fratiglioni, Paillard-Borg, & Winblad, 2004; Kramer, Bherer, Colcombe, Dong, & Greenough, 2004; Marx, 2005). Scientists do not yet know why social engagement helps to preserve cognition in later life, but it may involve cognitive stimulation in its own right and it also helps to reduce stress (thereby improving cardiovascular health).

**Cognitive Interventions**

The research discussed above suggests that healthy and engaged lifestyles may help to slow or postpone cognitive declines in later life. But can cognitive declines that have occurred be reversed? Although it may not be possible to reverse the severe cognitive declines caused by dementia, perhaps normal, age-related cognitive declines can be reversed. Evidence that the brains of healthy older adults exhibit considerable plasticity provides a reason for optimism that their cognitive abilities are also malleable. This possibility has been investigated in studies of cognitive interventions designed to improve older adults’ cognitive functioning.

Early intervention studies involved giving older adults several sessions of training in specific cognitive abilities (Hertzog et al., 2008). For example, in conjunction with the Seattle Longitudinal Study, older adults whose intelligence had either remained stable or declined received five 1-hour training sessions in specific cognitive skills that
tapped fluid intelligence (see Chapter 15, Schaie & Willis, 1986). By the end of the training program, roughly two-thirds of the participants showed gains in their performance. The greatest gains were seen among those whose intelligence scores had declined prior to the intervention. For many of these individuals, the size of the gains nearly matched the declines that had occurred over more than a decade (Schaie, 2005; Willis, Jay, Diehl, & Marsiske, 1992).

The gains in intervention studies like these often were substantial and durable, lasting for up to 14 years in some studies (Ball et al., 2002; Schaie, 1996; Willis & Nesselroade, 1990). When the gains began to taper off, they could be maintained with periodic “booster” sessions (Willis & Nesselroade, 1990). A key problem with these interventions, though, is that the gains typically were limited to the specific cognitive abilities trained; they did not generalize to other abilities (Hertzog et al., 2008). Older people who learned how to use imagery to remember lists more effectively, for example, did not improve on other kinds of memory or information processing tasks.

A new generation of intervention studies is seeking to overcome that limitation by providing training designed to improve more basic cognitive processes and information-processing efficiency (Hertzog et al., 2008). In one recent study, older adults were immersed in interesting and progressively more stimulating and demanding memory tasks (Mahncke et al., 2006). Participants completed these tasks using computers in their own homes 1 hour per day, 5 days per week, for 8 to 10 weeks. Rather than simply teaching older people a specific memory technique, this intervention was designed to improve how information actually flows through the systems of memory. The participants showed gains in memory not only on the specific tasks that were the focus of training but, importantly, on other kinds of memory tasks that had not been part of the training. New intervention strategies like this hold great promise for achieving broader gains in older adults’ cognitive functioning that can generalize to multiple cognitive abilities and to their everyday lives (Hertzog et al., 2008).

Studies of lifestyle factors and cognitive interventions are identifying valuable strategies for preserving brain health and cognitive vitality in later life. Actions can be taken even in old age to enhance cognitive functioning. As the popular saying “Use it or lose it” implies, the key to not “losing it” may be keeping one’s mind active and one’s body fit.

You can see that experiences over the course of a lifetime influence the extent to which cognitive declines occur. Could life experiences play a role helping to develop cognitive strengths in later life? Let’s conclude by examining a cognitive strength that is often attributed to the elderly: wisdom.

Wisdom

Do you know someone whom you consider to be especially wise? What characteristics make that person wise in your view? How did he or she come to be wise? Researchers have wrestled with exactly such questions, and it will not surprise you that many different definitions of wisdom exist (Brugman, 2006). A widely accepted definition describes wisdom as a form of expert knowledge or judgment about difficult life problems that has five key characteristics (Ardelt, 2004; Baltes, Staudinger, Maercker, & Smith, 1995; Kramer, 2003; Staudinger, Dorner, & Mickler, 2005):

- Great breadth and depth of knowledge about life and human nature
- Effective use of this knowledge to make decisions and solve problems
- Understanding of a problem in the context of another person’s unique life circumstances
- Concern with human values and the welfare of others
- Comfort with uncertainty and the lack of a perfect solution to many problems
A key issue for developmental researchers is how wisdom develops. If it emerges from life experience, then people who have had more life experience should be wiser. This is why wisdom is often assumed to develop in later life. Perhaps there is a reason why many U.S. Senators and four Supreme Court Justices are in their 70s and older! But are older adults especially likely to be wise, or can people of any age be wise? This question has been examined by asking people of different ages how they would approach challenging life problems, and then scoring their answers for the components of wisdom listed above (e.g., Smith & Baltes, 1990; Staudinger, Smith, & Baltes, 1996). For example, in one study, participants ages 25 to 81 were presented with hypothetical life problems and were asked how they thought each problem should be handled. Here is a sample problem from this study (Smith & Baltes, 1990, p. 497). How would you suggest handling it?

Joyce, a 60-year-old widow, recently completed a degree in business management and opened her own business. She has been looking forward to this new challenge. She has just heard that her son has been left with two small children to care for. Joyce is considering the following options: she could give up her business and live with her son, or she could plan to arrange for financial assistance for her son to cover child-care costs.

In this study, the average wisdom scores did not differ across age groups (Smith & Baltes, 1990). Other research, too, has failed to find age differences in average wisdom scores (Baltes & Staudinger, 2000; Brugman, 2006; Staudinger, 1999). Yet in another study, the wise group of participants—those whose wisdom scores were in the top 20 percent—contained more older adults than middle-aged or younger adults (Baltes et al., 1995; Staudinger, 1999). It seems, then, that adults of all ages have the capacity to develop wisdom, but those who show the highest levels of wisdom tend to be older adults (Staudinger et al., 1992). (For a summary of this section, see “Interim Summary 17.6: Enhancing Cognitive Functioning in Later Life.”)

## INTERIM SUMMARY 176

### Enhancing Cognitive Functioning in Later Life

<table>
<thead>
<tr>
<th>Lifestyle Factors</th>
<th>Four lifestyle factors are especially important for preserving cognitive functioning: stimulating cognitive activity, physical exercise, reducing cardiovascular risk factors, and social engagement.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Healthy and engaged lifestyles may help to prevent or postpone cognitive declines.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cognitive Interventions</th>
<th>Evidence that the brains of healthy older adults exhibit considerable plasticity provides a reason for optimism that cognitive abilities are malleable. This possibility has been investigated in studies of cognitive interventions designed to improve older adults’ cognitive functioning.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cognitive training programs produce gains in cognitive functioning. Interventions designed to improve cognitive processing and the efficiency of information processing show broad gains that generalize to many cognitive abilities and to older adults’ everyday lives.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wisdom</th>
<th>Wisdom is defined as a form of expert knowledge or judgment about difficult life problems.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adults of all ages have the capacity to develop wisdom, but those who show the highest levels of wisdom tend to be older adults.</td>
</tr>
</tbody>
</table>
SUMMING UP AND LOOKING AHEAD

We have seen that later adulthood, a life period that has become commonplace only fairly recently in human history, is characterized by considerable developmental variability, although declines in some aspects of physical and cognitive functioning appear to be inevitable. The declines reflect the effects of biological damage that accumulates over time and begins to overwhelm the body’s own capacities for maintenance and self-repair. How this damage affects older adults’ health and cognitive functioning depends to a large extent on their biological and cognitive reserves, which are determined by their genes and by lifestyle and environmental factors. Despite the challenges posed by physical and cognitive declines, many older adults are remarkably resilient and adaptable. They find ways to compensate for declines, maintaining generally positive views of their health and experiencing relatively modest limitations of their daily activities until advanced old age. The aging brain is adaptive, too, exhibiting compensatory changes that help to preserve cognitive functioning when declines in brain efficiency occur.

We will see further evidence of older adults’ adaptive capacities as we examine social and emotional development in later adulthood in the next chapter. As our exploration of later life continues, you’ll see that a balanced picture of old age requires us to acknowledge not only the losses and declines that are inevitable but also the strengths and resilience that come with age.

HERE’S WHAT YOU SHOULD KNOW

Did You Get It?
After reading this chapter, you should understand the following:

- The main theories of the causes of aging
- How genes and longevity are related
- Physical changes that take place in late adulthood
- Health conditions that affect older adults and how older adults rate their own health
- The life expectancy for U.S. adults and what affects life expectancy
- Normal changes in memory that take place in late adulthood
- Pathological changes in memory that may take place in late adulthood
- Factors and interventions that can enhance cognitive functioning in later life
- The meaning of wisdom

Important Terms and Concepts

activities of daily living (ADLs) (p. 554)
ageism (p. 535)
Alzheimer’s disease (p. 561)
amyloid plaques (p. 563)
apolipoprotein (APOE) (p. 563)
arteriosclerosis (p. 548)
autoimmune diseases (p. 550)
bodily control systems (p. 548)
caloric restriction (p. 540)
cataracts (p. 545)
centenarian (p. 538)
compensation (p. 543)
compression of morbidity (p. 555)
delirium (p. 561)
dementia (p. 561)
episodic memory (p. 559)
evolutionary theories of aging (p. 539)
frailty (p. 544)
free radicals (p. 540)
Hayflick limit (p. 541)
hypertension (p. 548)
immune system (p. 549)
inflammation (p. 550)
instrumental activities of daily living (IADLs) (p. 554)
life expectancy (p. 536)
long-term memory (p. 558)
loss-based selection (p. 551)
macular degeneration (p. 546)
maximum lifespan (p. 538)
neurofibrillary tangles (p. 563)
old-old (p. 535)
plasticity (p. 543)
population aging (p. 537)
procedural memory (p. 560)
programmed theories of aging (p. 548)
random damage theories of aging (p. 539)
reaction time (p. 549)
recall (p. 559)
recognition (p. 559)
reserve capacity (p. 542)
semantic memory (p. 560)
sensory memory (p. 557)
supercentenarian (p. 538)
t cells (p. 550)
telomeres (p. 541)
urinary incontinence (p. 548)
vascular dementia (p. 564)
wisdom (p. 568)
working memory (p. 558)
young-old (p. 535)