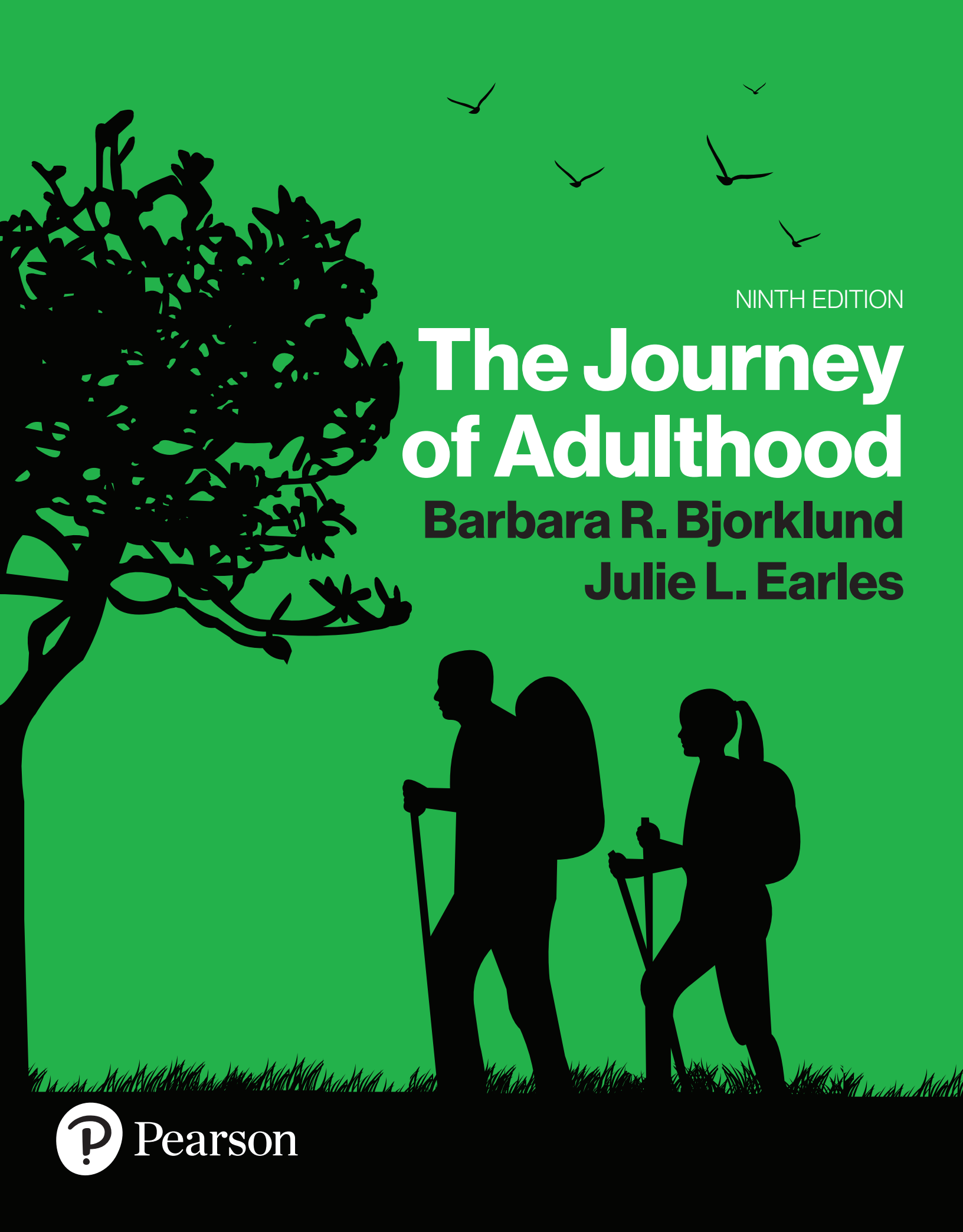

NINTH EDITION

The Journey of Adulthood

Barbara R. Bjorklund
Julie L. Earles

Pearson

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Ninth Edition

Barbara R. Bjorklund
Wilkes Honors College of Florida Atlantic University

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Portfolio Manager: *Tanimaa Mehra*
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Product Marketer: *Marianela Silvestri*
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For my new grandchildren: Jane and Wesley Zeman, Sage Zeman, and Amelia Tobiaz.

You light up my life! BRB

For my father, Dr. Tom Earles, who taught me to appreciate human complexity and search for the good in every person.

I love you dad. JLE

Brief Contents

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Preface

Now in its ninth edition, *The Journey of Adulthood* continues to capture the dynamic process of adult development from early adulthood to the end of life. Its core is made up of research findings from large-scale projects and major theories of adult development, but it also reflects smaller studies of diverse groups, showing the influences of gender, culture, ethnicity, race, and socioeconomic background on this journey. I have balanced new research with classic studies from pioneers in the field of adult development. And I have sweetened this sometimes medicinal taste with a spoonful of honey—a little personal warmth and humor. After all, I am now officially an older adult who is on this journey along with my husband, looking ahead at the examples our parents' journeys gave us, and back toward our children who are blazing their own trails. And as of this edition, we have 14 grandchildren—seven of whom are beginning their own journeys of adulthood either as college students or starting their careers.

Not only have I changed over the course of this book, but I have taken on a co-author and have truly enjoyed having her input. She is Dr. Julie Earles, a long-time friend and colleague at the Wilkes Honors College of Florida Atlantic University. She has a little different spin on things, and I think it will make this an even better book as she adds more and more to the chapters.

The first chapter contains the basics for the course—definitions, methods, and guiding perspectives for the study of adult development. Chapters 2 through 8 cover traditional developmental topics, featuring recent research, classic studies, current theories, new directions, and practical applications. Chapters 9, 10, and 11 cover topics not traditionally found in adult development texts, but which we feel are important to round out a student's experience in this course: the quest for meaning; the inevitability of stress, coping, and resilience in adult life; and the way we face our own deaths and those of our loved ones. The final chapter takes a chronological look at adult development, in contrast to the topical theme in the earlier chapters, and also suggests a model of adult development that will "pull the threads together and tie up loose ends."

New in This Edition

The ninth edition of *The Journey of Adulthood* features a comprehensive update of all chapters. Almost one-third of the references are new to this edition, as are many of the figures and tables. The field of adult development is changing quickly, and this edition of *The Journey of Adulthood* gives a thorough coverage of the changes that have taken place since the previous edition was written 4 years ago. Ultimately a text on development, *The Journey of Adulthood* has itself developed through numerous editions over the past two decades. This ninth edition features several types of change; some reflect change in the field of adult development and some reflect change in the world around us, specifically, the academic settings in which this text is used.

Changes in the Field of Adult Development

The study of adult development is a fairly new field and it expands exponentially from year to year. It began as a field of psychology, but more and more disciplines have shown an interest in the changes that take place over the adult years. This book includes research from scientists who identify themselves as psychologists, sociologists, anthropologists, neuroscientists, epidemiologists, behavioral geneticists, cellular biologists, biogerontologists, and many more. The terminology and methods in these fields have become more and more similar, and many researchers publish in the journals of a variety of fields. This edition of *The Journey of Adulthood* reflects this wonderful collaboration and the richness of a number of multidisciplinary projects. It is an exciting time in developmental science, and this text reflects that energy.

Some of the projects that have been tapped for this text are the Midlife in the U.S. Study (MIDUS), the Berlin Study of Aging, the Grant Study of Harvard Men, the National Comorbidity Study, the Nun Study of the School Sisters of Notre Dame, the Victoria Longitudinal Study, the Swedish Twin Study, the National Survey of Sexual and Health Behavior, The Women's Health Study, and the National Longitudinal Mortality Study.

To emphasize these collaborations, we have identified each major researcher or theorist with his or her field of study. Two editions ago, I was struck with the diversity of scientific fields contributing to the adult development literature. We want this text to reflect that diversity. When we discuss some work in detail, we give the full names of the researchers and how they identify their field of study. We hope that the students who are interested in adult development will take note and consider these areas when they declare their majors or make plans for graduate school. As professors, we all need to remember that we not only teach

the content of the courses, but also guide our students in career decisions—in life decisions.

Another change in the field of adult development is that more and more research projects reported in major journals are done by international groups of researchers in settings all over the developed world. We are no longer limited to information on adults in the United States, we also have research being done by Swedish, Japanese, and Egyptian scientists using Swedish, Japanese, and Egyptian participants. When the findings are similar to studies done in the United States, we can be more confident that the developmental phenomenon being studied is an integral part of the human experience and not something particular to people in the United States. When the findings are different from studies done in the United States, we can investigate these differences and find their roots. We have identified these international research teams and the nationalities of their participants. We hope this accentuates the global aspects of our academic community and, as seasoned travelers ourselves, we hope it inspires students to consider "study-abroad" programs and to consider the world outside their own.

We include full names of major researchers and theorists when we discuss their work in detail. Seeing the first and last names makes the researchers more real to the students than conventional citations of "last names, comma, date." Full names also reflect the diversity of scientists—often their gender and their national or ethnic backgrounds. Our students represent a wide range of races and ethnicities, and the time of science being the sole domain of an elite group most of us cannot identify with is gone.

One of the most exciting changes in the field of adult development has been its expansion to emphasize a wider and wider range of age groups. In the early editions of this text, the focus of interest was older adults. The last three editions have featured more and more studies of young adults, middle-aged adults, and emerging adults. This edition features additional research on the opposite end of the age spectrum: those who are 75, 80, 90 years of age and older. Although having people in this age group is nothing new, the growing numbers of them have made it important (and relatively easy) to include them in studies of adult development. Clearly the study of adult development is no longer the study of certain specific age groups, it is now truly a study of every aspect of adulthood. We have tried to capture this inclusion by choosing topics, examples, opening stories, photos, suggested reading, and critical thinking questions that represent the entire adult lifespan.

Changes in the World Around Us

Since the last edition of this book, the world has changed in many ways. As we write this preface, we seem to have recovered from the financial setbacks many families experienced a decade ago and unemployment numbers are low. However, technology and outsourcing have replaced workers in many areas, and those replaced workers are often underemployed in fields that have lower wages. Many students are graduating from college with student loan debt and poor job prospects in their areas of study. Opioid abuse has become a public health crisis, taking a toll on every part of the country and every level of society. Cutbacks in government funding and the weakening of regulations threaten our environment and our planet's future. There is a large political divide. More troops are coming home from overseas deployment, but many have war-related disabilities that include posttraumatic stress disorder (PTSD) and traumatic brain injury (TBI). Single-parent families and dual-earner families in the United States (and in many other developed countries) are having a rough time; they receive little cooperation from the government, the workplace, or the community to assist them in caring for both job and family. Many older women, especially those who live alone, are living below the poverty line. The United States has the highest rates of mental health disorders of any developed country and most of the people experiencing these symptoms do not get adequate treatment. Unhealthy lifestyles are resulting in increased health problems for many adults in the developing world, and the ages of those affected are extending to both the younger and older end of the spectrum. Although we try to maintain a positive tone, these topics are part of the reality of adult life, and we have included them in *The Journey of Adulthood*.

Other changes in the world around us are more positive. Health awareness is increasing at all ages; advances are being made in many areas of disease prevention, detection, and treatment; and a greater percentage of people in developed countries are living into old age. The rate of cancer deaths continues to decline as advances are made in early detection and treatment. Although there is still no "cure" for aging and no sign of a way to increase the existing maximum lifespan, people are increasing the number of healthy years in their lives. Programs such as hospice are making it possible for an increasing number of people to choose to have "a good death" when that time comes. Women are making great strides in professional careers and in their positive adjustment to children leaving home and widowhood. Communication technology has made it easier for families to stay in touch and for older adults to live independently. The average age of people using social media, cell phones, and e-games is increasing. These are also among the topics selected for this text.

Changes in the Classroom

Courses in adult development are offered in all major colleges and universities in the United States and are becoming popular around the world. It is safe to say that graduates in almost all majors will be working in fields that deal with

the changes that occur during adulthood. It is also safe to say that students in all majors will be dealing with the topic on a personal level, both their own progress through adulthood and that of their parents. The students at the Wilkes Honors College at Florida Atlantic University this semester are majoring in psychology, counseling, nursing, criminal justice, premedical sciences, prelaw, social work, occupational therapy, sociology, and education. About one-half are bilingual and about one-third speak English as a second language. The majority will be the first in their families to graduate from college. We no longer assume that they have the same academic backgrounds as students a decade ago. For these reasons, we include basic definitions of key terms in the text of each chapter, clear explanations of relevant statistical methods, and basic details of major theories. We meet the readers knowing that the "typical student" is an outdated stereotype, but we meet them with respect for their intelligence and motivation. We firmly believe that it is possible to explain complex ideas clearly and connect with students from a variety of backgrounds and experiences. We do it every week in our classes, and we do it in this text.

Features

Learning Objectives distill the major takeaways of each chapter, stimulating interest in the main topics, helping focus student attention on the most salient points, and serving as a preview of what is to come. Learning Objectives also are linked to the content of the Chapter Summaries and to all questions in the Test Item File.

A Word from the Author—a sometimes funny, sometimes personal, and often introspective look at the main themes of a chapter, illustrated through lived experience and other relevant stories—begins each chapter. This feature helps to ground what can be abstract and theoretical concepts in the real world.

Interactive figures give students the opportunity to take a closer look at the data behind the graphics, allowing them to dive deeper into studies on topics as varied as mortality rates around the world, the top plastic surgery procedures in the United States, and how "in love" long-term couples are at different times in their relationships.

Journal questions encourage students to reflect on the content and relate it to their own experiences.

Shared Writing prompts allow students to write their own essays and then to read and comment on fellow students' essays, giving them a broader understanding of different experiences and perspectives.

Key terms are set in boldface type and defined immediately in the text. We believe we learn best by seeing a term in context. Definitions are also offered in the Glossary.

Highlights of Chapters in This Edition

Chapter 1 serves as an introduction to the study of adult development, beginning with the concept of development being both stable and changing. I use my own journey of adulthood as an example of these concepts and invite students to think of their own lives in these terms. Two guiding perspectives are introduced: Baltes's lifespan developmental approach and Bronfenbrenner's bioecological model. The next section covers developmental research. We don't assume that all students have taken a research methods class, so we limit the methods, measures, analyses, and designs to those that are used in later chapters. In fact, we use some of these studies as examples, hoping that students will feel comfortable with them when they encounter them later in the text.

New in this chapter:

- Studies comparing Eastern and Western cultures on their attitudes toward aging adults.
- New research on age-related changes in olfactory abilities.
- New research on the development of perceived control in emerging adults as they undergo the transition to adulthood.

The theme of **Chapter 2** is *primary aging*, the physical changes that take place predictably in most of us when we reach certain milestones in our journeys of adulthood. Again we begin with some basic theories including Harmon's theory of oxidative damage, Hayflick's theory of genetic limits, and the theory of caloric restriction. Then we cover age-related physical changes including outward appearance, the senses, the bones and muscles, the cardiovascular and respiratory systems, the brain and nervous system, the immune system, and the hormonal system. Most of the age-related change in these systems is gradual, but much can be done to avoid premature aging (and much of that can be done in early adulthood, such as avoiding excessive exposure to sunlight and tobacco use). Next, we cover four areas of more complex functioning: (1) athletic abilities; (2) stamina, dexterity, and balance; (3) sleep; and (4) sexual activity, all of which decline gradually with age. We cover some of the ways these declines can be slowed, but end the chapter with the caution that so far, we have no proven way to "turn back the clock."

New in this chapter:

- Evidence of psychological problems that arise with hearing loss.
- News that hearing loss has decreased in the past two decades, probably because of workplace noise restrictions.

- Studies that show increased risk of hip osteoarthritis for men who play handball, soccer, and hockey. Other studies show that professional ballet dancers have increased risk of hip osteoarthritis, especially women.
- More evidence that physical exercise can promote brain health.
- New research findings on sleep and insomnia.
- On the horizon—lab-grown replacement organs, transfusions of "young" blood components to older people, and identification of gene segments in people 100+ years of age and insertion into the DNA of younger people.
- Ethical and practical implications of extending the maximum lifespan.

Chapter 3 is about age-related disease, or *secondary aging*. We try to keep this separate from the normal changes discussed in the previous chapter. Not everyone suffers from these diseases no matter how long they live, and many age-related conditions can be prevented or cured. We start with data of mortality rates by age because we think it helps students put the risk of death and disease into perspective. For most of our students, the risk of premature death is very low, and the top cause is accidents. We then discuss four of the top age-related diseases and explain their causes, their risk factors, and some preventative measures. These are heart disease, cancer, diabetes, and Alzheimer's disease. We try to balance good news (lower rates of cancer deaths due to early detection and treatment, lower disability rates in the United States) with the bad (rising rates of diabetes at all ages, still no cure for Alzheimer's disease). The second part of the chapter is about mental health disorders. We try to impress upon the students that most of these disorders begin early in adulthood (or even in adolescence) and that most can be treated. However, the individuals suffering from these disorders (or their families) need to seek help and seek competent help. We end the chapter by telling that these physical and mental health disorders are not distributed randomly. Some groups are more apt to suffer than others, depending on one's genes, socioeconomic background, gender, lifestyle, personality patterns, and events that happened to them in very early childhood or even before birth.

New in this chapter:

- Completely updated mortality and morbidity statistics.
- Decreasing rates of disability for adults in the United States and the increasing rates of older adults "aging in place" around the world.
- New findings on the difference in heart disease in women and men.
- Continued decline in cancer deaths in the United States.
- New information about type 2 diabetes rates leveling off and even declining in some age groups.
- New diagnosis techniques for Alzheimer's disease.
- Updated statistics on mental health in the United States.
- New categories of mental disorders to fit DSM-5 classifications (anxiety disorders, depressive disorders, substance-related and addictive disorders).
- Extended discussion about the opioid problem in the United States.
- New information on robotic assistance and assistance animals.
- Bad news about continued poor diets and sedentary lifestyles among most age groups; good news about a drop in tobacco use.
- LGBTQ community faces more isolation and discrimination by the healthcare system than other minority groups, but have more need for physical and mental health assistance due to higher rates of victimization, homelessness, and job discrimination.
- New research on how adversity affects the immune system.
- New findings about intergenerational effects and how they affect our health.

Cognitive aging is discussed in **Chapter 4**. This chapter is about age-related changes in cognitive abilities, including attention, memory, intelligence, and problem solving. We explain how flaws in early research led to the conclusion that cognition declines sharply with age, and we present new research with better methodology that shows different patterns of age-related changes for different cognitive abilities. We demonstrate that some abilities, such as cognitive speed, do decline with age, whereas other cognitive abilities, such as those involving knowledge and expertise, improve with increased age. We begin the chapter with a discussion of research on attention, including research on divided attention tasks. The second part of the chapter is focused on memory and shows students the effects of age on different components of and different types of memory. We include a demonstration of the negative effects that stereotypes of cognitive aging can have on memory performance. We then turn to a discussion of intelligence, including differences in results for longitudinal and cross-sectional studies and differential effects of aging on separate components of intelligence. We also talk about individual differences in cognitive aging and mechanisms for improving cognitive abilities as one ages, and we hope students will be able to apply the research findings to their own cognitive health.

New in this chapter:

- New section on attention that includes research on divided attention and visual search.

- Reorganization of the chapter so that students can see how changes in attention and memory influence intelligence and problem solving.
- New research on the positive effects of physical exercise and cognitive engagement on cognitive abilities.
- Expanded discussion of the use of technology to assist adults with cognitive impairments.

Chapter 5 is about social roles and the change that takes place during adulthood. Social roles refer to the attitudes and behaviors we adopt when we make a transition into a particular role, such as worker, husband, or grandmother. This chapter covers changes within a person due to these life transitions. Gender is a major part of social roles, and several theories suggest how we learn what attitudes and behaviors fit the gender roles we fill. Bem's learning schema theory, Eagly's social role theory, and Buss's evolutionary psychology theory are presented. Various social roles, arranged chronologically, are discussed, including the transition from living in one's parents' home to living independently to living with a romantic partner in a cohabitation relationship or a marriage. Being part of a committed couple is related to good mental and physical health. Another role transition is from being part of a couple to being a parent. Social-role transitions in middle adulthood involve going from having children living in your home to having children who are independently living adults to becoming a grandparent. Another role in middle adulthood is often as caregiver for one's own parents. In late adulthood, many move into the role of living alone and becoming a care receiver. Not everyone fits these role transitions. Some adults never marry and some never have children but still have happy and productive lives. Lots of new social roles appear when there is a divorce in a family and then a remarriage, as most students know firsthand.

New in this chapter:

- Increased proportion of emerging adults and young adults who live in their parents' home. Decreased proportion of emerging adults and young adults who are married or cohabiting.
- Record low birthrates for teens and higher birthrates for women over age 40.
- New research comparing time use of mothers versus fathers when they are employed full time, part time, or not at all.
- Research on how couples divide up housework before and after becoming parents.
- Research that working mothers raise egalitarian sons.
- Increase in proportion of children living in grandparent-headed households, especially African American, Hispanic, and Asian families.
- More detailed look at young and middle-aged adults who spend time as caregivers for older adults. Most report a stressful but positive experience.
- Decreased proportion of older adults who live in nursing homes.
- New research on infertility and the effect it can have on couples.

Social relationships are covered in **Chapter 6** and differ from social roles because they involve two-way interactions between individuals, not just the behavior a person performs in a certain role. This is a difficult distinction, but there is just too much material on social-related topics for one chapter, so it's the division we have chosen. It also roughly fits the division between sociology studies (roles) and psychology studies (relationships). I begin this chapter with Bowlby's attachment theory, Ainsworth's model of attachment behaviors, Antonucci's convoy model, Carstensen's socioemotional selectivity theory, and Buss's evolutionary psychology approach. Then we start with various relationships in which adults participate, beginning with intimate partnerships, which include opposite-sex cohabitation, marriage, and same-sex partnerships. Next are parent–child relationships in adulthood, grandparent–grandchild relationships, and sibling relationships in adulthood. The chapter ends with a section on friendship. Students of all ages relate to this chapter personally and it works well in the middle of the text.

New in this chapter:

- New material on social contacts across the lifespan.
- New findings on what traits men and women find desirable in potential long-term partners.
- New findings on online dating.
- Meta-analyses of longitudinal studies of attachment styles.
- Cross-cultural studies of the acceptance of cohabitation.
- New research on cohabitation in the over-50 age group.
- Research on same-sex couples' counseling.
- Increased contact between parents and adult children, both face-to-face and via telecommunications.
- Increase in divorce for couples age 50 and older and the effect it has on their adult children.
- Older adults dealing with the life crises of adult children—a major source of distress.
- Importance of sibling relationships in middle and older adulthood.
- Benefits of giving social support.
- Social networks in later life.
- Social media and mental health across the lifespan.
- Social media's role in reducing interethnic prejudice.

The topics of work and retirement are covered in **Chapter 7**. In the early editions of this text, students applied the information in this chapter to their futures or to their parents' careers, but recently many apply it to themselves because they are part of the labor force and some are retraining for a second career. A few are even retired and attending college as a pastime. We start the chapter with Super's theory of career development and Holland's theory of career selection. Students are usually familiar with vocational preference tests and interested in finding out what type of work they would enjoy most. Gender differences are an important part of career selection and we question the reasons that even though women are found in almost every line of work and attend college in greater numbers than men, they still make less money and are not equally represented in top-paying, high-prestige jobs. The next section deals with age differences in job performance and job satisfaction. The section on work and personal life includes how jobs can affect individuals, intimate relationships, and responsibilities for other family members, including how household chores are divided up. The section on retirement includes reasons a person decides to retire or not, the effects of retirement, and some middle ground between full-time work and full-time retirement. We try to impress upon the young student that much of one's quality of life in retirement depends on planning ahead, and we hope they take that more seriously than we would have at his or her age.

New in this chapter:

- The concepts of careers that have no boundaries, are versatile, and are open to change.
- New data on women in the labor force.
- Longitudinal study of older adults in the labor force.
- How pre-retirement work complexity contributes to successful cognitive aging.
- How job strain contributes to cognitive changes and health.
- The worldwide problem of young people who are not working and not in school.
- New research on the paid work/family divide by gender and employment status.
- Longitudinal studies of caregivers.
- New research findings on volunteer work.

The topic of **Chapter 8** is personality. We divide the chapter into two parts: first, the research on personality structures, featuring Costa and McCrae's five-factor model, and, second, the grand old theories of personality, including Erikson's theory of psychosocial development, Loevinger's theory of ego development, Vaillant's theory of mature adaptation, Gutmann's theory of gender crossover, and Maslow's theory of positive well-being. We selected these from many because they have continued to inform research into age-related personality stability and change.

New in this chapter:

- New section on stereotypes of personality change.
- New longitudinal research on changes in dependability.
- New discussion of the effects of major life events on personality.
- New research on the relationship between openness and achievement.
- Increased discussion of the relationship between personality and health.
- New research on the effects of discrimination on personality.

Chapter 9 presents information on the quest for meaning and how it is manifest at different stages of adult life. This continues to be the most controversial chapter, with some adopters rating it as the best chapter and others questioning why it is included. Our belief is that it fills an important place in the journey of adulthood as we question how this journey started and where, exactly, we are going. It's a chance to look a little further up the road and a little further back than the other chapters give us. I start by showing how the topic of religion and spirituality has ballooned in empirical journals over the last four decades and the importance of having a sense of the sacred in our lives. Then I cover some diverse theories, including Kohlberg's theory of moral reasoning and Fowler's theory of faith development, showing the similarities in those and two theories from the personality chapter we just covered, Loevinger's theory of ego development and Maslow's theory of positive well-being. Then we conclude the chapter with material about mystical experiences and transitions, which William James, one of the founding fathers of psychology, wrote about in 1902.

New in this chapter:

- Increase in the percent of people in the United States who report belief in God.
- Argument that spirituality is an evolved trait in humans.
- Research on the relationship of religious beliefs and sound mental health, even when socioeconomic status, health behaviors, and specific religious practices are considered.

The related topics of stress and resilience comprise the subject matter for **Chapter 10**. This type of research is usually done by health psychologists and medical researchers but has recently been of interest to social psychologists, sociologists, forensic psychologists, and military leaders. This is another chapter that students take very personally because most are dealing with more than their fair share of stressors. We begin with Selye's concept of the general adaptation syndrome and then present Holmes and Rahe's measurement of life-change events. Research is cited to

show that high levels of stress are related to physical and mental disorders. The timely topic of PTSD is covered and individual differences, such as gender and age, are included. We cover racial discrimination as a source of chronic stress and talk about stress-related growth—the idea that what doesn't kill you makes you stronger. Types of coping mechanisms are presented followed by the topic of resilience. Recent studies have shown that the most frequent reaction to trauma is resilience and that some people are more apt to be resilient than others.

New in this chapter:

- Longitudinal study of stress and mortality.
- New APA guidelines on PTSD.
- Research on PTSD in the children of Holocaust survivors.
- Research findings on perceived discrimination and psychological well-being.
- Studies of stress experienced by the LGBTQ community mediated by social support and gay identity.
- Longitudinal study of optimism and whether it acts as a buffer to trauma.
- Use of virtual therapists in military settings.

Chapter 11 covers death: how we think about it at different ages, how we cope with the death of loved ones, and how we face the reality of our own deaths. We begin the chapter with a discussion of how we acquire an understanding of death, both the deaths of others and the eventual death of oneself. This includes abstract methods like overcoming the fear of death as well as practical methods, like making a living will and becoming an organ donor. The place of one's death is important to many people, and most want to die at home with their families. That is becoming more feasible because of the hospice approach, and we explain that in detail. Others who are terminally ill would like to choose the time of their deaths, and that has become possible in several states that have legalized physician-assisted suicide, and we explain how that is arranged and how people make that decision. For the next section we have compiled numerous mourning rituals that take place in different cultures in the United States. It is not an exhaustive list and there may be many exceptions, but it is a good way to start a discussion about our multi-cultural society and about respecting and understanding each other at these most personal times. The chapter ends on a hopeful note with a study of bereavement that shows that the most common response to the loss of a spouse in older adulthood is resilience.

New in this chapter:

- New cross-cultural studies of death anxiety.
- Research suggesting new ways of communicating with dementia patients using classic baseball games and antique cars.
- Updated figures on hospice care and physician-assisted suicide.

In **Chapter 12**, the final chapter, we wrap up everything in chronological order. We add in the relevant new material and present my own model of adult development complete with a flow chart of how we move from disequilibrium to equilibrium in several areas of our lives. We also include a master table of age-related changes throughout adulthood.

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Instructor's Manual—includes outcome-based chapter outlines along with questions for discussion and research assignments.

Test Bank—includes additional questions in multiple-choice and open-ended—short and essay response—formats. Each question includes a corresponding skill, difficulty level, text reference, and learning objective.

MyTest—an electronic version of the Test Bank to customize in-class tests or quizzes.

About the Authors

Dr. Barbara Bjorklund has authored the last six editions of Journey of Adulthood, and is pleased to co-author this edition with Dr. Julie Earles. Dr. Bjorklund has taught psychology classes at colleges and universities around south Florida for over 40 years and has conducted research in both child and adult development. In addition to publishing research in academic journals, she has also written for the popular press and been a columnist for Parents magazine. Earlier editions of this book have been written in Germany, Spain, and New Zealand where she was living as a visiting scholar. Currently, Dr. Bjorklund is an Affiliate Professor at the Wilkes Honors College of Florida Atlantic University.

Dr. Julie Earles is a Professor of Psychology at the Wilkes Honors College of Florida Atlantic University where she teaches Lifespan Human Development, Adult Development and Aging, and Research Methods in Psychology. Her research program involves understanding how cognition changes with age, with an emphasis on developmental changes in memory for events. She has published over 30 articles and given over 100 presentations on her work. Her proudest accomplishment is her supervision of over 80 honors thesis projects by undergraduate students. She is also the Faculty in Residence for the Wilkes Honors College and enjoys enhancing connections between faculty and students as part of an engaged learning environment.

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Barbara R. Bjorklund

Julie L. Earles

Jupiter, Florida

Chapter 1

Introduction to Adult Development

A multigenerational family.

Learning Objectives

1.1 Explore major themes in developmental psychology

1.2 Explain the major sources of development

1.3 Differentiate between the perspectives of psychological and bioecological models

1.4 Evaluate developmental research methods

A Word From the Author

My Journey of Adulthood

MY JOURNEY OF adulthood began early, as did that of many women of my generation, when I married shortly after high school and began a family. But unlike many women in my peer group, I spent more time reading than I did having morning coffee with the other moms. I always took a book along to read while the kids had music lessons, baseball practice, and orthodontist appointments. The library was important to me. It was as much a weekly stop as the grocery store. By the time my youngest child began kindergarten, I enrolled in college as a freshman—at the age of 29, which was much older than the average at that time. For the next 7 years, my children and I did our homework together at the kitchen table, counted the days to the next holiday break, and posted our grade reports on the refrigerator. Today, as adults, they tell me that they can't remember a time in their childhood when I wasn't in school. Just before I earned my master's degree in developmental psychology, the marriage ended, and I spent some time as a single mother. I abandoned plans for a PhD and took a job at

the university, teaching psychology courses and doing research on children's memory development. And just as my children began to leave the nest, I married a man whose own journey of adulthood had brought him to fatherhood rather late, making me stepmother of a 5-year-old, who quickly became an important part of my life. Not too much later, the grandchildren began to arrive, and life settled into a nice routine. It seemed I had done it all—marriage, parenthood, career, single parenthood, stepparenthood, and grandparenthood; my life was full.

Suddenly, my 50th birthday loomed. It seemed to represent much more than turning "just another year older" and caused me to reevaluate my life. I realized that I wasn't ready to ride slowly into the sunset for the next several decades; I needed to get back on track and move forward with my education. The next fall, I entered a PhD program in lifespan developmental psychology at the University of Georgia. It was an invigorating and humbling experience. Instead of being the teacher, I was the student. Instead of supervising the research project, I was being supervised. Instead of giving advice, I was asking where the bookstore was, where to park, and how to use the copy machine. But 3 years later I was awarded a red-and-black hood in a formal graduation ceremony with my children and grandchildren, parents, and siblings cheering for me from the audience.

Now I have an affiliate position at the Wilkes Honors College of Florida Atlantic University, and I write college textbooks. My husband and I live in a rural community in southeastern Florida with a cypress stand in the front yard and a small pine forest in the back. Our neighbors have horses, and we wake to roosters crowing in the morning. The book club I started 13 years ago is still going strong, and I enjoy attending community lectures at the university.

One son and daughter-in-law live nearby with three of our grandchildren, and my typical day consists of early-morning writing followed by a water aerobics class. Afternoons I am on homework-help duty or driving grandkids from school to music lessons to home. One grandson is a budding chef at 15, and he comes to our house after school to cook with my husband. Recently, they have been trying to create the perfect French baguette. Another son and daughter-in-law live with their three children just an hour down the coast, and we visit each other often. Despite some typical family drama, in general, life is good.

Seven years ago, with three children and eight grandchildren ranging in age from 8 to 25, my husband and I felt that our lives had settled down. But then both sons, who had been divorced for some time, remarried and started new families. Within the last 5 years, we have added Lily Pearl (age 5), twins Wesley and Jane (age 4), and Sage (age 2). Our younger son married a woman with a 15-year-old son, Andrés, and we quickly added him to our list. As I write this, our 14th grandchild, Amelia, is getting ready to come home from the NICU, after making her entrance into our family a month ago at 3-1/2 pounds. Looking back, we can't imagine how we felt our lives were complete without these six additions!

If there is a message to take from this text it is this: development doesn't stop at 21, or 40, or 65. Your life will never stop surprising you until you breathe your last breath. My wish for you is that the surprises are mostly happy ones.

I approach the topic of this text both as a developmental psychologist and on a more personal level. Like many people, I am on this journey of adulthood with my sisters, my husband, my friends, my adult children, and my college-aged grandchildren who are in emerging adulthood, so my interest is both scientific and personal. I want to understand how it all works and why, both because that is what I have chosen for my career and also because it is what I think about a good deal of the time when I am not at work. My journey through adulthood is no doubt similar to yours, but it is also different in other ways. What I am searching for in this text are the basic rules or processes that account for both the similarities and the differences. I hope you can share with me the sense of adventure in the scientific search as well as in the personal journey.

1.1: Basic Concepts in Adult Development

OBJECTIVE: Explore major themes in developmental psychology

Developmental psychology is the field of study that deals with the behavior, thoughts, and emotions of individuals as they go through various parts of the lifespan. It includes child development, adolescent development, and **adult development**—the particular concern of this book. We are interested in the changes that take place within individuals as they progress from emerging adulthood (when adolescence is ending) to the end of life. Although many autobiographies give first-person accounts of people's lives and many interesting stories about people's

experiences in adulthood, this book is based on **empirical research**—scientific studies of observable events that are measured and evaluated objectively. When personal accounts and examples are used (including the opening story about my life), they are chosen to illustrate concepts that have been carefully researched.

By the end of this module, you will be able to:

1.1.1 **Describe differences and commonalities in experiences of adulthood**

1.1.2 **Identify constants and changes that impact adult development**

1.1.3 **Differentiate among the various types of age**

1.1.1: Differences and Commonalities

OBJECTIVE: **Describe differences and commonalities in experiences of adulthood**

Some of you are just beginning the journey of your own adult life; some of you are partway along the road, having traveled through your 20s, 30s, and perhaps 40s, 50s, and beyond. Whatever your age, you are traveling, moving through the years and the transformations that come along the way. We do not all follow the same itinerary on this journey; you may spend a long time in a location that I do not visit at all; I may make an unscheduled side trip. Or we may visit the same places but experience them very differently. Every journey has **individual differences**, aspects that are unique to the individual. You may not have experienced the trials of single parenthood as I have or the joys of grandparenthood, and I cannot relate to the independence you must feel when living alone or the confusion you experience when your parents divorce. Likewise, there are also some **commonalities**, typical aspects of adult life that most of us can relate to (either now or in the future). Most of us have moved out of our parents' homes (or plan to), experienced romantic relationships, entered college with some plans for the future, and either started a family or given some serious thought to parenthood. My goal for this book is to explore with you both the uniqueness and the common grounds of our adult lives.

WRITING PROMPT

What Makes You You?

Think about some of the things you have experienced individually that make you the same or different from some of your peers. What are they? How do they impact how you experience adulthood?

The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

1.1.2: Stability and Change

OBJECTIVE: **Identify constants and changes that impact adult development**

Two of the concepts featured in this text are stability and change during the developmental process. **Stability** refers to the important parts of ourselves that make up a consistent core. It is the constant set of personality traits, preferences, and typical ways of behaving that make each of us the individuals that we are throughout our lifetimes. In other words, your 40-year-old self will be similar to your 20-year-old self in some ways, as will your 60-year-old self. For example, one of the stable themes of my adult life is a love for books. In fact, it goes back to my childhood. Some of my most prized possessions are the books in my library. I always have several books that I am in the process of reading, and an audiobook that plays in my car via Bluetooth. Thirteen years ago, I started a book club in my neighborhood that has become a big source of joy for me. Another theme that keeps popping up in my life is children, beginning early on with three younger sisters, then my own children, then my stepdaughter, nieces and nephews, then grandchildren. I have always had a toy box in my living room and sippy cups in the kitchen cabinet. In fact, the two themes of books and children often mix. I send books on birthdays for the children on my gift list, and when visiting children spend the night, I have a shelf of children's books in the guestroom, some that belonged to their own parents many years ago. Perhaps you find stability in your life in terms of playing a musical instrument or participating in sports. The genre of books I read may change over the years, and your choice of musical selections or sporting events may be different from time to time, but the core essence of these stable themes remains an integral part of our lives.

Change is the opposite force to stability. It is what happens to us over time that makes us different from our younger (and older) selves. An example from my life is travel. As a child, I never traveled too far out of my home state of Florida. Almost all my relatives lived nearby, and those who didn't were more than happy to visit our warm climate during winter. In fact, at the age of 35, I had never been on an airplane. But when I married my current husband (and no longer had children living at home), I had the opportunity to travel to national conferences and accompany him on international trips as he collaborated with colleagues and worked as a visiting professor around the world. In the last 20 years, we have spent extended periods of time in Germany, Spain, and New Zealand. We have made shorter trips to Japan, China, Italy, Sweden, Norway, Denmark, England, Scotland, Wales, Austria, Switzerland, and Egypt. Last year we made it to Paris! I am an expert packer, and my office is filled with framed photos I have taken in many exotic locations. To compare myself at 30

and 50, my travel habits would constitute a dramatic change. Other examples of change in the adult developmental process occur when one becomes a parent, switches careers, or decides to move to another part of the country (or to an entirely different country). One way to view the journey of adulthood is to consider both the stability and the change that define our lives.

Photo of the author, Barbara Bjorklund, visiting a Roman aqueduct on a recent trip to Pont du Gard, France.

CONTINUITY AND STAGES Still another way of looking at this journey is gauging how straight the road is. Some stretches of our lives are **continuous**—slow and gradual, taking us in a predictable direction. My gardening certainly fits this definition. In my earliest apartments I had potted plants, and when we rented our first house, I persuaded the landlord to let me put in a small flower garden. As our yards have grown bigger, so have my garden projects. I enjoy plant fairs, trade plant cuttings with friends, and of course, read books about gardening. I find it relaxing to spend time "digging in the dirt." I have increased my knowledge and skill over the years. Now that our yard is measured in acres instead of square feet, I'm in heaven. So far, I have a butterfly garden in the front yard, and I'm working on a vegetable garden in the back. Hopefully I will continue to "develop" as a gardener for many years.

In contrast, our lives also have **stages**, parts of the journey where there seems to be no progress for some time, followed by an abrupt change. Stages are much like driving on a quiet country road for a long time and then getting onto a busy interstate highway (or vice versa). In my adult life I view the years of being home with my young children as a stage that was followed by the abrupt change of the youngest entering school and me starting college. I suddenly went from having minute-to-minute, hands-on parenting duties to the type that involve preparations the night before and then dropping the children off at school in the morning. I also went from having mostly tasks that involved physical work and concrete thinking skills (e.g., how to get crayon marks off the walls) to those that required abstract thinking (e.g., Psychology 101). This mother/student stage continued for many years until I reached the single-mother/researcher stage. An interesting question in the study of adulthood is exploring how **typical** these stages of adult life are: Do most adults go through them along their journeys and, if so, do they go through them in the same order and at the same age? Or are they **atypical**, unique to the individual? I think that sending one's youngest child off to school is probably a universal event in a parent's life, signaling the end of one stage and the beginning of another, but I don't think that the transition from full-time mother to full-time student is typical, though it is more common today than it was a generation ago.

EXTERNAL AND INTERNAL CHANGE A final theme of this text has to do with internal versus external changes. As we proceed along the journey of adulthood, many **external changes** are visible and apparent to those we encounter. We enter early adulthood and become more confident in our step and our carriage; we fill out and mature; some of us become pregnant; some begin to lose their hair. In middle age many of us lose and gain weight, increase and decrease in fitness. **Internal changes** are not as apparent to the casual observer. We fall in and out of love, hold our children close, and then learn to give them space. We look to our parents for guidance at the beginning of our journeys and then assist them at the end of theirs. And we grow in wisdom and grace. Of course, the internal and external changes are not independent of one another. External changes can affect the way we feel about ourselves, and vice versa. They also affect the way others perceive us, and this, in turn, affects our self-perceptions. Untangling this conceptual ball of yarn is another goal of this text.

WRITING PROMPT

Describe Your Own Life Experience

Think about your current lived experience. What are some things you might characterize as stable? As changing? As continuous or a stage? As external or internal?

▶ The response entered here will appear in the performance dashboard and can be viewed by your instructor.

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1.1.3: A Word About "Age"

OBJECTIVE: Differentiate among the various types of age

Most people know that age is just a number. Perhaps ages in childhood give valid information about what to expect in the way of appearance or behavior, but once a child reaches adolescence, many more factors are involved. In fact, the further we venture on the journey of adulthood, the more variability there is among people our "own" age.

Several types of age have been identified, and they illustrate the many dimensions of adult development.

Types of Age

Chronological Age—The number of years that have passed since your birth or the number of candles on your last birthday cake is your **chronological age**. While this may be important in childhood, when all 7-year-olds look relatively similar and have similar interests and abilities, in adulthood, this number is seldom relevant, except during young adulthood when driving, purchasing alcohol, and voting are determined by chronological age, and in older adulthood when eligibility for Social Security and Medicare are determined by chronological age. However, your development in adulthood does not occur because the clocks have struck a certain number of times or the heat from your birthday candles reaches a certain temperature. It may be related, but chronological age does not *cause* developmental changes.

Biological Age—**Biological age** is a measure of how an adult's physical condition compares with others. "He has the memory of a 50-year-old" and "She runs like a 30-year-old" are examples of informal measures of biological age. Of course, biological age is related to the person's chronological age. Having the memory of a 50-year-old means one thing if the person is 70, a much different thing if 30! And riding a bicycle like a woman in her 40s may not seem exceptional unless that woman is Kristin Armstrong, 42-year-old Gold Medal cyclist in the Rio Olympics. Biological age is used to evaluate aging of physical systems, such as with bone density scans, in which patients' bones are compared to those of a healthy 20-year-old. Biological age can often be affected by lifestyle changes.

Psychological Age—Another type of age is **psychological age**, which is a measure of how an adult's ability to deal effectively with the environment compares to others. A 30-year-old woman who can't pay her electric bill because she couldn't resist buying designer jeans and is often late for work because she oversleeps is functioning like many teenagers. Her psychological age is much below her chronological age. In addition, a 25-year-old man who starts his own business and is successful 3 years later, having expanded to several cities and increasing his workforce, is showing the organizational skills and problem-solving abilities of someone twice his age.

Social Age—**Social age** is based on the expected roles a person takes on at a specific point in his or her life. A 23-year-old who works full time, goes to school full time, and sends money home to help support her grandmother has a social age much greater than her years. A middle-aged woman who enrolls in college is taking on the social role of a person who is younger.

Sometimes biological age, psychological age, and social age are considered in a package as **functional age**, or how well a person is functioning as an adult compared to others. But it seems clear that the question "How old are you?" has a number of answers.

As developmental psychologists, we try not to depend solely on chronological age when investigating some aspect of adult behavior. As you will see, many studies use age groups (young adults compared with middle-aged adults) or roles (people without children compared with people with children). Often, they avoid the chronological age question by comparing the same people before and after they take on a role, such as parenthood or retirement. It is important to keep in mind that development and chronological age do not travel hand in hand, and this becomes more and more apparent the older we get.

1.2: Sources of Change

OBJECTIVE: Explain the major sources of development

There are many potential influences on adult development. In fact, the types of influences that result in change have been classified as: (1) normative age-graded influences, (2) normative history-graded influences, and (3) nonnormative life events. In the following section I explain these various influences and give you some examples so you can see them at work in your own lives.

By the end of this module, you will be able to:

- **1.2.1** Identify normative age-graded influences on development
- **1.2.2** Describe how historical events impact development
- **1.2.3** Evaluate the ways that nonnormative events affect adulthood
- **1.2.4** Explain the interactionist view on the influences of nature and nurture on development

1.2.1: Normative Age-Graded Influences

OBJECTIVE: Identify normative age-graded influences on development

When you hear the phrase "sources of change," your first thought is probably of **normative age-graded influences**, those influences that are linked to age and experienced by most adults as they grow older.

BIOLOGY Some of the changes we see in adults are shared by all of us because we are all members of our species undergoing natural aging processes. This is often represented by the idea of a **biological clock**, ticking away to mark the common changes that occur with time. Many such changes are easy to see, such as hair gradually turning gray or skin becoming wrinkled. Others are not visible from the outside but occur internally, such as the loss of muscle tissue, which results in a gradual loss of physical strength. The rate at which such physical changes occur varies quite a lot from one person to another.

SHARED EXPERIENCES Another normative influence that is dictated for most of us by our ages can be envisioned by a culturally determined **social clock** defining a typical sequence of adult life experiences, such as the timing of college graduation, marriage, and retirement. Even though our society has expanded the choices we have in the timing of these experiences, we still are aware of the "normative" timing of these events. Where we stand in relation to the social clock can affect our own sense of self. The middle-aged man still living at home, the "perpetual student," the older working woman whose friends have retired—all may be doing well in important aspects of their lives, but if those lives are out of sync with what society expects in the way of timing, it may lead to some personal doubts. In contrast, the young adult who is CEO of his own high-tech company, the middle-aged woman who completes law school, and the octogenarian who finishes the Boston Marathon may have reason to celebrate over and above the face value of their accomplishments. Of course, the normal sequence of adult life differs by culture and even subculture. For example, the average age of marriage in India and many African countries is the early 20s, while in most of Europe and Australia it is the early 30s.

Another effect the social clock can have is **ageism**, a type of discrimination in which opinions are formed and decisions are made about others based solely on the fact that they are in a particular age group. Older adults are sometimes stereotyped as cranky, sexless, forgetful, and less valuable than younger people. Television sitcoms, commercials, birthday cards, and jokes on social media all perpetuate these stereotypes. Emerging adults can also be targets of ageism, when they are perceived as being less capable than their older coworkers or when they are stereotyped as delinquents because of their style of clothes and speech. One of my goals for this text is to give a realistic and respectful look at adults of every age.

Another manifestation of the influence of the social clock in virtually all cultures is the pattern of experiences associated with family life. For example, the majority of adults experience parenthood, and once their first child is born, they begin a fixed pattern of shared social experiences with other parents that move along with their children's stages of life—infancy, toddlerhood, the school years, adolescence, and preparation to leave home. Each of these periods in a child's life makes a different set of demands on parents—attending childbirth classes, setting preschool playdates, hosting scout meetings, coaching Little League baseball, visiting potential colleges—and this sequence shapes 20 or 30 years of most adults' lives, regardless of their own biological ages.

Obviously, shared developmental changes based on the social clock are much less likely to be universal than those based on the biological clock. But within any given culture, shared age-graded experiences can explain some of the common threads of adult development.

1.2.2: Normative History-Graded Influences

OBJECTIVE: Describe how historical events impact development

Experiences that result from historical events or conditions, known as **normative history-graded influences**, also shape adult development. These influences are helpful for explaining both the similarities found among people within certain groups and also the dissimilarities among people in those same groups. Both are important parts of a course on adult development.

The large social environments in which development takes place are known as **cultures**, and the ways they influence the adult life pattern can vary enormously: the expected age of marriage or childbearing, the typical number of children (and spouses), the roles of men and women, class structures, religious practices, and laws. I was reminded of this on a trip several years ago, when a young Chinese mother in Beijing struck up a conversation with me, and we began talking about our families. She had a toddler daughter with her who was 2-1/2, just the age of my youngest grandson, I told her. "*Youngest* grandson?" she asked, "How many grandchildren do you have?" I told her I had eight, then realized from her expression of surprise that this was very unusual in China. She explained to me that since 1979 there has been a one-child policy in China. Almost all Chinese parents in urban areas limit their families to one child. She was an only child; her daughter

was an only child (and the only grandchild of both sets of grandparents). The typical person in her culture has no siblings, no aunts or uncles, and no cousins. She asked to see pictures of my grandchildren and wanted to know their ages and details about them. We had a very friendly visit, but I could not help but wonder how different my life would be in that culture, and what her life will be like when she is my age. When I learned that China had begun phasing out this policy in 2015, I immediately thought of the nice woman in Beijing, whose daughter might be an adult now. I wondered how this cultural change would affect her and her family.

COHORTS A **cohort** is a more finely grained concept than a culture because it refers to a group of people who share a common historical experience at the same stage of life. The term is roughly synonymous with generation, but narrower—a generation refers to about 20 years, whereas a cohort can be a much shorter period. And a generation can refer to a much larger geographic area, whereas a cohort can be just one country or one region of one country. For example, Cuban Americans who came to the United States in the 1960s to flee Fidel Castro make up an important cohort in south Florida.

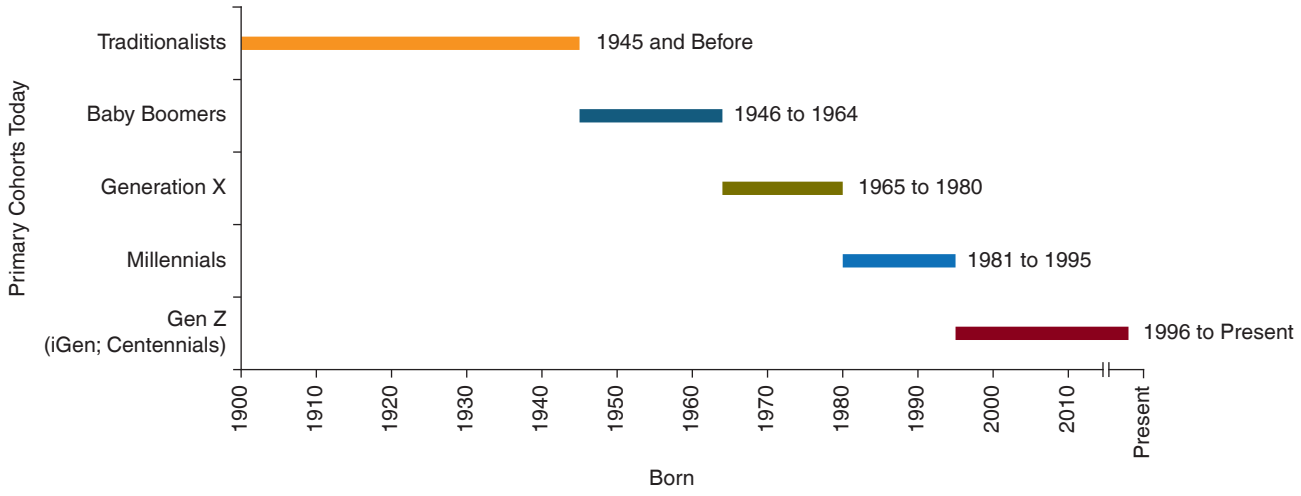
One of the most studied cohorts in the social sciences is the group of people who grew up during the Great Depression of the 1930s. This was a time in the United States (and in most of the world) that crops failed, factories closed, the stock market crashed, unemployment skyrocketed, and without unemployment benefits and government social programs, the only help available was from family, neighbors, or churches (none of whom had much to share). Almost no one escaped the effects of this disaster. But what were its effects, and were people affected differently depending on what age they were when the Great Depression hit? That was the thrust of the research on growing up in the Great Depression conducted by sociologist Glen H. Elder, Jr. (1979). He found that the cohort of people who were teenagers during the Great Depression showed fewer long-term effects than those who had been in early elementary school at the same time. The younger cohort spent a greater portion of their childhood under conditions of economic hardship. The hardship altered family interaction patterns, educational opportunities, and even the personalities of the children, so that the negative effects could still be detected in adulthood. Those who were teenagers during the Great Depression did not show negative effects in adult life; on the contrary, some of them seemed to have grown from the experience of hardship and showed more independence and initiative in adulthood as a result. Thus, two cohorts, rather close in actual age, experienced the same historical event differently because of their ages. The timing of events interacts with tasks, issues, and age norms, producing unique patterns of influence for each cohort and helping to create common adult-life trajectories for those in the same cohort.

Although the era of the Great Depression is past, this research should remind us that every one of us, as an adult, bears the marks of the events we have lived through and the age-specific ways we reacted to those events. The recession of 2008 affected many families, and although the economy is doing much better, young adults who grew up in those times will be different in their outlooks toward job security than those who grew up a decade before or a decade afterward.

Although there are no definite ages for the cohorts living today, several general groupings have been suggested. Figure 1.1 shows one such grouping.

Figure 1.1 Primary Cohorts Today

Which cohort do you belong to? Your parents? Your grandparents?



1.2.3: Nonnormative Life Events

OBJECTIVE: Evaluate the ways that nonnormative events affect adulthood

Along with the aspects that you share with most other adults your age and in your culture, there are **nonnormative life events**, aspects that influence your life that are unique to you and not shared with most others. These can have an important effect on the pathway of your life. Examples of nonnormative life events are having one's spouse die in early adulthood, inheriting enough money to retire at age 40, taking over parental responsibility for one's grandchildren, and starting one's own business at 65.

Some of these events are nonnormative for anyone at any age, such as inheriting a large amount of money, but others are nonnormative because of the timing. The death of a spouse is, unfortunately, a normative event in older adulthood, but not so in the earlier years. And starting one's own business may be remarkable in early adulthood, but it is highly nonnormative at the age of 65. As pioneering developmental psychologist Bernice Neugarten advised us back in 1976, we have to pay attention not only to the event itself, but also to the timing. Events that are on time are much easier to cope with (even the death of a spouse) than those that are off time.

I can speak from experience as one who was off time in several aspects of my life—becoming a parent early, going to college late, becoming a grandparent early, going to graduate school late. It makes for a good chapter introduction, but it was not always easy. One problem is the lack of peers—I was always "the older one" or "the younger one," never just one of the group. You don't fit in with your agemates because you are doing something different, but you don't fit in with your fellow students or other moms either because you are not their age. And if this situation is easy to deal with yourself, sometimes others have problems, such as administrators who don't want to hire beginning professors who are older than they are. So, in the best of all possible worlds, it is probably easier to do things "on time" than march to your own drummer—I've just never lived in the best of all possible worlds.

WRITING PROMPT

Marching to Your Own Drummer

What is an example of an event, perhaps from your own life or someone you know, that might be described as nonnormative? What impact might it have (or did it have)?

▶ The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

1.2.4: Genetics, the Environment, and their Interactions

OBJECTIVE: Explain the interactionist view on the influences of nature and nurture on development

Each of us inherits, at conception, a unique combination of genes. A very large percentage of these genes is identical from one member of the species to the next. This is why our developmental patterns are so much alike—why children all over the world walk at about 12 months, and why we go through puberty in our early teens and menopause around age 51. But our genetic inheritance is individual as well as collective. The study of **behavioral genetics**, or the contributions genes make to individual behavior, has been a particularly active research topic in recent decades. We now know that specific heredity affects a remarkably broad range of behaviors, including cognitive abilities, such as problem solving; physical characteristics, such as height or body shape or a tendency to fatness or leanness; personality characteristics; and even pathological behavior, such as a tendency toward alcoholism, schizophrenia, or depression (Plomin et al., 2012). The extent to which these traits and tendencies remain in place throughout our lives shows the influence of heredity on stability in development.

In searching for genetic influences on variations in adult behavior, behavioral geneticists rely primarily on **twin studies**. These are studies that compare monozygotic twins with dizygotic twins on some behavior. Such studies are based on the fact that *monozygotic twins* develop from the same sperm and ovum and thus share exactly the same genetic patterning at conception, whereas *dizygotic twins* each develop from a separate sperm and ovum and are therefore no more alike, genetically, than any other pair of siblings. In typical twin studies, measurements of some trait or ability are taken on each twin, and then the pairs are compared to see how similar their scores are. If the monozygotic twin pairs are more similar for that trait or ability than the dizygotic twin pairs, then it is taken as evidence that the trait or ability is influenced by genetics.

Twin studies are difficult because the statistics involved require large numbers of participants, and it is difficult for a researcher to recruit hundreds of pairs of twins. For this reason, several countries that have central databanks of their citizens' birth records and health records have taken the lead in this type of research. The largest databank of twins is in Sweden at the Karolinska Institute in Stockholm. It maintains a database of information on over 85,000 twin pairs.

ENVIRONMENT Our environment also contributes to the parts of ourselves that remain relatively stable over time. Although neither our biology nor our upbringing dictates

our destiny, both have long-term effects. The lifelong effect of early family experience has been clearly demonstrated by the Grant Study of Harvard Men. Psychiatrist George Vaillant (2002), the study's current director, has concluded that those who lived in the warmest, most trusting homes as children are more apt to be living well-adjusted lives in adulthood than those who spent their childhoods in the bleakest homes. Men from the warmest homes are more able, as adults, to express emotions appropriately and openly, to see the world and the people in it as trustworthy, and to have friends with whom they enjoy leisure-time activities. Vaillant's interpretation is that parents who provide basic trust to their children (in this case, their sons) instill a sense of self-worth, good coping skills, the ability to form meaningful relationships, and in general construct a solid foundation for the core values the child will take with him or her throughout adulthood. And what's more, subsequent studies show that these data could predict which men at age 75 would most likely be aging successfully (i.e., be healthy and happy) and which would be aging unsuccessfully (i.e., be sick and sad). Taken together, Vaillant's studies show that at least for extreme situations, the early childhood environment can set the course for a lifetime of either emotional openness, trust, and good health or loneliness, mistrust, and illness.

A more recent study showed the effects of living in an impoverished environment on mental health. In the National Health and Nutrition Examination Survey, adults were asked about their depressive symptoms. When responses were examined by income level, respondents at every age who lived in impoverished environments reported more symptoms of depression.

INTERACTIONS Of course, there are no simple partitions between genes and environment, and we can't separate their contributions to the stability we experience throughout adulthood. Most developmental psychologists now subscribe to an **interactionist view** in which one's genetic traits determine how one interacts with the environment and even the environment itself (Greenberg et al., 2010). For example, a boy with a genetic makeup that promotes avoiding risks will grow up with a certain pattern of interactions with his parents and siblings and will seek out friends and activities that do not involve high risk. Teachers may view this as stable and sensible and steer him to a career such as accounting. The result is a young adult with risk-avoiding genes working in a low-risk career environment and enjoying low-risk activities with his friends. He will probably marry someone who shares these interests, giving him even more support for this lifestyle. You can imagine the life course of this person, perhaps having one child, living in the same home and working in the same job until retirement. Quiet evenings would be spent at home or at the neighborhood tavern. He would have good health because of regular checkups, exercise, and sensible eating habits. He would probably wear his seatbelt and drive defensively. Vacations would be carefully planned tours of scenic places, and retirement would bring regular golf games with the same friends each week and volunteer work with the foster grandparent program at the local elementary school. Risk avoidance is the theme of this person's life, but can we really say it was caused by his genetic makeup? Or was it the environment? These kinds of questions make up the interactionist's chicken-and-egg dilemma.

One mechanism for this interaction between genes and environment is **epigenetic inheritance**, a process by which the genes one receives at conception are modified by subsequent environmental events that occur during the prenatal period and throughout the lifespan (Kremen & Lyons, 2011). The process by which genes are modified is known as **DNA methylation** because it involves the chemical modification of DNA through the addition of a methyl group, resulting in reduced gene expression. This type of inheritance explains how the environment can cause permanent, lifelong characteristics that were not part of the original genetic endowment at conception. For example, autopsies of adults who committed suicide show that those who had a history of childhood abuse are more apt to have modified glucocorticoid receptor genes in their brains than both adults who committed suicide but had no history of childhood abuse and a control group of adults who died of other causes (McGowan et al., 2009). Glucocorticoid receptors determine how an individual responds to stress. In this case, it seems that early childhood experiences bring forth changes in the children's genetic expression that have lifelong consequences.

1.3: Guiding Perspectives

OBJECTIVE: Differentiate between the perspectives of psychological and bioecological models

Before any questions about adult development can be asked, we need to determine what platform to stand on—the base from which we set the course of this journey. The remainder of this text covers specific areas of development and includes specific theories to guide that research, but two broad approaches are used throughout, and they define the tone of the book.

By the end of this module, you will be able to:

1.3.1 Describe elements of the lifespan developmental psychology approach

1.3.2 Outline the systems used in the bioecological model of development

1.3.1: Lifespan Developmental Psychology Approach

OBJECTIVE: Describe elements of the lifespan developmental psychology approach

One major approach of this text is the **life-span developmental psychology approach**, which states that development is lifelong, multidimensional, plastic, contextual, and has multiple causes (Baltes et al., 1980). Psychologist Paul Baltes and his colleagues introduced these ideas in 1980, and although this approach sounds very ordinary today, it marked a turning point in developmental psychology, which before that time was focused almost exclusively on child development. The major points of the lifespan developmental approach are illustrated in Table 1.1, along with some examples of each. As you read through, you will see that it opened the door for the study of development at all ages—not just your 12-year-old brother, but also you, your fellow students, your parents, your professor, and even your grandparents.

1.3.2: Bioecological Model of Development

OBJECTIVE: Outline the systems used in the bioecological model of development

A second major approach this text takes is based on the **bioecological model**, which points out that we must consider the developing person within the context of multiple environments. The idea is that development must take place within biological, psychological, and, especially, social contexts that change over time, and that these various influences are in constant interaction (Lerner, 2006; Sameroff, 2009). These ideas were introduced by psychologist Urie Bronfenbrenner in 1979 and have been modified over the last four decades (Bronfenbrenner & Morris, 2006). Bronfenbrenner proposed five systems: the *microsystem*, the *exosystem*, and the *macrosystem*, as shown in Figure 1.2, with the *mesosystem* as the interaction among elements in the microsystem. In addition, there is the *chronosystem*, which reflects the fact

Table 1.1 Lifespan Developmental Psychology: Concepts, Propositions, and Examples

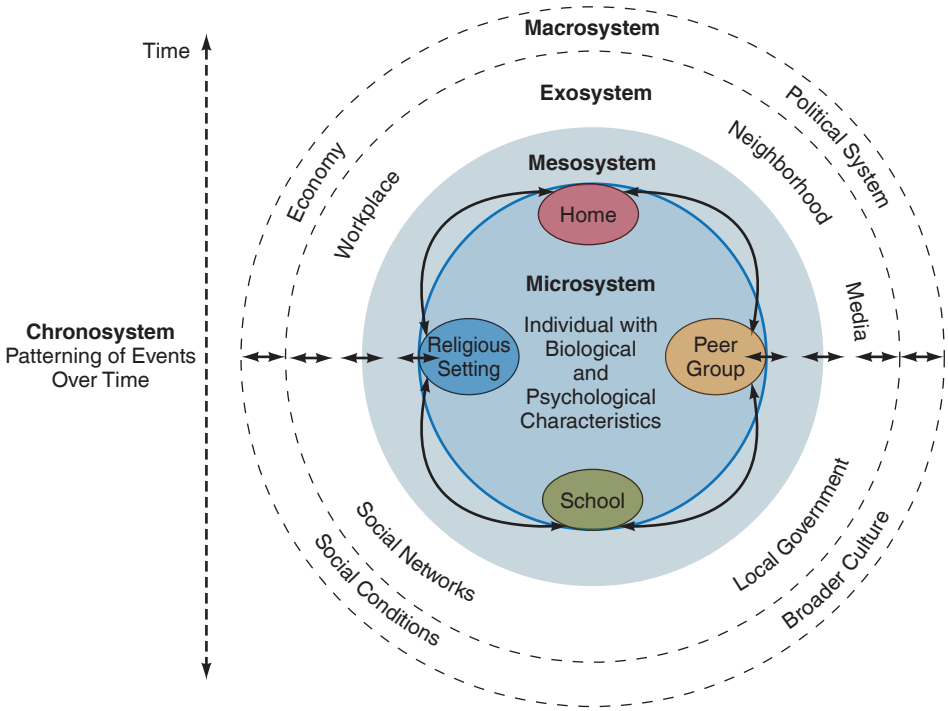
Concept	Proposition	Example
Lifespan development	Human development is a lifelong process. No single age is more important than another. At every age, various developmental processes are at work. Not all developmental processes are present at birth.	A 38-year-old single woman makes plans to adopt a child; a 52-year-old bookkeeper becomes less satisfied with her job now that her kids are grown, and she goes back to school to become a small business owner; a 75-year-old Vietnam veteran loses interest in reunions with his former buddies and begins taking a class in memoir writing. They are all experiencing development.
Multidirectionality	We develop in different directions and at different rates. Developmental processes increase and decrease. At one time of life, we can change in some areas and remain stable in others.	Some intellectual abilities increase with age, and some decline. Young adults show independence when they complete college and start a career, but show dependence at the same time when they remain in their parents' homes.
Development as gain and loss	Development is a combination of gains and losses at every age, and we need to learn how to anticipate and adapt to both.	Middle-aged adults may lose their parents, but gain a new feeling of maturity. Young adults add a baby to their family, but may lose some equality in their marriage. Workers start losing speed and precision as they age, but they gain expertise.
Plasticity	Many aspects of development can be modified. Not much is set in stone, but there are limits.	Young people who enter adulthood with behavior problems or substance-abuse problems can overcome them and become responsible, successful adults. Couples with a lot of conflict in their marriages during the childrearing years can be happy once the children are grown. Fathers can stay home with kids and be nurturing and attentive while mothers work outside the home. Older parents can change their values as a result of their young adult children's lifestyles.
Historical embeddedness	Development is influenced by historical and cultural conditions.	People who grew up in the 1970s have more open attitudes toward legalizing drugs than earlier or later cohorts. Those who lived through the Great Depression have different attitudes toward work than members of other cohorts.
Contextualism	Development depends on the interaction of normative age-graded, normative history-graded, and nonnormative influences.	Each of us is an individual because of the interaction of influences we share with other adults in general, those we share because of the times we live in, and those that are unique to us.
Multidisciplinary	The study of human development across the lifespan does not belong to psychology alone. It is the territory of many other disciplines, and we can benefit from the contributions of all.	Contributions to the study of development come from the field of psychology, but also from sociology, anthropology, economics, public health, social work, nursing, epidemiology, education, and other disciplines. Each brings a different and valuable point of view.

SOURCE: Adapted from Baltes (1987).

Figure 1.2 The Bioecological Model

This figure illustrates Urie Bronfenbrenner's model of the ecological-systems approach to studying development. He suggested that researchers look beyond behavior in laboratory settings and consider how development takes place within multiple environments and through time.

SOURCE: Based on Bronfenbrenner (1979)



that the other three systems are dynamic—constantly changing over time. This change can be as individual as physical maturation or as encompassing as a large-scale earthquake or an economic recession in one's country.

The major point of Bronfenbrenner's theory, and other developmental contextual approaches in general, is that individuals and their development cannot be studied "out of context." Rather, we must consider the social environment—from family and friends through community and the broader culture, all in interaction—when trying to explain the factors that influence the course of a person's journey to and through adulthood.

As you will see throughout this text, recent research in most areas of the social sciences has reflected this model, investigating the development of adults in the context of their lives as individuals, as partners in relationships, as parents in families, as workers on job sites, and as members of particular cultural groups and cohorts.

WRITING PROMPT

The Systems of Your Life

Identify and reflect on Bronfenbrenner's five systems within your own life.

The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

1.4: Developmental Research

OBJECTIVE: Evaluate developmental research methods

To understand adult development, it is important to know a little about the research process because information today in the social sciences is, for the most part, science based. I won't attempt to present a whole course on research methods and statistics, but I cover some of the methods that are used in the studies described throughout this text.

All research begins with questions. Suppose, for example, that I want to know something about change or stability in personal relationships over the adult years—relationships with a spouse, with other family members, or with friends. Or suppose that I wanted to study memory over adulthood. Older adults frequently complain that they can't remember things as well as when they were younger. Is this a valid perception? Is there really a loss in memory ability in old age, or earlier? How would I go about designing research to answer such questions? In every instance, there is a set of questions to answer:

- Should I study groups of people of different ages, or should I study the same group of people over time, or some combination of the two? This is a question dealing with basic research *methods*.

- How will I measure the behavior, thought, or emotion I am studying? How can I best inquire about the quality of marriage—with a questionnaire or in an interview? How do I measure depression—is there a set of questions I can use? These are questions of research *measures*.
- What will I do with the data? Is it enough merely to compare the average number of friends, or the average relationship satisfaction described by participants in each age group? What else would I want to do to tease out some of the possible explanations? These are questions of research *analysis*.
- What do the results mean? Depending on the research method, measures, and analysis, what is the overall conclusion? What is the answer to the research question I began with? These are questions of research *design*.

By the end of this module, you will be able to:

1.4.1 **Identify methods used in developmental research**

1.4.2 **Explain the advantages and disadvantages of different measures**

1.4.3 **Describe forms of data analysis**

1.4.4 **Differentiate among research designs**

1.4.1: Methods

OBJECTIVE: **Identify methods used in developmental research**

Choosing a research method is perhaps the most crucial decision the researcher makes. This is true in any area of science, but there are special considerations when the topic of study is development. There are essentially three choices:

1. You can choose different groups of participants at each of a series of ages and compare their responses—in other words, the cross-sectional method.
2. You can study the same participants over a period of time, observing whether their responses remain the same or change in systematic ways—the longitudinal method.
3. You can combine the two in any of several ways, collectively called sequential methods.

CROSS-SECTIONAL STUDIES A **cross-sectional study** in developmental psychology describes a study that is based on data gathered at one time from groups of participants who represent different age groups. Each participant is measured or tested only once, and the results give us information about differences between the groups.

One example of a cross-sectional research design was performed by neurobiologist Janina Seubert and her colleagues (2017) to investigate the decline of the sense of smell in participants of different ages. This is an important ability as people get older because without the sense of smell they may not detect gas leaks or other noxious substances in their homes, and because smell is closely related to taste, they may not eat enough to remain healthy or may eat food that is spoiled. The sense of smell is also important for the enjoyment of food and other aromas.

Seubert and her colleagues collected demographic information from 2,848 adults in 11 different age groups between 66 and 99+ years. They were chosen randomly from the participants in a larger study, the Swedish National Study of Aging and Care. The number chosen at each age reflected the population of Sweden at the time. They removed those who reported having allergies, asthma, or just did not want to participate. They also removed any participant who had dementia or several other cognitive impairments, leaving 2,234 healthy participants. Researchers collected demographic information, such as gender, education, physical health, mental health, and whether they had certain genetic markers for diseases, such as the APOE ε4 gene associated with Alzheimer's disease. The participants were also asked about their own evaluations of their senses of smell. Table 1.2 shows the number of participants at each age group and each gender,

The odor test involved 16 items: apple, banana, clove, coffee, cinnamon, fish, garlic, lemon, leather, licorice, peppermint, pineapple, rose, turpentine, mushrooms, and gasoline. Odors were infused into felt-tip pens and each participant was exposed to the odor on the pen for 5 seconds. The researchers recorded how many of the odors each participant was able to identify correctly and how many they identified incorrectly, giving each a score. Those with scores below an established cutoff were considered to have *olfactory dysfunction*, or difficulty with their sense of smell. Figure 1.3 shows what percentage of participating

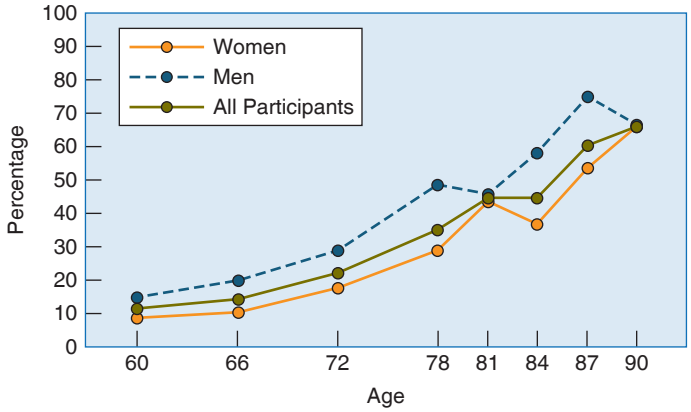
Table 1.2 Number of Participants (*n*) for Each Age and Gender

	60 Years	66 Years	72 Years	78 Years	81 Years	84 Years	87 Years	90 Years
Women	*n* = 361	*n* = 272	*n* = 224	*n* = 212	*n* = 89	*n* = 76	*n* = 54	*n* = 65
Men	*n* = 288	*n* = 202	*n* = 156	*n* = 99	*n* = 48	*n* = 43	*n* = 24	*n* = 21
All Participants	*n* = 649	*n* = 474	*n* = 380	*n* = 311	*n* = 137	*n* = 119	*n* = 78	*n* = 86

SOURCE: Data from Seubert et al. (2017).

Figure 1.3 Prevalence of Olfactory Dysfunction

SOURCE: Data from Seubert et al. (2017).



men and women at each age had olfactory dysfunction. As you can see, this problem increases with age from 66 to 90, and it is generally more prevalent in men than in women.

Some cross-sectional studies do not use age groups. Instead, they use stages in life, such as comparing young couples without children to couples who have had their first child to see the effects of parenthood on a marriage. Or comparing young people entering college with those who are graduating to see the effects of education on political views. But all cross-sectional studies are designed to test people from different age groups or stages in life at the same point in time—kind of a shortcut for following one group of people throughout a period of years and charting individual changes. The benefit is that it is quicker, easier, and less expensive than following the same people around the whole time. The downside is that it only shows *age differences*, not change. When cross-sectional studies are conducted with older adults, it is possible that the people in the older groups do not represent the general population as well as those in the younger groups, due to transportation problems, chronic health concerns, and difficulty in recruiting older participants. It is also the case that older participants are those who have survived into old age and may be healthier and wealthier (and perhaps wiser). But again, the minimal time and effort it takes to conduct cross-sectional studies makes them attractive to most researchers, and many of these problems can be predicted and controlled for. At our university, we are able to avoid some of these problems by running studies that compare our students (the young adult group) with students of our Lifelong Learning program (the older adult group). Since the older adults who attend this lecture series tend to be college educated, it gives us an older group that is matched to our younger group.

LONGITUDINAL STUDIES A **longitudinal study** is one in which a researcher follows the same group of people over a period of time, taking measurements of some behavior of interest at regular intervals. In comparison to the cross-sectional study, a longitudinal study might start with a group of people who are 35 to 44, asking how much effort they devote to their health. Then, 10 years later, the researchers could find the same people, now at the ages of 45 to 54, and ask them the same question again. Finally, another 10 years later, the last data could be gathered when the participants are 55–64 years of age. Then comparisons could be made, telling the story of these individuals, at least in regard to *age-related changes* in the time they devoted to their health over their middle years (not just *age-related differences* as are revealed by cross-sectional studies).

An example of a study using the longitudinal method is one conducted by developmental psychologist Dyuma I. Vargas Lascano and her colleagues (2015), who were interested in how the concept of perceived control changes during the transition to adulthood. These researchers were also interested in what factors might affect changes in perceived control. Details of this study are shown in Table 1.3 (see 'Example of a Longitudinal Study').

Some of the most ambitious longitudinal studies are done in large European research centers. For example, the Berlin Study of Aging began in 1990 with 516 participants ranging in age from 70 to over 100. It was the first large-scale multidisciplinary assessment of people in this age group. The initial group was examined on many aspects of their physical, psychological, and social well-being—an examination that took 3 years to complete. Over the next 19 years, the research team repeated key tests on the surviving participants (Baltes & Mayer, 1999). Some of the participants outlived the principle investigator, psychologist Paul Baltes, who died at the age of 67 in 2006. At one point, there were 40 researchers on the staff along with hundreds of students and research assistants. Although the data-gathering ended in 2009, there are still 13 core researchers working on this project and publishing new research articles. Archived data is available for researchers around the world to incorporate into their own projects, and blood samples have been stored for future genetic research.

Another drawback to longitudinal studies is **attrition**, or participant dropout. The Vargas Lascano study began with a fairly general sample of high school students, but as the years went by, each wave of data collection yielded fewer and fewer returns. More than half of the original participants were absent from the last wave of the study. When attrition is present, we need to ask whether those who dropped out might have made a difference in the results. The researchers mentioned this in the discussion section of their journal article. They said that the perceived control scores of those who dropped out and those who remained in the study did not differ in the earlier parts of the survey in which all participated.

Example of a Longitudinal Study

Vargas Lascano and her colleagues began the study in the spring of 1985 with 983 high school seniors from six high schools in Edmonton, Canada. The students' perception of control was assessed by asking them how much they agreed with the statement, "I have little control over the things that happen to me." They responded by rating the statement on a scale of 1 to 6, with the highest level of perceived control scored as 6 and the lowest scored as 1. Data were also collected on their parents' education levels.

The second wave of the study took place in 1986 followed by subsequent waves in 1987, 1989, 1992, 1999, and 2010. The number of participants dropped in each wave, due primarily to problems locating former participants. Between Wave 1 in 1985 and Wave 7 in 2010, the number of participants dropped from 957 to 403, which is just 42% of the original number (Table 1.3). However, this drop is actually less than is found in many longitudinal studies.

Table 1.3 Wave of Longitudinal Study, Years of Testing, Participants' Ages, and the Number (*n*) of Participants

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7
Year of Survey	1985	1986	1987	1989	1992	1999	2010
Age of Participant	18	19	20	22	25	32	43
Number of Participants	957	662	547	500	403	506	403

SOURCE: Data from Vargas Lascano et al. (2015).

Vargas Lascano and her colleagues computed the average scores of the participants on the perceived control question at each wave and found that the scores increased from 18 to 25 years, then decreased by age 32, with a smaller and slower decrease by 43. These findings are shown in Figure 1.4 on the middle line, labeled "Average trajectory." Researchers then divided the participants into those whose parents had no college degree and those who had at least one parent with a college degree. The scores for these two subgroups are shown in Figure 1.4 in the upper and lower lines. These data show that the participants with college-educated parents had higher perceptions of control and that this perception of control increased throughout the transition to adulthood and beyond. Those whose parents had no college degrees increased somewhat until age 25, then showed a steady decline in perceived control.

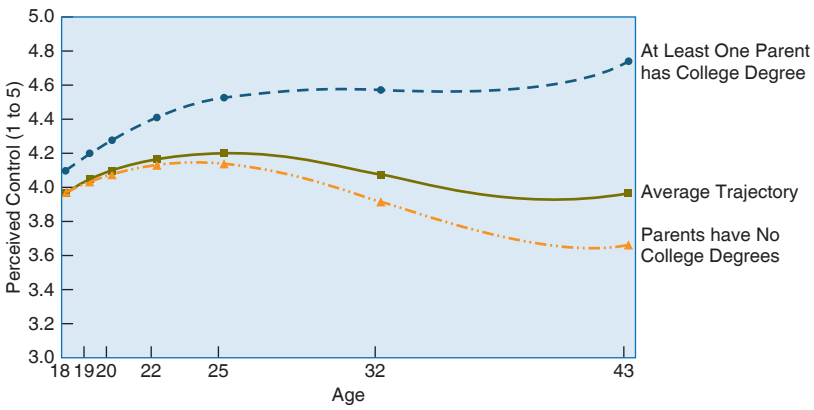
Education level of parents is one way of computing the socio-economic status (SES) of a family, and this study indicates that higher-SES parents are able to transmit certain advantages to their children in terms of parenting styles that promote self-reliance and responsibility and also have family resources that foster healthy lifestyles and higher education. High levels of perceived control have been associated with better mental and physical health and lower mortality risk.

The longitudinal method used by Vargas Lascano and her colleagues truly demonstrates *change* because the same participants were tested at each age. There were only 403 participants compared to 2,234 in the cross-sectional study described earlier, but the data points on the graph show increases in perceived control for the same participants over the course of 25 years. Another plus for longitudinal studies is that the participants are from the same cohort, which increases the probability that the changes in perceived control are age related and not the result of some normative history-graded influence on that cohort. However, the minuses of longitudinal studies should be apparent. From the first wave of testing to the published article, the study took 30 years! This method is time-consuming and expensive.

Figure 1.4

Emerging adults (solid line) show a mean average increase in perceived control between the ages of 18 and 25, then decrease until their 40s. When divided by educational attainment of parents, those with college-educated parents (top line) show higher levels and little decline: those with parents who did not attend college (lower line) begin declining at age 25.

SOURCE: Adapted from Vargas Lascano et al. (2015).



SEQUENTIAL STUDIES One of the ways to combine the positive aspects of the cross-sectional design with those of the longitudinal design is to use the **sequential study**, which is a series of longitudinal studies begun at different points in time. In the simplest form, one longitudinal study (Cohort 1) is begun with participants who are in one age group. Several years later, a second longitudinal study (Cohort 2) is begun with participants who are the same age as the Cohort 1 participants were when the study began. As the two studies progress, they yield two sets of longitudinal data, and they also give cross-sectional data. For example, a sequential study was conducted by psychologist Susan Krauss Whitbourne and her colleagues (Whitbourne et al., 1992) to answer the question of whether young adults' personalities change or remain stable as they moved into middle age (see 'Example of a Sequential Study').

1.4.2: Measures

OBJECTIVE: Explain the advantages and disadvantages of different measures

Once the research design is determined, the next major set of decisions has to do with how to measure the behavior of interest. Each method has its own set of advantages and disadvantages, and I discuss them here briefly.

One of the most common instruments used to gather data is a **personal interview**, that is, having the experimenter ask the participant questions, one-on-one. Personal interviews can be *structured*, like a multiple-choice test, or *open ended*, like an essay test, or a combination of both. While personal interviews have the advantage of allowing the interviewer to clarify questions and ask follow-up questions, and might make participants feel more comfortable than they might simply writing answers on an impersonal questionnaire, one drawback is that the participants might provide responses they feel are socially acceptable to the interviewer. Similarly, the interviewer's feelings toward the participant might cloud the recording or coding of responses, especially with very long interviews. Building rapport between interviewer and participant can be a plus or a minus.

This problem is avoided by using the **survey questionnaire**, consisting of structured and focused questions that participants can answer on their own. Survey questionnaires are often given out on a large scale, such as online or at large gatherings, allowing researchers to reach a large number of people in a wide geographic range. Participants may be more truthful and forthcoming about sensitive topics with a survey than if talking face-to-face with an interviewer. Survey questionnaires are much less expensive and time-consuming than personal interviews. One drawback of survey questionnaires is that there is often a low return rate (an average of 30% of participants return the first questionnaire). Group-administered questionnaires have fewer lost participants, but can be affected by peer influence (especially if given out in the social environment of high school auditoriums or retirement condominium recreation rooms). Good survey questionnaires are also incredibly difficult to construct.

Some of the problems of survey questionnaire construction can be avoided by using **standardized tests**. These are instruments that measure some trait or behavior and have already been established in your field of interest. Drawbacks are that many of these tests are owned by publishing companies, and you have to purchase the right to use them in your research. An example is measuring IQ using the Wechsler scales or personality using the MMPI or the Myers-Briggs Type Indicator. However, a number of tests are also available at no charge that have been standardized and published in research articles, along with instructions for administering and scoring them. For example, researchers in a number of studies in this text measure depression in their participants with an instrument known as the CES-D-10, or the Center for Epidemiological Studies Short Depressive Symptoms Scale (Radloff, 1977). This test is easily available on the Internet. It is a good example of a standardized test that is easily scored and has a good record of **validity** (it measures what it claims to measure) and **reliability** (it would yield a similar score if the person took it again). How would you select a standardized test for your own research? There are reference books that review tests periodically, such as the *Mental Measurements Yearbook* (Carlson et al., 2017), but the advice I give students is to read similar studies published by other researchers and see what they use.

These are by no means the only research measures available. There are many ways to measure human behavior, from complex brain-imaging techniques to one-item questionnaires ("How would you rate your health? Circle one of the following: Very Poor, Poor, Average, Good, Very Good"). Depending on the research question, it's important to find the most appropriate way to measure the behavior of interest.

1.4.3: Data Analysis

OBJECTIVE: Describe forms of data analysis

Once the research method has been chosen and the measure of behavior has been selected, researchers must make another set of decisions about how to analyze the data they will collect. Some of the statistical methods now being used are extremely sophisticated and complex. For now, let's talk about the most common ways of looking at adult development.

COMPARISON OF MEANS The most common and the simplest way to describe age-related differences is to collect the data (scores, measurement results) for each group, find the means (averages), and determine whether the differences in the means are large enough to be significant, a process known as **comparison of means**. With cross-sectional

Example of a Sequential Study

The study began in 1966 with a group of 347 undergraduate students at the University of Rochester whose average age was 20. They were given a personality inventory questionnaire asking them, among other things, to rate statements about their work ethic (or industry) according to how well each described them. In Table 1.4, this group is shown in the top left box labeled Cohort 1, 1966. In 1977, this group was on average 31 years old, and the researchers sent out questionnaires again, receiving 155 in return, as shown in the box labeled Cohort 1, Year of Testing 1977. Also in 1977 a new group of 20-year-old students from the University of Rochester were given the personality inventory questionnaire (Cohort 2, 1977). In 1988

Table 1.4 Year of Testing, Age of Participants, and Number of Participants for Two Cohorts of a Sequential Study

	Year of Testing 1966	Year of Testing 1977	Year of Testing 1988
Cohort 1	Age = 20 Number of Participants = 347	Age = 31 *n* = 155	Age = 42 *n* = 99
Cohort 2		Age = 20 *n* = 296	Age = 31 *n* = 83

SOURCE: Data from Whitbourne et al. (1992).

the process was repeated for the participants in Cohort 1, who were now 42 years of age, and Cohort 2, who were now 31 years of age. As you can see, 99 of the original 347 in Cohort 1 returned questionnaires, and 83 of the original 296 in Cohort 2 returned questionnaires.

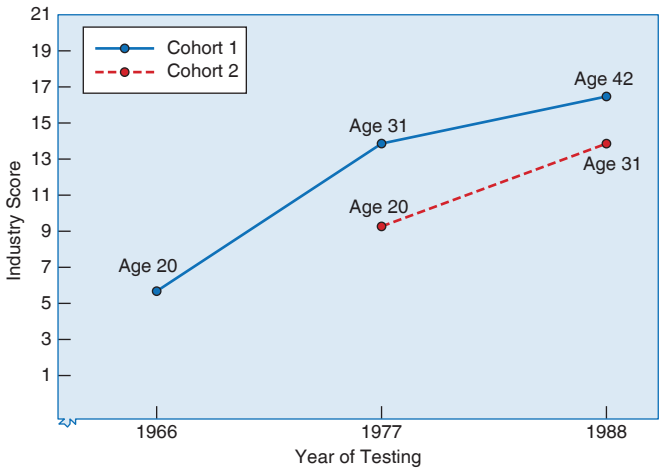
Comparing longitudinal results, Cohort 1 shows a sharper increase in industry (work ethic) scores between age 20 and 31 than does Cohort 2, though both have similar scores at age 31. Cross-sectional results suggest that the normative history-graded influences (Vietnam War, civil rights movement) lowered the young adults' scores in 1966.

At this point, there are two longitudinal studies going on, Cohort 1 with data available for the ages of 20, 31, and 42 and Cohort 2 with data available for the ages of 20 and 31. There is also a cross-sectional study going on, with a group of 20-year-olds, a group of 31-year-olds, and a group of 42-year-olds. Figure 1.5 shows how Whitbourne and her colleagues analyzed the results. The top line shows the work ethic (industry) scores for Cohort 1 at ages 20, 31, and 42. The scores increase sharply between 20 and 31, and the increase becomes more gradual from 31 to 42. This definitely shows change in personality traits during adulthood, but does the same hold for other cohorts? The lower line in the figure shows the pattern for Cohort 2, tested at 20 years and 31 years of age. The pattern is different than for Cohort 1. First, the work ethic (industry) scores are much higher at age 20 for Cohort 2 (6.54 for Cohort 1 and 9.19 for Cohort 2) and, second, the rate of increase is much slower for Cohort 2. Still, both groups had similar work ethic (industry) scores at the age of 31 (13.58 for Cohort 1 and 14.32 for Cohort 2).

The researchers suggest that the 20-year-olds in Cohort 1 were in college during the 1960s, when the work ethic of the establishment was being questioned and rejected, and their low scores on industry were reflections of that era. Once out of school and in the workplace, this group had some catching up to do. Their catching up is represented by the sharp increase in industry scores, which at 31 are very close to the scores of Cohort 2, who were not part of the protest era. Clearly there are nonnormative history-graded influences going on here. Perhaps the normative age-graded pattern of change in the personality trait of industry is more like that of Cohort 2, but when history (e.g., the Vietnam War, civil rights issues) brings about a large student protest movement, it causes a detour in the journey of adulthood for many in that cohort, although in the case of the personality trait of industry, these college students were able to catch up to speed and be back on track by the time they were age 31.

Figure 1.5 Results from A Sequential Study of Two Cohorts Tested at Three Ages and at Three Different Points in Time

SOURCE: Adapted from Whitbourne et al. (1992).



studies, the means of the age groups are compared. With longitudinal studies, the means of the scores for the same people at different ages are compared. With sequential studies, both comparisons are possible. However, the similarity remains—we are looking for an age-related pattern of change.

If the group of participants is large enough, it is often possible to divide it into smaller groups and look for age differences or continuities in the subgroups, such as women versus men, rural dwellers versus urban dwellers, those with young children versus those without young children. If the same pattern appears in all subgroups, we'd be more likely to conclude that this is a significant age-related pattern. However, if the change is different for the subgroups (as is often the case), it opens the door for follow-up questions. For example, in the cross-sectional study described earlier (Seubert et al., 2017), the mean scores for all participants in each age group showed an age-related increase in the percentage of participants who suffered from olfactory dysfunction. (This is shown by the "All Participants" column in Table 1.2.) When the researchers divided the participants into groups by gender, it showed that not only did the prevalence of olfactory dysfunction increase with age, but it was also higher for men than for women in almost every age group (as shown by the rows in Table 1.2 labeled "Women" and "Men").

CORRELATIONAL ANALYSIS Comparisons of means for different age groups, either cross-sectionally or longitudinally, can give us some insights into possible age changes or developmental patterns, but they cannot tell us whether there has been stability or change within individuals. For this information, a different type of analysis is required: a **correlational analysis** (see 'Implementations of Correlational Analysis').

META-ANALYSIS Another way of analyzing data is the **meta-analysis**. This approach combines data from a large number of studies that deal with the same research question. A researcher conducting a meta-analysis selects a research question, such as, "Are older adults viewed differently in different cultures?" It is a common belief that people in Eastern cultures have more positive attitudes toward aging and older adults than do people in Western cultures, but is this belief actually true? Michael North and Susan Fiske (2015) conducted a meta-analysis of existing research in an attempt to find out. The first step in a meta-analysis is to find all of the research articles addressing the question of interest. The researchers conducted a literature search and found 37 articles published between 1984 and 2014 that directly compared the attitudes of people from Eastern and Western cultures toward older adults. There were data from a total of 21,093 people. They calculated the size of the difference in attitudes expressed by people from Eastern and Western cultures on every attitude measure from every article. A striking pattern emerged. People from Western cultures actually held older adults in higher esteem than did people from Eastern cultures. It turns out that only one article found that attitudes toward older adults were significantly more positive in Eastern than in Western cultures.

WRITING PROMPT

To Sleep or Not to Sleep?

It is a common belief that students who get more sleep earn higher grades. How would you design a study to support or refute this belief? What do you predict your results would be?

The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

1.4.4: Designs

OBJECTIVE: Differentiate among research designs

The closing statement researchers are allowed to make depends on what kind of research design has been used, experimental or nonexperimental. If it is experimental, researchers are able to say their findings show that their factor of interest *caused* the change observed in their participants. If it is not experimental research, they must limit themselves to saying that their results show a relationship or an association with the change.

The distinctions between experimental and nonexperimental designs could fill a whole book (and there are a number of good ones available), but for now, let me just say that the feature that distinguishes experimental from nonexperimental designs is how much control the experimenter has over the way the study is conducted. In the strictest sense of the word, an **experimental design** has a control group, the participants are selected randomly from the population of interest, they are assigned randomly to groups, there is random assignment of groups to treatment and control conditions, and there is a high degree of control over any outside factors that might affect the outcome.

The more of these features that are present, the stronger the case the researcher can make for causality. Table 1.5 shows two types of experimental designs and the presence or absence of these controls.

Experimental designs include true experiments and quasi-experiments, depending on which of the controls listed in the table are present. True experiments are often not possible in answering developmental research questions because when comparisons are made between age groups (or between groups of people at different stages of life, such as preretirement versus post-retirement), the participants cannot be assigned to groups; they are already in one group or the other. That automatically takes a large

Implementations of Correlational Analysis

A correlation is simply a statistic that tells us the extent to which two sets of scores on the same people tend to vary together. Correlations (*r*) can range from +1.00 to –1.00. A positive correlation shows that high scores on the two dimensions occur together. A negative correlation tells us that high scores on one dimension occur with low scores on the other. The closer the correlation is to 1.00 (positive or negative), the stronger the relationship. A correlation of 0.00 indicates no relationship.

For example, height and weight are positively correlated: taller people generally weigh more, shorter people less. But the correlation is not perfect (not +1.00) because there are some short, heavy people and some tall, light people. If you are on a diet, the number of pounds you lose is negatively correlated with the number of calories you eat: high calories go with low weight loss. But this correlation, too, is not a perfect –1.00 (as any of you who have dieted know full well!).

Correlations are also used to reveal patterns of stability or change.

For example, researchers interested in personality traits might give personality assessments to participants over a number of years and then correlate the early scores with the later scores for each person. A high positive correlation would show stability for that trait.

Ultimately, however, correlations can tell us only about relationships; they cannot tell us about causality, even though it is often very tempting to make the conceptual leap from a correlation to a cause. Some cases are easy. If I told you that there was a negative correlation between the per capita incidence of television sets in the countries of the world and the infant mortality rates in those countries, you would not be tempted to conclude that the presence of TV *causes* lower infant mortality. You'd look for other kinds of societal characteristics that might explain the link between the two facts such as income level. But if I tell you there is a correlation between the amount of time adults spend with friends and family and the overall life satisfaction those adults report, you would be much more tempted to jump to the conclusion that greater happiness is *caused* by contact with friends and family. And it may be. But the correlation, by itself, doesn't tell us that; it only tells us that there is a relationship. It remains for further research and theorizing to uncover the causal links, if any. Perhaps the greater life satisfaction people have, the more time their friends and family want to spend with them.

One unique way correlational analyses are used in developmental research is to determine the genetic contributions to various behaviors and abilities. For instance, the typical twin study involves comparing two types of twins, monozygotic and dizygotic, on the behavior you are interested in. For a simple example, let's use height (and twins of the same sex to rule out sex differences). Each twin would be measured and the height recorded. Then two correlations would be computed comparing the twins—one for monozygotic twins and one for dizygotic twins. Which do you think would be more similar in height? Of course, the monozygotic twins would be more similar because they have the same genes, and height is something that is determined by inheritance to a great extent. But what about other characteristics, like IQ, the tendency toward alcoholism, or religiosity?

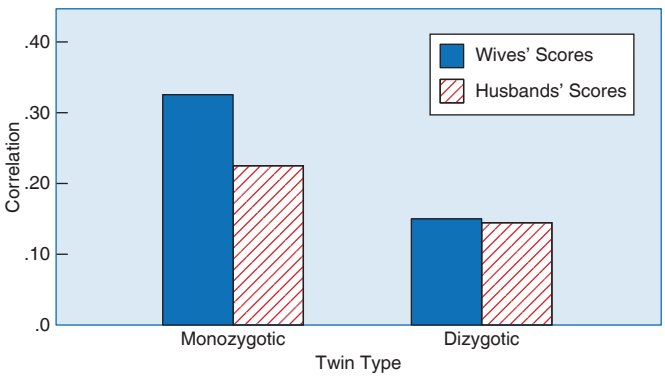
Those are all characteristics that have been shown to be influenced by heredity to a significant extent. And the research that revealed this involved correlational analyses.

For example, in a study using data from the Swedish Twin Registry, epidemiologist Erica Spotts and her colleagues (2004) investigated whether marital happiness is influenced by heredity. They gave a test of marital happiness to over 300 pairs of twins (all women) and their husbands. About half of the women were monozygotic twins and half were dizygotic twins. When the scores were analyzed, the monozygotic twin pairs were more alike than the dizygotic twin pairs. As you can see in Figure 1.6, if one monozygotic twin wife was happy in her marriage, the other twin tended to be happy too—and if one was unhappy, there was a good chance that the other was too. Their marital happiness scores were positively correlated. This was not the case for the dizygotic twin wives, whose correlations were about half what the monozygotic twins' correlations were. Comparing the two types of twins' correlations shows the

Figure 1.6 Marital Happiness in Twin Pairs

Wives who are monozygotic twin pairs are more similar in their marital happiness than wives who are dizygotic twin pairs. Interestingly, this genetic effect carried over to their husbands who were not related (compare striped columns).

SOURCE: Data from Spotts et al. (2004).



extent of the genetic contribution to marital happiness because the monozygotic twins share the same genes, whereas the dizygotic twins share only half, and as in the case of height, we would not expect them to be as similar. (Of course, parents may be more apt to treat monozygotic twins more similarly than dizygotic twins, thus providing a more similar environment for them.)

In a surprise twist, the researchers also gave the marital happiness questionnaires to the husbands of the twins, who were not related to each other or to anyone else in the study. As you can see in the figure, the husbands of the monozygotic twins also were more similar in their marital happiness scores than the husbands of the dizygotic twins. It may be that the genetic endowment of the monozygotic twins not only gave the women similar outlooks on marriage, but that the women, in turn, influenced the marital happiness of their husbands.

Table 1.5 Experimental Designs and Their Comparative Features

	True Experimental Design	Quasi-Experimental Design
Presence of a control group?	Always	Often
Random selection of participants from a population?	Yes	Some
Random assignment of participants to groups?	Yes	No
Random assignment of treatment to groups?	Yes	No
Degree of control over extraneous variables	Yes	Some

SOURCE: Salkind (2011).

amount of control out of the hands of the researcher and opens the door for a number of problems. As such, most developmental research is quasi-experimental.

DESCRIPTIVE AND QUALITATIVE RESEARCH Other designs include descriptive research and qualitative research. **Descriptive research** tells the current state of the participants on some measure of interest. The number of people of different ages who die of suicide each year is descriptive research. The rate of births to unmarried women over the past 50 years is descriptive research, and the cross-sectional, longitudinal, and sequential studies discussed earlier are descriptive research. What they have in common is the lack of a high level of experimenter control. They are still valuable sources of information on development.

Qualitative research uses less structured data collection techniques, such as case studies, interviews, participant observations, direct observations, and exploring documents, artifacts, and archival records. If you have ever done genealogy research to find your family history in old records and documents, you have done a form of qualitative research. It is a very old tradition that has only recently been included in developmental sciences. Although research without numbers may sound very enticing to students who have just completed a statistics course, it is not really a replacement for **quantitative research** (research with measurable data), but a different approach that is used to supplement quantitative research.

An example of qualitative research is a study by sociologists Amy Hequembourg and Sara Brallier (2005). They were interested in the role transitions among adult siblings when their parents need care in old age. We have long been aware that daughters are most likely to be the major caregiver of an aging parent, but these researchers found eight brother–sister pairs and interviewed them at length about their roles and feelings about their caregiving responsibilities. They recorded the answers in detail and then spent many months analyzing them. The finished product was a very interesting view of these families. Yes, the sisters did more, but sometimes they were pleased to be in that role. And other times the brothers stepped in and took over. There was evidence of adult sisters and brothers growing closer to each other as they shared the care for their parents. Although it was a study of only 16 participants, it gave more depth than a questionnaire sent out to 5,000. Clearly there is a place in developmental psychology for this type of research, and I am pleased to see it being discussed in research methods books.

Qualitative research is not easy. It needs to be carefully planned, the sources need to be wisely chosen, and questions need to be designed to focus on the topic at hand. If the research involves spending a lot of time with the people being interviewed, the experimenter needs to be able to remain as objective as possible. Data must be recorded precisely and completely. And then the findings need to be organized and written up to share with others.

Qualitative research is an excellent way to begin a new line of research. Epidemiologist David Snowden, former director of the Nun Study of the School Sisters of Notre Dame, started his research by visiting with the older nuns in a convent in Minnesota. As a beginning

professor, he had no idea what he wanted to do for a research program, but one day he stumbled onto a room that contained the archives of the convent. Each sister had a file going back to her first days as a nun, often 50 or 60 years before. They had all written essays about their childhoods and why they wanted to be nuns. Snowdon (2001) wrote that "for an epidemiologist, this sort of find is equivalent to an archaeologist's discovering an undisturbed tomb or a paleontologist's unearthing a perfectly preserved skeleton" (p. 24). From this beginning, he began the research that became his career. For example, he and his colleagues (Riley et al., 2005) found that the more complex the language in the essays the nuns had written as young women, the less likely they were to have Alzheimer's disease in late adulthood. Some of Snowdon's other research findings are discussed later in this text, but for now, this serves as a good example of qualitative research based on archival records.

Summary: Introduction to Adult Development

1.1 Basic Concepts in Adult Development

OBJECTIVE: Explore major themes in developmental psychology

- Developmental psychology includes the study of change and stability over time during childhood, adolescence, and adulthood. The study of adult development covers the time from emerging adulthood to the end of life and is based on empirical research.
- This text covers individual differences among people and also the commonalities they share. It looks at stability and change, continuity and stages, typical development and atypical development, and the external and internal changes that occur over the years of adulthood.
- The word *age* has many more meanings than how many years one has been alive (chronological age). In various usages it also designates estimates of a person's physical condition compared to others (biological age), the abilities one displays in dealing effectively with the environment (psychological age), and the roles one has taken on (social age). Functional age is a combination of biological, psychological, and social ages.

1.2 Sources of Change

OBJECTIVE: Explain the major sources of development

- Sources of change in adulthood are classified into three types. Normative age-graded influences are linked to age and happen to most people as they grow older. They come from both biological and environmental causes and also from interactions between genes and the environment.
- Normative history-graded influences are environmental factors that affect people within a group. These changes include cultural conditions and cohort experiences. One of the best-studied cohorts is the group of people who lived through the Great Depression.
- Nonnormative life events are unique to the individual and cause developmental changes that are not shared by most people.
- Genes and the environment also contribute to change. They usually interact, and one mechanism for this interaction is epigenetic inheritance, in which genes are modified through DNA methylation.

1.3 Guiding Perspectives

OBJECTIVE: Differentiate between the perspectives of psychological and bioecological models

- This text will approach the topic of adult development using the tenets of lifespan developmental psychology, a set of ideas introduced by Baltes in 1980 that encouraged psychologists to study development at many ages and to view development in a broader scope than they had before.
- A second approach this text will take is based on the ecological systems view introduced by Bronfenbrenner in 1979. This set of ideas inspired psychologists to consider the whole person, not just the isolated behavior of a participant in a laboratory experiment.

1.4 Developmental Research

OBJECTIVE: Evaluate developmental research methods

- The first step in conducting developmental research is to select a research method. There are three possibilities: (1) cross-sectional studies gather data on a group of people representing different age groups, (2) longitudinal studies follow the same people over a longer period of time, gathering data at several points along the way, and (3) sequential studies combine the preceding methods by conducting two longitudinal studies during different time periods, thereby making it possible to do both longitudinal and cross-sectional comparisons. There are pros and cons to each method.
- After a method is chosen, a researcher needs to choose an appropriate measure. Some of the most common ones in developmental research are personal interviews, survey questionnaires, and standardized tests.

- The next step in developmental research is selecting analyses. Most research uses either comparison of means, which involves computing the means of the measurement scores for each group and testing them statistically to see if they are significantly different, or correlational analysis, in which the researcher compares scores on several measurements for the participants to see if there is a relationship between the characteristics being measured. Correlations are used to show both change and stability. They are also used to demonstrate heritability by comparing scores of monozygotic twin pairs with scores of dizygotic twin pairs. The meta-analysis combines data from a number of previously published studies that focus on the same research question and reanalyzes it as a larger, more powerful study.
- The final step in developmental research involves stating conclusions, and this depends on whether the research design was experimental or not. If the design was experimental, it is possible to conclude that the results of the study were caused by the factor of interest. Experimental designs include true experiments, and quasi-experiments, and they differ in the amount of control the experimenter has over the conditions of the study and the outside factors that might also cause similar results. True experimental designs are not often used in developmental research. Research designs that are not experimental provide valuable knowledge about development even though researchers cannot conclude that their factor of interest caused the results. These designs include descriptive research and qualitative research.

SHARED WRITING

Introduction to Adult Development

Consider this chapter's discussion of research methods. Using what you've learned in this chapter, design a research study. Be sure to include the goal of your study, as well as methods, measures, controls, and any other pertinent information.

A minimum number of characters is required to post and earn points. After posting, your response can be viewed by your class and instructor, and you can participate in the class discussion.

Post

0 characters | 140 minimum

Chapter 2
Physical Changes

While everyone ages physically, not everyone ages on the same timeline.

Learning Objectives

2.1 Evaluate theories of primary aging

2.2 Analyze how adults deal with age-related changes in appearance

2.3 Summarize how the senses change with age

2.4 Analyze the social impact of age-related changes to the body

2.5 Determine how age-related physical changes impact life as an older adult

2.6 Relate aging experiences to demographic influences

A Word from the Author

A Short Lesson on Child Development

WHEN MY GRANDSON, Nicholas, was 5 years old, I was writing a book on child development. I wanted to open each chapter with a warm and personal story that would introduce the topic (much as I am doing now). Nicholas was a rich source of material. I was writing about children's cognitive processes, and I knew that at 5, children tend to judge everything at face value. They are convinced that the glass with the highest level of lemonade holds the most, regardless of its diameter. The longest line of M&Ms has the most candy, regardless of how far apart they are spaced. And people who are taller are older, period.

So I asked Nicholas who was older, Grandma or Dad. He quickly answered that Dad (who is 5′ 11″) is certainly older than Grandma (who is 5′ 7″), although he also knew that Dad was Grandma's son. He knew that Dad was 30 and Grandma was 54, and that 54

is more than 30, but logic is not important at 5. I was pleased—so far, he was perfectly illustrating the important concepts in my text book chapter.

Then I asked, "How do you tell how old a person is?" I expected him to comment on their height or hair color. But I was surprised when he replied, "You look at their hands." Hands? Well, I thought, I guess that's true. The hands of older people have dark spots and larger knuckles. Adolescents have larger hands in proportion to their other body parts. And infants have hands that are closed in reflexive fists. I thought he may be onto something interesting. So I asked, "What do you look for when you look at their hands?"

"Their fingers," he said patiently. He held up one hand with outstretched fingers and said, "You ask someone how old they are and when they hold up their fingers, you count them. See, I'm 5."

Nicholas's hypothesis of determining age by looking at hands may hold up with kids up to the age of 10, but it's not much use in adulthood. In fact, the further we get from "holding up fingers" to tell our ages, the more difficult it is to determine age just by looking at someone. One of the reasons is that there are two processes of aging. **Primary aging**, the topic of this chapter, consists of the gradual, inevitable changes that will happen to most of us as we go through adulthood. Research over the last few decades has given us two major facts about primary aging: first, that it can be differentiated from disease and, second, that there are many different "normal" time lines for primary aging (National Institutes of Health, 2008). **Secondary aging**, the topic of another chapter, refers to the changes that happen more suddenly and that are usually the result of disease, injury, or some environmental event.

I begin this chapter with some of the theories of primary aging and then describe the changes in the major systems of the body most adults experience as they age. Then I discuss the effects of primary aging on complex behaviors like sleep and sexual activity. Finally, I cover some of the individual differences that are found in primary aging patterns and answer the age-old question, "Can we turn back the clock?"

2.1: Theories of Primary Aging

OBJECTIVE: Evaluate theories of primary aging

Why do we age? This question has been the subject of speculation for centuries, but the technology and methodology to investigate it is fairly new. We now have Big Data—huge sets of secondary data such as national health registries that can be analyzed quickly—as well as major longitudinal data and advances in methods and statistics. These tools make it fairly easy for researchers to "churn out principally descriptive publications" (Bengtson & Settersten, 2016, p. 1), especially when their jobs and livelihood depend so heavily on publications and grants. This work is valuable in describing the primary aging process, but not in answering the "why" of aging. For this, we need theories. We need someone to compile empirical findings so we can integrate what is known, identify what is missing, and point the way to what needs to be investigated next. This is what theories do and why we need them.

In the relatively short life of lifespan development, we have gone from the grand theories of the 1930s and 1940s—theories that were large, inclusive explanations of all aspects of aging—to the minimalist theories of the 1960s and 1970s that were little more than descriptions of the data at hand. Today, the pendulum seems to have swung back to a Goldilocks balance, not too grandiose and not too sparse, but a middle ground that is "just right." Furthermore, the new era of theories are multidisciplinary and focused more on *healthspan* rather than *lifespan*, with a focus on prevention and treatment of age-related changes, whether it be lifestyle change or medical treatment. "Health and well-being are clearly central nodes around which scholars are fostering theories that bridge disciplines and levels of analysis, from cells to society" (Bengtson & Settersten, 2016, p. 8). I have selected a few of the more recent theories to describe here, along with support and criticism for each.

Before we move on, I should caution you not to expect any single theory to be proven to be the one and only correct answer to the question of why we age. As biochemist Brian K. Kennedy explains, "Gone are the days of scientists working on one model for aging or one hypothesis about what causes aging. Instead we are in a new research world that is at once exciting and a bit scary, in which complexity of the aging process is becoming appreciated and a system-level view of aging in an entire organism at least seems theoretically attainable, albeit not in the short term" (2016, p. 108).

By the end of this module, you will be able to:

- **2.1.1 Explain the idea that cell damage causes aging**
- **2.1.2 Describe how genetics influences aging**
- **2.1.3 Explain the relationship between aging and caloric intake**
- **2.1.4 Identify challenges in prolonging human life**

2.1.1: Oxidative Damage

OBJECTIVE: Explain the idea that cell damage causes aging

One theory of primary aging is based on random damage that takes place at the cellular level. This process, first

identified by biogerontologist Denham Harmon in 1956, involves the release of **free radicals**, molecules or atoms that possess an unpaired electron and are by-products of normal body metabolism as well as a response to diet, sunlight, X-rays, and air pollution. These molecules enter into many potentially damaging chemical reactions, most of which the healthy body can resist or repair. One consequence of oxidative stress is mutations in mitochondrial DNA. Mitochondria are organelles in most cells that produce energy, so mutations can lead to cellular dysfunction (Gredilla, 2011). According to this theory, our resistance and repair functions decline as we age, and the oxidative damage increases. The result is primary aging.

A number of vitamins and vitamin-like substances have been identified as **antioxidants**, substances with properties that protect against oxidative damage. Some of these are vitamins E and C, coenzyme Q10, beta-carotene, and creatine. Many nutritional supplements on the market contain large doses of these substances and advertise themselves as having antioxidant properties. However, there is no evidence that they can delay primary aging in humans or extend the lifespan. Most people in developed countries have adequate supplies of these nutrients in their diets, and no benefit has been shown for higher-than-recommended doses.

2.1.2: Genetic Limits

OBJECTIVE: Describe how genetics influences aging

The theory of genetic limits centers on the observation that every species has a characteristic maximum lifespan. Something between 110 and 120 years appears to be the effective maximum lifespan for humans, whereas for some turtles it is far longer, and for chickens (or dogs, or cats, or cows, or most other mammals) it is far shorter. Such observations led cellular biologist Leonard Hayflick (1977, 1994) to propose that there is a genetic program setting the upper age limit of each species. Hayflick showed that when human embryo cells are placed in nutrient solutions and observed over a period of time, the cells divide only about 50 times, after which they stop dividing and enter a state known as **replicative senescence** (Hornsby, 2001). Furthermore, cells from the embryos of longer-lived creatures such as the Galápagos tortoise double perhaps 100 times, whereas chicken embryo cells double only about 25 times. The number of divisions a species will undergo before reaching replicative senescence is known as its **Hayflick limit**, and there is a positive correlation between that number and the species' longevity. According to the genetic limits theory, primary aging results when we approach the Hayflick limit for the human species, exhausting our cells' ability to replicate.

The suggested mechanism behind the genetic limits theory of aging comes from the discovery that chromosomes in many human body cells (and those of some other species, too) have, at their tips, lengths of repeating DNA called **telomeres**. Telomeres are necessary for DNA replication and appear to serve as timekeepers for the cells. On average, the telomeres in the cells of a middle-aged adult are shorter than those of a young adult; the telomeres of an older adult are shorter still. And once the telomeres are used up, the cell stops dividing.

Telomere length has been related to both primary and secondary aging. People who are at high risk for heart disease or type 2 diabetes have shorter telomere lengths than healthy individuals the same age. Telomere length has also been related to chronic stress conditions. In one study, a group of mothers who were caregivers for children with chronic illnesses were found to have telomere lengths equivalent to women 10 years older who were caregivers for healthy children (Epel et al., 2004). Seemingly, the stress that comes with caring for a child with chronic illness adds 10 years to one's biological age.

IS IT POSSIBLE TO SLOW DOWN THE LOSS OF TELOMERE LENGTH IN ONE'S CELLS? This was the focus of a study by medical researcher Tim D. Spector and his colleagues (Cherkas et al., 2008), who interviewed over 2,400 individuals between 18 and 81 years of age about their leisure-time exercise. Following the interview, a sample of blood was drawn from each participant, and the telomeres from their white blood cells were examined. The researchers found that those in the light, moderate, and heavy exercise groups had cells with significantly longer telomeres than those in the inactive group. Participants in the heavy exercise group had telomere lengths similar to the people in the inactive group who were 10 years younger. It was interesting that the exercise described in this study was "leisure-time exercise." When researchers examined the amount of work-related exercise the participants got (such as stocking shelves in a grocery store), the results were not significant. This suggests that the "leisure" mode is a key feature of beneficial exercise.

It seems that shorter telomere lengths are good predictors of premature aging and age-related diseases. It also seems that shorter telomere lengths go hand in hand with poor health habits such as eating junk food, smoking cigarettes, and maintaining a sedentary lifestyle. None of this research shows that telomere length *determines* the rate of aging, but the relationships are very strong.

2.1.3: Caloric Restriction

OBJECTIVE: Explain the relationship between aging and caloric intake

One of the most promising explanations of why we age is that aging is connected with our diets—not so much what

we eat, but how many calories we metabolize per day. This idea was first suggested 60 years ago when researchers studied the effects of **caloric restriction** (CR) on lab animals by feeding them diets drastically reduced in calories (60–70% of normal diets), but containing all the necessary nutrients. Early researchers found that animals put on these diets shortly after weaning stayed youthful longer, suffered fewer late-life diseases, and lived significantly longer than their normally fed counterparts (McCay et al., 1935). More recent studies have supported these findings. For example, studies with rhesus monkeys show that animals on caloric restriction show a lower incidence of age-related disease, including type 2 diabetes, cancer, heart disease, and brain atrophy (Colman et al., 2009).

WOULD CALORIC RESTRICTION INCREASE HUMAN LONGEVITY? One problem is that, to receive maximum benefits, we would have to reduce our caloric intake by 30%. People eating a 2,000-calorie diet would need to cut back to 1,400 calories—difficult enough for a few months, but close to impossible as a lifetime regimen. Limited studies using human subjects on CR have shown some positive health benefits such as protection against type 2 diabetes and heart disease and a reduction in cancer incidence and cancer deaths (Fontana et al., 2011); however, a number of adverse effects have also been documented. These include cold intolerance, increases in stress hormones, decreases in sex hormones, and the psychological effects of extreme hunger—obsessive thoughts about food, low energy, social withdrawal, irritability, and loss of interest in sex. If the goals of caloric restriction are longevity and freedom from disease, this practice seems promising. But if the goals are quality of life, severely restricting calories does not seem to be the answer, especially in the developed countries of the world, where food cues are abundant and attractive (Polivy et al., 2008).

Scientists have now turned to finding a substance that provides the same health and longevity as caloric restriction without reducing normal food intake. Several candidates have been found, such as *resveratrol*, a substance found in red wine that extended the lifespans of yeast, worms, and flies. However, the results on mammals were disappointing. Another substance, *rapamycin*, has been more promising (Kapahi & Kockel, 2011). Originally found in soil collected on Easter Island, rapamycin inhibits cell growth and was first used as an antirejection medication for organ transplant patients. Studies of the effects of rapamycin on mice extended maximum lifespan by about 12% (Miller et al., 2011), including some mice that were the human equivalent of 60 years of age (Harrison et al., 2009). Unfortunately, rapamycin itself has side effects that rule it out for human consumption, but it is some of the most compelling evidence that aging may someday be slowed by a pharmaceutical product.

WRITING PROMPT

From Lifespan to Healthspan

You've read that there was a shift in aging theory from lifespan to healthspan, focusing on the physical experience of life rather than the simple length of life. What are some other quality-of-life issues that aging theory could address? What do you value most when you think about life as an older adult?

▶ The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

2.1.4: Turning Back the Clock

OBJECTIVE: Identify challenges in prolonging human life

When it comes to primary aging, there are many ideas about what can be done to slow down the process. We can exercise our minds and bodies. We can eat healthy food and keep our weight in the normal range. We can avoid tobacco, excessive alcohol, and exposure to loud noises. There are also things we can do to cover up some types of primary aging, such as cosmetics, hair dye, and plastic surgery. Despite seeing commercials on TV about how to look and feel young again and reading serious scientific articles about ideas to turn back the clock, I have no solid scientific evidence to offer about actually preventing or reversing the effects of primary aging at this time.

The **maximum lifespan** of our species has been about 120 years for some time now. That means that for centuries there have been a few individuals who live to that age, but none who live beyond. What has changed is the **average lifespan**, the number that comes from adding up the ages at which everyone in a certain population dies and then dividing by the number of people in that population. That number has increased each year, mainly due to eradication of infant and early childhood deaths. When there are fewer deaths of 2- and 3-year-old children, the average lifespan goes up dramatically. Currently, some researchers are trying to find ways to expand our maximum lifespan by finding ways to replace our aging organs with new organs grown in a lab (Kretzschmar & Clevers, 2016). Some are trying to rejuvenate old organs with stem cells or transfuse the blood of young mice into old mice in hopes of transferring components that will repair old cells (Apple et al., 2017). Some researchers are searching the DNA of families with many centenarians to find segments of genes that may be responsible for their longevity, hoping to someday insert it into the DNA of people who do not have those longevity genes (Passarino et al., 2016).

While all these attempts to slow down aging sound exciting, there is another side to the life-extension coin. How will we pay for this expensive life-extension treatment?

Will the retirement age increase? What will this do to our workforce? Do we have enough natural resources for a larger population of new, improved senior citizens?

I don't have the answers to these questions, but I think it is important to ask them and to think about what would happen if we could increase our maximum lifespan, because it is clearly a possibility.

WRITING PROMPT

A Question for the Ages

What changes might take place in a society where people died at an average age of 300?

The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

2.2: Physical Changes in Outward Appearance

OBJECTIVE: Analyze how adults deal with age-related changes in appearance

Other chapters in this text cover changes in thinking abilities, personality, spirituality, and disease patterns during adulthood. This chapter deals with the physical aspect of adult development, from outward appearance to working through the senses, to various systems of the body, to a discussion of individual differences in primary aging. In this section, we look specifically at changes in outward appearance.

I have reviewed the myriad details of primary aging in Table 2.1, showing the physical characteristics of adults at different ages. When you look at the information this way, you can see that adults are clearly at their physical peak in the years from 18 to 39. In the years of midlife, from 40 to 64, the rate of physical change varies widely from one person to the next, with some experiencing a loss of physical function quite early, and others much later. From age 65 to 74, the loss of some abilities continues, along with significant increases in chronic diseases—both trends that accelerate in late adulthood. But here, too, there are wide individual differences in the rate of change and effective compensations. Many adults maintain perfectly adequate (or even excellent) physical functioning well past 75 and into their 80s. In the oldest group, however, all these changes accelerate, and compensations become more and more difficult to maintain.

By the end of this module, you will be able to:

- **2.2.1 Outline changes to body composition over time**
- **2.2.2 Characterize how skin changes with age**
- **2.2.3 Describe issues associated with hair and the aging process**

Table 2.1 An Overview of Physical Changes in Adulthood

Age	Weight and Body Mass	Facial Features	Vision and Hearing	Bone Mass	Neuronal Development	Hormones	Sexual Response
18–24 Years	Weight and body mass are optimal for most. About 17% are obese.	Facial features and skin tone are youthful; hair is full.	Vision is at peak acuity; hearing may start to decline for some due to loud sports and leisure-time activities.	Bone mass is still building.	Neuronal development is mostly completed.	Hormones are fully functioning; fertility is at optimal level.	Sexual response is at optimal level.
25–39 Years	Weight and girth begin to increase around age 30. About one-third are obese.	Facial features remain youthful for most; some men begin hair loss.	Beginning of vision and hearing losses, declines in taste and smell, but not generally noticeable.	Peak bone mass reached at age 30.	Some neuronal loss, but not noticeable.	Production of major hormones begins to decline, but not noticeable.	Sexual responses begin slow decline.
40–64 Years	Weight continues to increase until 40s, remains stable until 60; girth continues to increase and fat moves from extremities to abdomen. About 40% are obese.	Skin begins to wrinkle and lose elasticity. Thinning of hair for men and women, more extreme for men. Largest group for cosmetic surgery.	Near vision loss around age 45; dark adaptation decrease becomes apparent in 60s; cataracts begin in 40s. Slight losses in taste and smell. Hearing loss is more noticeable.	Bone mass begins to decline gradually for men and more sharply for women, especially after menopause.	Neuronal loss continues, especially in brain centers related to memory.	Hormones continue to decline, fertility declines gradually for men; sharply for women after menopause.	Sexual responses become slower, less intense.

Table 2.1 *(Continued)*

Age	Weight and Body Mass	Facial Features	Vision and Hearing	Bone Mass	Neuronal Development	Hormones	Sexual Response
65–74 Years	Weight and girth begin to decrease in 70s. About 37% are obese.	Wrinkles and loss of skin elasticity increase.	Vision loss continues. Cataracts common. Loss of taste and smell becomes noticeable, especially sweet and salty tastes.	Bone mass continues to decline. Risk for fractures increases, especially for women.	Neuronal loss continues.	Hormones continue to decline.	Sexual responses continue to decline, though lack of partner is top reason for not having sexual relations.
75+ Years	Weight and girth continue to decrease until at least age 80. About 15% are obese.	Wrinkles and loss of skin elasticity increase.	Visual and hearing losses continue.	Bone mass continues to decline. Risk for fractures increases sharply, especially for women.	Neuronal loss continues.	Continued low levels of major hormones.	Sexual responses continue to decline, though many continue to enjoy sexual relations throughout adulthood.

2.2.1: Weight and Body Composition

OBJECTIVE: Outline changes to body composition over time

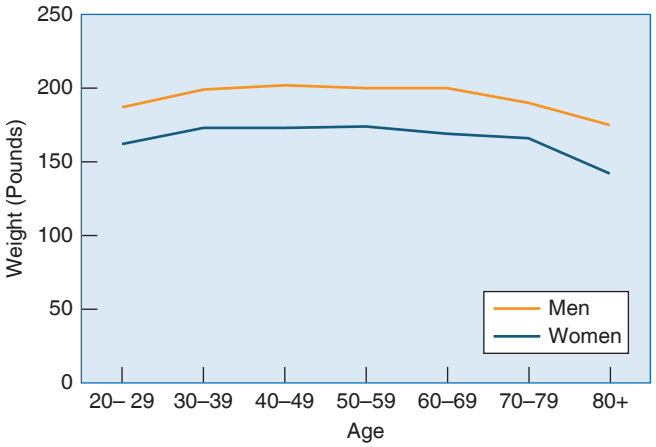
The U.S. Department of Health and Human Services reports that changes in total body weight follow a pattern over adulthood.

As you can see in Figure 2.1, this pattern takes the shape on a graph of an inverted U (Fryar et al., 2016). The upswing in weight that takes place during young adulthood and middle age can be attributed to our tendency to become more and more sedentary during that time without changing our eating habits to compensate (Masoro, 2011). Much of the downturn in total body weight that takes place in later adulthood is due to loss of bone density and muscle tissue (Florido et al., 2011).

Figure 2.1 Changes in Weight Over Adulthood

Total body weight for men and women rises from the 20s to the 40s, stays fairly level into the 50s and 60s, then declines in the 70s.

SOURCE: Data from Fryar et al. (2016).



Along with changes in total body weight, there are also changes in where the weight is distributed; starting in middle age, fat slowly leaves the face and extremities and begins to accumulate around the abdomen, resulting in a loss of plump cheeks and lips, a loss of protective padding on the soles of the feet, and a gain in waistline circumference.

When a person's total body weight is more than what is considered optimally healthy for their height, they are considered *overweight*. This is a concern for adults of all ages, and rightly so—almost two-thirds of us in the United States are above optimal weight. Being overweight can impair movement and flexibility, and it can alter appearance. Our society does not generally view overweight individuals as healthy and attractive, and this can result in social and economic discrimination (Lillis et al., 2011).

When the weight-to-height ratio increases to the point that it has an adverse effect on the person's health, it is a medical condition known as **obesity**. The Centers for Disease Control and Prevention (CDC) reports that over one-third of adults in the United States have this condition (Ogden et al., 2015).

How do you stand in the body composition evaluation? Table 2.2 shows how to find your **body mass index (BMI)** by finding your height (in inches) in the far left column and moving across that row to find your weight. The number at the top of the column is your BMI. According to the CDC (2016a), BMIs less than 18.5 are considered underweight, 18.5–24 are considered normal weight, 25–29 are overweight, and 30 and above are obese. This is not a perfect system because some healthy, very muscular people would be assigned the "overweight" label based on their height and weight, but most health organizations and medical researchers around the world use BMI to evaluate body composition.

Adults who are 40–59 years of age are slightly more likely to be obese, but as you can see in Figure 2.2, the proportion

Table 2.2 Find Your BMI

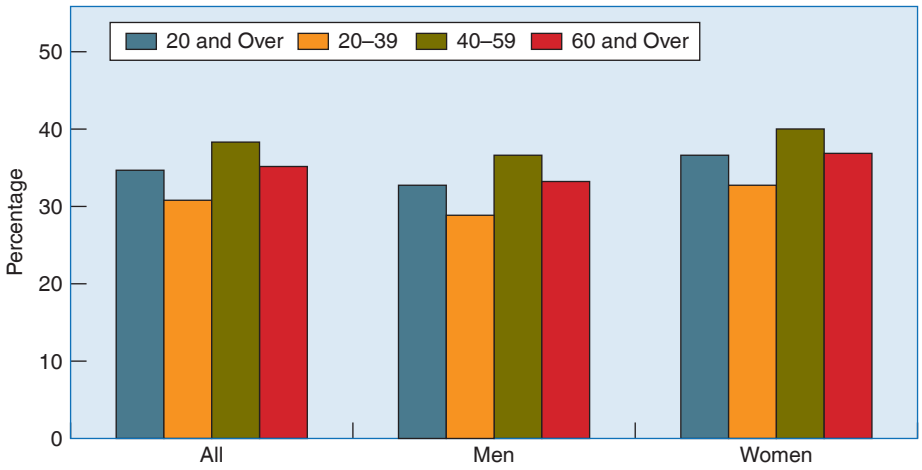
Body Mass Index (BMI)																						
Weight (Pounds)	**Normal**						**Overweight**										**Obese**					
Height (Inches)	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
58	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191
59	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198
60	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204
61	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211
62	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218
63	107	113	-118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220	225
64	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227	232
65	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240
66	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247
67	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255
68	125	131	138	144	151	158	164	171	177	184	190	197	204	210	216	223	230	236	243	249	256	262
69	128	135	142	149	155	162	169	176	182	189	196	203	210	216	223	230	236	243	250	257	263	270
70	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278
71	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286
72	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294
73	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295	302
74	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311
75	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319
76	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328

SOURCE: CDC (2016a).

Figure 2.2 Obesity in the United States

The proportion of people in the United States who are obese is highest for women and for those between the ages of 40 and 59.

SOURCE: Ogden et al. (2015).



of obese adults in other age groups is not much lower. Still, the fact remains that over one-third of all adults (and 17% of children) have total body weight that is considered a serious medical condition (Ogden et al., 2015).

What can be done about age-related changes in body composition? An active lifestyle in young adulthood and middle adulthood will help minimize age-related weight gain and the amount of fat that accumulates in the abdomen at middle age. Healthy eating habits can reduce excess fat. However, nothing has been found that will totally *prevent* these changes.

2.2.2: Skin Changes

OBJECTIVE: Characterize how skin changes with age

Youth is signaled by smooth skin, but beginning about age 45, wrinkles become evident, resulting in part from redistribution of body fat. Wrinkles also occur because of an age-related loss of elasticity that affects muscles, tendons, blood vessels, and internal organs as well as skin. The loss of elasticity is especially noticeable in skin that has been continually exposed to the sun, such as the skin of the face and hands.

From a quick trip down the beauty aisle of a drugstore or a look at the annual earnings of a cosmetic company, you would get the impression that many miracle cures are available for aging skin. However, the only effective products available over the counter are those that will cover up the wrinkles and age spots. One product available by prescription seems to be effective in reversing skin damage due to exposure to the sun. Several well-designed lab studies have shown that applying Retin-A (tretinoin) to the skin for several months not only changed the appearance of damaged skin but also reversed some of the underlying changes that had occurred (Rosenfeld, 2005). It is much easier to prevent sun damage by limiting strong, direct sun exposure. When that is not possible, it helps to use sunblock and protective clothing (Porter, 2009).

Skin damage that is too severe to be remedied by prescription creams can be treated by medical procedures, such as chemical peels or microdermabrasion, in which the outer layers of the skin are removed. As you might expect, these minimally invasive procedures are more expensive than skin creams and carry more risks. Nevertheless, many people have been pleased with the results and find that when they look younger, they feel younger. Table 2.3 shows the top procedures performed by plastic surgeons in the United States, along with the average surgeon's fee and the percentage of patients having these procedures in each of five age groups. As you can see, the 40- to 54-year-old age group makes up the largest segment (48%) for plastic surgery procedures (American Society of Plastic Surgeons, 2016).

Men make up about 13% of plastic surgery patients. Surgical procedures that are popular with both genders are nose reshaping, liposuction, and eyelid surgery. Women use it for breast augmentation and tummy tucks; men choose breast reduction and face-lifts. There has been a recent increase in two other surgical procedures for men—buttock lifts and buttock implants (American Society of Plastic Surgeons, 2016).

Several minimally invasive procedures have increased in popularity recently for both men and women. One is injections of Botox, a diluted preparation of a neurotoxin that paralyzes the muscles under the skin and eliminates creases and frown lines. This is now the most frequent procedure done by plastic surgeons for both men and women. Another popular procedure is injections of

Table 2.3 Top Plastic Surgery Procedures in the United States, Prices, Number, and Age of Patients

Procedure	Average Surgeon's Fee	Number of Procedures Performed in 2011	Percent of Patients in Each Age Group				
			13–19 Years	20–29 Years	30–39 Years	40–54 Years	55+ Years
Minimally Invasive Procedures							
Botox	$ 382	6,757,198	0	1	18	57	23
Soft-tissue filler	$ 949	2,440,724	0	3	11	50	36
Chemical peel	$ 636	1,310,252	1	1	13	42	44
Laser hair removal	$ 290	1,116,708	6	22	29	36	7
Microdermabrasion	$ 138	800,340	1	8	23	44	24
Cosmetic Surgery Procedures							
Breast augmentation	$3,822	279,143	3	29	37	29	2
Liposuction	$3,009	222,051	2	15	34	39	10
Nose reshaping	$4,771	217,979	14	32	24	21	10
Eyelid surgery	$2,880	203,934	1	2	6	43	48
Tummy tuck	$5,502	127,967	0	9	35	41	14

SOURCE: American Society of Plastic Surgeons (2016).

hyaluronic acid (Restylane or other products). This is a natural substance found in connective tissues throughout the body, and it cushions, lubricates, and keeps the skin plump. When injected into soft tissue, it fills the area and adds volume, temporarily reducing wrinkles and sagging of the skin. Botox has to be reinjected every few months; Restylane lasts somewhat longer—typically 6 months. Both procedures need to be administered by qualified medical professionals, and they carry slight risks. And needless to say, all are expensive—with Botox at an average of $382 a treatment and hyaluronic acid an average of $949—which is not covered by most health-care insurance plans (American Society of Plastic Surgeons, 2016).

Table 2.3 also shows the proportion of patients having these procedures in each age group. For example, the younger group (13–19 years) favors nose reshaping, whereas the older group (55 and older) tends to have eyelid surgery. It's an interesting picture of what procedures are favored at different ages. It is also interesting to see that almost half of all procedures are undertaken by people from 40 to 54 years of age, probably reflecting the intersection of declining youth and increasing incomes.

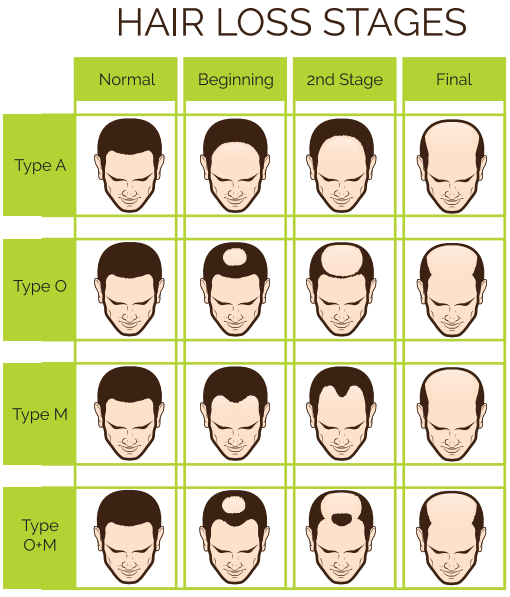
2.2.3: Hair

OBJECTIVE: Describe issues associated with hair and the aging process

Hair loss is a common characteristic of aging for both men and women, although it is more noticeable in men. About 67% of men in the United States show some hair loss by the age of 35, and 85% show significantly thinning hair by 50 (American Hair Loss Association, 2010). Graying of hair differs widely among ethnic groups and among individuals within any one group. Asian Americans, collectively, gray much later than Americans of European descent, for example. Figure 2.3 shows the various stages of typical patterns of hair loss.

Figure 2.3 Typical Hair Loss Patterns

There are several typical hair-loss patterns for men, and they proceed in predictable stages.



Men and women have used chemical and natural dyes to conceal gray hair throughout history, and it is still a widespread practice today. Other old solutions in new boxes are wigs, hairpieces, and hair replacement "systems." In addition, drugs are available that slow down or reverse hair loss, some over the counter for men and women, such as Rogaine (monoxidil), and others by prescription for men only, such as Propecia (finasteride). The most extreme solution to hair loss is hair transplant, a surgical procedure in which small plugs of hair and skin are transplanted from a high-hair-growth area of the body to the hairless part of the scalp. Over 15,000 people in the United States underwent this procedure in 2015, about 70% of them men and most of them over the age of 55 (American Society of Plastic Surgeons, 2016). Again, none of these antiaging measures actually turns back the clock, but when they are done by experienced professionals and patients have realistic expectations, they can give a good morale boost for those who need one.

WRITING PROMPT

Looking Younger

Do you plan to (or have you) take(n) measures to influence your age-related appearance? Why or why not?

The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

2.3: The Changing Senses

OBJECTIVE: Summarize how the senses change with age

Another series of body changes noted by many adults as they age affects the senses of vision, hearing, taste, and smell. Vision is by far the most researched, followed by hearing, with taste and smell trailing far behind.

By the end of this module, you will be able to:

2.3.1 Describe age-related vision changes

2.3.2 Relate hearing to the experience of aging

2.3.3 Explain how taste and smell change with age

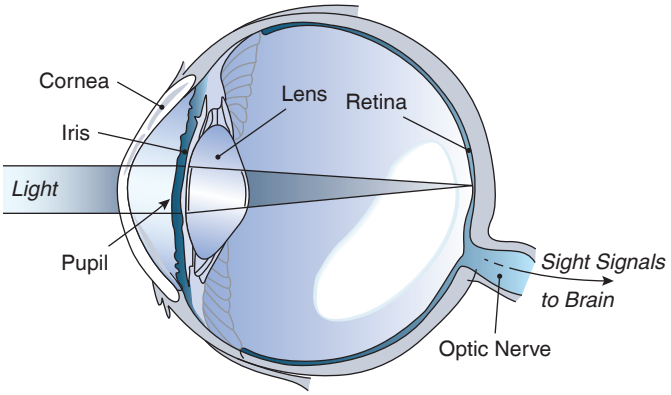
2.3.1: Vision

OBJECTIVE: Describe age-related vision changes

Vision is the last sense to develop in infants and the first to show signs of decline in middle age. It is also the sensory system that has the most complex structure and function and, as you might guess, has the most to go wrong.

Figure 2.4 Diagram of Eye with Labels

Cross section view of the human eye.



A diagram of the parts of the eye is shown in Figure 2.4. During normal aging, the **lens** of the eye gradually thickens and yellows, and the **pupil** loses its ability to open efficiently in response to reduced light. The result is that the older we get, the less light gets to our **retina**, the site of visual receptor cells. In fact, by age 60, our retinas are getting only one-third of the light they did in our 20s (Porter, 2009). One of the changes we experience as a result is a gradual loss of **visual acuity**, the ability to perceive detail in a visual pattern. To test this yourself, try reading a small-print book both indoors where you usually study and outdoors in full sunlight. If you are like most adults, you will notice that the clarity of the print is better in bright sunlight.

Around the age of 45, the lens of the eye, which has been accumulating layers of cells since childhood and gradually losing elasticity, shows a sharp decrease in its ability to **accommodate**, or change shape to focus on near objects or small print. This loss further reduces overall visual acuity in middle-aged and older adults. Most people with reduced visual acuity or loss of near vision, a condition known as **presbyopia**, can function quite well with prescription glasses or contact lenses.

Another visual change that takes place throughout adulthood is a gradual loss of **dark adaptation**, the ability of the pupil to adjust to changes in the amount of available light. This begins around age 30, but most people experience a marked decline after the age of 60. This causes minor inconveniences, such as difficulty reading menus in dimly lit restaurants or finding seats in darkened movie theaters. It also causes more dangerous situations, such as problems seeing road signs at night or recovering from the sudden glare of oncoming headlights. This is one of the reasons older people prefer attending matinee performances, making "early-bird" dinner reservations, and taking daytime classes at the university instead of participating in nighttime activities.

AGE-RELATED EYE DISORDERS Three more age-related conditions in the visual system may or may not be part of normal aging, but they are so common that I include them here.

Common Disorders of the Eye

Cataracts—The first is **cataracts**, the gradual clouding of the lens of the eye so that images are no longer transmitted to the retina sharply and in accurate color. Cataracts are the most common eye disorder found in adulthood. As you can see in Figure 2.5, the incidence of cataracts increases with age, with almost half the adults in the United States who are 75 years of age or older either having been diagnosed with cataracts or having had cataract surgery.

This outpatient procedure is done quickly and safely under local anesthesia. It involves removing the cloudy part of the lens and implanting an artificial lens that can even be designed to correct for loss of visual acuity and, in some cases, loss of near vision. Cataract surgery has become the most common surgical procedure in the United States; over 3 million are done each year. However, despite the ease of surgery and the fact that the procedure is covered under Medicare, cataracts remain a major cause of vision loss in the United States (Centers for Disease Control and Prevention, 2015b) and the leading cause of blindness in developing countries (World Health Organization, 2016).

Risk Factors for Cataracts

- Increased age
- Diabetes
- Family history
- European ancestry
- Extensive exposure to sunlight.*
- Smoking*
- Obesity*

*Can be controlled or prevented.

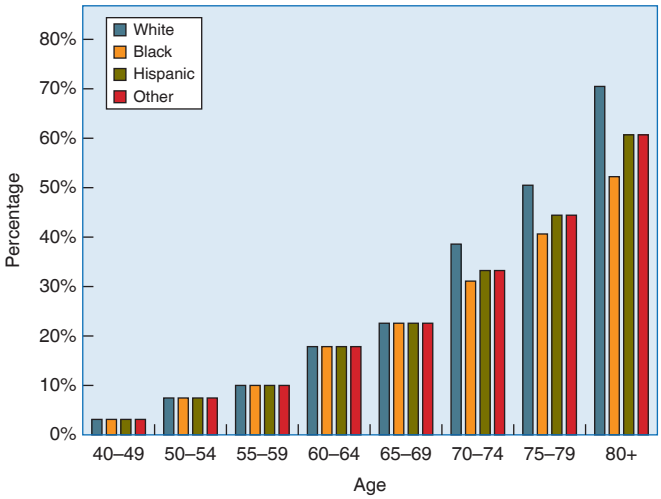
SOURCES: American Academy of Ophthalmology (2018); National Eye Institute (2015).

Glaucoma—A second common age-related condition of the visual system is **glaucoma**, a buildup of pressure inside the eye that ultimately can destroy the optic nerve and lead to blindness. Glaucoma is the third leading cause of blindness for all people in the United States and the second leading cause of blindness for people with African ancestry. Glaucoma can be treated with eye drops, laser treatment, or surgery, but first it has to be detected. What are the warning signs of glaucoma? Like other hypertension problems, there are not many. It is estimated that almost 3 million people in the United States currently have glaucoma, but only half are aware that they have it. Glaucoma can be detected as part of a routine eye examination, and it is recommended that people in high-risk groups be screened at age 40. Everyone should be screened at 60 (Glaucoma Research Foundation, 2016).

Figure 2.5 2010 U.S. Prevalence Rates for Cataract by Age and Race

The risk of developing cataracts increases, beginning about age 40 years, for all racial and ethnic groups in the United States, but the increase for white individuals is greater after 70 years.

SOURCE: National Eye Institute (2015).



Risk Factors for Glaucoma

- Increased age
- Family history
- African or Mexican ancestry
- Diabetes

SOURCES: American Academy of Ophthalmology (2018); Glaucoma Research Foundation (2016); National Eye Institute (2015).

Age-Related Macular Degeneration—A third common condition of the visual system is **age-related macular degeneration**, a disorder that affects the retina, causing central vision loss. The cause of this disorder is not clear, but the prevalence is; the risk stays low for all groups until the age of 75, when it increases dramatically for white individuals. Vitamin therapy and laser treatment have shown hopeful results for some types of this disorder, and rehabilitative interventions have helped people with low vision to function independently and increase their quality of life (National Eye Institute, 2015).

Risk Factors for Age-Related Macular Degeneration

- Increased age
- Family history
- European ancestry
- Smoking*

*Can be controlled or prevented.

SOURCES: American Academy of Ophthalmology (2018); Glaucoma Research Foundation (2016); National Eye Institute (2015).

THE IMPACT OF OCULAR CHANGES The overall result of declining visual ability over middle and late adulthood can be limiting in many ways. Often older adults give up driving, which means they are no longer able to do their shopping and no longer as able to visit friends, participate in leisure activities, attend religious services, or go to doctors' offices on their own. There is also a loss of status for some older adults when they must stop driving. Decreased vision is associated with many other problems in older adults, such as falls, hip fractures, family stress, and depression.

The World Health Organization (2015) estimates that over 80% of visual impairments worldwide can be prevented or cured. Problems involve lack of information about diagnosis and treatment, such as the mistaken belief many adults have that the eye exam given to renew drivers' licenses will screen for these visual conditions. Another problem is that many people in the United States and around the world live in areas without access to eye-care specialists. And still another problem arises when older adults and their family members believe that failing eyesight is an unavoidable part of aging.

2.3.2: Hearing

OBJECTIVE: Relate hearing to the experience of aging

Around age 30, many adults begin to experience some hearing loss, mainly of higher-pitched tones. There is also shortening of the *loudness scale*—that is, there is confusion between loud tones that are not being heard as well as before and softer tones that are still being heard accurately. Without the loud–soft discrimination, it is difficult to perceive which sounds are coming from nearby and which are from across a noisy room—which words are coming from your dinner partner and which from the server taking an order two tables over. This condition is known as **sensorineural hearing loss**, and it is caused by damage to the tiny hairs inside the **cochlea**, a small shell-shaped structure in the inner ear. This mechanism is responsible for picking up sound vibrations and turning them into nerve impulses that will be transmitted to the hearing centers of the brain.

Although age-related hearing loss is gradual for most people, it can reach a point that it has serious effects on peoples' lives. The obvious effects are problems in the workplace and in social situations. And at a time of life that medical information becomes more and more important, over half of people over 60 years of age in one study report that they have misunderstood instructions from their doctors (Cudmore et al., 2017). Less obvious effects are feelings of isolation, depression, and paranoia (Hearing Loss Association of America, 2017).

The prevalence of hearing loss increases with age and is more extreme in men than in women (Hoffman et al., 2017). Figure 2.6 shows this increase by age and gender at two time spans. There is some good news. The rate of hearing loss was higher in the 1999–2004 group (Panel A) than in the more recent 2011–2012 group (Panel B). This decrease is probably the result of a reduction in workplace noise, which is regulated by the U.S. Bureau of Labor.

Table 2.4 shows how loud workplace sounds are allowed to be at certain durations of time. For example, constant noise throughout the workday can't be more than 90 decibels.

Although workplace noise is more controlled now, many of our after-hours and weekend activities involve noise that exceeds safe levels of 85 decibels. For example,

Figure 2.6 Prevalence of Hearing Loss in Men and Women at Two Time Spans

SOURCE: Hoffman et al. (2017).

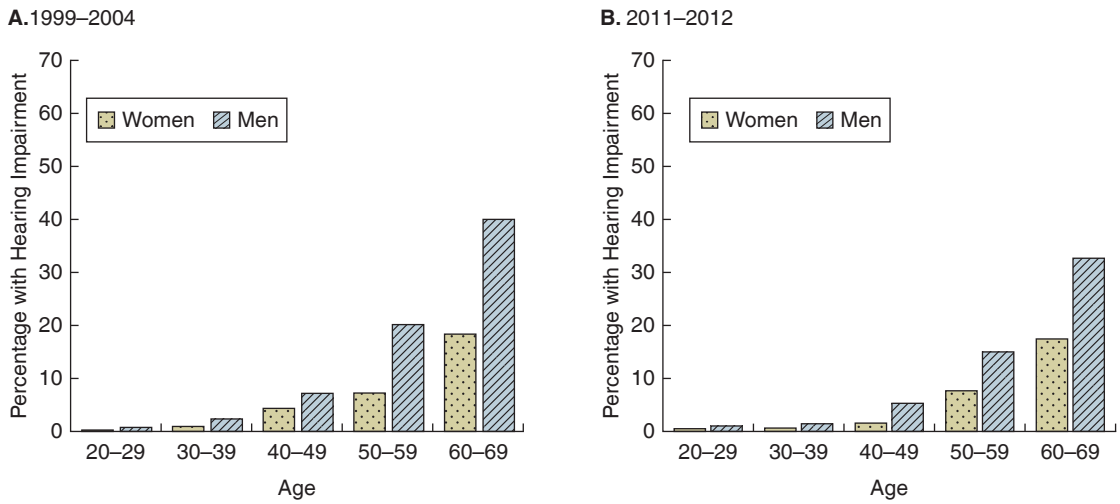


Table 2.4 Permissible Noise Exposure

Duration (Hours Per Day)	Sound Level (Decibels)
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

SOURCE: U.S. Department of Labor (2012).

motorcycles produce 98 decibels of noise, snowmobiles 100 decibels, rock concerts 125 decibels, and a gunshot at 100 feet produces 140 (Hearing Loss Association of America, 2017).

HEARING AIDS AND PSADS What can be done about hearing loss? Hearing aids are effective for some types of hearing loss, but not many people use them. Only 33% of people in the United States diagnosed with hearing loss actually use hearing aids. One reason is the cost; the average hearing aid costs $2,400, and most people need one for each ear. Medicare does not pay for them and neither do most private insurance policies (Grundfast & Liu, 2017). However, the rate of hearing-aid use is low in countries that do pay for them, such as Norway (only 43%), and within groups that provide them for free, such as the Veteran's Administration (less than 50%) (Valente & Amlani, 2017).

Clearly, it is not just the cost that undermines hearing-aid use, but also that it usually requires visiting an audiologist to be examined, being prescribed a particular device, having it fitted to your own specifications, and then returning several times to have it fine-tuned. Recently, many people with hearing loss have been buying personal sound amplification devices (PSADs) that look a lot like hearing aids but cost between $50 and $500. When a team of researchers compared several PSADs with a state-of-the art hearing aid, using a convenience sample of 42 participants with hearing loss, they found that three of the five PSADs improved the understanding of speech accuracy almost as well as the hearing aid. Mean score for the hearing aid was 88% while the three PSADs were 87%, 87%, and 84%. The cost for the hearing aid was $1,910 and the three PSADs were $350, $350, and $300 (Reed et al., 2017). Other people with hearing loss buy over-the-counter hearing aids and electronic devices that amplify sound. None of these are approved by the U.S. Food and Drug Administration (FDA) for hearing loss, but people seem to like the price and the ability to "unpack a box and plug it in their ear." Several large wholesale companies have begun selling the three most popular hearing aids online. These three hearing aids fit about 85% of the population that has hearing loss. This seems similar to buying over-the-counter reading glasses. In addition, online companies will send prescription hearing aids to people who have seen an audiologist and have an audiogram of the pattern of their individual hearing loss (Grundfast & Liu, 2017).

WRITING PROMPT

Disparities

What are some of the economic and social effects of hearing aids being so expensive and not covered by Medicare or most health-care plans?

▶ The response entered here will appear in the performance dashboard and can be viewed by your instructor.

Submit

2.3.3: Taste and Smell

OBJECTIVE: Explain how taste and smell change with age

Taste and smell depend on three mechanisms that interact to enable us to enjoy the food we eat and the fragrances in our environment. They also provide survival information that keeps us from eating food that is spoiled and warns us of dangerous substances such as smoke or gas leaks. These mechanisms consist of smell, taste, and common chemical sense. *Smell* takes place in the **olfactory membrane**, a specialized part of the nasal cavity. It consists of 350–400 types of odor receptors, and we perceive the results as subtle and complex scents. In addition, we experience *taste* through the **taste buds**, which are receptor cells found on the tongue, mouth, and throat. The five basic tastes that our species can sense are sweet, salty, sour, bitter, and umami, which is a mouth-filling, savory taste (Owen, 2015). Receptors on the moist surfaces of the mouth, nose, throat, and eyes sense irritating properties of food and odors—things like the spiciness of chili peppers and the coolness of mint (Fukunaga et al., 2005). All three types of receptors take information to different parts of the brain, where the total experience is integrated and translated into messages, such as knowing you are having a pleasurable dining experience or that the milk in your refrigerator has outlived its expiration date.

The ability to taste and smell declines over the adult years, beginning at about age 30 and becoming more noticeable around 65 or 70. Over 2 million people in the United States have disorders of taste or smell, and most of them are older adults. One reason for this is that the amount of

mucus in the nasal cavity is reduced so that odor molecules do not bind to the receptors as well as they do in younger people. Similarly, there is a reduction in the amount of saliva produced when chewing food, reducing the release of molecules in food to be sensed by the taste buds. There are fewer receptor cells, both in the sinus cavity and the mouth—about half as many at 70 years of age as at 20. Years of smoking and living in areas with air pollution contribute to the loss of taste and smell. Some diseases have this effect, as well as the use of some medications, both of which are more common in older adults (Douglass & Heckman, 2010).

The results can be minor ones. We prefer salsa to ketchup on our food. We use more salt and spices. We put extra sugar or sweetener in our coffee. Or they can be more serious, when food loses its appeal and older adults skip meals. The reduced sense of smell can cause older people to eat food that has spoiled and may interfere with their ability to smell dangerous odors such as the rotten-egg smell natural gas companies add to their product to signal a leak in the lines.

2.4: How Age Changes Internal Structures and Systems

OBJECTIVE: **Analyze the social impact of age-related changes to the body**

Most of us are concerned about our outward appearance and how it will change as we navigate the years of adulthood. Many of the most obvious signs of aging belong in this category, and we see them in our parents and grandparents, in our friends, and sometimes in our mirrors. Perhaps less obvious are those changes taking place beneath the surface—in our muscles and bones and heart and lungs and in our ability to fight off disease and infection. In this section, we examine these age-related changes to internal structures and systems.

By the end of this module, you will be able to:

- **2.4.1** **Determine the impacts of age-related bone and muscle changes**
- **2.4.2** **Explain how the cardiovascular and respiratory systems change with age**
- **2.4.3** **Identify age-related changes to the nervous system**
- **2.4.4** **Summarize age-related changes to the immune system**
- **2.4.5** **Differentiate how hormone changes affect males and females**

2.4.1: Bones and Muscles

OBJECTIVE: **Determine the impacts of age-related bone and muscle changes**

The major change involved in primary aging of the bones is calcium loss, which causes bones to become less dense. Peak bone mass is reached around the age of 30, followed by a gradual decline for both men and women, but the overall effect of this bone loss is greater for women for several reasons. First, women's bones are smaller and contain less calcium—in other words, even if the decline were equal, women begin at a disadvantage. Second, the decline is not equal; women's bone loss rate shows a marked acceleration between the ages of 50 and 65, whereas men's decline is more gradual. Severe loss of bone mass, or **osteoporosis**, makes the bones more likely to break than those of a younger person. There is controversy over whether or not osteoporosis is a disease because the process is not distinguishable from normal aging of the bones, except in degree of severity.

OSTEOPOROSIS Osteoporosis is based on a measure of **bone mass density (BMD)**, which is easily determined with a test called a DXA (dual-energy X-ray absorptiometry) scan of the hips and spine. The results are compared to those of a young healthy person. BMD measures at either hip or spine that are more than 2.5 standard deviations below normal are considered osteoporosis.

According to the CDC, osteoporosis affects 16% of people over age 65. Women are four times more apt to have osteoporosis than men, and individuals with Mexican American heritage are more likely to have osteoporosis than those of non-Hispanic white or non-Hispanic black heritage (Looker & Frenk, 2015).

The biggest problem caused by osteoporosis is the increased risk of injury after a fall. Diminished eyesight and a decreased sense of balance result in a greater number of falls as we get older. When brittle bones enter the equation, falls can result in serious injury, disability, loss of independent living, and even death. The typical sites of breaks are the wrist, spine, and hip.

New strategies to prevent osteoporosis focus on promoting bone health throughout life, starting with childhood, through proper diet containing required amounts of calcium and vitamin D. Healthy bones also require a regimen of exercise of the weight-bearing muscles, including high-impact exercise such as running and jumping. Peak bone mass is reached in the late teens and early 20s, and the denser the bone mass is at this age, the lower the risk for osteoporosis in later life (National Osteoporosis Foundation, 2016).

Measuring bone mass density is becoming more and more a part of routine examinations by gynecologists, internists, and family physicians. Treatment of bone loss includes vitamin D, estrogen, and drugs that slow down bone loss and increase the rate of bone formation. Recently more emphasis

is being placed on *patient adherence* to treatment for bone loss. Patients are being urged to refill their prescriptions before they run out of medication and to follow the instructions carefully to ensure that the drug is being absorbed well into the system and to avoid unpleasant side effects. Medication-delivery systems are available that allow patients to take only one pill a month or one IV treatment a year.

Risk Factors for Osteoporosis

- Increased age
- Family history
- Female gender
- European, Asian, or Latin ancestry
- History of earlier bone fracture
- Sedentary lifestyle*
- Smoking*
- Excessive alcohol consumption*
- Underweight BMI*

*Can be controlled or prevented.

SOURCES: CDC, 2015c; National Institute on Aging, 2013.

OSTEOARTHRITIS Over the adult years, bones also change at the joints. **Osteoarthritis** is a condition that occurs when the soft cartilage that covers the ends of the bones wears away with use and age. This allows the bones to rub together and causes pain, swelling, and loss of motion at the joint. The CDC (2015c) estimates that 34% of people who are 65 years of age or older have osteoarthritis. In older adults this condition is more prevalent in women; in younger adults it is more apt to appear in men and be the result of work and sports injuries.

Researchers are investigating the long-term effects of high-impact sports on bones and joints. Studies have been conducted with male elite athletes, defined as athletes playing at the national or professional levels of high-impact sports, to determine the relationship between participation in various sports and later osteoarthritis of the hip joint. One review of the available literature showed that there was an increase in the risk of hip osteoarthritis for men playing handball, soccer, and hockey, but the evidence for long distance running was not consistent (Vigdorchik et al., 2016).

Women athletes have not been studied enough for review articles, but one recent study involved women (and men) ballet dancers, an art form that can be as physically demanding as high-impact sports (Reider, 2016). Joshua D. Harris, a physician who specializes in orthopedic surgery and sports medicine, along with his colleagues (Harris et al., 2015) examined 47 male and female dancers from an international ballet company using radiographic images of their hip joints. He found evidence of a dysplasia (or deformity) of at least one hip joint in 89% of the dancers. This dysplasia was more apt to be found in female (92%) than male (74%) dancers. I should remind you that all these studies are cross-sectional, and longitudinal studies need to be conducted to determine how (or if) these risk factors and hip dysplasia develop into later-life osteoarthritis and whether some safeguards are possible, such as avoiding certain movements or wearing certain protective gear.

Osteoarthritis, no matter the cause, can lead to depression, anxiety, feelings of helplessness, lifestyle and job limitations, and loss of independence. However, most people with this condition find that the pain and stiffness of osteoarthritis can be relieved with anti-inflammatory and pain-relief medication, and also an appropriate balance of rest and exercise to preserve range of motion. Weight management is also helpful for many.

Some people with osteoarthritis report that they have found help through alternative and complementary medical treatment, such as acupuncture, massage therapy, vitamins, and nutritional supplements. Others have injections of *hyaluranic acid*, which is a natural component of cartilage and joint fluid. Studies are currently being done on all these treatments. For example, researchers recently conducted a meta-analysis of 29 randomized, controlled trials of over 17,000 acupuncture patients who either had needles inserted at traditional acupuncture sites or at sham sites, chosen randomly. When researchers asked patients about the effectiveness of the treatment in alleviating osteoarthritis pain, there was a modest but significant difference in the two treatments, showing that the results patients experience from traditional acupuncture sites are greater than a placebo effect (Vickers, Cronin, Maschino, et al., 2012).

When people with osteoarthritis cannot find relief with these treatments, there is the surgical option of joint replacement. In recent years, over 300,000 hip joints and over 600,000 knee joints have been replaced annually in the United States with high success rates. The vast majority of these surgeries are due to osteoarthritis (American Academy of Orthopaedic Surgeons, 2016a, 2016b).

Risk Factors for Osteoarthritis

- Increased age
- Female gender (after 50)
- Family history
- History of joint injury
- History of repeated joint stress*
- Overweight or obese BMI*

*Can be controlled or prevented.

SOURCES: CDC, 2015c; National Institute on Aging, 2013.

MUSCLE MASS AND STRENGTH With age, most adults experience a gradual decrease in muscle mass and strength. The reason for this is that the number of muscle fibers decreases, probably as a result of reduced levels of growth hormones and testosterone. Another normal, age-related change is that muscles slowly lose their ability to contract as quickly as they did at younger ages. In addition, older people do not regain muscle mass as quickly as younger people after

periods of inactivity, such as when recovering from illness or injury. All this being said, most older people have adequate muscle strength to attend to the tasks they need to do, and many athletes stay at high levels of functioning. However, even the most fit will notice some decline as they age.

Two types of exercise help rebuild muscle mass and strength: *resistance training*, which involves contracting muscles by lifting or pushing and holding the contraction for up to 6 seconds, and *stretching*, which lengthens muscles and increases flexibility. Stretches should be held for 5 seconds when beginning, but up to 30 seconds with increased practice. One good way to combine these two types of exercise is water aerobics, and I have used that as part of my exercise plan for many years. Stretching is much easier when the water is supporting much of your weight, and the water also provides more resistance than doing the same exercises on land. I'm lucky enough to live in south Florida and can attend the outdoor classes year-round. (But to be honest, they do heat the pool in the winter, and I stay home when the air temperature is below 60 degrees.)

2.4.2: Cardiovascular and Respiratory Systems

OBJECTIVE: Explain how the cardiovascular and respiratory systems change with age

The cardiovascular system includes the heart and its blood vessels. You may be glad to hear that the heart of an older person functions about as well as a younger person on a day-to-day basis, unless there is some disease present. The difference arises when the cardiovascular system is challenged, as happens during heavy exercise: The older heart is slow to respond to the challenge and cannot increase its function as well as a younger heart.

Another age-related change is that the walls of the arteries become thicker and less supple, so they do not adjust to changes in blood flow as well as younger arteries. This loss of elasticity can cause hypertension, or high blood pressure, which is more prevalent in older people than in younger people. Figure 2.7 shows the proportion of men and women of different ages in the United States who have been diagnosed with high blood pressure. As you can see, the proportion increases with age for both men and women, with the proportion of women being lower than men until the 45–64 age group, then similar to men until the 75+ age group, when it exceeds the proportion for men (CDC, 2016c).

The respiratory system is made up of the lungs and the muscles involved in breathing. This system weakens slightly with age, but in healthy people who don't smoke, the respiratory function is good enough to support daily activities. As with the cardiovascular system, the difference is noticed when the system is challenged, as it is with vigorous exercise or at high altitudes (Beers, 2004).

One good piece of news is that regular exercise can reduce some of the effects of aging. Exercise can make the heart stronger and lower blood pressure; well-toned muscles can aid in circulation and breathing. Aerobic exercise, which includes brisk walking, running, and bicycling, is recommended for the cardiovascular and respiratory systems.

2.4.3: Brain and Nervous System

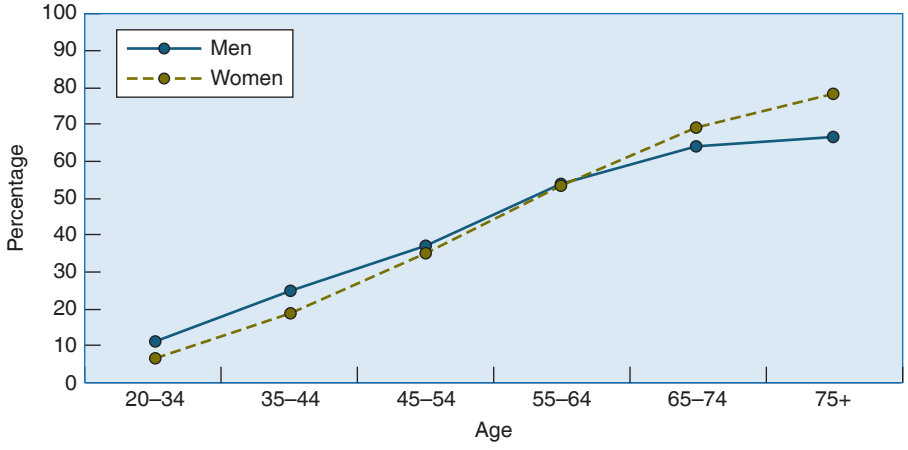
OBJECTIVE: Identify age-related changes to the nervous system

Many people believe that aging means deterioration of the brain, and research in the past seemed to support this, but more recent studies using new technology have shown that loss of **neurons**, or brain cells, in primary aging is much

Figure 2.7 Percentage of U.S. Men and Women by Age Group Who Have Been Diagnosed with High Blood Pressure

High blood pressure increases with age for both men and women.

SOURCE: CDC (2016).



less severe than once thought. Evidence now shows that the nervous system is characterized by lifelong **plasticity**, meaning that neurons are capable of making changes with age. For example, neurons form new connections with other neurons, change thresholds and response rates, and take over the functions of nearby neurons that have been damaged (Beers, 2004).

Along with neuronal loss and plasticity, the role of **neurogenesis**, which is the production of new neurons from neural stem cells, takes place throughout the adult years in two parts of the brain. One is the *dentate gyrus*, a small area of the hippocampus that is crucial for forming memories; the other is the *subventricular zone*, which is part of the lining of the cavities in the brain where cerebrospinal fluid is produced (Apple et al., 2017). **Stem cells** are immature undifferentiated cells that can multiply easily and mature into many different kinds of cells, including neurons. Although neurogenesis continues well into older adulthood, the rate at which neurons are produced slows down as we age, presumably leading to age-related cognitive loss. Researchers are trying to find ways to boost the rate of neurogenesis in the later years either by increasing stem cell production or by identifying factors that lead to the slowdown and finding ways to reduce their effects. One promising line of research is caloric restriction, which preserves the production of stem cells and new neurons in the hippocampus of aged mice (Park et al, 2013) and memory function in adult mice (Hornsby et al., 2016). A growth factor found in the blood of young mice can promote neurogenesis and improve learning and memory when injected into old mice (Valleda et al., 2014).

Molecular neurobiologists Désirée Seib and Ana Martin-Villalba (2015) recommend an alternative method for maintaining brain health – exercise. It has been demonstrated in many research studies that exercise restores cognitive functioning and physical health in human research participants with few side effects. If you add some mentally challenging tasks, the result is increased neurogenesis and brain plasticity in older adulthood.

2.4.4: Immune System

OBJECTIVE: Summarize age-related changes to the immune system

The immune system protects the body in two ways: (1) the **B cells**, produced in the bone marrow, make proteins called **antibodies**, which react to foreign organisms (such as viruses and other infectious agents), and (2) the **T cells**, produced in the thymus gland, reject and consume harmful or foreign cells, such as bacteria and transplanted organs. B cells show abnormalities with age and have been implicated in the increase of autoimmune disorders in older adults. With age, T cells show reduced ability to fight new infection. It is difficult to establish that the aging body's decreasing ability to defend itself from disease is a process of primary aging. It is possible, instead, that the immune system becomes weakened in older adulthood as chronic diseases become more prevalent and exercise and nutrition decline.

Taking nutritional supplements to boost immune function is a topic of controversy. On one side are warnings from the FDA that supplements are not intended to treat, prevent, or cure disease. On the other side are research findings that various antioxidant supplements (vitamins C, E, and others) increase immune function in lab animals (Catoni et al., 2008) and the nutritional supplement manufacturers, who claim that their products will prevent (and reverse) many aspects of primary aging. My personal conclusion is that that unless your physician tells you otherwise, middle-aged adults (and younger adults) with relatively healthy diets and lifestyles don't need to take vitamin supplements. For older adults, especially those with appetite loss or who don't get outdoors much, a daily multivitamin may help and can't hurt—except for the cost (Porter, 2009).

2.4.5: Hormonal System

OBJECTIVE: Differentiate how hormone changes affect males and females

Both men and women experience changes in their hormonal systems over the course of adult life, beginning around the age of 30. Growth hormone decreases with age, reducing muscle mass. *Aldosterone* production decreases, leaving some older adults prone to dehydration and heatstroke when summer temperatures soar. However, as with many other aspects of primary aging, most of these changes are not noticeable until late adulthood (Halter, 2011). One more obvious change is the reduction of hormones that results in loss of reproductive ability, a time of life known as the **climacteric**. The climacteric takes place gradually for men over middle and late adulthood and more abruptly for women around the late 40s and early 50s.

Climacteric in Men and Women

The Climacteric in Men—Research on healthy adults suggests that the quantity of viable sperm produced begins to decline in a man's 40s, but the decline is not rapid, and there are documented cases of men in their 80s fathering children. The testes shrink gradually, and after about age 60, the volume of seminal fluid begins to decline. These changes are associated in part with testicular failure and the resulting gradual decline in **testosterone**, the major male hormone, beginning in early adulthood and extending into old age (Fabbri et al., 2016). Declining hormone levels in men are also associated with decreases in muscle mass, bone density, sexual desire, and cognitive functions and with increases in body fat and depressive symptoms (Almeida et al., 2004).