Essentials of Life-Span Development

FIFTH EDITION

John W. Santrock

University of Texas at Dallas

Mc Graw Hill Education

ESSENTIALS OF LIFE-SPAN DEVELOPMENT, FIFTH EDITION

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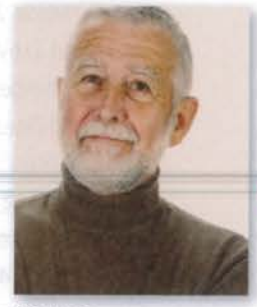
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How Would You?

Psychology Professions

Education Professions

Social Work Professions

Health Care Professions

Family Studies Professions

About the Author

John W. Santrock

John Santrock received his Ph.D. from the University of Minnesota in 1973. He taught at the University of Charleston and the University of Georgia before joining the Program in Psychology and Human Development at the University of Texas at Dallas, where he currently teaches a number of undergraduate courses and recently was given the University's Effective Teaching Award. In 2010, he created the UT-Dallas Santrock undergraduate scholarship, an annual award that is given to outstanding undergraduate students majoring in developmental psychology to enable them to attend research conventions.

John Santrock (back row middle) with the 2015 recipients of the Santrock Travel Scholarship Award in developmental psychology. Created by Dr. Santrock, this annual award provides undergraduate students with the opportunity to attend a professional meeting. A number of the students shown here attended the Society for Research in Child Development conference.

John has been a member of the editorial boards of *Child Development* and *Developmental Psychology*. His research on the multiple factors involved in how divorce affects children's development is widely cited and used in expert witness testimony to promote flexibility and alternative considerations in custody disputes.

John also has authored these exceptional McGraw-Hill texts: *Children* (13th edition), *Adolescence* (16th edition), *Life-Span Development* (16th edition), *A Topical Approach to Life-Span Development* (8th edition), and *Educational Psychology* (6th edition).

For many years, John was involved in tennis as a player, teaching professional, and coach of professional tennis players. At the University of Miami (FL), the tennis team on which he played still holds the NCAA Division I record for most consecutive wins (137) in any sport. His wife, Mary Jo, has a master's degree in special education and has worked as a teacher and a realtor. He has two daughters, Tracy and Jennifer, who are both realtors. Tracy has run the Boston and New York marathons. Jennifer is a former professional tennis player and NCAA tennis player of the year. John has one granddaughter, Jordan, age 25, who works at Ernst & Young accounting firm, and two grandsons, Alex, age 12, and Luke, age 10. In the last two decades, John also has spent time painting expressionist art.

Dedication:

With special appreciation to my wife, Mary Jo.

Connecting *research* and *results*

As a master teacher, John Santrock connects current research and real-world applications. Through an integrated, personalized digital learning program, students gain the insight they need to study smarter and improve performance.

McGraw-Hill Education Connect is a digital assignment and assessment platform that strengthens the link between faculty, students, and course work, helping everyone accomplish more in less time. Connect Psychology includes assignable and assessable videos, quizzes, exercises, and interactivities, all associated with learning objectives. Interactive assignments and videos allow students to experience and apply their understanding of psychology to the world with fun and stimulating activities.

Mc Graw Hill Education connect®

Learn, Apply, Reflect

At the higher end of Bloom's taxonomy (analyze, evaluate, create), students can learn, apply, and reflect through McGraw-Hill Education's *Quest: Psychology* now available for lifespan development, which takes them on an engaging journey through the lifespan where they are in the center of the action. Using a game-like learning environment based on real-life situations and points of view, including those of guidance counselors, health-care professionals, and parents, students collect clues and make decisions to see how their choices affect outcomes. The purpose-driven approach not only helps students build their critical thinking skills using core concepts and related research, but also answers the age-old question of "why does this matter for me?" These modules are assignable and assessable within Connect Psychology, to track student performance.

Real People, Real World, Real Life

Also at the higher end of Bloom's taxonomy, the McGraw-Hill Education Milestones video series is an observational tool that allows students to experience life as it unfolds, from infancy to late adulthood. This groundbreaking, longitudinal video series tracks the development of real children as they progress through the early stages of physical, social, and emotional development in their first few weeks, months, and years of life. Assignable and assessable within Connect Psychology, Milestones also includes interviews with adolescents and adults to reflect development throughout the entire lifespan.

Inform and Engage on Psychological Concepts

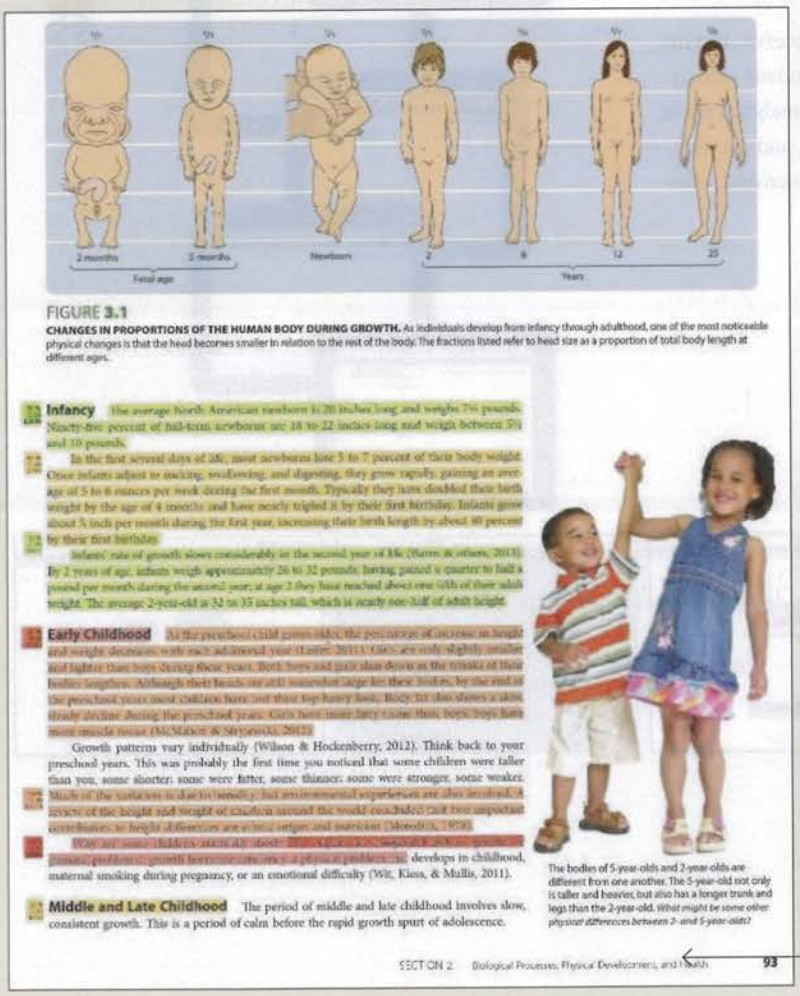
At the lower end of Bloom's taxonomy, students are introduced to Concept Clips—the dynamic, colorful graphics and stimulating animations that break down some of psychology's most difficult concepts in a step-by-step manner, engaging students and aiding in retention. They are assignable and assessable in Connect or can be used as a jumping-off point in class. Now with audio narration, the Fifth Edition also includes new Concept Clips on topics such as object permanence and conservation, as well as theories and theorists like Bandura's social cognitive theory, Vygotsky's sociocultural theory, Buss's evolutionary theory, and Kuhl's language development theory.

Better Data, Smarter Revision, Improved Results

Students helped inform the revision strategy of *Essentials of Life-Span Development.*

McGraw-Hill Education's Smartbook is the first and only adaptive reading and learning experience! SmartBook helps students distinguish the concepts they know from the concepts they don't, while pinpointing the concepts they are about to forget. SmartBook continuously adapts to create a truly personalized learning path. SmartBook's real-time reports help both students and instructors identify the concepts that require more attention, making study sessions and class time more efficient.

SMARTBOOK®



Informed by Students

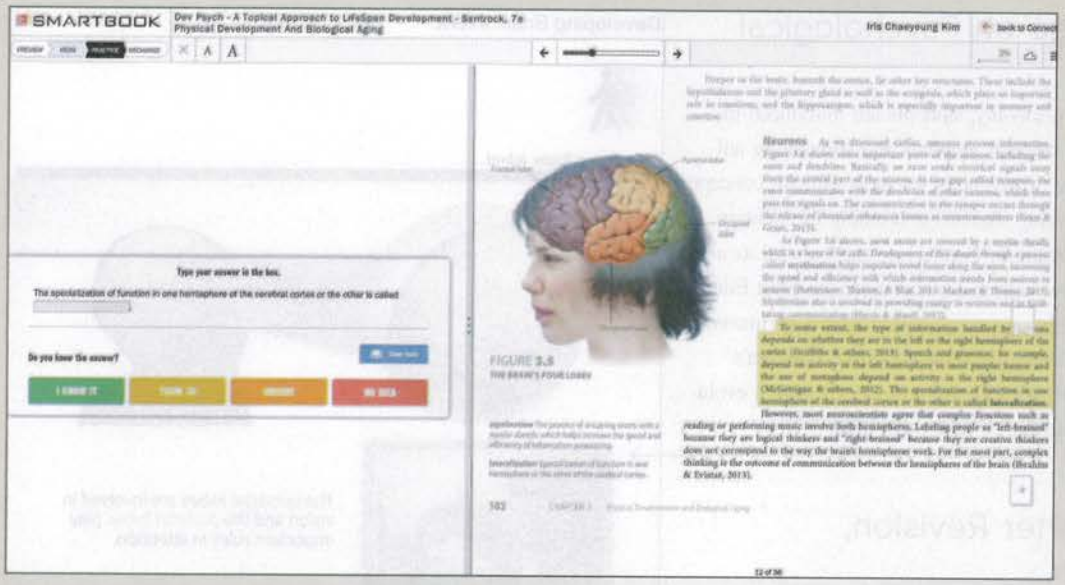
Content revisions are informed by data collected anonymously through McGraw-Hill Education's SmartBook.

STEP 1. Over the course of three years, data points showing concepts that caused students the most difficulty were anonymously collected from Connect for *Essentials of Life-Span Development* SmartBook®.

STEP 2. The data from LearnSmart was provided to the author in the form of a ***Heat Map***, which graphically illustrates "hot spots" in the content that affect student learning (see image at left).

STEP 3. The author used the ***Heat Map*** data to refine the content and reinforce student comprehension in the new edition. Additional quiz questions and assignable activities were created for use in Connect to further support student success.

RESULT: Because the ***Heat Map*** gave the author empirically based feedback at the paragraph and even sentence level, he was able to develop the new edition using precise student data that pinpointed concepts that gave students the most difficulty.



Personalized Grading, On the Go, At a Glance

Connect Insight™ is a one-of-kind visual analytics dashboard—now available for both instructors and students—that provides at-a-glance information regarding student performance. The immediate analysis from Connect Insight empowers students and helps instructors improve class performance efficiently and effectively.

- **Make It Intuitive.** Instructors and students receive instant, at-a-glance views of performance matched with student activity.
- **Make It Dynamic.** Connect Insight puts real-time analytics in the user's hands for a just-in-time approach to teaching and learning.
- **Make It Mobile.** Connect Insight is available on demand wherever and whenever needed.

The Essential Approach to Life-Span Development

In the view of many instructors who teach the lifespan development course, the biggest challenge they face is covering all periods of human development within one academic term. My own teaching experience bears this out. I have had to skip over much of the material in a comprehensive lifespan development text in order to focus on key topics and concepts that students find difficult and to fit in applications that are relevant to students' lives. I wrote *Essentials of Life-Span Development* to respond to the need for a shorter text that covers core content in a way that is meaningful to diverse students.

This fifth edition continues my commitment to provide a brief introduction to lifespan development—with an exciting difference. Recognizing that most of today's students have grown up in a digital world, I take very seriously the need for communicating content in different ways, online as well as in print. Consequently, I'm enthusiastic about McGraw-Hill's online assignment and assessment platform, **Connect for Life-Span Development,** which incorporates this text, the captivating **Milestones** video modules, and the brand new game-based learning assignment, ***Quest: Psychology.*** Together, these resources give students and instructors the essential coverage, applications, and course tools they need to tailor the lifespan course to meet their specific needs.

The Essential Teaching and Learning Environment

Research shows that students today learn in multiple modalities. Not only do their work preferences tend to be more visual and more interactive, but also their reading and study sessions often occur in short bursts. With shorter chapters and innovative interactive study modules, *Essentials of Life-Span Development* allows students to study whenever, wherever, and however they choose. Regardless of individual study habits, preparation, and approaches to the course, *Essentials* connects with students on a personal, individual basis and provides a road map for success in the course.

Essential Coverage

The challenge in writing *Essentials of Life-Span Development* was determining what comprises the core content of the course. With the help of consultants and instructors who have responded to surveys and reviewed the content at different stages of development, I am able to present all of the core topics, key ideas, and most important research in lifespan development that students need to know in a brief format that stands on its own merits.

The 17 brief chapters of *Essentials* are organized chronologically and cover all periods of the human lifespan, from the prenatal period through late adulthood and death. Providing a broad overview of lifespan development, this text especially gives attention to the theories and concepts that students seem to have difficulty mastering.

Essential Applications

Applied examples give students a sense that the field of lifespan development has personal meaning for them. In this edition of *Essentials* are numerous real-life applications as well as research applications for each period of the lifespan.

In addition to applied examples, *Essentials of Life-Span Development* offers applications for students in a variety of majors and career paths.

- *How Would You . . . ?* questions. Given that students enrolled in the lifespan course have diverse majors, *Essentials* includes applications that appeal to different interests. The most prevalent areas of specialization are education, human development and family studies, health professions, psychology, and social work. To engage these students and ensure that *Essentials* orients them to concepts that are key to their understanding of lifespan development, instructors specializing in these fields contributed *How Would You . . . ?* questions for each chapter. Strategically placed in the margin next to relevant topics, these questions highlight the essential takeaway ideas for these students.
- *Careers in Life-Span Development.* This feature personalizes lifespan development by describing an individual working in a career related to the chapter's focus. One example is Holly Ishmael, a genetic counselor. The feature describes Ms. Ishmael's education and work setting, includes a direct quote from Ms. Ishmael, discusses various employment options for genetic counselors, and provides resources for students who want to find out more about careers in genetic counseling.

Essential Resources

The following resources accompany *Essentials of Life-Span Development*, 5th edition. Please contact your McGraw-Hill representative for details concerning the availability of these and other valuable materials that can help you design and enhance your course.

- Instructor's Manual
- Test Bank
- PowerPoint Slides

Content Revisions

As an indication of the up-to-date nature of this new edition, the text has more than 1,500 citations from 2014, 2015, and 2016. Following are many of the chapter-by-chapter changes that were made in this new edition of *Essentials of Life-Span Development*.

Chapter 1: Introduction

- Update on life expectancy in the United States (U.S. Census Bureau, 2015)
- Expanded coverage of the effects of the rapid and dramatic increase in life expectancy on society and on the quality of life for older adults, with commentary about how society has essentially been built for young people rather than older adults and what is needed to improve the lives of older people (Carstensen, 2015, 2016)
- Updated statistics on the percentage of U.S. children and adolescents under 18 years of age living in poverty, including data reported separately for African American and Latino families (DeNavas-Walt & Proctor, 2015)
- Description of recent research that found a higher level of conscientiousness was protective of older adults' cognitive functioning (Wilson & others, 2015)
- Inclusion of recent research on individuals from 22 to 93 years of age that found older adults reported having more positive emotional experiences than did young adults (English & Carstensen, 2014)
- Inclusion of recent information from studies on variations in age and well-being, including variations involving middle age and health (OECD, 2014; Steptoe, Deaton, & Stone, 2015)
- New section, "Three Developmental Patterns of Aging," that describes the pathways of normal aging, pathological aging, and successful aging (Schaie, 2016)
- New coverage of the distinction between the evaluative and hedonic aspects of well-being, and how these different aspects produce different life course trajectories (Lachman, Teshale, & Agrigoroaei, 2015)
- Expanded discussion of physiological measures to include cortisol and its use by researchers to assess stress (Jacoby & others, 2016)
- Coverage of a recent study in which older adults assessed in 2013–2014 engaged in a higher level of abstract reasoning than their counterparts who were assessed two decades earlier (Gerstorf & others, 2015)
- Inclusion of findings that cross-sectional studies indicate that 90 percent of cognitive aging decline is due to a slowing of processing speed while longitudinal studies reveal that 20 percent or less of cognitive aging decline is due to processing speed (MacDonald & Stawski, 2015, 2016)

Chapter 2: Biological Beginnings

- Editing and updating of chapter based on comments by leading expert David Moore
- Updated and expanded discussion of genome-wide association studies, including research on suicide (Sokolowski, Wasserman, & Wasserman, 2016) and glaucoma (Bailey & others, 2016)
- New description of recent research on how exercise and nutrition can modify the behavior of genes (Lindholm & others, 2014; Ma & others, 2015)
- New content on how sleep deprivation can influence gene expression in negative ways such as increased inflammation, expression of stress-related genes, and impairment of protein functioning (Da Costa Souza & Ribeiro, 2015)
- Update on the percentage of individuals who have Klinefelter syndrome (1 in 1000 males)
- New content on fertility drugs being more likely to produce multiple births than in vitro fertilization (March of Dimes, 2016)
- Coverage of a recent large-scale study in Brazil in which flour that was fortified with folic acid produced a significant reduction in neural tube defects (Santos & others, 2016)
- Description of a recent research review that concluded many aspects of the developing prenatal brain can be detected in the first trimester using ultrasound, which also can help to identify spina bifida early (Engels & others, 2016)
- Inclusion of information from a recent review that concluded fetal MRI does not provide good results in the first trimester of pregnancy because of small fetal structures and movement artifacts (Wataganara & others, 2016). In this review, it also was argued that fetal MRI can especially be beneficial in assessing central nervous system abnormalities in the third trimester of pregnancy.
- Discussion of recent research that found isotretinoin (used to treat acne) is one of the most commonly prescribed drugs for adolescent girls seeking contraceptive advice, yet girls do not receive adequate information about its harmful effects on offspring if they become pregnant (Eltonsy & others, 2016; Stancil & others, 2016)
- Coverage of recent research on negative outcomes for fetal alcohol spectrum disorders (FASD) that include a lower level of executive function (Kingdon, Cardoso, & McGrath, 2016), externalized and internalized behavior problems (Tsang & others, 2016), and a significantly lower life expectancy (Thanh & Johnsson, 2016)
- Inclusion of recent research indicating that maternal cigarette smoking during pregnancy was linked to increased risk of smoking by offspring at 16 years of age (De Genna & others, 2016)
- Discussion of a recent study that found simultaneous exposure to environmental tobacco smoke and alcohol

during pregnancy increased the offspring's risk of having ADHD (Suter & others, 2015)

- Description of a recent study that revealed maternal smoking during pregnancy was associated with increased risk of asthma and wheezing in adolescence (Hollams & others, 2014)
- Discussion of recent research indicating that cocaine use by pregnant women is linked to attention deficit hyperactivity disorder, oppositional defiant disorder, and posttraumatic stress disorder (PTSD) in offspring (Richardson & others, 2016)
- Coverage of a recent meta-analysis that found marijuana use during pregnancy was associated with low birth weight in offspring and an increased likelihood of being placed in a neonatal intensive care unit (Gunn & others, 2016)
- Inclusion of two recent research reviews that concluded maternal obesity during pregnancy is associated with an increased likelihood of offspring becoming obese in childhood and adulthood (Pinto Pereira & others, 2016; Santangeli, Sattar, & Huda, 2015)
- Coverage of the recent increase in e-cigarette use, including a survey that found pregnant women hold misconceptions about e-cigarettes (Mark & others, 2015)
- Description of a recent study in which at 14 weeks following conception fetuses of obese pregnant women had less efficient cardiovascular functioning (Ingul & others, 2016)
- Inclusion of a recent research review indicating that pregestational diabetes increases the risk of fetal heart disease (Pauliks, 2015)
- Coverage of a recent study that found maternal pregnancy diabetes was linked to an increased risk of fatty liver disease in offspring at 18 years of age (Patel & others, 2016)
- Description of recent research in which maternal pregnancy diabetes was associated with an increased risk of autism in offspring (Xiang & others, 2015)
- Discussion of a recent study in China that revealed folic acid supplementation during pregnancy decreased the risk of preterm birth (Liu & others, 2015)
- Revised content on fish consumption by pregnant women, who are now being advised to increase their fish consumption, especially low-mercury fish such as salmon, shrimp, tilapia, and cod (American Pregnancy Association, 2016; Federal Drug Administration, 2016)
- Coverage of two recent studies that found very advanced maternal age (40 years and older) was linked to negative perinatal outcomes, including spontaneous abortion, preterm birth, stillbirth, and fetal growth restriction (Traisrislip & Tongsong, 2015; Waldenstrom & others, 2015)
- Inclusion of a recent research review that found antidepressant use by pregnant women is linked to small increased risks of cardiac malfunctions in the fetus and persistent pulmonary hypertension in the newborn (Pearlstein, 2015), increased risk of miscarriage (Almeida & others, 2016), and increased risk of autism spectrum disorders in children (Boukhris & others, 2016)
- Coverage of recent research that has found increasing paternal age decreases the success rate of in vitro fertilization and increases the risk of preterm birth (Sharma & others, 2015)
- New discussion of how the father's relationship with the mother might influence the mother's health and well-being and contribute to positive or negative prenatal development and birth
- Inclusion of a recent study that found intimate partner violence increased the mother's stress level (Fonseca-Machado Mde & others, 2015)
- Description of recent research in which CenteringPregnancy participation was linked to reduced incidence of low birth weight and reduced likelihood of placement in a neonatal intensive care unit (Gareau & others, 2016)
- Coverage of a recent study of adolescent mothers in which the CenteringPregnancy program was successful in getting participants to attend meetings, have appropriate weight gain, increase the use of highly effective contraceptive methods, and increase breast feeding (Trotman & others, 2015)
- Discussion of a recent research review in which waterbirth neonates experienced fewer negative outcomes than non-waterbirth neonates (Bovbjerg, Cheyney, & Everson, 2016)
- Description of a recent research review that concluded waterbirth is associated with high levels of maternal satisfaction with pain relief and the experience of childbirth (Nutter & others, 2015)
- Discussion of a recent study in which acupuncture reduced labor pain 30 minutes after the intervention (Allameh, Tehrani, & Ghasemi, 2015)
- Coverage of recent studies that have found low Apgar scores are linked to long-term additional educational support needs and decreased educational attainment (Tweed & others, 2016), risk of developmental vulnerability at 5 years of age (Razaz & others, 2016), and risk of developing ADHD (Hanc & others, 2016)
- Update on the percentage of U.S. births that take place in hospitals, at home, and in birthing centers and the percentage of babies born through caesarean delivery (Martin & others, 2015)
- Updated statistics on the percentage of babies born preterm and low birth weight in the United States, including ethnic variations (Martin & others, 2015)
- Inclusion of information about a recent study in which kangaroo care and massage therapy were equally effective in improving body weight and reducing hospital stay for low birth weight infants (Rangey & Sheth, 2015)
- Description of a recent study that found kangaroo care significantly reduced the amount of crying and increased heart rate stability in preterm infants (Choudhary & others, 2016)

- Coverage of a recent study in Great Britain in which the use of kangaroo care in neonatal units resulted in substantial cost savings mainly because of its reductions in diseases such as gastroenteritis and colitis (Lowson & others, 2016)
- Inclusion of a recent study in which massage therapy improved the scores of HIV-exposed infants on both physical and mental scales, as well as improving their hearing and speech (Perez & others, 2015)
- Discussion of a recent study in which depressive symptoms in both the mother and father were associated with impaired bonding with their infant in the postpartum period (Kerstis & others, 2016)

Chapter 3: Physical and Cognitive Development in Infancy

- New description indicating that neuronal connections number in the trillions (de Haan, 2015)
- Coverage of a recent study that found higher-quality mother-infant interaction predicted a higher level of frontal lobe functioning when assessed by EEG later in infancy (Bernier, Calkins, & Bell, 2016)
- New discussion of the recent increase in the use of functional near-infrared spectroscopy to assess infants' brain activity through a device that is portable and allows researchers to monitor infants' brain activity while they are exploring the world around them (Brigadoi & Cooper, 2015; de Haan & Johnson, 2016; Ravicz & others, 2015). Also, inclusion of new Figure 3 that shows an infant in an experiment using near-infrared spectroscopy.
- New commentary that after prone sleeping position, the two most critical factors in predicting SIDS are (1) maternal smoking, and (2) bed sharing (Mitchell & Krous, 2015)
- Coverage of three recent studies that found sleep difficulties in infancy were linked to later developmental problems in attention (Geva, Yaron, & Kuint, 2016; Sadeh & others, 2015) and emotional dysfunction (Geva, Yaron, & Kuint, 2016)
- Updated data on the continuing increase in breast feeding by U.S. mothers (Centers for Disease Control and Prevention, 2014)
- Description of a recent Danish study that found breast feeding did not protect against allergic sensitization in early childhood and allergy-related diseases at 7 years of age (Jelding-Dannemand, Malby Schoos, & Bisgaard, 2015)
- Coverage of a recent large-scale study of more than 500,000 Scottish children in which those who were exclusively breast fed at 6 to 8 weeks were less likely to ever have been hospitalized through early childhood than their formula-fed counterparts (Ajetunmobi & others, 2015)
- Inclusion of recent research that found breast feeding was associated with a small increase in intelligence in children (Kanazawa, 2015)
- New discussion of how walking skills might produce a developmental cascade of changes in infancy, including increases in language skills (Adolph & Robinson, 2015; He, Walle, & Campo, 2015)
- Description of recent studies that indicated short-term training involving practice of reaching movements increased both preterm and full-term infants' reaching for and touching objects (Cunha & others, 2015; Guimaraes & Tudelia, 2015)
- Coverage of a recent study in which 3-month-olds who had regular gentle tactile stimulation when they were fetuses were more likely to have an easy temperament than their counterparts who experienced irregular gentle or no gentle tactile stimulation as fetuses (Wang, Hua, & Xu, 2015)
- Inclusion of recent research in which kangaroo care was effective in reducing neonatal pain (Seo, Lee, & Ahn, 2016)
- Coverage of recent research that revealed problems in joint attention as early as 8 months of age were linked to diagnosis of autism by 7 years of age (Veness & others, 2014)
- A recent study that found infants who initiated joint attention at 14 months of age had higher executive function at 18 months of age (Miller & Marcovitch, 2015)
- Discussion of recent research on when infantile amnesia begins to occur by Patricia Bauer and her colleagues (Bauer, 2015; Bauer & Larkina, 2015; Pathman, Doydum, & Bauer, 2015). In a recent study, by 8 to 9 years of age, children's memory of events that occurred at 3 years of age began to significantly fade away (Bauer & Larkina, 2014).
- New discussion of Patricia Kuhl's (2015) findings that a baby's brain is most open to learning the sounds of a native language beginning at 6 months for vowels and at 9 months for consonants
- Description of recent research in which vocabulary development from 16 to 24 months of age was linked to vocabulary, phonological awareness, reading accuracy, and reading comprehension five years later (Duff & others, 2015)
- Discussion of a recent study of toddlers in which frequent TV exposure increased the risk of delayed language development (Lin & others, 2015)
- Coverage of a recent study that found Skype provides some improvement in children's language learning over television and videos (Roseberry & others, 2014)

Chapter 4: Socioemotional Development in Infancy

- Revisions in chapter based on feedback from leading experts John Bates and Ross Thompson
- Coverage of recent research indicating that smiling and laughter at 7 months of age was associated with self-regulation at 7 years of age (Posner & others, 2014)

- Inclusion of a recent study in which mothers were more likely than fathers to use soothing techniques to reduce infant crying (Dayton & others, 2015)
- New discussion of describing infant temperament in terms of reactivity and self-regulation (Bates & Pettit, 2015)
- Revised description of the temperament category of extraversion/surgency
- Description of recent research that found an inhibited temperament at 2 to 3 years of age was related to social-phobia-related symptoms at 7 years of age (Lahat & others, 2014)
- Inclusion of recent findings indicating that an inhibited temperament in infants and young children is linked to the development of social anxiety disorder in adolescence and adulthood (Rapee, 2014; Perez-Edgar & Guyer, 2014)
- New research that revealed effortful control was a strong predictor of academic success skills in kindergarten children from low-income families (Morris & others, 2014)
- New discussion of the recent interest in the *differential susceptibility* and *biological sensitivity to context* models that emphasize certain characteristics—such as a difficult temperament—may render children more vulnerable to difficulty in adverse contexts but also make them more likely to experience optimal growth in very supportive conditions (Belsky & others, 2015; Belsky & Pluess, 2016; Simpson & Belsky, 2016)
- New commentary about recent advances in infants' understanding of others (Rhodes & others, 2015), including research indicating that infants as young as 13 months of age seem to consider another's perspective when predicting their actions (Choi & Luo, 2015)
- Inclusion of recent research in which infant attachment insecurity (especially insecure resistant attachment) and early childhood behavioral inhibition predicted adolescent social anxiety symptoms (Lewis-Morrarty & others, 2015)
- Discussion of a recent study in dual-earner couples that found women did more than 2 hours of additional work compared with 40 minutes more for men after the birth of their child (Yavorsky & others, 2015)
- Description of a recent national poll that estimated there are 2 million stay-at-home dads in the United States, a significant increase from 1.6 million in 2004 and 1.1 million in 1989 (Livingston, 2014)
- Coverage of a recent study in which both paternal and maternal sensitivity assessed when the infant was 10 to 12 months old were linked to the child's cognitive development at 18 months of age and the child's language development at 36 months (Malmburg & others, 2016)
- Added commentary that infants and toddlers are more likely to be found in family child care and informal care settings while older children are more likely to be in child care centers and preschool and early education programs
- Description of a recent Australian study in which higher-quality child care at 2 to 3 years of age was linked to children's better self-regulation of attention and emotion at 4 to 5 and 6 to 7 years of age (Gialamas & others, 2014)

Chapter 5: Physical and Cognitive Development in Early Childhood

- Coverage of a recent study in which young children with higher cognitive ability showed increased myelination by 3 years of age (Deoni & others, 2016)
- Inclusion of recent research on how poverty is linked to maturational lags in children's frontal and temporal lobes that in turn were associated with lower school readiness skills (Meyer & others, 2015)
- Description of a recent study that revealed higher levels of maternal sensitivity in early childhood were related to higher total brain volume in children (Kok & others, 2015)
- Discussion of a recent study in which viewing as little as one hour of television daily was associated with an increase in body mass index (BMI) between kindergarten and the first grade (Peck & others, 2015)
- Coverage of recent research indicating that in longitudinal studies, when mothers participated in prenatal and early childhood WIC programs, young children showed short-term cognitive benefits and longer-term reading and math benefits (Jackson, 2015)
- Recent description by expert panels from Australia, Canada, the United Kingdom, and the United States that were remarkably similar in recommending that young children get an average of 15 or more minutes of physical activity per hour over a 12-hour period, or about 3 hours total activity per day (Pate & others, 2015)
- Coverage of recent research in which 60 minutes of physical activity per day in preschool academic contexts improved young children's early literacy (Kirk & Kirk, 2016)
- Inclusion of recent research in which myelination in a number of brain areas was linked to young children's processing speed (Chevalier & others, 2015)
- Discussion of recent research that found preschool sustained attention was linked to a greater likelihood of completing college by 25 years of age (McClelland & others, 2013)
- Coverage of a recent study of young children that found executive function was associated with emergent literacy and vocabulary development (Becker & others, 2014)
- Description of recent research in which executive function at 3 years of age predicted theory of mind at 4 years of age and executive function at 4 years of age predicted theory of mind at 5 years of age, but the reverse did not occur—theory of mind at earlier ages did not predict executive function at later ages (Marcovitch & others, 2015)

- New coverage of developmental changes in executive function in early childhood, including recent research on executive function and school readiness (Willoughby & others, 2016)
- Inclusion of research in which secure attachment to mothers during the toddler years was linked to a higher level of executive function at 5 to 6 years of age (Bernier & others, 2015)
- Discussion of a recent observational study that found a higher level of control by fathers predicted a lower level of executive function in 3-year-olds (Meuwissen & Carlson, 2016)
- Coverage of recent research in which experiencing peer problems in early childhood was linked to lower executive function later in childhood (Holmes, Kim-Spoon, & Deater-Deckard, 2016)
- Expanded and updated coverage of factors that influence children's theory of mind development: prefrontal cortex functioning (Powers, Chavez, & Hetherington, 2016) and various aspects of social interaction (Hughes & Devine, 2015), including secure attachment and mental state talk, and having older siblings and friends who engage in mental state talk
- Description of two recent studies that confirmed the importance of improved parenting engagement and skills in the success of Head Start programs (Ansari & Gershoff, 2016; Roggman & others, 2016)

Chapter 6: Socioemotional Development in Early Childhood

- Some changes made in chapter based on feedback from leading expert Jennifer Lansford
- Expanded coverage of the importance of emotion regulation in childhood and links between emotion regulation and executive function (Calkins & Perry, 2016; Durlak, Comitrovich, & Gullotta, 2015; Griffin, Freund, & McCardle, 2015)
- Description of recent research in which young children with authoritative parents were less likely to be obese than their counterparts with authoritarian parents (Kakinami & others, 2015)
- Inclusion of new information that physical punishment is outlawed in 41 countries (Committee on Rights of the Child, 2014)
- New content on the correlational nature of research on punishment, as well as bidirectional, reciprocal socialization influences that take into account child characteristics and problems (Laible, Thompson, & Froimson, 2015; Sheehan & Watson, 2008)
- Coverage of a recent study in which unmarried African American parents who were instructed in coparenting techniques during the prenatal period and also one month after the baby was born had better rapport, communication, and problem-solving skills when the baby was 3 months old (McHale, Salman-Engin, & Covert, 2015)
- Updated data on the number of U.S. children who were victims of child maltreatment in 2013 (U.S. Department of Health and Human Services, 2015)
- Discussion of a recent study in which individuals who had experienced their parents' divorce were more at risk for engaging in a lifetime suicide attempt (Alonzo & others, 2015)
- Inclusion of a 30-year longitudinal study that found offspring of parents who engaged in child maltreatment and neglect are at increased risk for engaging in child neglect and sexual maltreatment themselves (Widom, Czaja, & Dumont, 2015)
- Description of recent research on almost 3,000 adolescents that revealed a negative association of the father's, but not the mother's, unemployment on the adolescents' health (Bacikov-Sleskova, Benka, & Orosova, 2015)
- Coverage of recent research indicating that enriched work-family experiences were positively linked to better parenting quality, which in turn was associated with better child outcomes; by contrast, conflicting work-family experiences were related to poorer parenting quality, which in turn was linked to more negative child outcomes (Viera & others, 2016)
- Inclusion of recent research in which children were more likely to have behavior problems if their post-divorce environment was less supportive and stimulating, their mother was less sensitive and more depressed, and their household income was lower (Weaver & Schofield, 2015). Also in this study, higher levels of predivorce maternal sensitivity and child IQ served as protective factors in reducing child problems after the divorce.
- Inclusion of recent research in which maladaptive marital conflict when children were 2 years old was associated with an increase in internalizing problems eight years later due to an undermining of attachment security in girls, while negative emotional aftermath of conflict increased both boys' and girls' internalizing problems (Brock & Kochanska, 2016)
- Coverage of a longitudinal study that revealed parental divorce experienced prior to 7 years of age was linked to a lower level of the children's health through 50 years of age (Thomas & Hognas, 2015)
- Description of recent research on non-residential fathers in divorced families that linked high father-child involvement and low interparental conflict to positive child outcomes (Flam & others, 2016)
- Discussion of a recent study that found co-parenting following divorce was positively associated with better mental health and higher self-esteem and academic achievement (Lamela & Figueiredo, 2016)
- Inclusion of a recent research review that concluded higher screen time was associated with a lower level of cognitive development in early childhood (Carson & others, 2015)
- Description of a study that found parental reduction in their own screen time was associated with a decrease in child screen time (Xu, Wen, & Rissel, 2014)

- Inclusion of recent research on children in which higher viewing of TV violence, video game violence, and music video violence was independently associated with a higher level of physical aggression (Coker & others, 2015)
- New coverage of recommendations by Kathy Hirsh-Pasek and her colleagues (2015) that the best educational applications (apps) for young children are characterized by active involvement, engagement, meaningfulness, and social interaction

Chapter 7: Physical and Cognitive Development in Middle and Late Childhood

- Inclusion of a recent Chinese study that found higher blood pressure in 23 percent of boys and 15 percent of girls was attributable to being overweight or obese (Dong & others, 2015)
- Description of a 14-year longitudinal study in which parental weight gain predicted children's weight change (Andriani, Liao, & Kuo, 2015)
- Coverage of a study that found both a larger waist circumference and a higher body mass index (BMI) combined to place children at higher risk for developing cardiovascular disease (de Koning & others, 2015)
- Discussion of a recent study of elementary school children that revealed 55 minutes or more of daily moderate-to-vigorous physical activity was associated with a lower incidence of obesity (Nemet, 2016)
- Updated statistics on the percentage of U.S. children who have ever been diagnosed with ADHD (American Psychiatric Association, 2013; Centers for Disease Control and Prevention, 2016)
- New research that revealed the dopamine transporter gene DAT 1 was involved in decreased cortical thickness in the prefrontal cortex of children with ADHD (Fernandez-Jaen & others, 2015)
- Inclusion of recent research in which a higher physical activity level in adolescence was linked to a lower level of ADHD in emerging adulthood (Rommel & others, 2015)
- Description of a recent meta-analysis that concluded short-term aerobic exercise is effective in reducing symptoms such as inattention, hyperactivity, and impulsivity (Cerillo-Urbina & others, 2015)
- Coverage of a recent meta-analysis in which exercise was associated with better executive function in children with ADHD (Vysniauske & others, 2016)
- Discussion of a recent meta-analysis in which mindfulness training significantly improved the attention of children with ADHD (Cairncross & Miller, 2016)
- Updated data on the increasing percentage of children diagnosed with autism spectrum disorder (Centers for Disease Control and Prevention, 2016)
- Update on the percentage of children with a disability who spend time in a regular classroom (*Condition of Education*, 2015)
- Expanded and updated coverage of Alan Baddeley's important concept of working memory, including coverage of its link to improving many aspects of children's cognitive and academic development (Gerst & others, 2016; Peng & Fuchs, 2016)
- Discussion of a recent study in which a social and emotional learning program focused on mindfulness and caring for others was effective in improving a number of cognitive processes in fourth- and fifth-grade students, including mindfulness and cognitive control (Schonert-Reichl & others, 2015)
- Expansion of the activities that improve executive function to include scaffolding of self-regulation (Bodrova & Leong, 2015)
- Coverage of recent research in which mindfulness training improved children's attention and self-regulation (Poehlmann-Tynan & others, 2016), achievement (Singh & others, 2016), and coping strategies in stressful situations (Dariotis & others, 2016)
- Updated description of the most recent editions of the various Wechsler intelligence scales
- Description of a recent meta-analysis that revealed a correlation of +.54 between intelligence and school grades (Roth & others, 2015)
- Description of a recent study using Stanford-Binet intelligence scales that found no differences between non-Latino White and African American preschool children when they were matched for age, gender, and level of parent education (Dale & others, 2014)
- Coverage of a recent analysis that concluded the underrepresentation of African Americans in STEM subjects and careers is linked to practitioners' expectations that they have less innate talent than non-Latino Whites (Leslie & others, 2015)
- New description of how children who are gifted excel in various aspects of processing information (Ambrose & Sternberg, 2016a)
- Discussion of a recent study that revealed parents and teachers rated elementary school children who are not gifted as having more emotional and behavioral problems than children who are gifted (Eklund & others, 2015)
- Inclusion of some changes in the coverage of language development based on recommendations by leading expert Mandy McGuire
- Revised and updated content on bilingualism, including information about whether parents of infants and young children should teach them two languages simultaneously (Bialystok, 2014, 2015)
- New description of the rate at which bilingual and monolingual children learn language(s) (Hoff, 2016) and inclusion of a recent study that found by 4 years of age children who continued to learn both Spanish and English had a total vocabulary growth that was greater than that of monolingual children (Hoff & others, 2014)

Chapter 8: Socioemotional Development in Middle and Late Childhood

- Description of a recent study that found narcissistic parents especially overvalue their children's talents (Brummelman & others, 2015)
- Inclusion of recent research in which higher levels of self-control at 4 years of age were linked to improvements in math and reading achievement in the early elementary school years for children living predominantly in rural and low-income contexts (Blair & others, 2015)
- New content on how during middle and late childhood, as part of their understanding of emotions, children can engage in "mental time travel," in which they anticipate and recall the cognitive and emotional aspects of events (Lagattuta, 2014a, b; Lagattuta & others, 2015)
- New commentary on how children who have developed a number of coping techniques have the best chance of adapting and functioning competently after disasters and traumas (Ungar, 2015)
- New section on Jonathan Haidt's (2013) criticism of Kohlberg's view of moral reasoning as always conscious and deliberate, and his lack of attention to the automatic, intuitive precursors of moral reasoning
- New commentary about the multiple factors that may contribute to gender differences in academic achievement in areas such as reading and math (Wentzel & Miele, 2016)
- Inclusion of information from a meta-analysis that found females are better than males at recognizing nonverbal displays of emotion (Thompson & Voyer, 2014)
- New content on peer rejection being consistently linked to the development and maintenance of conduct problems (Chen, Drabick, & Burgers, 2015)
- Discussion of a recent analysis that concluded bullying can have long-term effects, including problems at work and difficulty in establishing long-term relationships (Wolke & Lereya, 2015)
- New research review that found antibullying interventions that focused on the whole school, such as Olweus', were more effective than interventions involving classroom curricula or social skills training (Cantone & others, 2015)
- New content on the *Every Student Succeeds Act (ESSA)* that became U.S. law in December 2015 (Rothman, 2016). This law replaces *No Child Left Behind* and while not totally eliminating state standards for testing students, reduces their influence. The new law also allows states to opt out of *Common Core* standards.
- New discussion of recent research in which underachieving high school students who read online modules about how the brain changes when people learn and study improved their grade point averages (Paunesku & others, 2015)
- Description of a longitudinal study of university students in which a nonlimited mindset predicted better self-regulation and higher grades (Job & others, 2015)
- Discussion of a recent study that found young Chinese adolescents have a greater sense of responsibility to parents than do their U.S. counterparts and that the U.S. students' sense of responsibility, but not the Chinese students', declined across two years (Qu & Pomerantz, 2015)

Chapter 9: Physical and Cognitive Development in Adolescence

- Description of a recent research review that concluded there is insufficient quality research to confirm that changing testosterone levels in puberty are linked to adolescent males' mood and behavior (Duke, Glazer, & Steinbeck, 2014)
- Inclusion of a recent study of Chinese girls that confirmed childhood obesity contributed to an earlier onset of puberty (Zhai & others, 2015)
- Coverage of a recent Korean study in which early menarche was associated with risky sexual behavior in females (Cheong & others, 2015)
- Coverage of a recent study that found early maturation predicted a stable higher level of depression for adolescent girls (Rudolph & others, 2015)
- Discussion of a recent study that revealed early-maturing Chinese boys and girls engaged in delinquency more than their on-time or late-maturing counterparts (Chen & others, 2015)
- New discussion of neurotransmitter changes in adolescence, particularly increased dopamine production (Monahan & others, 2016)
- Updated national data on the percentages of adolescents at different age levels who have engaged in sexual intercourse, including gender and ethnic variations, as well as updates in Figure 3 (Kann & others, 2014)
- Description of a recent Swedish study of more than 3,000 adolescents indicating that sexual intercourse prior to age 14 was linked to a number of risky sexual behaviors at age 18 (Kastbom & others, 2015)
- Discussion of a recent study of a number of parenting practices that found the factor that best predicted a lower level of risky sexual behavior by adolescents was supportive parenting (Simons & others, 2016)
- New research indicating that adolescent males who play sports engage in more risky sexual behavior while adolescent females who play sports engage in less risky sexual behavior (Lipowski & others, 2016)
- Updated data on the percentage of adolescents who use contraceptives when they have sexual intercourse (Kann & others, 2014)
- Inclusion of a recent cross-cultural study of adolescent pregnancy rates in 21 countries (Sedgh & others, 2015)
- Updated statistics on the continuing decline in overall adolescent pregnancy rates in the United States and the

decline in all ethnic groups, including updates in Figure 4 (Martin & others, 2015)
- Coverage of a recent study of African American teen versus nonteen mothers' and fathers' long-term life outcomes in a number of areas (Assini-Meytim & Green, 2015)
- Description of a recent study in which family meals during adolescence protected against being overweight or obese in adulthood (Berge & others, 2015)
- Updated national data on adolescents' exercise patterns, including gender and ethnic variations (Kann & others, 2014)
- Inclusion of recent research in which an exercise program of 180 minutes per week improved the sleep patterns of obese adolescents (Mendelson & others, 2016)
- Discussion of a recent study in which a high-intensity exercise program decreased the depressive symptoms and improved the moods of depressed adolescents (Carter & others, 2016)
- Updated national data on adolescents' sleep patterns, including developmental changes (Kann & others, 2014)
- Coverage of a large-scale study of more than 270,000 adolescents from 1991 to 2012 that found adolescents have been decreasing the amount of sleep they get in recent years (Keyes & others, 2015)
- Description of recent Swedish studies of 16- to 19-year-olds in which shorter sleep duration was associated with a greater likelihood of school absence and shorter sleep duration and sleep deficit were the best sleep predictors of having a low grade point average (Hysing & others, 2015, 2016)
- Discussion of a recent study that revealed early school start times were linked to a higher vehicle crash rate by adolescent drivers (Vorona & others, 2014)
- Inclusion of the recent recommendation by the American Academy of Pediatrics that schools institute start times from 8:30 to 9:30 a.m. to improve students' academic performance and quality of life (Adolescent Sleep Working Group, AAP, 2014)
- Updated coverage of the Monitoring the Future study's assessment of drug use by secondary school students with 2014 data on U.S. eighth-, tenth-, and twelfth-graders (Johnston & others, 2016)
- Description of a longitudinal study in which earlier age at first use of alcohol was linked to risk of heavy alcohol use in early adulthood (Liang & Chikritzhs, 2015)
- New research that revealed early- and rapid-onset trajectories of alcohol, marijuana, and substance use were associated with substance use in early adulthood (Nelson, Van Ryzin, & Dishion, 2015)
- New content on why the transition to high school may produce problems for students (Eccles & Roeser, 2016)
- Updated data on school dropouts with a continuing decline in dropout rates for various ethnic groups (Child Trends, 2014; National Center for Education Statistics, 2014)
- Discussion of a recent study in which adolescents took greater risks when they were with three same-aged peers than when they were alone (Silva, Chein, & Steinberg, 2016)

Chapter 10: Socioemotional Development in Adolescence

- Changes made based on leading expert Kate McLean's recommendations
- New coverage of the narrative approach to identity, which involves examining identity by having individuals tell their life stories and then evaluating the extent to which the stories are meaningful and integrated (McAdams & Zapata-Gietl, 2015; Singer & Kasmark, 2015)
- Inclusion of a recent study that examined identity domains using both identity status and narrative approaches with the interpersonal domain (especially dating and friendship aspects) frequently mentioned (McLean & others, 2016). In the narrative approach, family stories were common.
- Coverage of two recent studies that found a strong and positive ethnic identity was linked to a lower incidence of substance abuse and psychiatric problems (Anglin & others, 2016; Grindal & Nieri, 2016)
- Description of recent research in which higher parental monitoring reduced negative peer influence on adolescent risk-taking (Wang & others, 2016)
- Coverage of a recent meta-analysis that found a higher level of parental monitoring and rule enforcement were linked to later initiation of sexual intercourse and greater use of condoms by adolescents (Dittus & others, 2016)
- New research in which lower disclosure to parents was linked to antisocial behavior in 10- to 18-year-olds (Chriss & others, 2015)
- Discussion of recent research that found snooping was a relatively infrequent parental monitoring technique (compared with solicitation and control) but was a better indicator of problems in adolescent and family functioning (Hawk, Becht, & Branje, 2016)
- Coverage of a recent study that revealed insecure attachment to mothers was linked to becoming depressed and remaining depressed from 15 to 20 years of age (Agerup & others, 2015)
- Description of a study in which high parent-adolescent conflict was associated with a lower level of empathy across a six-year period (Van Lissa & others, 2015)
- Inclusion of a recent study that found a higher level of parent-adolescent conflict was linked to higher anxiety, depression, and aggression, and lower self-esteem (Smokowski & others, 2015a)
- New research on Chinese American families that revealed parent-adolescent conflict was linked to a sense of alienation between parents and adolescents, which in turn was related to more depressive

- symptoms, delinquent behavior, and lower academic achievement (Hou, Kim, & Wang, 2016)
- Discussion of a recent study that found boys were more likely to be influenced by peer pressure involving sexual behavior than were girls (Widman & others, 2016)
- Description of recent research in which adolescents adapted their smoking and drinking behavior to that of their best friends (Wang & others, 2016b)
- Inclusion of recent research that revealed mother-daughter conflict in Mexican American families was linked to an increase in daughters' romantic involvement (Tyrell & others, 2016)
- Description of a recent research review in which a higher level of media multitasking was linked to lower levels of school achievement, executive function, and growth mindset in adolescents (Cain & others, 2016)
- New information from a research review with details about the complexities of why media multitasking can interfere with learning and driving (Courage & others, 2015)
- Updated data on the percentage of adolescents who use social networking sites and engage in text messaging daily (Lenhart, 2015a, b)
- Coverage of a recent study in which having friends who engage in delinquency is associated with early onset and more persistent delinquency (Evans, Simons, & Simons, 2015)
- New content on the link between low academic success and delinquency (Mercer & others, 2015) and the association of cognitive factors, such as low self-control, with delinquency (Fine & others, 2016)
- New coverage of the roles of stress and loss in adolescent depression and inclusion of a recent study that found adolescents who became depressed were characterized by a sense of hopelessness (Weersing & others, 2016)
- New description of a recent study that found adolescent girls' greater experience of interpersonal dependent stress was linked to their higher level of rumination, which accounted for their higher level of depressive symptoms than boys (Hamilton & others, 2015)
- Description of a recent study in which family therapy improved juvenile court outcomes beyond what was achieved in nonfamily-based treatment (Dakof & others, 2015)
- Inclusion of recent research that revealed positive parenting characteristics were associated with less depression in adolescents (Smokowski & others, 2015)
- New information from a research review that concluded SSRIs show clinical benefits for adolescents at risk for moderate and severe depression (Cousins & Goodyer, 2015)
- Updated data on the percentage of U.S. adolescents who seriously consider suicide each year (Kann & others, 2014)
- Inclusion of recent research in which both depression and hopelessness were predictors of whether adolescents would repeat a suicide attempt across a six-month period (Consoli & others, 2015)
- Coverage of a recent study that found child maltreatment was linked to adolescent suicide attempts (Hadland & others, 2015)
- New research in which a lower level of school connectedness was associated with increased suicidal ideation in female and male adolescents, and with suicide attempts by female adolescents (Langille & others, 2015)

Chapter 11: Physical and Cognitive Development in Early Adulthood

- Description of a recent Danish study focused on the most widely described markers of emerging adulthood (Arnett & Padilla-Walker, 2015)
- New commentary that 70 percent of college students do not get adequate sleep and 50 percent report daytime sleepiness (Hershner & Chervin, 2015)
- Inclusion of information from a recent national survey indicating that 29.5 percent of U.S. 20- to 39-year-olds are overweight and 31.5 percent are obese (Dietary Guidelines Advisory Committee, 2015)
- Discussion of recent international comparisons of 33 countries in which the United States had the highest percentage of obese adults (35.3 percent) and Japan the lowest percentage (3.7); the average of the countries was 23.2 percent of the population being obese
- Coverage of recent research on binge drinking by U.S. college students, including recent trends (Johnston & others, 2015)
- Recent research on the atypical features of depression in overweight/obese adults (Lojko & others, 2015)
- Coverage of a recent meta-analysis in which moderate and vigorous aerobic exercise resulted in a lower incidence of major depressive disorder (Schuch & others, 2016b)
- Description of a recent study in which adults who regularly exercise had lower levels of anxiety and depression (Khanzada, Soomro, & Khan, 2015)
- Discussion of recent research that found a one-year exercise intervention decreased stress symptoms in working adults (Kettunen, Vuorimaa, & Vasankari, 2015)
- Coverage of recent research indicating that 40 percent of 22-year-olds reported recently having had a casual sex partner (Lyons & others, 2015)
- Description of a recent study that revealed when emerging adults drink alcohol, they are more likely to have casual sex and less likely to discuss possible risks (Johnson & Chen, 2015)
- Inclusion of recent research of more than 3,900 18- to 25-year-olds that found having casual sex was negatively linked to well-being and positively related to psychological distress (Bersamin & others, 2014)
- Updated data on the percentage of individuals who have AIDS globally (UNAIDS, 2015)
- New description of a recent study in which the personality trait of openness to experience predicted creativity

in the arts while intellect predicted creativity in the sciences (Kaufman & others, 2016)
- Inclusion of two recent studies indicating the importance of purpose in life in predicting well-being in emerging adulthood (Hill & others, 2016) and a lower incidence of cardiovascular disease and likelihood of living a longer life (Cohen, Bavishi, & Rozanski, 2016)
- Updated discussion of the job categories most likely to have an increase in openings through 2024 (Occupational Outlook Handbook, 2016/2017)
- New coverage of the unemployment rate of recent college graduates and the high percentage who have to take jobs that do not require a college degree (Center for Economic and Policy Research, 2014; Gabor, 2014)
- Discussion of a recent study in which unemployment was associated with higher mortality but the link was higher among those who were unmarried (Van Hedel & others, 2015)
- Inclusion of a longitudinal study that found low self-control in childhood was linked to the emergence and persistence of unemployment from 21 to 50 years of age (Daly & others, 2015)
- Description of recent research in which women reported more family interference from work than did men (Allen & Finkelstein, 2014)
- Inclusion of recent research in which partner coping, having a positive attitude about multiple roles, using planning and management skills, and not having to cut back on professional responsibilities were linked to better relationships between dual earners (Matias & Fontaine, 2015)

Chapter 12: Socioemotional Development in Early Adulthood

- Discussion of a longitudinal study in which insecure avoidant attachment at 8 years of age was linked to negative social outcomes at 21 years of age (Fransson & others, 2016)
- Description of a recent study of adoptees that found higher maternal sensitivity in infancy and middle and late childhood predicted more secure attachment representations in emerging adulthood (Schoenmaker & others, 2015)
- Discussion of recent research that revealed young adults with an anxious attachment style were more likely to be characterized by higher negative affect, stress, and perceived social rejection; those with an avoidant attachment style were more likely to be characterized by less desire to be with others when alone (Sheinbaum & others, 2015)
- New research in which adults with a secure attachment style had fewer sleep disruptions than their counterparts with an insecure avoidant or insecure anxious attachment (Adams & McWilliams, 2015)
- Coverage of a recent study in which insecurely attached adults had a higher level of social anxiety than their securely attached counterparts (Notzon & others, 2016)
- New content on the potential positive and negative aspects of cross-gender friendships (Hart, Adams, & Tullet, 2016)
- Updated coverage of the continued dramatic rise in the number of never married, single adults in the United States, including specific data on the 18- to 29-year age bracket (Gallup Poll, 2015; U.S. Census Bureau, 2015a)
- Inclusion of a recent U.S. survey on the percentage of adults in different age brackets who had used online dating sites or apps (Pew Research Center, 2015)
- Discussion of a recent study that confirmed declaring a relationship status on Facebook was associated with both romantic love and jealousy (Orosz & others, 2015)
- Updated information about the continuing sharp increase in cohabitation in the United States
- Updated data on the continuing decline of U.S. marriage rates (Centers for Disease Control and Prevention, 2014)
- Updated data on the continuing rise in the age at which U.S. men and women get married (U.S. Census Bureau, 2015b)
- Description of recent research indicating that an increasing number of children are growing up in homes in which their parents never got married and that this is far more likely to occur when the mother has a low level of education (Pew Research, 2015)
- Coverage of a recent study that explored what U.S. never-married men and women are looking for in a potential spouse (Wang, 2014)
- Updated data on the continuing decline in the percentage of U.S. adults who are getting divorced (Centers for Disease Control and Prevention, 2015)
- Inclusion of a recent research review that concluded the experience of divorce or separation confers risk for poor health outcomes, including a 23 percent higher mortality rate (Sbarra, 2015)
- Description of a recent large-scale study in the United States and six European countries that explored the buffering effect of marriage on mortality for individuals who are not in the labor force (Van Hedel & others, 2015)
- Coverage of a recent research review that concluded divorced men and women are more likely to commit suicide than their married counterparts (Yip & others, 2015)
- Discussion of a recent study on the increased risk of heart attack for divorced adults, especially female divorced adults (Dupre & others, 2015)
- Updated data on the percentage of U.S. adults who get remarried and the gender remarriage gap in which men were almost twice as likely to get remarried in a recent year than women were (Payne, 2015)
- Discussion of a recent study that found remarried adults had less frequent sex than those in their first marriage (Stroope, McFarland, & Uecker, 2015)
- Inclusion of content from a recent study that found greater sharing of responsibilities in same-sex couples than in different-sex couples (Matos & others, 2015)
- New coverage of the increasing interest in individuals who describe themselves as transgender (Scelfo, 2015)

- Updated data on the average age at which U.S. women have their first child (Martin & others, 2015)
- Inclusion of content from a recent Pew Research (2015) poll on the influence of educational attainment on the age when U.S. women first became mothers

Chapter 13: Physical and Cognitive Development in Middle Adulthood

- Changes based on input from leading experts K. Warner Schaie, George Rebok, and David Almeida
- New commentary about middle adulthood not getting nearly as much research attention as late adulthood
- Description of recent data from the U.S. Census Bureau (2012) that indicate more than 102,000,000 U.S. adults are 40 to 64 years of age, which accounts for 33 percent of the U.S. population
- Inclusion of Margie Lachman and her colleagues' (2015) recent comments about why middle age is a pivotal period in life
- Coverage of recent research that has shown a combination of adaptive biological and social factors can buffer physical and cognitive declines in middle adulthood (Agrigoroaei & Lachman, 2010; Lachman, Teshale, & Agrigoroaei, 2015; Puteman & others, 2013)
- Discussion of a recent study in which sarcopenic obesity was associated with a 24 percent increase in risk for all-cause mortality, with men having a higher risk than women (Tian & Xu, 2016)
- Description of a recent study that found middle-aged individuals who exercised regularly in adolescence were less likely to develop cardiovascular disease (Nechuta & others, 2015)
- Coverage of a recent study in which a high level of physical activity was associated with a lower risk of cardiovascular disease in all three weight categories studied (normal, overweight, and obese) (Carlsson & others, 2016)
- Inclusion of a recent national study that confirmed moderate-to-vigorous exercise on a regular basis was linked to reduced all-cause mortality, especially for men (Loprinzi, 2015)
- Coverage of a recent study in which having an unhealthy diet was a strong predictor of cardiovascular disease (Menotti & others, 2015)
- Inclusion of a recent Korean study that linked a number of lifestyle factors to sleep problems in middle age (Yoon & others, 2015)
- Description of recent research in which poor sleep quality in middle adulthood was linked to cognitive decline (Waller & others, 2016)
- New commentary that chronic disorders account for 86 percent of all health care expenditures in the United States (Qin & others, 2015)
- Discussion of recent research indicating that how individuals react to daily stressors is linked to future health outcomes and longevity (Mroczek & others, 2015; Sin & others, 2015)
- New coverage of recent research on the influence of yoga, relaxation, and hypnosis on immune system functioning (Derry & others, 2015; Kiecolt-Glazer & others, 2014)
- Updated data on deaths in middle age due to cancer and cardiovascular disease (Centers for Disease Control and Prevention, 2015)
- New discussion of testosterone replacement therapy (TRT), including a recent large-scale study of more than 80,000 men that linked testosterone replacement therapy with a reduction in cardiovascular disease and all-cause mortality (Sharma & others, 2015)
- Description of a recent study in which TRT was associated with increased longevity in men with a low level of testosterone (Comhaire, 2016)
- Updated data on the percentage of men 40 to 70 years of age and over 70 years of age who have erectile dysfunction (Mola, 2015)
- Discussion of Timothy Salthouse's (2015) recent emphasis on the main reason for different age trends in longitudinal and cross-sectional comparisons of cognitive functioning being prior experience, with test scores improving the next time a test is taken
- Coverage of a recent study in which a smaller decline in processing speed was one of the key predictors of living longer (Aichele, Rabbitt, & Ghisletta, 2016)
- Updated and expanded information about the percentage of U.S. 45- to 54- and 55- to 65-year-olds in the workforce, including trends from 2000 to 2015 (Short, 2015)
- Description of recent research that found engaging in physical and cognitive leisure activities after retirement decreased cognitive decline for individuals who worked in less cognitively challenging jobs prior to retirement (Andel, Finkel, & Pedersen, 2015)
- Inclusion of recent research in which middle-aged individuals who engaged in active leisure pursuits had a higher level of cognitive performance in late adulthood (Ihle & others, 2015)
- Coverage of a recent study that revealed individuals who engaged in a greater amount of sedentary screen-based leisure activity had shorter telomere lengths (Loprinzi, 2015)

Chapter 14: Socioemotional Development in Middle Adulthood

- Discussion of a recent meta-analysis that revealed stressful life events were related to increased risk of autoimmune diseases such as arthritis and psoriasis (Porcelli & others, 2016)
- Coverage of a recent study that found stressful daily hassles were linked to increased anxiety and lower physical well-being (Falconier & others, 2015)
- New discussion of Margie Lachman and her colleagues' (2015) recent views on how personal control

changes when individuals move into middle age, including comparison of the factors involved in personal control for young people and middle-aged adults
- Revised organization of the discussion of the Big Five factors of personality describing research on each of the five factors
- Description of recent research that found individuals high in openness to experience have superior cognitive functioning across the lifespan (Briley, Domiteaux, & Tucker-Drob, 2014) and experience less negative affect to stressors (Leger & others, 2016)
- Inclusion of recent research that found conscientiousness was linked to superior problem-focused coping (Sesker & others, 2016), greater success in accomplishing goals (McCabe & Fleeson, 2016), and better cognitive status and less cognitive decline in older adults (Luchetti & others, 2016)
- Coverage of recent research indicating that individuals high in extraversion are more satisfied with their relationships (Toy, Nai, & Lee, 2016), show less negative affect to stressors (Leger & others, 2016), and have a more positive outlook on their future well-being (Soto & others, 2015)
- Discussion of recent research indicating that people high in agreeableness engage in more positive affect to stressors (Leger & others, 2016)
- Description of recent research documenting that individuals high in neuroticism have a lower sense of well-being 40 years later (Gale & others, 2014)
- New section on the personality-trait-like characteristic of optimism and recent research on its link to better health and physical functioning in middle age (Boelen, 2015)
- Inclusion of a recent study in which a higher level of optimism increased the likelihood that individuals who had just experienced an acute coronary event would engage in more physical activity and have fewer cardiac readmissions (Huffman & others, 2016)
- Description of a recent research review of the influence of optimism on positive outcomes for individuals with chronic diseases through direct and indirect pathways (Avvenuti, Baiardini, & Giardini, 2016)
- Discussion of a recent study indicating that middle-aged married individuals have a lower likelihood of work-related health limitations than their counterparts who are not married (Lo, Cheng, & Simpson, 2016)
- Inclusion of recent research with middle-aged adults that indicated positive marital quality was linked to better health for both spouses (Choi, Yorgason, & Johnson, 2016)
- New discussion of the increasing divorce rate in middle-aged adults and the reasons for the increase (Brown & Lin, 2013)
- Coverage of a recent study that found the life satisfaction of middle-aged women in low-quality marriages increased after divorce (Bourassa, Sbarra, & Whisman, 2015)
- Updated information about the percentage of children who are living with at least one grandparent in the United States (U.S. Census Bureau, 2015)

Chapter 15: Physical and Cognitive Development in Late Adulthood

- Changes based on feedback from leading experts K. Warner Schaie, Kristen Kennedy, George Rebok, and William Hoyer
- Update on the increasing life expectancy at birth in the United States (78.8 years in 2013) and at age 65 (19.3 additional years) (Yu & others, 2016)
- Updated data on international comparisons of the countries where life expectations are highest and lowest (Central Intelligence Agency, 2015)
- Update on gender and ethnic differences in life expectancies in the United States (U.S. Department of Health and Human Services, 2015)
- Updated data on the increasing number of U.S. centenarians, which reached 72,000 in 2014 (Xu, 2016)
- Description of a recent list (2015) of the oldest people who have ever lived, with the list having only two men (number 11 and number 17) in the top 25
- New criticisms of the evolutionary theory of aging (Singer, 2016)
- Coverage of a recent study in which greater leisure time screen-based sedentary behavior was linked to shorter telomere length (Loprinzi, 2015)
- Inclusion of recent interest in energy sensing and apoptosis as key aspects of the mitochondrial theory of aging (Gonzalez-Freire & others, 2015)
- Reorganization of the discussion of biological theories of aging to include a new heading, "Cellular Processes," with new content on the increasing interest in sirtuins (Covington & Bajpeyi, 2016; Giblin & Lombard, 2016) and the mTOR pathway (Chen & others, 2016; Cheng & others, 2016; Schreiber, O'Leary, & Kennedy, 2016) as key cellular processes in aging and longevity
- Description of a recent study in which the percentage of T cells decreased in adults in their seventies, eighties, and nineties (Valiathan, Ashman, & Asthana, 2016)
- New section, "Conclusions," that describes the current belief that although there are some individual aging triggers, such as telomere shortening, a full understanding of biological aging involves multiple processes operating at different biological levels (de Magalhaes & Tacutu, 2016)
- Inclusion of research indicating that global brain volume predicted mortality in adults (Van Elderen & others, 2016)
- Discussion of a recent study in which mice in an enriched environment learned more flexibly because of adult hippocampal neurogenesis (Garthe, Roeder, & Kempermann, 2016)
- New discussion of the increasing risk of falls in older adults and a recent meta-analysis that concluded exercise reduces the risk of falls in adults 60 years of age and older (Stubbs, Brefka, & Denkginer, 2015) and another study that found walking was more effective

than balance training in reducing older adults' falls (Okubo & others, 2016)
- New discussion of researchers' conclusions that older adults' sleep is lighter and more disrupted than young adults' sleep (McRae & others, 2016)
- New content on the increasing consensus that short (less than seven hours) and long (nine hours or more) sleep duration per night is detrimental to older adults' cognitive functioning (DeVore, Grodstein, & Schemhammer, 2016; Lo & others, 2016)
- Description of a recent study in which engaging in regular aerobic exercise improved the sleep profiles of older men (Melancon, Lorrain, & Dionne, 2015)
- Description of a recent study of older adults indicating that regular walking at or above 150 minutes per week predicted a lower likelihood of sleep onset and sleep maintenance problems four years later (Hartescu, Morgan, & Stevinson, 2015)
- Coverage of a recent study of older adults in which a faster walking pace, not smoking, modest alcohol intake, and avoiding obesity were associated with a lower risk of heart failure (Del Gobbo & others, 2015)
- Inclusion of a national study of the percentage of community-dwelling older adults with touch, taste, and smell impairment (Correia & others, 2016)
- Inclusion of recent research with sarcopenic older adults that found those who were physically active had a 25 percent probability of greater longevity than their sedentary counterparts (Brown, Harhay, & Harhay, 2016)
- Discussion of a recent research review that concluded more physically fit and active older adults have greater prefrontal cortex and hippocampal volume, a higher level of brain connectivity, more efficient brain activity, better memory, and a higher level of executive function (Erickson, Hillman, & Kramer, 2015)
- New research on women that indicated leisure-time physical inactivity was a risk factor for subsequent development of arthritis (Di Giuseppe & others, 2016)
- Discussion of recent research indicating that calorie restriction slows RNA decline during the aging process (Hou & others, 2016)
- Description of research on joggers in Denmark that revealed engaging in light or moderate jogging on a regular basis was linked to increased longevity (Schnohr & others, 2015)
- Discussion of a recent study in which core resistance and balance training improved older adult women's balance, muscle strength, leg power, and body composition better than Pilates training (Markovic & others, 2015)
- Inclusion of new information about the benefits of exercise for cellular functioning, including recent research that found aerobic exercise was linked to greater telomere length in older adults (Loprinzi & Loenneke, 2015)
- Description of recent research in which calorie restriction maintained more youthful functioning of the hippocampus, which is an important brain structure in memory (Schafer & others, 2015)
- New research involving a 20-year longitudinal study of 42- to 97-year-olds that revealed a greater processing speed decline was associated with mortality risk (Aichele, Rabbitt, & Ghisletta, 2015)
- Coverage of research in which episodic memory performance predicted which individuals would develop dementia 10 years prior to the clinical diagnosis of the disease (Boraxbekk & others, 2015)
- Inclusion of a recent study that found executive function but not memory predicted a higher risk of coronary disease and stroke three years later (Rostamian & others, 2015)
- New research that indicated executive function predicted higher levels of self-rated health in community-dwelling older adults (McHugh & Lawlor, 2015)
- Discussion of a recent study in which executive dysfunction was a strong predictor of stroke in cognitively normal aging adults (Oveisgharan & Hachinski, 2015)
- Coverage of a recent study in which older adults assessed in 2013–2014 engaged in a higher level of abstract reasoning than their counterparts who had been assessed two decades earlier (Gerstorf & others, 2015)
- Discussion of recent research on 60- to 90-year-olds in which iPad training 15 hours a week for 3 months improved their episodic memory and processing speed relative to engaging in social or non-challenging activities (Chan & others, 2015)
- Discussion of a recent research review in which Exergaming was linked to improved cognitive functioning in older adults (Ogawa, You, & Leveille, 2016)
- New research indicating that use of fish oil supplements was linked to higher cognitive scores and less atrophy in one or more brain regions (Daiello & others, 2015)
- Updated information on brain training games based on the consensus of leading experts (Stanford Center for Longevity and Max Planck Institute for Human Development, 2014)
- Updated data on the dramatically increased percentage of older adults who are in the work force and projections of work force participation to 2020, including gender differences (Short, 2015)
- Coverage of recent research in which cortical thickness in frontoparietal networks predicts executive function in older adults (Schmidt & others, 2016)
- Expanded content on the diverse mix of pathways of work and retirement that individuals now pursue (Kojola & Moen, 2016)
- New description of how new neuroimaging techniques have been developed that can detect the presence of plaques and tangles, providing scientists with an opportunity to identify the transition from healthy cognitive functioning to the earliest indication of Alzheimer disease (Park & Farrell, 2016)
- New commentary noting that more than 60 percent of individuals with Alzheimer disease have at least one ApoE4 allele (Riedel, Thompson, & Brinton, 2016)

- New coverage of a recent meta-analysis of modifiable risk factors for Alzheimer disease, including some medical exposures, dietary factors, preexisting diseases, cognitive activity, and alcohol consumption (Xu & others, 2015)

Chapter 16: Socioemotional Development in Late Adulthood

- Discussion of a recent study of older adults with dementia revealing that reminiscence therapy reduced their depressive symptoms and improved their self-acceptance and positive relationships with others (Gonzales & others, 2015)
- Coverage of a recent study in which *attachment-focused* reminiscence therapy reduced the depressive symptoms, perceived stress, and emergency room visits of older African Americans (Sabir & others, 2016)
- Inclusion of recent research in which aging adults who were more physically active were more satisfied with their lives (Maher & others, 2015)
- Description of a recent study that revealed older adults who increased their leisure-time activity were three times more likely to have a slower progression to functional disability (Chen & others, 2016)
- New content on how individuals with a positive affect, upbeat outlook on life, and optimism live longer (Carstensen & others, 2015; Reed & Carstensen, 2015)
- Inclusion of new content about a recent large-scale examination of healthy living in different age groups by the Stanford Center on Longevity that found social engagement with individuals and communities appeared to be weaker today than it was 15 years ago for 55- to 64-year-olds (Parker, 2016)
- Discussion of a recent study of 22- to 94-year-olds that found older adults showed selective optimization with compensation if they had a high level of cognitive resources (Robinson, Rickenbach, & Lachman, 2015)
- Inclusion of research that revealed processing speed was slower for older adults living in poverty (Zhang & others, 2015)
- Updates on the percentage of U.S. older adults living in poverty, including gender and ethnicity differences (Cubanski, Casillas, & Damice, 2015; Gabe, 2015)
- Inclusion of recent research on 65-and-older adults that found having an iPad increased their family ties and sense of having a greater overall connection to society (Delello & McWhorter, 2016)
- Updated information about the percentage of older adults who are married (U.S. Census Bureau, 2015)
- Description of a recent study of married and cohabiting older adults that indicated negative relationship quality predicted a higher level of blood pressure when both members of the couple reported having negative relationship quality (Birditt & others, 2016)
- Discussion of recent research of 40- to 60-year-olds who reported that their relationships with their children were more important than those with their parents but that their relationships with their children were more negative than with their parents (Birditt & others, 2015)
- Description of a recent study in which more frequent negative (but not positive) marital experiences were linked to a slower increase in older adults' cognitive limitations over time (Xu, Thomas, & Umbersom, 2016)
- Coverage of a recent study that found spousal support was more strongly linked to an important biomarker of biological aging, telomere length, than were other sources of social support (Barger & Cribbet, 2016)
- Discussion of a recent study in which a higher level of social support was associated with older adults' increased life satisfaction (Dumitrache, Rubio, & Rubio-Herrera, 2016)
- Description of recent research in which older adults involved in volunteering showed a strong link to lower incidence of cardiovascular disease and living longer (Han & others, 2016)
- New research that revealed having multiple chronic diseases was linked to a lower level of successful aging (Hsu, 2015)
- Inclusion of recent research on 90- to 91-year-olds that found living circumstances, independence, health, and a good death were associated with successful aging (Nosraty & others, 2015)
- Coverage of Laura Carstensen's (2015) recent commentary about the challenges and opportunities involved in the dramatic increase in life expectancy that has been occurring and continues to occur

Chapter 17: Death, Dying, and Grieving

- Some changes made in chapter based on feedback from leading expert Crystal Park
- Updated information that two additional states (New Mexico and Vermont) are among the five that allow assisted suicide
- New inclusion of Canada on the list of countries that allow assisted suicide, a change that occurred in 2016
- New content on why euthanasia is so controversial
- Discussion of recent research that found 61 percent of dying patients were in pain in their last year of life and almost one-third had symptoms of depression and confusion prior to death (Singer & others, 2015)
- Description of a recent research review that concluded the three most frequent themes in articles on a good death involved (1) preference for dying process, (2) pain-free status, and (3) emotional well-being (Meier & others, 2016)
- Discussion of recent research that found college students who lost someone close to them in college shootings and had severe posttraumatic stress symptoms four

months later were more likely to have severe grief one year after the shootings (Smith & others, 2015)
- Among individuals diagnosed with complicated grief, 40 percent reported at least one full or limited-symptom grief-related panic attack in the past week (Bui & others, 2015)
- Coverage of recent research that identified four meaning-making processes (sense making, benefit finding, continuing bonds, and identity reconstruction) in parent-physician bereavement meetings following a child's death (Meert & others, 2015)
- Updated data on the percentages of U.S. women and men 65 years and older who are widowed (Administration on Aging, 2014)
- Discussion of a recent study that found Mexican American older adults experienced a signficant increase in depressive symptoms during the transition to widowhood (Monserud & Markides, 2016). In this study, frequent church attendance served as a protective buffer against increases in depressive symptoms.
- New commentary noting that becoming widowed is especially difficult when individuals have been happily married for a number of decades
- Updated data on the dramatic increase in the percentage of people in the United States who choose cremation (45 percent in 2013, compared with 27 percent in 2000 and 14 percent in 1985) (Cremation Association of America, 2015)

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1 Introduction

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CHAPTER OUTLINE

Stories of Life-Span Development: How Did Ted Kaczynski Become Ted Kaczynski and Alice Walker Become Alice Walker?

Ted Kaczynski sprinted through high school, not bothering with his junior year and making only passing efforts at social contact. Off to Harvard at age 16, Kaczynski was a loner during his college years. One of his roommates at Harvard said that he avoided people by quickly shuffling by them and slamming the door behind him. After obtaining his Ph.D. in mathematics at the University of Michigan, Kaczynski became a professor at the University of California at Berkeley. His colleagues there remember him as hiding from social interaction—no friends, no allies, no networking.

After several years at Berkeley, Kaczynski resigned and moved to a rural area of Montana, where he lived as a hermit in a crude shack for 25 years. Town residents described him as a bearded eccentric. Kaczynski traced his own difficulties to growing up as a genius in a kid's body and sticking out like a sore thumb in his surroundings as a child. In 1996, he was arrested and charged as the notorious Unabomber, America's most wanted killer. Over the course of 17 years, Kaczynski had sent 16 mail bombs that left 23 people wounded or maimed and 3 people dead. In 1998, he pleaded guilty to the offenses and was sentenced to life in prison.

Ted Kaczynski, the convicted Unabomber, traced his difficulties to growing up as a genius in a kid's body and not fitting in when he was a child.

(Top) © Seanna O'Sullivan; (bottom) © WBBM-TV/AFP/Getty Images

A decade before Kaczynski mailed his first bomb, Alice Walker spent her days battling racism in Mississippi. She had recently won her first writing fellowship, but rather than use the money to follow her dream of moving to Senegal, Africa, she put herself into the heart and heat of the civil rights movement. Walker had grown up knowing the brutal effects of poverty and racism. Born in 1944, she was the eighth child of Georgia sharecroppers who earned $300 a year. When Walker was 8, her brother accidentally shot her in the left eye with a BB gun. Since her parents had no car, it took them a week to get her to a hospital. By the time she received medical care, she was blind in that eye, and it had developed a disfiguring layer of scar tissue. Despite the counts against her, Walker overcame pain and anger and went on to win a Pulitzer Prize for her book *The Color Purple*. She became not only a novelist but also an essayist, a poet, a short-story writer, and a social activist.

Alice Walker won the Pulitzer Prize for her book *The Color Purple.* Like the characters in her book, Walker overcame pain and anger to triumph and celebrate the human spirit.

(Top) © AP Images; (bottom) © Alice Walker

What leads one individual, so full of promise, to commit brutal acts of violence and another to turn poverty and trauma into a rich literary harvest? If you have ever wondered why people turn out the way they do, you have asked yourself the central question we will explore in this book.

Essentials of Life-Span Development is a window into the journey of human development—your own and that of every other member of the human species. Every life is distinct, a new biography in the world. Examining the shape of life-span development helps us to understand it better. In this chapter, we explore what it means to take a life-span perspective on development, examine the nature of development, and outline how science helps us to understand it. ■

The Life-Span Perspective

Each of us develops partly like all other individuals, partly like some other individuals, and partly like no other individual. Most of the time we notice the qualities in an individual that make that person unique. But as humans, we have all traveled some common paths. Each of us—Leonardo da Vinci, Joan of Arc, George Washington, Martin Luther King, Jr., and you—walked at about 1 year, engaged in fantasy play as a young child, and became more independent as a youth. Each of us, if we live long enough, will experience hearing problems and the death of family members and friends. This is the general course of our **development,** the pattern of movement or change that begins at conception and continues through the human life span.

development The pattern of movement or change that starts at conception and continues through the life span.

In this section we explore what is meant by the concept of development and why the study of life-span development is important. We outline the main characteristics of the life-span perspective and discuss various influences on development. In addition, we examine some contemporary concerns related to life-span development.

The Importance of Studying Life-Span Development

How might you benefit from studying life-span development? Perhaps you are, or will be, a parent or teacher. If so, responsibility for children is, or will be, a part of your everyday life. The more you learn about them, the better you can raise them or teach them. Perhaps you hope to gain some insight about your own history—as an infant, a child, an adolescent, or a young adult. Perhaps you want to know more about what your life will be like as you grow through the adult years—as a middle-aged adult, or as an adult in old age, for example. Or perhaps you just stumbled across this course, thinking that it sounded intriguing. Whatever your reasons, you will discover that the study of life-span development addresses some provocative questions about who we are, how we came to be this way, and where our future will take us.

In our exploration of development, we will examine the life span from the point of conception until the time when life (at least, life as we know it) ends. You will see yourself as an infant, as a child, and as an adolescent, and you will learn about how those years influenced the kind of individual you are today. And you will see yourself as a young adult, as a middle-aged adult, and as an adult in old age, and you may be motivated to consider how your experiences will affect your development through the remainder of your adult years.

Characteristics of the Life-Span Perspective

Growth and development are dramatic during the first two decades of life, but development is not something that happens only to children and adolescents. The traditional approach to the study of development emphasizes extensive change from birth to adolescence (especially during infancy), little or no change in adulthood, and decline in old age. Yet a great deal of change does occur in the decades after adolescence. The life-span approach emphasizes developmental change throughout adulthood as well as childhood (Schaie & Willis, 2016).

Recent increases in human life expectancy have contributed to greater interest in the life-span approach to development. The upper boundary of the human life span (based on the oldest age documented) is 122 years. The maximum life span of humans has not changed since the beginning of recorded history. What has changed is life expectancy, the average number of years that a person born in a particular year can expect to live. In the twentieth century alone, life expectancy increased by 30 years, thanks to improvements in sanitation, nutrition, and medicine (see Figure 1). In the middle of the second decade of the twenty-first century, the life expectancy in the United States was 79 years of age (U.S. Census Bureau, 2015). Today, for most individuals in developed countries, childhood and adolescence represent only about one-fourth of their lives.

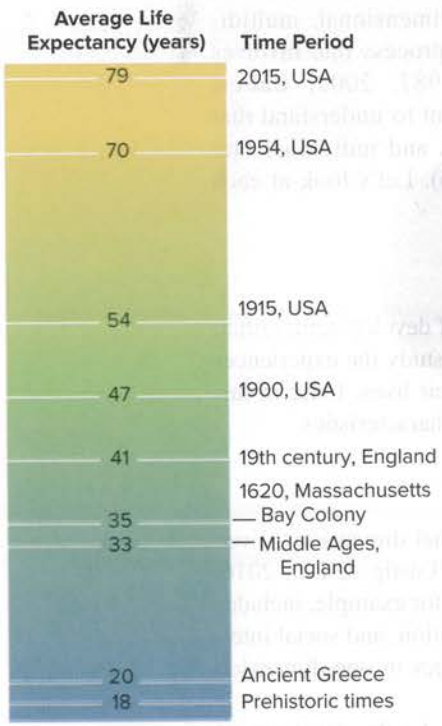

Figure 1 Human Life Expectancy at Birth from Prehistoric Times to Contemporary Times
It took 5,000 years to extend human life expectancy from 18 to 41 years of age.

Laura Carstensen (2015, 2016) recently described the challenges and opportunities involved in this dramatic increase in life expectancy. In her view, the remarkable increase in the number of people living to old age has taken place so quickly that science, technology, and behavioral challenges have not kept pace. She proposes that the challenge is to transform a world constructed mainly for young people into a world that is more compatible and supportive for the increasing number of people living to 100 and older.

In further commentary, Carstensen (2015, p. 70) remarked that making this transformation would be no small feat:

> . . . parks, transportation systems, staircases, and even hospitals presume that the users have both strength and stamina; suburbs across the country are built for two parents and their young children, not single people, multiple generations or elderly people who are not able to drive. Our education system serves the needs of young children and young adults and offers little more than recreation for experienced people.
>
> Indeed, the very conception of work as a full-time endeavor ending in the early 60s is ill suited for long lives. Arguably the most troubling is that we fret about ways the older people lack the qualities of younger people rather than exploit a growing new resource right before our eyes: citizens who have deep expertise, emotional balance, and the motivation to make a difference.

Certainly recent progress has been made in improving the lives of older adults. In our discussion of late adulthood, you will read about researchers who are exploring ways to modify the activity of genes related to aging, methods for improving brain functioning in older people, medical discoveries for slowing or even reversing the effects of various chronic diseases, and ways to prepare for a better quality of life when we get old, including strategies for staying cognitively sharp, maintaining our physical fitness, and becoming more satisfied with our lives as older adults. But much more remains to be accomplished, as described earlier by Laura Carstensen (2015, 2016) and others (Antonucci & others, 2016; Hudson, 2016).

The belief that development occurs throughout life is central to the life-span perspective on human development, but this perspective has other characteristics as well. According to life-span development expert Paul Baltes (1939–2006), the **life-span perspective** views development as lifelong, multidimensional, multidirectional, plastic, multidisciplinary, and contextual, and as a process that involves growth, maintenance, and regulation of loss (Baltes, 1987, 2003; Baltes, Lindenberger, & Staudinger, 2006). In this view, it is important to understand that development is constructed through biological, sociocultural, and individual factors working together (Baltes, Reuter-Lorenz, & Rösler, 2006). Let's look at each of these characteristics.

1. Development Is Lifelong

In the life-span perspective, early adulthood is not the endpoint of development; rather, no age period dominates development. Researchers increasingly study the experiences and psychological orientations of adults at different points in their lives. Later in this chapter we describe the age periods of development and their characteristics.

2. Development Is Multidimensional

Development consists of biological, cognitive, and socioemotional dimensions. Even within each of those dimensions, there are many components (Lustig & Lin, 2016; Reuter-Lorenz, Festini, & Jantz, 2016). The cognitive dimension, for example, includes attention, memory, abstract thinking, speed of processing information, and social intelligence. At every age, changes occur in every dimension. Changes in one dimension also affect development in the other dimensions.

To get an idea of how interactions occur, consider the development of Ted Kaczynski, the so-called Unabomber discussed at the opening of the chapter. When he was 6 months old, he was hospitalized with a severe allergic reaction, and his parents were rarely allowed to visit him. According to his mother, the previously happy baby was never the same after his hospital stay. He became withdrawn and unresponsive. As Ted grew up, he had periodic "shutdowns" accompanied by rage. In his mother's view, a biological event in infancy warped the development of her son's mind and emotions.

life-span perspective The perspective that development is lifelong; multidimensional, multidirectional, plastic, multidisciplinary, and contextual; that it involves growth, maintenance, and regulation; and that it is constructed through biological, sociocultural, and individual factors working together.

3. Development Is Multidirectional

Throughout life, some dimensions or components of a dimension expand and others shrink. For example, when one language (such as English) is acquired early in development, the capacity for acquiring second and third languages (such as Spanish and Chinese) decreases later in development, especially after early childhood (Levelt, 1989). During adolescence, as individuals establish romantic relationships, their relationships with friends might decrease. During late adulthood, older adults might become wiser by being able to call on experience to guide their intellectual decision making (Lim & Yu, 2015), but they perform more poorly on tasks that require speed in processing information (Hedden & others, 2016; Salthouse, 2014).

4. Development Is Plastic

Even at 10 years old, Ted Kaczynski was extraordinarily shy. Was he destined to remain forever uncomfortable with people? Developmentalists debate how much plasticity people have in various dimensions at different points in their development (Kuhn & Lindenberger, 2016). Plasticity means the capacity for change. For example, can you still improve your intellectual skills when you are in your seventies or eighties? Or might these intellectual skills be fixed by the time you are in your thirties so that further improvement is impossible? Researchers have found that the cognitive skills of older adults can be improved through training and developing better strategies (Willis & Belleville, 2016). However, possibly we possess less capacity for change when we become old (Salthouse, 2012). The exploration of plasticity and its constraints is a key element on the contemporary agenda for developmental research (Kuhn & Lindenberger, 2016; Schaie, 2016).

5. Developmental Science Is Multidisciplinary

Psychologists, sociologists, anthropologists, neuroscientists, and medical researchers all share an interest in unlocking the mysteries of development through the life span (George & Ferraro, 2016; Kaeberlein & Martin, 2016; Schaie & Willis, 2016). How do your heredity and health limit your intelligence? Do intelligence and social relationships change with age in the same way around the world? How do families and schools influence intellectual development? These are examples of research questions that cut across disciplines.

6. Development Is Contextual

All development occurs within a **context,** or setting. Contexts include families, schools, peer groups, churches, cities, neighborhoods, university laboratories, countries, and so on. Each of these settings is influenced by historical, economic, social, and cultural factors (Eccles & Roeser, 2016; Kerig, 2016).

Contexts, like individuals, change (Gauvain & Perez, 2015). Thus, individuals are changing beings in a changing world. As a result of these changes, contexts exert three types of influences (Baltes, 2003): (1) normative age-graded influences, (2) normative history-graded influences, and (3) nonnormative or highly individualized life events. Each of these types can have a biological or environmental impact on development.

Normative age-graded influences are similar for individuals in a particular age group. These influences include biological processes such as puberty and menopause. They also include sociocultural, environmental processes such as beginning formal education (usually at about age 6 in most cultures) and retirement (which takes place during the fifties and sixties in most cultures).

Normative history-graded influences are common to people of a particular generation because of historical circumstances. For example, in their youth American baby boomers shared the experience of the Cuban missile crisis, the assassination of John F. Kennedy, and the Beatles invasion. Other examples of normative history-graded influences

context The setting in which development occurs, which is influenced by historical, economic, social, and cultural factors.

normative age-graded influences Biological and environmental influences that are similar for individuals in a particular age group.

normative history-graded influences Biological and environmental influences that are associated with history. These influences are common to people of a particular generation.

Nonnormative life events, such as Hurricane Sandy, are unusual circumstances that can have a major influence on a person's development.

include economic, political, and social upheavals such as the Great Depression in the 1930s, World War II in the 1940s, the civil rights and women's rights movements of the 1960s and 1970s, the terrorist attacks of 9/11/2001, as well as the integration of computers and cell phones into everyday life during the 1990s (Schaie, 2013). Long-term changes in the genetic and cultural makeup of a population (due to immigration or changes in fertility rates) are also part of normative historical change.

Nonnormative life events are unusual occurrences that have a major impact on the individual's life. These events do not happen to all people, and when they do occur they can influence people in different ways. Examples include the death of a parent when a child is young, pregnancy in early adolescence, a fire that destroys a home, winning the lottery, or getting an unexpected career opportunity.

How Would You...?

As a **social worker,** how would you explain the importance of considering nonnormative life events when working with a new client?

Development Involves Growth, Maintenance, and Regulation of Loss

Baltes and his colleagues (2006) assert that the mastery of life often involves conflicts and competition among three goals of human development: growth, maintenance, and regulation of loss. As individuals age into middle and late adulthood, maintenance and regulation of loss in their capacities takes center stage away from growth. Thus, a 75-year-old man might aim not to improve his memory or his golf swing but to maintain his independence and to continue playing golf. In other chapters, we will discuss these ideas about maintenance and regulation of loss in greater depth.

Development Is a Co-Construction of Biology, Culture, and the Individual

Development comes from biological, cultural, and individual factors influencing each other (Baltes, Reuter-Lorenz, & Rösler, 2006). For example, the brain shapes culture, but it is also shaped by culture and the experiences that individuals have or pursue. In terms of individual factors, we can go beyond what our genetic inheritance and environment give us. We can create a unique developmental path by actively choosing from the environment the things that optimize our lives (Rathunde & Csikszentmihalyi, 2006).

Contemporary Concerns in Life-Span Development

Pick up a newspaper or magazine and you might see headlines like these: "Political Leanings May Be Written in the Genes," "Mother Accused of Tossing Children into Bay," "Gender Gap Widens," "FDA Warns About ADHD Drug," "Heart Attack Deaths Higher in African American Patients," "Test May Predict Alzheimer Disease." Researchers using the life-span perspective explore these and many other topics of contemporary concern. The roles that health and well-being, parenting, education, and sociocultural contexts play in life-span development, as well as how social policy is related to these issues, are a particular focus of this textbook.

nonnormative life events Unusual occurrences that have a major impact on a person's life. The occurrence, pattern, and sequence of these events are not applicable to many individuals.

Health and Well-Being

Health professionals today recognize the power of lifestyles and psychological states in health and well-being (Donatelle, 2017; Insel & Roth, 2016). Clinical psychologists are among the health professionals who help people improve their well-being. Read about one clinical psychologist who helps adolescents who have become juvenile delinquents or substance abusers in the *Careers in Life-Span Development* profile.

Careers in life-span development

Luis Vargas, Child Clinical Psychologist

Luis Vargas is Director of the Clinical Child Psychology Internship Program and a professor in the Department of Psychiatry at the University of New Mexico Health Sciences Center. He also is Director of Psychology at the University of New Mexico Children's Psychiatric Hospital.

Luis obtained an undergraduate degree in psychology from St. Edward's University in Texas, a master's degree in psychology from Trinity University in Texas, and a Ph.D. in clinical psychology from the University of Nebraska–Lincoln.

Luis' main areas of interest are cultural issues and the assessment and treatment of children, adolescents, and families. He is motivated to find better ways to provide culturally responsive mental health services. One of his special interests is the treatment of Latino youth for delinquency and substance abuse.

Clinical psychologists like Luis Vargas seek to help people with psychological problems. They work in a variety of settings, including colleges and universities, clinics, medical schools, and private practice. Some clinical psychologists only conduct psychotherapy; others do psychological assessment and psychotherapy; some also do research. Clinical psychologists may specialize in a particular age group, such as children (child clinical psychologist) or older adults (geropsychologist).

Luis Vargas (*left*) conducts a child therapy session.

Clinical psychologists like Dr. Vargas have either a Ph.D. (which involves clinical and research training) or a Psy.D. degree (which only involves clinical training). This graduate training usually takes five to seven years and includes courses in clinical psychology and a one-year supervised internship in an accredited setting toward the end of the training. Most states require clinical psychologists to pass a test to become state licensed and to call themselves clinical psychologists.

Parenting and Education

Can two gay men raise a healthy family? Do children suffer if they grow up in a divorced family? Are U.S. schools failing to teach children how to read and write and calculate adequately? We hear many questions like these related to pressures on the contemporary family and the problems of U.S. schools (Bullard, 2017; Lamb & Lewis, 2015). In later chapters, we analyze child care, the effects of divorce, parenting styles, intergenerational relationships, early childhood education, relationships between childhood poverty and education, bilingual education, new educational efforts to improve lifelong learning, and many other issues related to parenting and education (Feeney, Moravcik, & Nolte, 2016; Pianta, 2016; Wadsworth & others, 2016).

Sociocultural Contexts and Diversity

Health, parenting, and education—like development itself—are all shaped by their sociocultural context. To analyze this context, four concepts are especially useful: culture, ethnicity, socioeconomic status, and gender.

Culture encompasses the behavior patterns, beliefs, and all other products of a particular group of people that are passed on from generation to

culture The behavior patterns, beliefs, and all other products of a group that are passed on from generation to generation.

Two Korean-born children on the day they became United States citizens. Asian American and Latino children are the fastest-growing immigrant groups in the United States. *How diverse are the students in your life-span development class? Are their experiences in growing up likely to have been similar to or different from yours?*

generation. Culture results from the interaction of people over many years (Cole & Tan, 2015). A cultural group can be as large as the United States or as small as an isolated Appalachian town. Whatever its size, the group's culture influences the behavior of its members (Masumoto & Juang, 2017). **Cross-cultural studies** compare aspects of two or more cultures. The comparison provides information about the degree to which development is similar, or universal, across cultures, or is instead culture-specific (Chen & Liu, 2016).

How Would You...?

As a **health-care professional**, how would you explain the importance of examining cross-cultural research when searching for developmental trends in health and wellness?

Ethnicity (the word *ethnic* comes from the Greek word for "nation") is rooted in cultural heritage, nationality, race, religion, and language. African Americans, Latinos, Asian Americans, Native Americans, European Americans, and Arab Americans are a few examples of broad ethnic groups in the United States. Diversity exists within each ethnic group (Gonzales & others, 2016). In recent years, there has been a growing realization that research on children's development needs to include more children from diverse ethnic groups (Schaefer, 2015). A special concern is the discrimination and prejudice experienced by ethnic minority children (Spencer & Swanson, 2016).

Doly Akter, age 17, lives in a slum in Dhaka, Bangladesh, where sewers overflow, garbage rots in the streets, and children are undernourished. Nearly two-thirds of the women in Bangladesh marry before they are 18. Doly organized a club supported by UNICEF in which girls go door-to-door to monitor the hygiene habits of households in their neighborhood, which has led to improved hygiene and health in the families. Also, her group has managed to stop several child marriages by meeting with parents and convincing them that it is not in their daughter's best interests. They emphasize the importance of staying in school and how this will improve their daughter's future. Doly says that the girls in her UNICEF group are far more aware of their rights than their mothers ever were (UNICEF, 2007).

Socioeconomic status (SES) refers to a person's position within society based on occupational, educational, and economic characteristics. Socioeconomic status implies certain inequalities. Differences in the ability to control resources and to participate in society's rewards produce unequal opportunities (George & Ferraro, 2016; Wadsworth & others, 2016).

How Would You...?

As a **psychologist,** how would you explain the importance of examining sociocultural factors in developmental research?

Gender, the characteristics of people as females and males, is another important aspect of sociocultural contexts. Few aspects of our development are more central to our identity and social relationships than gender (Leaper, 2015). We discuss sociocultural contexts and diversity in each chapter.

The conditions in which many of the world's women live are a serious concern (UNICEF, 2016). Inadequate educational opportunities, violence, and lack of political access are just some of the problems faced by many women.

Social Policy

Social policy is a government's course of action designed to promote the welfare of its citizens. Values, economics, and politics all shape a nation's social policy. Out of concern that policy makers are doing too little to protect the well-being of children and older adults, life-span researchers are increasingly undertaking studies that they hope will lead to effective social policy (Hudson, 2016; Sommer & others, 2016; Yeung & Mui-Teng, 2015).

cross-cultural studies Comparisons of one culture with one or more other cultures. These provide information about the degree to which children's development is similar, or universal, across cultures, and the degree to which it is culture-specific.

ethnicity A range of characteristics rooted in cultural heritage, including nationality, race, religion, and language.

socioeconomic status (SES) Refers to the conceptual grouping of people with similar occupational, educational, and economic characteristics.

gender The characteristics of people as females and males.

social policy A national government's course of action designed to promote the welfare of its citizens.

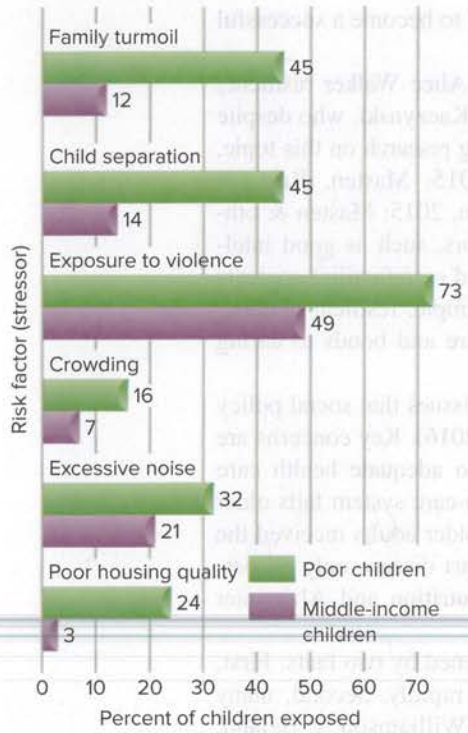

Figure 2 Exposure to Six Stressors Among Poor and Middle-Income Children
One study analyzed the exposure to six stressors among poor children and middle-income children (Evans & English, 2002). Poor children were much more likely to face each of these stressors.

Children who grow up in poverty represent a special concern (Duncan, Magnuson, & Votruba-Drzal, 2015; Wadsworth & others, 2016). In 2014, 21.1 percent of U.S. children under 18 years of age were living in families with incomes below the poverty line, with African American and Latino families with children having especially high rates of poverty (more than 30 percent) (DeNavas-Walt & Proctor, 2015). This is an increase from 2001 (16 percent) but slightly down from a peak of 23 percent in 1993. As indicated in Figure 2, one study found that a higher percentage of children in poor families than in middle-income families were exposed to family turmoil, separation from a parent, violence, crowding, excessive noise, and poor housing (Evans & English, 2002).

Developmental psychologists are seeking ways to help families living in poverty improve their well-being, and they have offered many suggestions for improving government policies (Gonzales & others, 2016; McCartney & Yoshikawa, 2015; Yoshikawa & others, 2016). For example, the Minnesota Family Investment Program (MFIP) was designed in the 1990s primarily to influence the behavior of adults—specifically, to move adults off welfare rolls and into paid employment. A key element of the program was its guarantee that adults participating in the program would receive more income if they worked than if they did not. How did the increase in income affect their children? A study of the effects of MFIP found that higher incomes of working poor parents were linked with benefits for their children (Gennetian & Miller, 2002). The children's achievement in school improved, and their behavior problems decreased. A current MFIP study is examining the influence of specific services on low-income families at risk for child maltreatment and other negative outcomes for children (Minnesota Family Investment Program, 2009).

There is increasing interest in developing two-generation educational interventions to improve the academic success of children living in poverty (Gardner, Brooks-Gunn, & Chase-Lansdale, 2016; Sabol & others, 2016; Sommer & others, 2016). For example, a recent large-scale effort to help children escape from poverty is the Ascend two-generation educational intervention being conducted by the Aspen Institute (2013; King, Chase-Lansdale, & Small, 2015). The focus of the intervention emphasizes education (increasing postsecondary education for mothers and improving the quality of their children's early childhood education), economic support (housing, transportation, financial education, health insurance, and food assistance), and social capital (peer support including friends and neighbors; participation in community and faith-based organizations; school and work contacts).

Some children triumph over poverty or other adversities. They show *resilience* (Masten & Cicchetti, 2016). Think back to the chapter-opening story about Alice Walker. In spite of racism, poverty, her low

Ann Masten (*far right*) with a homeless mother and her child who are participating in her research on resilience. She and her colleagues have found that good parenting skills and good cognitive skills (especially attention and self-control) improve the likelihood that children in challenging circumstances will do well when they enter elementary school.

socioeconomic status, and a disfiguring eye injury, she went on to become a successful author and champion for equality.

Are there certain characteristics that make children like Alice Walker resilient? Are there other characteristics that influence children like Ted Kaczynski, who despite his intelligence and education, became a killer? After analyzing research on this topic, Ann Masten and her colleagues (Masten, 2006, 2014, 2015; Masten, Burt, & Coatsworth, 2006; Masten & Cicchetti, 2016; Masten & Monn, 2015; Masten & others, 2015, 2016) concluded that a number of individual factors, such as good intellectual functioning, influence resiliency. In addition, family and extrafamilial contexts of resilient individuals tend to share certain features. For example, resilient children are likely to have a close relationship to a caring parent figure and bonds to caring adults outside the family.

At the other end of the life span, older adults have health issues that social policy can address (Hooyman, Kiyak, & Kawamoto, 2015; Hudson, 2016). Key concerns are escalating health-care costs and the access of older adults to adequate health care (Gaugler, 2016; Moon, 2016). One study found that the health-care system fails older adults in many ways (Wenger & others, 2003). For example, older adults received the recommended care for general medical conditions such as heart disease only 52 percent of the time; they received appropriate care for undernutrition and Alzheimer disease only 31 percent of the time.

Concerns about the well-being of older adults are heightened by two facts. First, the number of older adults in the United States is growing rapidly. Second, many of these older Americans are likely to need society's help (Williamson & Beland, 2016). Compared with earlier decades, U.S. adults today are less likely to be married, more likely to be childless, and more likely to live alone (Machielse, 2015). As the older population continues to expand during the twenty-first century, an increasing number of older adults will be without either a spouse or children—traditionally the main sources of support for older adults. These individuals will need social relationships, networks, and other supports (Antonucci & others, 2016; LaMantia & others, 2015).

The Nature of Development

In this section we explore what is meant by developmental processes and periods, as well as variations in the way age is conceptualized. We examine some key developmental issues.

If you wanted to describe how and why Alice Walker or Ted Kaczynski developed during their lifetimes, how would you go about it? A chronicle of the events in any person's life can quickly become a confusing and tedious array of details. Two concepts help provide a framework for describing and understanding an individual's development: developmental processes and periods.

Biological, Cognitive, and Socioemotional Processes

At the beginning of this chapter, we defined development as the pattern of change that begins at conception and continues through the life span. The pattern is complex because it is the product of biological, cognitive, and socioemotional processes.

Biological Processes

Biological processes produce changes in an individual's physical nature. Genes inherited from parents, the development of the brain, height and weight gains, changes in motor skills, nutrition, exercise, the hormonal changes of puberty, and cardiovascular decline are all examples of biological processes that affect development.

biological processes Changes in an individual's physical nature.

Cognitive Processes

cognitive processes Changes in an individual's thought, intelligence, and language.

socioemotional processes Changes in an individual's relationships with other people, emotions, and personality.

Cognitive processes refer to changes in an individual's thinking, intelligence, and language. Watching a colorful mobile swinging above the crib, putting together a two-word sentence, memorizing a poem, imagining what it would be like to be a movie star, and solving a crossword puzzle all involve cognitive processes.

Socioemotional Processes

Socioemotional processes involve changes in the individual's relationships with other people, changes in emotions, and changes in personality. An infant's smile in response to a parent's touch, a toddler's aggressive attack on a playmate, a school-age child's development of assertiveness, an adolescent's joy at the senior prom, and the affection of an elderly couple all reflect the role of socioemotional processes in development.

Connecting Biological, Cognitive, and Socioemotional Processes

Biological, cognitive, and socioemotional processes are inextricably intertwined (Diamond, 2013). Consider a baby smiling in response to a parent's touch. This response depends on biological processes (the physical nature of touch and responsiveness to it), cognitive processes (the ability to understand intentional acts), and socioemotional processes (the act of smiling often reflects a positive emotional feeling, and smiling helps to connect us in positive ways with other human beings). Nowhere is the connection across biological, cognitive, and socioemotional processes more obvious than in two rapidly emerging fields:

- *developmental cognitive neuroscience*, which explores links between development, cognitive processes, and the brain (de Haan & Johnson, 2016; Johnson, 2016)
- *developmental social neuroscience*, which examines connections between socioemotional processes, development, and the brain (Decety & Cowell, 2016; Monahan & others, 2016).

In many instances, biological, cognitive, and socioemotional processes are bidirectional. For example, biological processes can influence cognitive processes and vice versa. For the most part, we will study the different processes of development (biological, cognitive, and socioemotional) in separate chapters, but the human being is an integrated individual with a mind and body that are interdependent. Thus, in many places throughout the book we will call attention to the connections between these processes.

Periods of Development

The interplay of biological, cognitive, and socioemotional processes (see Figure 3) over time gives rise to the developmental periods of the human life span. A developmental period is a time frame in a person's life that is characterized by certain features. The most widely used classification of developmental periods involves an eight-period sequence. For the purposes of organization and understanding, this book is structured according to these developmental periods.

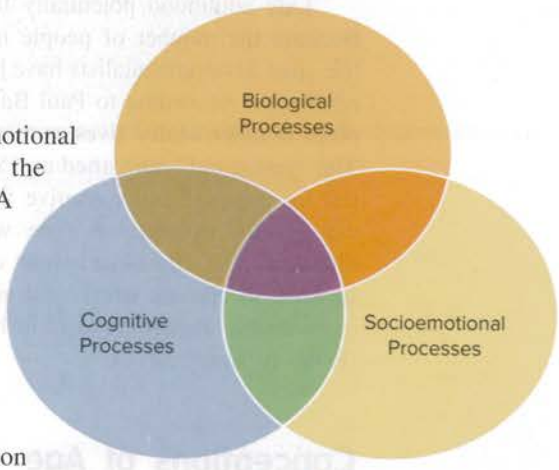

Figure 3 Processes Involved in Developmental Changes
Biological, cognitive, and socioemotional processes interact as individuals develop.

The *prenatal period* is the time from conception to birth. It involves tremendous growth—from a single cell to a complete organism with a brain and behavioral capabilities—and takes place in approximately a nine-month period.

Infancy is the developmental period from birth to 18 or 24 months when humans are extremely dependent on adults. During this period,

"This is the path to adulthood. You're here."

many psychological activities—language, symbolic thought, sensorimotor coordination, and social learning, for example—are just beginning.

Early childhood is the developmental period from the end of infancy to age 5 or 6. This period is sometimes called the "preschool years." During this time, young children learn to become more self-sufficient and to care for themselves. They also develop school readiness skills, such as the ability to follow instructions and identify letters, and they spend many hours playing with peers. First grade typically marks the end of early childhood.

Middle and late childhood is the developmental period from about 6 to 11 years of age, approximately corresponding to the elementary school years. During this period, children master the fundamental skills of reading, writing, and arithmetic. They are formally exposed to the world outside the family and to the prevailing culture. Achievement becomes a more central theme of the child's world, and self-control increases.

Adolescence encompasses the transition from childhood to early adulthood, entered at approximately 10 to 12 years of age and ending at 18 to 22 years of age. Adolescence begins with rapid physical changes—dramatic gains in height and weight, changes in body contour, and the development of sexual characteristics such as enlargement of the breasts, growth of pubic and facial hair, and deepening of the voice. At this point in development, the pursuit of independence and an identity are prominent themes. Thought is more logical, abstract, and idealistic. More time is spent outside the family.

Early adulthood is the developmental period that begins in the late teens or early twenties and lasts through the thirties. For young adults, this is a time for establishing personal and economic independence, becoming proficient in a career, and for many, selecting a mate, learning to live with that person in an intimate way, starting a family, and rearing children.

Middle adulthood is the developmental period from approximately 40 years of age to about 60. It is a time of expanding personal and social involvement and responsibility; of assisting the next generation in becoming competent, mature individuals; and of achieving and maintaining satisfaction in a career.

Late adulthood is the developmental period that begins in the sixties or seventies and lasts until death. It is a time of life review, retirement from the workforce, and adjustment to new social roles involving decreasing strength and health.

Late adulthood potentially lasts longer than any other period of development. Because the number of people in this age group has been increasing dramatically, life-span developmentalists have been paying more attention to differences within late adulthood. According to Paul Baltes and Jacqui Smith (2003), a major change takes place in older adults' lives as they become the "oldest-old," at about 85 years of age. The "young-old" (classified as 65 through 84 in this analysis) have substantial potential for physical and cognitive fitness, retain much of their cognitive capacity, and can develop strategies to cope with the gains and losses of aging. In contrast, the oldest-old (85 and older) show considerable loss in cognitive skills, experience an increase in chronic stress, and are more frail (Baltes & Smith, 2003). Nonetheless, considerable variation exists in how much of their capabilities the oldest-old retain (Rowe & Kahn, 2016).

Conceptions of Age

In our description of developmental periods, we attached an approximate age range to each period. But we also have noted that there are variations in the capabilities of individuals of the same age, and we have seen how age-related changes can be exaggerated. How important is age when we try to understand an individual?

(a)

(b)

(*a*) Dawn Russel, competing in a Senior Olympics competition in Oregon. (*b*) A sedentary, overweight middle-aged man. *Even if Dawn Russel's chronological age is older, might her biological age be younger than the middle-aged man's?*

(*a*) © Jay Syverson/Corbis; (*b*) © Owaki-Kulla Corbis

According to some life-span experts, chronological age is not very relevant to understanding a person's psychological development (Hoyer & Roodin, 2009). Chronological age is the number of years that have elapsed since birth. But time is a crude index of experience, and it does not cause development. Chronological age, moreover, is not the only way of measuring age (MacDonald & Stawski, 2016). Just as there are different domains of development, there are different ways of thinking about age.

Four Types of Age

Age has been conceptualized not just as chronological age but also as biological age, psychological age, and social age (Hoyer & Roodin, 2009). *Biological age* is a person's age in terms of biological health. Determining biological age involves knowing the functional capacities of a person's vital organs. One person's vital capacities may be better or worse than those of others of comparable chronological age. The younger the person's biological age, the longer the person is expected to live, regardless of chronological age.

Psychological age is an individual's adaptive capacities compared with those of other individuals of the same chronological age. Thus, older adults who continue to learn, remain flexible, are motivated, think clearly, and have positive personality traits are engaging in more adaptive behaviors than their chronological age-mates who do not do these things (Schaie, 2016). And a recent study found that a higher level of conscientiousness was protective of cognitive functioning in older adults (Wilson & others, 2015).

Social age refers to connectedness with others and the social roles individuals adopt. Individuals who have better social relationships with others are happier and tend to live longer than individuals who are lonely (Antonucci & others, 2016; Carstensen, 2015).

From a life-span perspective, an overall age profile of an individual involves not just chronological age but also biological age, psychological age, and social age. For example, a 70-year-old man (chronological age) might be in good physical health (biological age), but might be experiencing memory problems and having trouble coping with the demands placed on him by his wife's recent hospitalization (psychological age) and dealing with a lack of social support (social age).

Three Developmental Patterns of Aging

K. Warner Schaie (2016) recently described three different developmental patterns that provide a portrait of how aging can involve individual variations:

- *Normal aging* characterizes most individuals, for whom psychological functioning often peaks in early middle age, remains relatively stable until the late fifties to

early sixties, and then shows a modest decline through the early eighties. However, marked decline can occur as individuals near death.

- *Pathological aging* characterizes individuals who show greater than average decline as they age through the adult years. In early old age, they may have mild cognitive impairment, develop Alzheimer disease later on, or have a chronic disease that impairs their daily functioning.
- *Successful aging* characterizes individuals whose positive physical, cognitive, and socioemotional development is maintained longer, declining later in old age than is the case for most people. For too long, only the declines that occur in late adulthood were highlighted but recently there has been increased interest in the concept of successful aging (Araujo & others, 2016; Carstensen, Smith, & Jaworski, 2015; Rowe & Kahn, 2015).

Age and Happiness

Is there a best age to be? An increasing number of studies indicate that at least in the United States adults are happier as they age (Stone & others, 2010). Consider also a U.S. study of approximately 28,000 individuals from 18 to 88 that revealed happiness increased with age (Yang, 2008). For example, about 33 percent were very happy at 88 years of age compared with only about 24 percent in their late teens and early twenties. In a recent study of individuals from 22 to 93 years of age, older adults reported having more positive emotional experiences than did young adults (English & Carstensen, 2014).

Why might older people report being happier and more satisfied with their lives than younger people? Despite the increase in physical problems and losses older adults experience, they are more content with what they have in their lives, have better relationships with the people who matter to them, are less pressured to achieve, have more time for leisurely pursuits, and have many years of experience that may help them adapt to their circumstances with greater wisdom than younger adults do (Carstensen, 2015, 2016; Sims, Hogan, & Carstensen, 2015).

Not all studies, though, have found an increase in life satisfaction with age (Steptoe, Deaton, & Stone, 2015). Some studies indicate that the lowest levels of life-satisfaction are in middle age, especially from 45 to 54 years of age (OECD, 2014). Other studies have found that life satisfaction varies across some countries. For example, research with respondents from the former Soviet Union and Eastern Europe, as well as those from South American countries, report a decrease in life satisfaction with advancing age (Deaton, 2008). Further, older adults in poor health, such as those with cardiovascular disease, chronic lung disease, and depression, are less satisfied with their lives than are their healthier older adult counterparts (Wikman, Wardle, & Steptoe, 2011).

Researchers also have distinguished between the evaluative and hedonic aspects of life-course trajectories (Lachman, Teshale, & Agrigoroaei, 2015). In some studies, it is only the *evaluative* dimension (life satisfaction) that reaches a low point in middle adulthood (Stone & others, 2010). In contrast, the *hedonic* aspects (happiness and positive affect) take an upward trajectory from early adulthood through late adulthood, which is sometimes referred to as a *positivity effect* (Carstensen, 2015; Sims, Hogan, & Carstensen, 2015).

Now that you have read about age variations in life satisfaction, think about how satisfied you are with your life. To help you answer this question, complete the items in Figure 4, which presents the most widely used measure in research on life satisfaction (Diener, 2016).

Developmental Issues

Was Ted Kaczynski born a killer, or did his life turn him into one? Kaczynski himself thought that his childhood was the root of his troubles. He said he grew up as a genius in a boy's body and never fit in with other children. Did his early experiences determine his later life? Is your own journey through life marked out ahead of time, or can your

Below are five statements that you may agree or disagree with. Using the 1–7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

Scale
7 Strongly agree
6 Agree
5 Slightly agree
4 Neither agree nor disagree
3 Slightly disagree
2 Disagree
1 Strongly disagree

Response	Statement
2	In most ways my life is close to my ideal.
3	The conditions of my life are excellent.
5	I am satisfied with my life.
5	So far I have gotten the important things I want in life.
3	If I could live my life over, I would change almost nothing.
18	Total score

Scoring	
31–35	Extremely satisfied
26–30	Satisfied
21–25	Slightly satisfied
20	Neutral
15–19	Slightly dissatisfied
10–14	Dissatisfied
5–9	Extremely dissatisfied

Figure 4 How Satisfied Am I With My Life?
Source: Diener, E., Emmons, R.A., Larson, R.J., & Griffin, S. (1985). The Satisfaction with Life Scale. *Journal of Personality Assessment, 49,* 71–75.

experiences change your path? Are the experiences you have early in your journey more important than later ones? Is your journey more like taking an elevator up a skyscraper with distinct stops along the way or more like a cruise down a river with smoother ebbs and flows? These questions point to three issues about the nature of development: the roles played by nature and nurture, stability and change, and continuity and discontinuity.

Nature and Nurture

The **nature-nurture issue** concerns the extent to which development is influenced by nature and by nurture. *Nature* refers to an organism's biological inheritance, *nurture* to its environmental experiences.

According to those who emphasize the role of nature, just as a sunflower grows in an orderly way—unless flattened by an unfriendly environment—so too the human grows in an orderly way. An evolutionary and genetic foundation produces commonalities in growth and development (Belsky & Pluess, 2016; Buss, 2015; Del Giudice & Ellis, 2016; Sutphin & Korstanje, 2016). We walk before we talk, speak one word before two words, grow rapidly in infancy and less so in early childhood, experience a rush of sex hormones in puberty, reach the peak of our physical strength in late adolescence and early adulthood, and then physically decline. Proponents of the importance of nature acknowledge that extreme environments—those that are psychologically barren or hostile—can depress development. However, they believe that basic growth tendencies are genetically programmed into humans (Yang, Song, & Johnson, 2016).

By contrast, other psychologists emphasize the importance of nurture, or environmental experiences, in development (Burt, Coatsworth, & Masten, 2016). Experiences run the gamut from the individual's biological environment (nutrition, exercise, medical care, drugs, and physical accidents) to the social environment (family, peers, schools, community, media, and culture) (Gonzales & others, 2016; Pianta, 2016).

What are some key developmental issues?
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nature-nurture issue The debate about the extent to which development is influenced by nature and by nurture. Nature refers to an organism's biological inheritance, nurture to its environmental experiences.

Stability and Change

Is the shy child who hides behind the sofa when visitors arrive destined to become a wallflower at college dances, or might the child become a sociable, talkative individual? Is the fun-loving, carefree adolescent

bound to have difficulty holding down a 9-to-5 job as an adult? These questions reflect the **stability-change issue,** involving the degree to which early traits and characteristics persist or change over time.

Many developmentalists who emphasize stability in development argue that stability is the result of heredity and possibly early experiences in life. For example, many argue that if an individual is shy throughout life (as Ted Kaczynski was), this stability is due to heredity and possibly early experiences in which the infant or young child encountered considerable stress when interacting with people. Some argue that unless infants experience warm, nurturant caregiving in the first year or so of life, their development will never be optimal (Easterbrooks & others, 2013; O'Connor, 2016).

Developmentalists who emphasize change take the more optimistic view that later experiences can produce change. Recall that in the life-span perspective, plasticity, the potential for change, exists throughout the life span (Kuhn & Lindenberger, 2016). Experts such as Paul Baltes (2003) argue that older adults often show less capacity for learning new things than younger adults do. However, many older adults continue to be good at applying what they have learned in earlier times.

Continuity and Discontinuity

When developmental change occurs, is it gradual or abrupt? Think about your own development for a moment. Did you gradually become the person you are today? Or did you experience sudden, distinct changes in your growth? For the most part, developmentalists who emphasize nurture describe development as a gradual, continuous process. Those who emphasize nature often describe development as a series of distinct stages.

The **continuity-discontinuity issue** focuses on the degree to which development involves either gradual, cumulative change (continuity) or distinct stages (discontinuity). In terms of continuity, as the oak grows from a seedling to a giant tree, its development is continuous. Similarly, a child's first word, though seemingly an abrupt, discontinuous event, is actually the result of weeks and months of growth and practice. Puberty might seem abrupt, but it is a gradual process that occurs over several years.

In terms of discontinuity, as an insect grows from a caterpillar to a chrysalis to a butterfly, it passes through a sequence of stages in which change is qualitatively rather than quantitatively different. Similarly, at some point a child moves from not being able to think abstractly about the world to being able to do so. This is a qualitative, discontinuous change in development rather than a quantitative, continuous change.

Evaluating the Developmental Issues

Developmentalists generally acknowledge that development is not all nature or all nurture, not all stability or all change, and not all continuity or all discontinuity. Nature and nurture, stability and change, continuity and discontinuity characterize development throughout the life span.

Although most developmentalists do not take extreme positions on these three important issues, there is spirited debate regarding how strongly development is influenced by each of these factors (Grigorenko & others, 2016; Hill & Roth, 2016; Sroufe, 2016; Thompson & Goodvin, 2016).

Theories of Development

stability-change issue The debate about the degree to which early traits and characteristics persist through life or change.

continuity-discontinuity issue The debate about the extent to which development involves gradual, cumulative change (continuity) or distinct stages (discontinuity).

How can we answer questions about the roles of nature and nurture, stability and change, and continuity and discontinuity in development? How can we determine, for example, whether memory loss in older adults can be prevented or whether special care can repair the harm inflicted by child neglect? The scientific method is the best tool we have to answer such questions (Smith & Davis, 2016).

The scientific method is essentially a four-step process: (1) conceptualize a process or problem to be studied, (2) collect research information (data), (3) analyze data, and (4) draw conclusions.

In step 1, when researchers are formulating a problem to study, they often draw on theories and develop hypotheses. A **theory** is an interrelated, coherent set of ideas that helps to explain phenomena and make predictions. It may suggest **hypotheses,** which are specific assertions and predictions that can be tested. For example, a theory on mentoring might state that sustained support and guidance from an adult makes a difference in the lives of children from impoverished backgrounds because the mentor gives the children opportunities to observe and imitate the behavior and strategies of the mentor.

theory A coherent set of ideas that helps to explain data and to make predictions.

hypotheses Assertions or predictions, often derived from theories, that can be tested.

psychoanalytic theories Theories holding that development depends primarily on the unconscious mind and is heavily couched in emotion, that behavior is merely a surface characteristic, that it is important to analyze the symbolic meanings of behavior, and that early experiences are important in development.

This section outlines five theoretical orientations to development: psychoanalytic, cognitive, behavioral and social cognitive, ethological, and ecological. These theories look at development from different perspectives, and they disagree about certain aspects of development. But many of their ideas are complementary, and each contributes an important piece to the life-span development puzzle. Although the theories disagree about certain aspects of development, many of their ideas are complementary rather than contradictory. Together they let us see the total landscape of life-span development in all its richness.

Psychoanalytic Theories

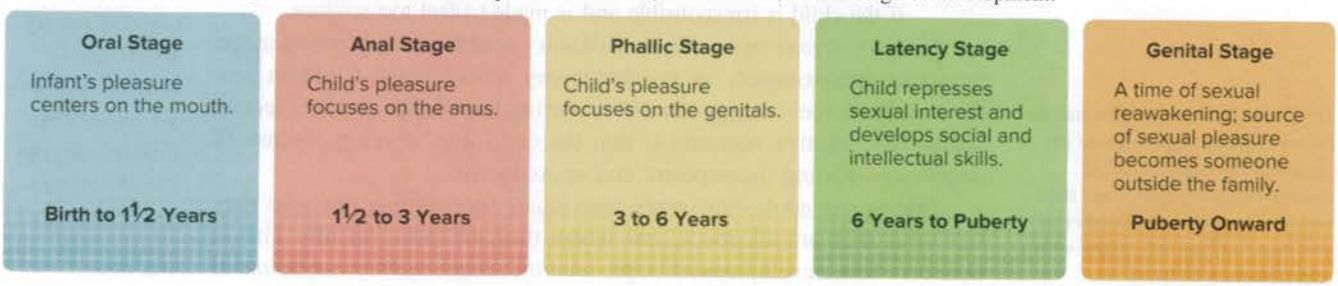
Psychoanalytic theories describe development primarily in terms of unconscious (beyond awareness) processes that are heavily colored by emotion. Psychoanalytic theorists emphasize that behavior is merely a surface characteristic and that a true understanding of development requires analyzing the symbolic meanings of behavior and the deep inner workings of the mind. Psychoanalytic theorists also stress that early experiences with parents extensively shape development. These characteristics are highlighted in the main psychoanalytic theory, that of Sigmund Freud (1856–1939).

Freud's Theory

Freud was a pioneer in the treatment of psychological problems. Based on his belief that patients who talked about their problems could be restored to psychological health, Freud developed a technique called psychoanalysis. As he listened to, probed, and analyzed his patients, he became convinced that their problems were the result of experiences early in life. He thought that as children grow up, their focus of pleasure and sexual impulses shifts from the mouth to the anus and eventually to the genitals. Consequently, he determined, we pass through five stages of psychosexual development: oral, anal, phallic, latency, and genital (see Figure 5). Our adult personality, Freud (1917) claimed, is determined by the way we resolve conflicts between sources of pleasure at each stage and the demands of reality.

Freud's followers significantly revised his psychoanalytic theory. Many of today's psychoanalytic theorists believe that Freud overemphasized sexual instincts; they place more emphasis on cultural experiences as determinants of an individual's development. Unconscious thought remains a central theme, but conscious thought plays a

Figure 5 Freudian Stages
Because Freud emphasized sexual motivation, his stages of development are known as psychosexual stages. In his view, if the need for pleasure at any stage is either undergratified or overgratified, an individual may become fixated, or locked in, at that stage of development.



Erikson's Stages	Developmental Period
Integrity versus despair	Late adulthood (60s onward)
Generativity versus stagnation	Middle adulthood (40s, 50s)
Intimacy versus isolation	Early adulthood (20s, 30s)
Identity versus identity confusion	Adolescence (10 to 20 years)
Industry versus inferiority	Middle and late childhood (elementary school years, 6 years to puberty)
Initiative versus guilt	Early childhood (preschool years, 3 to 5 years)
Autonomy versus shame and doubt	Infancy (1 to 3 years)
Trust versus mistrust	Infancy (first year)

Figure 6 Erikson's Eight Life-Span Stages

Like Freud, Erikson proposed that individuals go through distinct, universal stages of development. In terms of the continuity-discontinuity issue, both favor the discontinuity side of the debate. Notice that the timing of Erikson's first four stages is similar to that of Freud's stages. *What are the implications of saying that people go through stages of development?*

greater role than Freud envisioned. Next, we will outline the ideas of an important revisionist of Freud's theory—Erik Erikson.

Erikson's Psychosocial Theory

Erik Erikson recognized Freud's contributions but believed that Freud misjudged some important dimensions of human development. For one thing, Erikson (1950, 1968) said we develop in psychosocial stages, rather than the psychosexual stages that Freud described. According to Freud, the primary motivation for human behavior is sexual in nature; according to Erikson, motivation is social and reflects a desire to affiliate with other people. According to Freud, our basic personality is shaped in the first five years of life; according to Erikson, developmental change occurs throughout the life span. Thus, Freud viewed early experiences as far more important than later experiences, whereas Erikson emphasized the importance of both early and later experiences.

In **Erikson's theory,** eight stages of development unfold as we go through life (see Figure 6). At each stage, a unique developmental task confronts individuals with a crisis that must be resolved. According to Erikson, this crisis is not a catastrophe but a turning point marked by both increased vulnerability and enhanced potential. The more successfully an individual resolves these crises, the healthier his or her development will be.

Trust versus mistrust is Erikson's first psychosocial stage, which is experienced in the first year of life. Trust during infancy sets the stage for a lifelong expectation that the world will be a good and pleasant place to live.

Autonomy versus shame and doubt is Erikson's second stage. This stage occurs in late infancy and toddlerhood (1 to 3 years). After gaining trust in their caregivers, infants begin to discover that their behavior is their own. They start to assert their sense of independence or autonomy. They realize their will. If infants and toddlers are restrained too much or punished too harshly, they are likely to develop a sense of shame and doubt.

Initiative versus guilt, Erikson's third stage of development, occurs during the preschool years. As preschool children encounter a widening social world, they face new challenges that require active, purposeful, responsible behavior. Feelings of guilt may arise, though, if the child is irresponsible and is made to feel too anxious.

Industry versus inferiority is Erikson's fourth developmental stage, occurring approximately in the elementary school years. Children now need to direct their energy toward mastering knowledge and intellectual skills. The negative outcome is that the child may develop a sense of inferiority—feeling incompetent and unproductive.

During the adolescent years individuals face finding out who they are, what they are all about, and where they are going in life. This is Erikson's fifth developmental stage, *identity versus identity confusion.* If

Erik Erikson with his wife, Joan, an artist. Erikson generated one of the most important developmental theories of the twentieth century. *Which stage of Erikson's theory are you in? Does Erikson's description of this stage characterize you?*

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Erikson's theory A psychoanalytic theory in which eight stages of psychosocial development unfold throughout the life span. Each stage consists of a unique developmental task that confronts individuals with a crisis that must be faced.

adolescents explore roles in a healthy manner and arrive at a positive path to follow in life, then they achieve a positive identity; if not, then identity confusion reigns.

Intimacy versus isolation is Erikson's sixth developmental stage, which individuals experience during early adulthood. At this time, individuals face the developmental task of forming intimate relationships. If young adults form healthy friendships and an intimate relationship with a partner, intimacy will be achieved; if not, isolation will result.

Generativity versus stagnation, Erikson's seventh developmental stage, occurs during middle adulthood. By generativity, Erikson means primarily a concern for helping the younger generation to develop and lead useful lives. The feeling of having done nothing to help the next generation is stagnation.

Integrity versus despair is Erikson's eighth and final stage of development, which individuals experience in late adulthood. During this stage, a person reflects on the past. If the person's life review reveals a life well spent, integrity will be achieved; if not, the retrospective glances likely will yield doubt or gloom—the despair Erikson described.

Evaluating Psychoanalytic Theories

Contributions of psychoanalytic theories like Freud's and Erikson's to life-span development include an emphasis on a developmental framework, family relationships, and unconscious aspects of the mind. These theories have been criticized for a lack of scientific support, too much emphasis on sexual underpinnings, and an image of people that is too negative.

Cognitive Theories

Whereas psychoanalytic theories stress the unconscious, cognitive theories emphasize conscious thoughts. Three important cognitive theories are Piaget's cognitive developmental theory, Vygotsky's sociocultural cognitive theory, and information-processing theory. All three focus on the development of complex thinking skills.

Piaget's Cognitive Developmental Theory

Piaget's theory states that children go through four stages of cognitive development as they actively construct their understanding of the world. Two processes underlie this cognitive construction of the world: organization and adaptation. To make sense of our world, we organize our experiences. For example, we separate important ideas from less important ideas, and we connect one idea to another. In addition to organizing our observations and experiences, we must adjust to changing environmental demands (Miller, 2015).

Piaget (1954) described four stages in understanding the world (see Figure 7). Each stage is age-related and consists of a distinct way of thinking, a different way of understanding the world. Thus, according to Piaget, the child's cognition is *qualitatively* different in one stage compared with another. What are Piaget's four stages of cognitive development?

The *sensorimotor stage,* which lasts from birth to about 2 years of age, is the first Piagetian stage. In this stage, infants construct an understanding of the world by coordinating sensory experiences (such as seeing and hearing) with physical, motor actions—hence the term *sensorimotor.*

The *preoperational stage,* which lasts from approximately 2 to 7 years of age, is Piaget's second stage. In this stage, children begin to go beyond simply connecting sensory information with physical action and are now able to represent the world with words, images, and drawings. However, according to Piaget, preschool children still lack the ability to perform what he calls *operations,* which are internalized mental actions that allow children to do mentally what they previously could only do physically. For example, if you imagine putting two sticks together to see whether they would be as long as another stick, without actually moving the sticks, you are performing a concrete operation.

Piaget's theory The theory that children construct their understanding of the world and go through four stages of cognitive development.

Jean Piaget, the famous Swiss developmental psychologist, changed the way we think about the development of children's minds. *What are some key ideas in Piaget's theory?*

Sensorimotor Stage

The infant constructs an understanding of the world by coordinating sensory experiences with physical actions. An infant progresses from reflexive, instinctual action at birth to the beginning of symbolic thought toward the end of the stage.

Birth to 2 Years of Age

Preoperational Stage

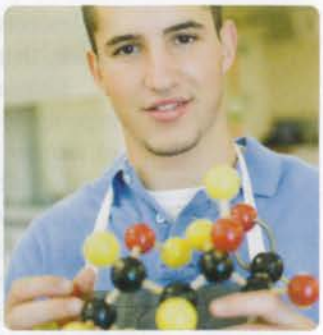
The child begins to represent the world with words and images. These words and images reflect increased symbolic thinking and go beyond the connection of sensory information and physical action.

2 to 7 Years of Age

Concrete Operational Stage

The child can now reason logically about concrete events and classify objects into different sets.

7 to 11 Years of Age



Formal Operational Stage

The adolescent reasons in more abstract, idealistic, and logical ways.

11 Years of Age Through Adulthood

Figure 7 Piaget's Four Stages of Cognitive Development
According to Piaget, how a child thinks—not how much the child knows—determines the child's stage of cognitive development.

Left to right © Stockbyte/Getty Images RF; © BananaStock/PunchStock RF; © image100/Corbis RF; © Purestock/Getty Images RF

Lev Vygotsky was born the same year as Piaget, but he died much earlier, at the age of 37. There is considerable interest today in Vygotsky's sociocultural cognitive theory of child development. *What are some key characteristics of Vygotsky's theory?*

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The *concrete operational stage,* which lasts from approximately 7 to 11 years of age, is the third Piagetian stage. In this stage, children can perform operations that involve objects, and they can reason logically about specific or concrete examples. Concrete operational thinkers, however, cannot imagine the steps necessary to complete an algebraic equation because doing so would require a level of thinking that is too abstract for this stage of development.

The *formal operational stage,* which appears between the ages of 11 and 15 and continues through adulthood, is Piaget's fourth and final stage. In this stage, individuals move beyond concrete experiences and think in abstract and more logical terms. As part of thinking more abstractly, adolescents develop images of ideal circumstances. They might think about what an ideal parent is like and compare their parents to this ideal standard. They begin to entertain possibilities for the future and are fascinated with what they can become. In solving problems, they become more systematic, developing hypotheses about why something is happening the way it is and then testing these hypotheses. We will examine Piaget's cognitive developmental theory further.

Vygotsky's Sociocultural Cognitive Theory

Like Piaget, the Russian developmentalist Lev Vygotsky (1896–1934) reasoned that children actively construct their knowledge. However, Vygotsky (1962) gave social interaction and culture far more important roles in cognitive development than Piaget did.

Vygotsky's theory is a sociocultural cognitive theory that emphasizes how culture and social interaction guide cognitive development. Vygotsky portrayed the child's development as inseparable from social and cultural activities (Gauvain & Perez, 2015). He stressed that cognitive development involves learning to use the inventions of society, such as language, mathematical systems, and memory strategies. Thus, in one culture children might learn to count with the help of a computer; in another they might learn by using beads. According to Vygotsky, children's social interaction with more-skilled adults and peers is indispensable to their cognitive development (Rogoff & others, 2015). Through this interaction, they learn to use the tools that will help them adapt and be successful in their culture. Later we will examine ideas about learning and teaching that are based on Vygotsky's theory.

Information-Processing Theory

Information-processing theory emphasizes that individuals manipulate information, monitor it, and strategize about it. Unlike Piaget's theory but like Vygotsky's theory, information-processing theory does not describe development as stage-like. Instead, according to this theory individuals develop a gradually increasing capacity for processing information, which allows them to acquire increasingly complex knowledge and skills (Muller & Kerns, 2015).

Robert Siegler (2006, 2013), a leading expert on children's information processing, states that thinking is information processing. In other words, when individuals perceive, encode, represent, store, and retrieve information, they are thinking. Siegler emphasizes that an important aspect of development is learning good strategies for processing information (Siegler, 2016a, b). For example, becoming a better reader might involve learning to monitor the key themes of the material being read.

Siegler (2006) also argues that the best way to understand how children learn is to observe them while they are learning. He emphasizes the importance of using the *microgenetic method* to obtain detailed information about processing mechanisms as they are occurring moment to moment. Siegler concludes that most research methods indirectly assess cognitive change, being more like snapshots than movies. The microgenetic method seeks to discover not just what children know but the cognitive processes involved in how they acquired the knowledge (Miller, 2015). A number of microgenetic studies have focused on a specific aspect of academic learning, such as how children learn whole number arithmetic, fractions, and other areas of math (Siegler, 2016a, b).

Evaluating Cognitive Theories

Contributions of cognitive theories include a positive view of development and an emphasis on the active construction of understanding. Criticisms include skepticism about the pureness of Piaget's stages and a belief that too little attention is paid to individual variations.

Behavioral and Social Cognitive Theories

Behavioral and social cognitive theories hold that development can be described in terms of behaviors learned through interactions with our surroundings. Behaviorism essentially holds that we can study scientifically only what can be directly observed and measured. Out of the behavioral tradition grew the belief that development is observable behavior that can be learned through experience with the environment (Spiegler, 2016). In terms of the continuity-discontinuity issue discussed earlier in this chapter, the behavioral and social cognitive theories emphasize continuity in development and argue that development does not occur in stage-like fashion. Let's explore two versions of behaviorism: Skinner's operant conditioning and Bandura's social cognitive theory.

Vygotsky's theory A sociocultural cognitive theory that emphasizes how culture and social interaction guide cognitive development.

information-processing theory A theory emphasizing that individuals manipulate information, monitor it, and strategize about it. The processes of memory and thinking are central.

behavioral and social cognitive theories Theories holding that development can be described in terms of the behaviors learned through interactions with the environment.

Skinner's Operant Conditioning

According to B. F. Skinner (1904–1990), through *operant conditioning* the consequences of a behavior produce changes in the probability of the behavior's recurrence. A behavior followed by a rewarding stimulus is more likely to recur, whereas a behavior followed by a punishing stimulus is less likely to recur. For example, when an adult smiles at a child after the child has done something, the child is more likely to engage in that behavior again than if the adult gives the child a disapproving look.

In Skinner's (1938) view, such rewards and punishments shape development. For Skinner the key aspect of development is behavior, not thoughts and feelings. He emphasized that development consists of the pattern of behavioral changes that are brought about by rewards and punishments. For example, Skinner would say that shy people learned to be shy as a result of experiences they had while growing up. It follows that modifications to an environment can help a shy person become more socially oriented.

Albert Bandura is a leading architect of social cognitive theory. *How does Bandura's theory differ from Skinner's?*

Bandura's Social Cognitive Theory

Some psychologists agree with the behaviorists' notion that development is learned and is influenced strongly by environmental interactions. However, unlike Skinner, they also see cognition as important in understanding development. **Social cognitive theory** holds that behavior, environment, and person/cognitive factors are the key factors in development.

American psychologist Albert Bandura (1925) is the leading architect of social cognitive theory. Bandura (1986, 2004, 2010a, b, 2012, 2015) emphasizes that cognitive processes have important links with the environment and behavior. His early research program focused heavily on *observational learning* (also called *imitation* or *modeling*), which is learning that occurs through observing what others do. For example, a young boy might observe his father yelling in anger and treating other people with hostility; and then later with his peers, the young boy acts very aggressively, showing the same behavioral characteristics as his father. Social cognitive theorists stress that people acquire a wide range of behaviors, thoughts, and feelings through observing others' behavior and that these observations form an important part of life-span development.

What is *cognitive* about observational learning in Bandura's view? He proposes that people cognitively represent the behavior of others and then sometimes adopt this behavior themselves.

Bandura's (2004, 2010a, b, 2012, 2015) most recent model of learning and development includes three elements: behavior, the person/cognition, and the environment. An individual's confidence that he or she can control his or her success is an example of a person factor; strategies for achieving success are an example of a cognitive factor. As shown in Figure 8, influences from behavior, person/cognition, and environment operate interactively.

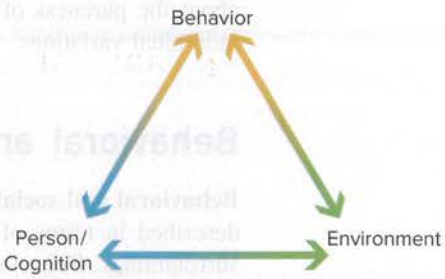


Figure 8 Bandura's Social Cognitive Model The arrows illustrate how relations between behavior, person/cognition, and environment are reciprocal rather than one-way. Person/cognition refers to cognitive processes (for example, thinking and planning) and personal characteristics (for example, believing that you can control your experiences).

Evaluating Behavioral and Social Cognitive Theories

Contributions of the behavioral and social cognitive theories include an emphasis on scientific research and environmental determinants of behavior. These theories have been criticized for placing too little emphasis on cognition (Skinner) and giving inadequate attention to developmental changes.

social cognitive theory The theory that behavior, environment, and person/cognitive factors are important in understanding development.

Ethological Theory

ethology An approach stressing that behavior is strongly influenced by biology, tied to evolution, and characterized by critical or sensitive periods.

Ethology is the study of the behavior of animals in their natural habitat. Ethological theory stresses that behavior is strongly influenced by biology, is tied to evolution, and is characterized by critical or sensitive periods (Bateson, 2015). These are specific time frames during which, according to ethologists, the presence or absence of certain experiences has a long-lasting influence on individuals.

Lorenz's Research with Greylag Geese

European zoologist Konrad Lorenz (1903–1989) helped bring ethology to prominence. In his best-known research, Lorenz (1965) studied the behavior of greylag geese, which follow their mothers as soon as they hatch. Lorenz separated the eggs laid by one goose into two groups. One group he returned to the goose to be hatched by her. The other group was hatched in an incubator. The goslings in the first group performed as predicted. They followed their mother as soon as they hatched. However, those in the second group, which saw Lorenz when they first hatched, followed him everywhere as though he were their mother. Lorenz marked the goslings and then placed both groups under a box. Mother goose and "mother" Lorenz stood aside as the box was lifted. Each group of goslings went directly to its "mother." Lorenz called this process *imprinting*—the rapid, innate learning that involves attachment to the first moving object seen.

John Bowlby (1969, 1989) illustrated an important application of ethological theory to human development. Bowlby stressed that attachment to a caregiver over the first year of life has important consequences throughout the life span. In his view, if this attachment is positive and secure, the individual will likely develop positively in childhood and adulthood. If the attachment is negative and insecure, development will likely not be optimal. Later we will explore the concept of infant attachment in much greater detail.

In Lorenz's view, imprinting needs to take place at a specific, very early time in the life of the animal, or else it will not take place. This point in time is called a critical period. A related concept is that of a sensitive period, and an example is the time during infancy when, according to Bowlby, attachment should occur in order to promote optimal development of social relationships.

Another theory that emphasizes biological foundations of development—evolutionary psychology—will be presented in another chapter, along with views on the role of heredity in development. In addition, we will examine a number of biological theories of aging.

Evaluating Ethological Theory

Contributions of ethological theory include a focus on the biological and evolutionary basis of development, and the use of careful observations in naturalistic settings. Criticisms include a belief that it places too much emphasis on biological foundations and that the concept of a critical and sensitive period might be too rigid.

Ecological Theory

While ethological theory stresses biological factors, ecological theory emphasizes environmental factors. One ecological theory that has important implications for understanding life-span development was created by Urie Bronfenbrenner (1917–2005).

Konrad Lorenz, a pioneering student of animal behavior, is followed through the water by three imprinted greylag geese. Describe Lorenz's experiment with the geese. *Do you think his experiment would have the same results with human babies? Explain.*

Bronfenbrenner's Ecological Theory

Bronfenbrenner's ecological theory (1986, 2004; Bronfenbrenner & Morris, 2006) holds that development reflects the influence of several environmental systems. The theory identifies five environmental systems: microsystem, mesosystem, exosystem, macrosystem, and chronosystem (see Figure 9).

The *microsystem* is the setting in which the individual lives. These contexts include the person's family, peers, school, and neighborhood. It is in the microsystem that the most direct interactions with social agents take place—with parents, peers, and teachers, for example. The individual is not a passive recipient of experiences in these settings, but someone who helps to construct the settings.

The *mesosystem* involves relations between microsystems or connections between contexts. Examples are the relation of family experiences to school experiences, school experiences to church experiences, and family experiences to peer experiences. For example, children whose parents have rejected them may have difficulty developing positive relations with teachers.

The *exosystem* consists of links between a social setting in which the individual does not have an active role and the individual's immediate context. For example, a husband's or child's experience at home may be influenced by a mother's experiences at work. The mother might receive a promotion that requires more travel, which might increase conflict with the husband and change patterns of interaction with the child.

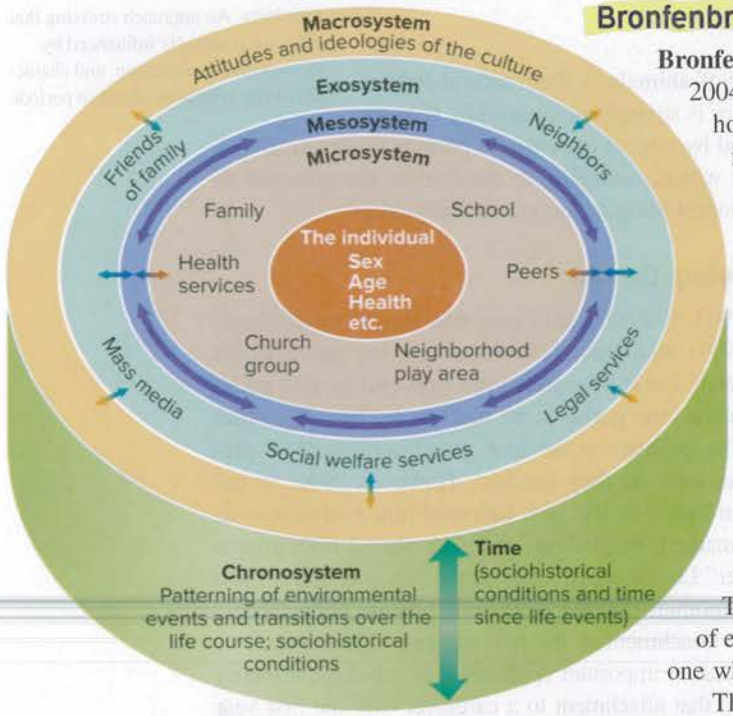


Figure 9 Bronfenbrenner's Ecological Theory of Development
Bronfenbrenner's ecological theory consists of five environmental systems: microsystem, mesosystem, exosystem, macrosystem, and chronosystem.

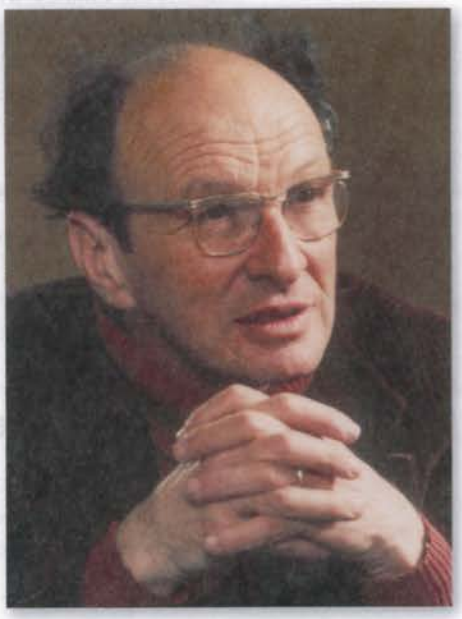
The *macrosystem* involves the culture in which individuals live. Remember from earlier in the chapter that *culture* refers to the behavior patterns, beliefs, and all other products of a group of people that are passed on from generation to generation. Remember also that cross-cultural studies—the comparison of one culture with one or more other cultures—provide information about the generality of development.

How Would You...?

If you were an **educator,** how might you explain a student's chronic failure to complete homework from the mesosystem level? From the exosystem level?

The *chronosystem* consists of the patterning of environmental events and transitions over the life course, as well as sociohistorical circumstances. For example, divorce is one transition. Researchers have found that the negative effects of divorce on children often peak in the first year after the divorce (Hetherington, 2006). By two years after the divorce, family interaction has become more stable. As an example of sociohistorical circumstances, consider how the opportunities for women to pursue a career have increased since the 1960s.

Bronfenbrenner's ecological theory Bronfenbrenner's environmental systems theory, which focuses on five environmental systems: microsystem, mesosystem, exosystem, macrosystem, and chronosystem.



Urie Bronfenbrenner developed ecological theory, a perspective that is receiving increased attention today. His theory emphasizes the importance of both micro and macro dimensions of the environment in which the child lives.

Responding to growing interest in biological contributions to development, Bronfenbrenner (2004) added biological influences to his theory and relabeled it as a bioecological theory. Nonetheless, it is still dominated by ecological, environmental contexts (Gauvain & Perez, 2015).

Evaluating Ecological Theory

Contributions of ecological theory include its systematic examination of macro and micro dimensions of environmental systems and its attention to connections between environmental systems. A further contribution of Bronfenbrenner's theory is an emphasis on a range of social contexts beyond the family, such as neighborhood, religious, school, and workplace environments, as influential in children's development (Gauvain & Perez, 2015). The theory has been criticized for giving inadequate attention to biological factors, as well as placing too little emphasis on cognitive factors.

An Eclectic Theoretical Orientation

No single theory described in this chapter can explain entirely the rich complexity of life-span development, but each has contributed to our understanding of development. Psychoanalytic theory highlights the importance of the unconscious mind. Erikson's theory best describes the changes that occur in adult development. Piaget's, Vygotsky's, and the information-processing views provide the most complete description of cognitive development. The behavioral and social cognitive and ecological theories have been the most adept at examining the environmental determinants of development. The ethological theories have drawn attention to biology's role and the importance of sensitive periods in development.

In short, although theories are helpful guides, relying on a single theory to explain development is probably a mistake. This book instead takes an **eclectic theoretical orientation,** which does not follow any one theoretical approach but rather presents what are considered the best features of each theory. In this way, it represents the study of development as it actually exists—with different theorists making different assumptions, stressing different problems, and using different strategies to discover information. Figure 10 compares the main theoretical perspectives in terms of how they view important issues in life-span development.

eclectic theoretical orientation An approach that selects and uses whatever is considered the best in many theories.

THEORY	ISSUES	
	Continuity/discontinuity, early versus later experiences	Biological and environmental factors
Psychoanalytic	Discontinuity between stages—continuity between early experiences and later development; early experiences very important; later changes in development emphasized in Erikson's theory	Freud's biological determination interacting with early family experiences; Erikson's more balanced biological-cultural interaction perspective
Cognitive	Discontinuity between stages in Piaget's theory; continuity between early experiences and later development in Piaget's and Vygotsky's theories; no stages in Vygotsky's theory or information-processing theory	Piaget's emphasis on interaction and adaptation; environment provides the setting for cognitive structures to develop; information-processing view has not addressed this issue extensively but mainly emphasizes biological-environmental interaction
Behavioral and social cognitive	Continuity (no stages); experience at all points of development important	Environment viewed as the cause of behavior in both views
Ethological	Discontinuity but no stages; critical or sensitive periods emphasized; early experiences very important	Strong biological view
Ecological	Little attention to continuity/discontinuity; change emphasized more than stability	Strong environmental view

Figure 10 Summary of Theories and Issues in Life-Span Development

Research in Life-Span Development

How do scholars and researchers with an eclectic orientation determine that one theory is somehow better than a different theory? The scientific method discussed earlier in this chapter provides a guide. Through scientific research, theories are tested and refined (Christensen, Johnson, & Turner, 2015).

Generally, research in life-span development is designed to test hypotheses, which may be derived from the theories just described. Through research, theories are modified to reflect new data, and occasionally new theories arise. How are data about life-span development collected? What types of research designs are used to study life-span development? And what are some ethical considerations in conducting research on life-span development?

Methods for Collecting Data

Whether we are interested in studying attachment in infants, the cognitive skills of children, or social relationships in older adults, we can choose from several ways of collecting data (Salkind, 2017; Trochim, Donnelly, & Arora, 2016). Here we outline the measures most often used, beginning with observation.

Observation

Scientific observation requires an important set of skills. For observations to be effective, they must be systematic (Jackson, 2016). We need to have some idea of what we are looking for. We have to know whom we are observing, when and where we will observe, how the observations will be made, and how they will be recorded.

Where should we make our observations? We have two choices: the laboratory and the everyday world.

What are some important strategies in conducting observational research with children?

When we observe scientifically, we often need to control certain factors that determine behavior but are not the focus of our inquiry (Stangor, 2015). For this reason, some research in life-span development is conducted in a **laboratory,** a controlled setting where many of the complex factors of the "real world" are absent. For example, suppose you want to observe how children react when they see other people behaving aggressively. If you observe children in their homes or schools, you have no control over how much aggression the children observe, what kind of aggression they see, which people they see acting aggressively, or how other people treat the children. In contrast, if you observe the children in a laboratory, you can control these and other factors and therefore have more confidence about how to interpret your observations.

Laboratory research does have some drawbacks, however, including the following concerns: (1) it is almost impossible to conduct research without the participants' knowing they are being studied; (2) the laboratory setting is unnatural and therefore can cause the participants to behave unnaturally; (3) people who are willing to come to a university laboratory may not fairly represent groups from diverse cultural backgrounds; (4) people who are unfamiliar with university settings, and with the idea of "helping science," may be intimidated by the laboratory setting.

laboratory A controlled setting in which research can take place.

naturalistic observation Observation that occurs in a real-world setting without any attempt to manipulate the situation.

Naturalistic observation provides insights that we sometimes cannot attain in the laboratory (Leedy & Ormrod, 2016). **Naturalistic observation** means observing behavior in real-world settings and making no effort to manipulate or control the situation. Life-span researchers

conduct naturalistic observations at sporting events, child-care centers, work settings, malls, and other places people live in and frequent.

Naturalistic observation was used in one study that focused on conversations in a children's science museum (Crowley & others, 2001). When visiting exhibits at the museum with their children, parents were more than three times as likely to engage boys than girls in explanatory talk. The gender difference occurred regardless of whether the father, the mother, or both parents were with the child, although the gender difference was greatest for fathers' science explanations to sons and daughters. This finding suggests a gender bias that encourages boys more than girls to be interested in science.

Survey and Interview

Sometimes the best and quickest way to get information about people is to ask them for it. One technique is to interview them directly. A related method is administering a survey (sometimes referred to as a questionnaire) consisting of a standard set of questions designed to obtain people's self-reported attitudes or beliefs about a particular topic. Surveys are especially useful when information from many people is needed (Madill, 2012). In a good survey, the questions are clear and unbiased, allowing respondents to answer unambiguously.

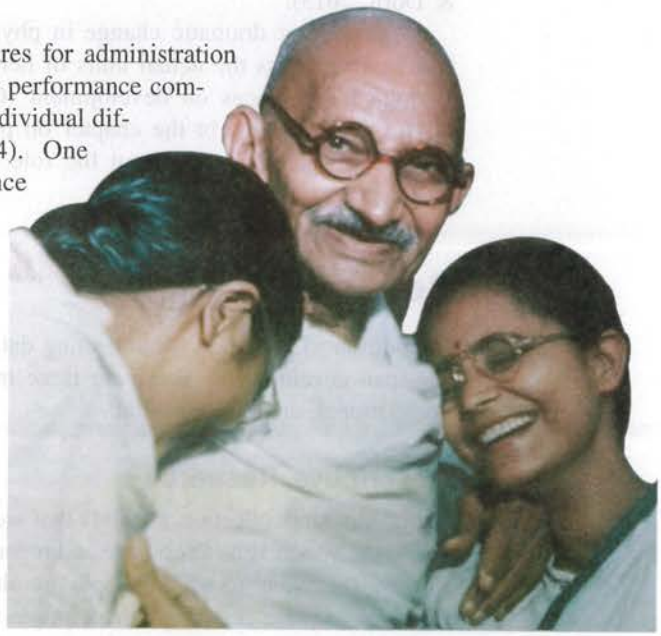
Surveys and interviews can be used to study topics ranging from religious beliefs to sexual habits to attitudes about gun control to beliefs about how to improve schools. Surveys and interviews may be conducted in person, over the telephone, by mail, and over the Internet.

One problem with surveys and interviews is the tendency of participants to answer questions in a way that they think is socially acceptable or desirable rather than to say what they truly think or feel. For example, on a survey or in an interview some individuals might say that they do not take drugs even though they do.

Standardized Test

A **standardized test** has uniform procedures for administration and scoring. Many standardized tests allow performance comparisons; they provide information about individual differences among people (Gregory, 2014). One example is the Stanford-Binet intelligence test, which is discussed in detail later. Your score on the Stanford-Binet test tells you how your performance compares with that of thousands of other people who have taken the test.

One criticism of standardized tests is that they assume a person's behavior is consistent and stable, yet personality and intelligence—two primary targets of standardized testing—can vary with the situation. For example, a person may perform poorly on a standardized intelligence test in an office setting but score much higher at home, where he or she is less anxious.



Mahatma Gandhi was the spiritual leader of India in the mid-twentieth century. Erik Erikson conducted an extensive case study of Gandhi's life to determine what contributed to his identity development. *What are some limitations of the case study approach?*

Case Study

A **case study** is an in-depth look at a single individual. Case studies are performed mainly by mental health professionals when, for either practical or ethical reasons, the unique aspects of an individual's life cannot be duplicated and tested in other individuals. A case study provides information about one person's experiences; it may focus on

standardized test A test that is given with uniform procedures for administration and scoring.

case study An in-depth examination of an individual.

nearly any aspect of the subject's life that helps the researcher understand the person's mind, behavior, or other attributes. A researcher may gather information for a case study from interviews and medical records. In later chapters we discuss vivid case studies, such as that of Michael Rehbein, who had much of the left side of his brain removed at 7 years of age to end severe epileptic seizures.

A case study can provide a dramatic, in-depth portrayal of an individual's life, but we must be cautious when generalizing from this information. The subject of a case study is unique, with a genetic makeup and personal history that no one else shares. In addition, case studies involve judgments of unknown reliability. Researchers who conduct case studies rarely check to see whether other professionals agree with their observations or findings (Yin, 2012).

Physiological Measures

Researchers are increasingly using physiological measures when they study development at different points in the life span (Johnson, 2016; Kennedy & others, 2015; Zisner & Beauchaine, 2016). A physiological measure that is increasingly being used is neuroimaging, especially *functional magnetic resonance imaging* (fMRI), in which electromagnetic waves are used to construct images of a person's brain tissue and biochemical activity (de Haan & Johnson, 2016; Galvan & Tottenham, 2016; Park & Farrell, 2016). Heart rate has been used as an indicator of infants' and children's development of perception, attention, and memory (Kim, Yang, & Lee, 2015). Further, heart rate has been used as an index of different aspects of emotional development, such as inhibition, anxiety, and depression (Blood & others, 2015).

Cortisol is a hormone produced by the adrenal gland that is linked to the body's stress level and has been measured in studies of temperament, emotional reactivity, peer relations, and child psychopathology (Jacoby & others, 2016). As puberty unfolds, the blood levels of certain hormones increase. To determine the nature of these hormonal changes, researchers analyze blood samples from adolescent volunteers (Susman & Dorn, 2013).

Yet another dramatic change in physiological methods is the advancement in methods to assess the actual units of hereditary information—genes—in studies of biological influences on development (Cho & Suh, 2016; Grigorenko & others, 2016). For example, in the chapter on physical and cognitive development in late adulthood you will read about the role of the ApoE4 gene in Alzheimer disease (Park & Farrell, 2016).

Research Designs

In addition to a method for collecting data, you also need a research design to study life-span development. There are three main types of research designs: descriptive, correlational, and experimental.

Descriptive Research

All of the data-collection methods that we have discussed can be used in **descriptive research,** which aims to observe and record behavior. For example, a researcher might observe the extent to which people are altruistic or aggressive toward each other. By itself, descriptive research cannot prove what causes some phenomenon, but it can reveal important information about people's behavior and provide a basis for more scientific studies (Leedy & Ormrod, 2016).

descriptive research Type of research that aims to observe and record behavior.

Correlational Research

In contrast with descriptive research, correlational research goes beyond describing phenomena by providing information that helps to predict how people will behave. In **correlational research,** the goal is to describe the strength of the relationship between two or more events or characteristics. The more strongly the two events are correlated

correlational research A type of research that focuses on describing the strength of the relation between two or more events or characteristics.

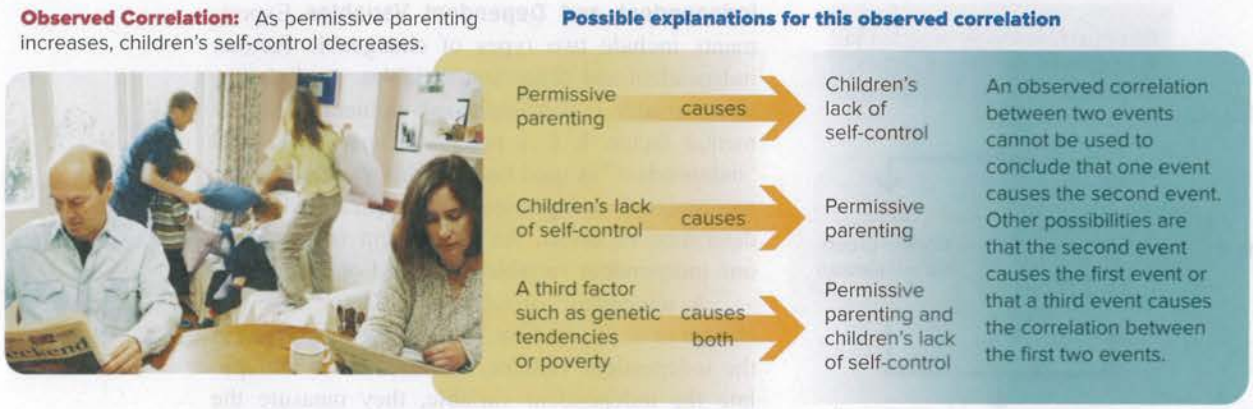


Figure 11 Possible Explanations for Correlational Data

(or related or associated), the more effectively we can predict one event from the other (Aron, Aron, & Coups, 2017).

For example, to determine whether children of permissive parents have less self-control than other children, you would need to carefully record observations of parents' permissiveness and their children's self-control. You might observe that the higher a parent was in permissiveness, the lower the child was in self-control. You would then analyze these data statistically to yield a **correlation coefficient,** a number based on a statistical analysis that is used to describe the degree of association between two variables. Correlation coefficients range from –1.00 to +1.00. A negative number means an inverse relation. In the above example, you might find an inverse correlation between permissive parenting and children's self-control, with a coefficient of, say, –.30 meaning that parents who are permissive with their children are likely to have children who have low self-control. By contrast, you might find a positive correlation of +.30 between parental monitoring of children and children's self-control, meaning that parents who monitor their children effectively have children with good self-control.

The higher the correlation coefficient (whether positive or negative), the stronger the association between the two variables. A correlation of 0 means that there is no association between the variables. A correlation of –.40 is stronger than a correlation of +.20 because we disregard whether the correlation is positive or negative in determining the strength of the correlation.

A word of caution is in order, however. Correlation does not equal causation (Heiman, 2014, 2015). The correlational finding just mentioned does not mean that permissive parenting necessarily causes low self-control in children. It could have that meaning, but it also could mean that a child's lack of self-control caused the parents to throw up their arms in despair and give up trying to control the child. It also could mean that other factors, such as heredity or poverty, caused the correlation between permissive parenting and low self-control in children. Figure 11 illustrates these possible interpretations of correlational data.

Experimental Research

To study causality, researchers turn to experimental research. An **experiment** is a carefully regulated procedure in which one or more factors believed to influence the behavior being studied are manipulated while all other factors are held constant. If the behavior under study changes when a factor is manipulated, we say that the manipulated factor has caused the behavior to change. In other words, the experiment has demonstrated cause and effect. The cause is the factor that was manipulated. The effect is the behavior that changed because of the manipulation. Nonexperimental research methods (descriptive and correlational research) cannot establish cause and effect because they do not involve manipulating factors in a controlled way (Kantowitz, Roediger, & Elmes, 2015).

correlation coefficient A number based on statistical analysis that is used to describe the degree of association between two variables.

experiment A carefully regulated procedure in which one or more of the factors believed to influence the behavior being studied is manipulated and all other factors are held constant. Experimental research permits the determination of cause.

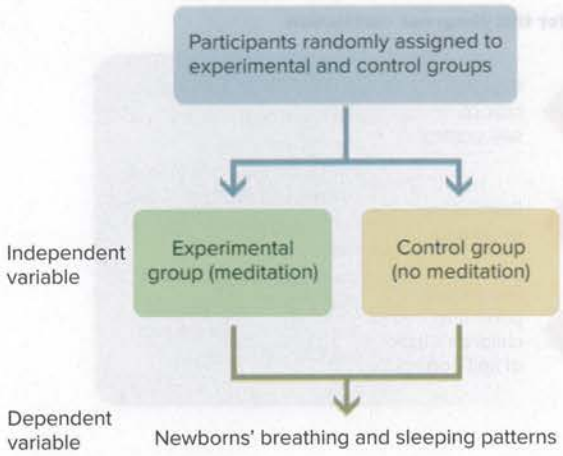


Figure 12 Principles of Experimental Research Imagine that you decide to conduct an experimental study of the effects of meditation by pregnant women on their newborns' breathing and sleeping patterns. You randomly assign pregnant women to experimental and control groups. The experimental-group women engage in meditation over a specified number of sessions and weeks. The control group does not. Then, when the infants are born, you assess their breathing and sleeping patterns. If the breathing and sleeping patterns of newborns whose mothers were in the experimental group are more positive than those of the control group, you conclude that meditation caused the positive effects.

Independent and Dependent Variables Experiments include two types of changeable factors: independent and dependent variables. An *independent variable* is a manipulated, influential experimental factor. It is a potential cause. The label "independent" is used because this variable can be manipulated independently of other factors to determine its effect. An experiment may include one independent variable or several of them.

A *dependent variable* is a factor that can change in an experiment, in response to changes in the independent variable. As researchers manipulate the independent variable, they measure the dependent variable for any resulting effect (Gravetter & Forzano, 2016).

For example, suppose that you wanted to study whether pregnant women could change the breathing and sleeping patterns of their newborn babies by meditating during pregnancy. You might require one group of pregnant women to engage in a certain amount and type of meditation each day, while another group would not meditate; the meditation is thus the independent variable. When the infants are born, you would observe and measure their breathing and sleeping patterns. These patterns are the dependent variable, the factor that changes as the result of your manipulation.

Experimental and Control Groups Experiments can involve one or more experimental groups and one or more control groups. An experimental group is a group whose experience is manipulated. A control group is a comparison group that is as much like the experimental group as possible and that is treated in every way like the experimental group except for the manipulated factor (independent variable). The control group serves as a baseline against which the effects of the manipulated condition can be compared.

Random assignment is an important principle for deciding whether each participant will be placed in the experimental group or in the control group. Random assignment means that researchers assign participants to experimental and control groups by chance. It reduces the likelihood that the experiment's results will be due to any preexisting differences between groups (Gravetter & Forzano, 2016). In the example of the effects of meditation by pregnant women on the breathing and sleeping patterns of their newborns, you would randomly assign half of the pregnant women to engage in meditation over a period of weeks (the experimental group) and the other half to not meditate over the same number of weeks (the control group). Figure 12 illustrates the nature of experimental research.

Time Span of Research

Researchers in life-span development have a special concern with the relation between age and some other variable. To explore these relations, researchers can study different individuals of different ages and compare them, or they can study the same individuals as they age over time.

Cross-Sectional Approach

cross-sectional approach A research strategy in which individuals of different ages are compared at one time.

The **cross-sectional approach** is a research strategy that simultaneously compares individuals of different ages. A typical cross-sectional study might include three groups of children: 5-year-olds, 8-year-olds, and

11-year-olds. Another study might include groups of 15-year-olds, 25-year-olds, and 45-year-olds. The groups can be compared with respect to a variety of dependent variables, such as IQ, memory, peer relations, attachment to parents, hormonal changes, and so on. All of this can be accomplished in a short time. In some studies data are collected in a single day. Even in large-scale cross-sectional studies with hundreds of subjects, data collection does not usually take longer than several months to complete.

The main advantage of the cross-sectional study is that the researcher does not have to wait for the individuals to grow up or become older. Despite its efficiency, though, the cross-sectional approach has its drawbacks. It gives no information about how individuals change or about the stability of their characteristics. It can obscure the hills and valleys of growth and development. For example, a cross-sectional study of life satisfaction might reveal average increases and decreases, but it would not show how the life satisfaction of individual adults waxed and waned over the years. It also would not tell us whether the same adults who had positive or negative perceptions of life satisfaction in early adulthood maintained their relative degree of life satisfaction as they became middle-aged or older adults.

Longitudinal Approach

The **longitudinal approach** is a research strategy in which the same individuals are studied over a period of time, usually several years or more. For example, in a longitudinal study of life satisfaction, the same adults might be assessed periodically over a 70-year time span—at the ages of 20, 35, 45, 65, and 90, for example.

Longitudinal studies provide a wealth of information about vital issues such as stability and change in development and the importance of early experience for later development, but they do have drawbacks (Cicchetti & Toth, 2015, 2016). They are expensive and time-consuming. The longer the study lasts, the more participants drop out—they move, get sick, lose interest, and so forth. The participants who remain may be dissimilar to those who drop out, biasing the outcome of the study. Those individuals who remain in a longitudinal study over a number of years may be more responsible and conformity-oriented than the ones who dropped out, for example, or they might have more stable lives.

Cohort Effects

A *cohort* is a group of people who are born at a similar point in history and share similar experiences as a result, such as living through the Vietnam war or growing up in the same city around the same time. These shared experiences may produce a range of differences among cohorts (Kadlecova & others, 2015; MacDonald & Stawski, 2016). For example, people who were teenagers during the Great Depression are likely to differ from people who were teenagers during the booming 1990s in their educational opportunities and economic status, in how they were raised, and in their attitudes toward sex and religion. In life-span development research, **cohort effects** are due to a person's time of birth, era, or generation but not to actual age.

Cohort effects are important because they can powerfully affect the dependent measures in a study ostensibly concerned with age (Carstensen & others, 2015; George & Ferraro, 2016). Researchers have shown it is especially important to be aware of cohort effects when assessing adult intelligence (Schaie, 2013, 2016). Individuals born at different points in time—such as 1920, 1940, and 1960—have had varying opportunities for education. Individuals born in earlier years had less access to education, and this fact may have a significant effect on how this cohort performs on intelligence tests. Some researchers have found that cross-sectional studies indicate more than 90 percent of cognitive decline in aging is due to a slowing of processing speed, whereas longitudinal studies reveal that 20 percent or less of cognitive decline is due to processing speed (MacDonald & others, 2003; MacDonald & Stawski, 2015, 2016; Stawski, Sliwinski, & Hofer, 2013). Another recent example of a cohort effect occurred in a study in which older adults assessed in 2013–2014 engaged in a higher

longitudinal approach A research strategy in which the same individuals are studied over a period of time, usually several years or more.

cohort effects Effects that are due to a subject's time of birth or generation but not age.

Generation	Historical Period	Reasons for Label
Millennials	Individuals born in 1980 and later	First generation to come of age and enter emerging adulthood (18 to 25 years of age) in the twenty-first century (the new millennium). Two main characteristics: (1) connection to technology, and (2) ethnic diversity.
Generation X	Individuals born between 1965 and 1980	Described as lacking an identity and savvy loners.
Baby Boomers	Individuals born between 1946 and 1964	Label used because this generation represents the spike in the number of babies born after World War II; the largest generation ever to enter late adulthood in the United States.
Silent Generation	Individuals born between 1928 and 1945	Children of the Great Depression and World War II; described as conformists and civic minded.

Figure 13 Generations, Their Historical Periods, and Characteristics

level of abstract reasoning than their counterparts assessed two decades earlier in 1990–1993 (Gerstorf & others, 2015).

Cross-sectional studies can show how different cohorts respond, but they can confuse age changes and cohort effects. Longitudinal studies are effective in studying age changes, but only within one cohort.

Various generations have been given labels by the popular culture. Figure 13 describes the labels of various generations, the historical period for each one, and the reasons for their labels. Consider the following description of the current generation of youth and think about how they differ from earlier youth generations:

> They are history's first "always connected" generation. Steeped in digital technology and social media, they treat their multi-tasking hand-held gadgets almost like a body part—for better or worse. More than 8-in-10 say they sleep with a cell phone glowing by the bed, poised to disgorge texts, phone calls, e-mails, songs, news, videos, games, and wake-up jingles. But sometimes convenience yields to temptation. Nearly two-thirds admit to texting while driving (Pew Research Center, 2010, p. 1).

How does the youth experienced by today's millennials differ from that of earlier generations?

Conducting Ethical Research

Researchers who study human development and behavior confront many ethical issues. For example, a developmentalist who wanted to study aggression in children would have to design the study in such a way that no child would be harmed physically or psychologically, and the researcher would need to get permission from the university to carry out the study. Then the researcher would have to explain the study to the children's parents and obtain consent for the children to participate. Ethics in research may affect you personally if you ever serve as a participant in a study. In that event, you need to know your rights as a participant and the responsibilities of researchers to ensure that these rights are safeguarded.

Today, proposed research at colleges and universities must pass the scrutiny of a research ethics committee before the research can begin. In addition, the American Psychological Association (APA) has developed ethics guidelines for its members. This code of ethics instructs psychologists to protect their research participants from mental and physical harm. The participants' best interests need to be kept foremost in the researcher's mind (Jackson, 2016).

APA's guidelines address four important issues:

1. *Informed consent*—All participants must know what their research participation will involve and what risks might develop. Even after informed consent is given, participants must retain the right to withdraw from the study at any time and for any reason.

2. *Confidentiality*—Researchers are responsible for keeping all of the data they gather on individuals completely confidential and, when possible, completely anonymous.
3. *Debriefing*—After the study has been completed, participants should be informed of its purpose and the methods that were used. In most cases, the experimenter also can inform participants in a general manner beforehand about the purpose of the research without leading participants to behave in a way they think that the experimenter is expecting.
4. *Deception*—In some circumstances, telling the participants beforehand what the research study is about substantially alters the participants' behavior and invalidates the researcher's data. In all cases of deception, however, the psychologist must ensure that the deception will not harm the participants and that the participants will be *debriefed* (told the complete nature of the study) as soon as possible after the study is completed.

Summary

The Life-Span Perspective

- Development is the pattern of change that begins at conception and continues through the life span. It includes both growth and decline.
- The life-span perspective includes these basic ideas: development is lifelong, multidimensional, multidirectional, and plastic; its study is multidisciplinary; it is embedded in contexts; it involves growth, maintenance, and regulation; and it is a co-construction of biological, sociocultural, and individual factors.
- Health and well-being, parenting, education, sociocultural contexts and diversity, and social policy are all areas of contemporary concern for those who study life-span development.

The Nature of Development

- Three key developmental processes are biological, cognitive, and socioemotional. Development is influenced by an interplay of these processes.
- The life span is commonly divided into the prenatal period, infancy, early childhood, middle and late childhood, adolescence, early adulthood, middle adulthood, and late adulthood.
- We often think of age only in chronological terms, but a full evaluation of age requires the consideration of biological age, psychological age, and social age as well.
- Three pathways of aging are pathological aging, normal aging, and successful aging.
- In research covering adolescence through late adulthood, many but not all studies find that older adults report the highest level of life satisfaction.
- Three important issues in the study of development are the nature-nurture issue, the continuity-discontinuity issue, and the stability-change issue.

Theories of Development

- According to psychoanalytic theories, including those of Freud and Erikson, development primarily depends on the unconscious mind and is heavily couched in emotion.
- Cognitive theories emphasize thinking, reasoning, language, and other cognitive processes. Three main cognitive theories are Piaget's, Vygotsky's, and information processing.
- Behavioral and social cognitive theories emphasize the environment's role in development. Two key behavioral and social cognitive theories are Skinner's operant conditioning and Bandura's social cognitive theory.
- Lorenz's ethological theory stresses the biological and evolutionary bases of development.
- According to Bronfenbrenner's ecological theory, development predominantly reflects the influence of five environmental systems—the microsystem, mesosystem, exosystem, macrosystem, and chronosystem.
- An eclectic orientation incorporates the best features of different theoretical approaches.

Research in Life-Span Development

- The main methods for collecting data about life-span development are observation, survey (questionnaire) or interview, standardized test, case study, and physiological measures.
- Three basic research designs are descriptive, correlational, and experimental.
- To examine the effects of time and age, researchers can conduct cross-sectional or longitudinal studies. Life-span researchers are especially concerned about cohort effects.
- Researchers have an ethical responsibility to safeguard the well-being of research participants.

Key Terms

behavioral and social cognitive theories
biological processes
Bronfenbrenner's ecological theory
case study
cognitive processes
cohort effects
context
continuity-discontinuity issue
correlational research
correlation coefficient
cross-cultural studies
cross-sectional approach
culture
descriptive research
development
eclectic theoretical orientation
Erikson's theory
ethnicity
ethology
experiment
gender
hypotheses
information-processing theory
laboratory
life-span perspective
longitudinal approach
naturalistic observation
nature-nurture issue
nonnormative life events
normative age-graded influences
normative history-graded influences
Piaget's theory
psychoanalytic theories
social cognitive theory
social policy
socioeconomic status (SES)
socioemotional processes
stability-change issue
standardized test
theory
Vygotsky's theory

2 Biological Beginnings

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CHAPTER OUTLINE

Stories of Life-Span Development: The Jim and Jim Twins

Jim Springer and Jim Lewis are identical twins. They were separated at 4 weeks of age and did not see each other again until they were 39 years old. Both worked as part-time deputy sheriffs, vacationed in Florida, drove Chevrolets, had dogs named Toy, and married and divorced women named Betty. One twin named his son James Allan, and the other named his son James Alan. Both liked math but not spelling, enjoyed carpentry and mechanical drawing, chewed their fingernails down to the nubs, had almost identical drinking and smoking habits, had hemorrhoids, put on 10 pounds at about the same point in development, first suffered headaches at the age of 18, and had similar sleep patterns.

Jim and Jim do have some differences. One wears his hair over his forehead, the other slicks it back and has sideburns. One expresses himself best orally; the other is more proficient in writing. But, for the most part, their profiles are remarkably similar.

Another pair of identical twins, Daphne and Barbara, were called the "giggle sisters" by researchers because after being reunited they were always making each other laugh. A thorough search of their adoptive families' histories revealed no gigglers. The giggle

sisters ignored stress, avoided conflict and controversy whenever possible, and showed no interest in politics.

Jim and Jim and the giggle sisters were part of the Minnesota Study of Twins Reared Apart, directed by Thomas Bouchard and his colleagues. The study brings identical twins (who are identical genetically because they come from the same fertilized egg) and fraternal twins (who come from different fertilized eggs) from all over the world to Minneapolis to investigate their lives. There the twins complete personality and intelligence tests, and provide detailed medical histories, including information about diet and smoking, exercise habits, chest X-rays, heart stress tests, and EEGs. The twins are asked more than 15,000 questions about their family and childhood, personal interests, vocational orientation, values, and aesthetic judgments (Bouchard & others, 1990).

When genetically identical twins who were separated as infants show such striking similarities in their tastes and habits and choices, can we conclude that their genes must have caused these similarities? Although genes play a role, we also need to consider other possible causes. The twins shared not only the same genes but also some similar experiences. Some of the separated twins lived together for several months prior to their adoption; some had been reunited prior to testing (in some cases, many years earlier); adoption agencies often place twins in similar homes; and even strangers who spend several hours together and start comparing their lives are likely to come up with some coincidental similarities (Joseph, 2006).

The Minnesota study of identical twins points to both the importance of the genetic basis of human development and the need for further research on genetic and environmental factors.

The examples of Jim and Jim and the giggle sisters stimulate us to think about our genetic heritage and the biological foundations of our existence. Organisms are not like billiard balls, moved by simple, external forces to predictable positions on life's pool table. Environmental experiences and biological foundations work together to make us who we are. Our coverage of life's biological beginnings and experiences will emphasize the evolutionary perspective; genetic foundations; the interaction of heredity and environment; and charting growth from conception through the prenatal period, the birth process itself, and the postpartum period that follows birth. ■

The Evolutionary Perspective

From the perspective of evolutionary time, humans are relative newcomers to Earth. As our earliest ancestors left the forest to feed on the savannahs and then to form hunting societies on the open plains, their minds and behaviors changed, and humans eventually became the dominant species on Earth. How did this evolution come about?

Natural Selection and Adaptive Behavior

Charles Darwin (1859) described *natural selection* as the evolutionary process by which those individuals of a species that are best *adapted* to their environment are the ones that are most likely to survive and reproduce. He reasoned that an intense, constant struggle for food, water, and resources must occur among the young of each generation, because many of them do not survive. Those that do survive and reproduce pass on their characteristics to the next generation (Audesirk, Audesirk, & Byers, 2017; Johnson, 2017). Darwin concluded that these survivors are better adapted to their world than are the nonsurvivors. The best-adapted individuals survive and leave the most offspring. Over the course of many generations, organisms with the characteristics needed for survival make up an increased percentage of the population (Mader & Windelspecht, 2016; Simon, 2017).

How Would You...?

As a **health-care professional,** how would you explain technology and medicine working against natural selection?

Evolutionary Psychology

evolutionary psychology Emphasizes the importance of adaptation, reproduction, and "survival of the fittest" in shaping behavior.

Although Darwin introduced the theory of evolution by natural selection in 1859, his ideas have only recently become a popular framework for explaining behavior. Psychology's newest approach, **evolutionary psychology,** emphasizes the importance of adaptation, reproduction, and "survival of the fittest" in shaping behavior. ("Fit" in this sense refers to the ability to bear offspring that survive long enough to bear offspring of their own.) In this view, natural selection favors behaviors that increase reproductive success—that is, the ability to pass your genes to the next generation (Del Giudice & Ellis, 2016; Grinde, 2016).

David Buss (2008, 2012, 2015) argues that just as evolution has contributed to our physical features, such as body shape and height, it also pervasively influences how we make decisions, how aggressive we are, our fears, and our mating patterns. For example, assume that our ancestors were hunters and gatherers on the plains and that men did most of the hunting and women stayed close to home, gathering seeds and plants for food. If you have to travel some distance from your home to track and slay a fleeing animal, you need certain physical traits along with the capacity for certain types of spatial thinking. Men with these traits would be more likely than men without them to survive, to bring home lots of food, and to be considered attractive mates—and thus to reproduce and pass on these characteristics to their children. In other words, if their assumptions were correct, potentially these traits would provide a reproductive advantage for males, and over many generations, men with good spatial thinking skills might become more numerous in the population. Critics point out that this scenario might or might not have actually happened.

Evolutionary Developmental Psychology

There is growing interest in using the concepts of evolutionary psychology to understand human development (Bjorklund, 2012; Bugental, Corpuz, & Beaulieu, 2015). Following are some ideas proposed by evolutionary developmental psychologists (Bjorklund & Pellegrini, 2002).

One important concept is that an extended childhood period might have evolved because humans require time to develop a large brain and learn the complexity of human societies. Humans take longer to become reproductively mature than any other primate (see Figure 1). During this extended childhood period, they develop a large brain and have the experiences needed to become competent adults in a complex society.

Another key idea is that many of our evolved psychological mechanisms are *domain-specific*. That is, the mechanisms apply only to a specific aspect of a person's psychological makeup. According to evolutionary psychology, the mind is not a general-purpose device that can be applied equally to a vast array of problems. Instead, as our ancestors dealt with certain recurring problems such as hunting and finding shelter, specialized modules evolved that process information related to those problems: for example, such specialized modules might include a module for physical knowledge for tracking animals, a module for mathematical knowledge for trading, and a module for language.

How Would You...?

As an **educator,** how would you apply the concept of domain-specific psychological mechanisms to explain how a student with a learning disability in reading may perform exceptionally well in math?

Evolved mechanisms are not always adaptive in contemporary society. Some behaviors that were adaptive for our prehistoric ancestors may not serve us well today. For example, the food-scarce environment of our ancestors likely led to humans' propensity to gorge when food is available and to crave high-caloric foods, a trait that might lead to an epidemic of obesity when food is plentiful.

Evaluating Evolutionary Psychology

Although the popular press gives a lot of attention to the ideas of evolutionary psychology, it remains just one theoretical approach. Like the theories described earlier, it has limitations, weaknesses, and critics (Hyde, 2014). One criticism comes from

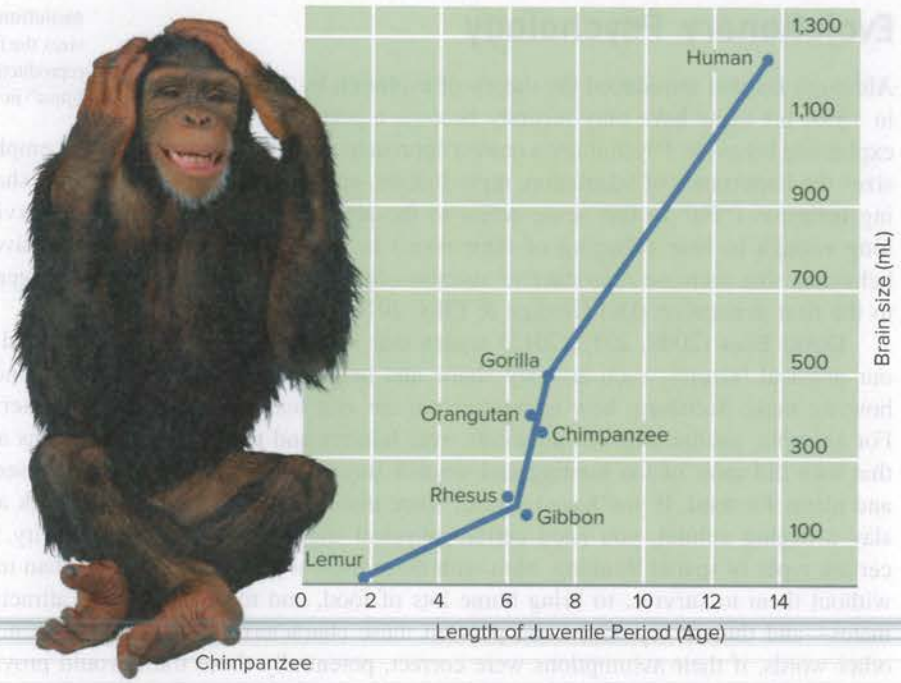


Figure 1 The Brain Sizes of Various Primates and Humans in Relation to the Length of the Juvenile Period

Compared with other primates, humans have both a larger brain and a longer childhood period. *What conclusions can you draw from the relationship indicated by this graph?*

Albert Bandura (1998), whose social cognitive theory was described earlier. Bandura acknowledges the important influence of evolution on human adaptation. However, he rejects what he calls "one-sided evolutionism," which sees social behavior as the product of evolved biological characteristics. An alternative is a *bidirectional view* in which environmental and biological conditions influence each other. In this view, evolutionary pressures created changes in biological structures that allowed the use of tools, which enabled our ancestors to manipulate the environment, constructing new environmental conditions. In turn, environmental innovations produced new selection pressures that led to the evolution of specialized biological systems for consciousness, thought, and language.

Children in all cultures are interested in the tools used by adults in their cultures. This 11-month-old boy from the Efe culture in the Democratic Republic of the Congo in Africa is trying to cut a papaya with an apopau (a smaller version of a machete). *Might the infant's behavior be evolutionary-based or be due to both biological and environmental conditions?*

In other words, evolution gave us bodily structures and biological potentialities, but it does not dictate behavior. People have used their biological capacities to produce diverse cultures—aggressive and peace-loving, egalitarian and autocratic. As American scientist Stephen Jay Gould (1981) concluded, in most domains of human functioning, biology allows a broad range of cultural possibilities.

The "big picture" idea of natural selection leading to the development of human traits and behaviors is difficult to refute or test because evolution occurs on a time scale that does not lend itself to empirical study. Thus, studying specific genes in humans and other species—and their links to traits and behaviors—may be the best approach for testing ideas coming out of the evolutionary psychology perspective.

Genetic Foundations of Development

Genetic influences on behavior evolved over time and across many species. Our many traits and characteristics that are genetically influenced have a long evolutionary history that is retained in our DNA. In other

words, our DNA is not just inherited from our parents; it's also what we've inherited as a species from the species that came before our own. Let's take a closer look at DNA and its role in human development.

How are characteristics that suit a species for survival transmitted from one generation to the next? Darwin did not know the answer to this question because genes and the principles of genetics had not yet been discovered. Each of us carries a human "genetic code" that we inherited from our parents. Because a fertilized egg carries this human code, a fertilized human egg cannot grow into an egret, eagle, or elephant.

Each of us began life as a single cell weighing about one twenty-millionth of an ounce. This tiny piece of matter housed our entire genetic code—instructions that orchestrated growth from that single cell to a person made of trillions of cells, each containing a replica of the original code. That code is carried by our genes. What are genes and what do they do? For the answer, we need to look into our cells.

The nucleus of each human cell contains **chromosomes,** which are threadlike structures made up of deoxyribonucleic acid, or DNA. **DNA** is a complex molecule that has a double helix shape, like a spiral staircase, and contains genetic information. **Genes,** the units of hereditary information, are short segments of DNA, as you can see in Figure 2. They help cells to reproduce themselves and to assemble proteins. Proteins, in turn, are the building blocks of cells as well as the regulators that direct the body's processes (Cowan, 2015; Goodenough & McGuire, 2017).

Each gene has its own designated place on a particular chromosome. Today, there is a great deal of enthusiasm about efforts to discover the specific locations of genes that are linked to certain functions and developmental outcomes (Johnson, 2017; Sutphin & Korstanje, 2016). An important step in this direction was taken when the Human Genome Project and the Celera Corporation completed a preliminary map of the human *genome*—the complete set of developmental instructions for creating proteins that initiate the making of a human organism (Brooker, 2015).

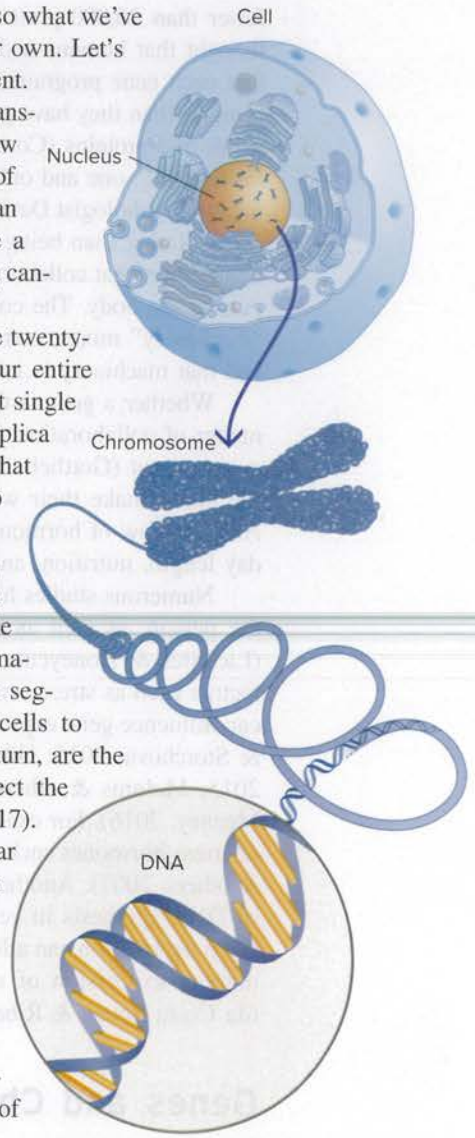


Figure 2 Cells, Chromosomes, DNA, and Genes
(Top) The body contains trillions of cells. Each cell contains a central structure, the nucleus. *(Middle)* Chromosomes are threadlike structures located in the nucleus of the cell. Chromosomes are composed of DNA. *(Bottom)* DNA has the structure of a spiral staircase. A gene is a segment of DNA.

chromosomes Threadlike structures made up of deoxyribonucleic acid, or DNA.

DNA A complex molecule with a double helix shape that contains genetic information.

genes Units of hereditary information composed of DNA. Genes direct cells to reproduce themselves and manufacture the proteins that maintain life.

Completion of the Human Genome Project has led to use of the *genome-wide association method* to identify genetic variations linked to a particular disease, such as cancer, cardiovascular disease, or Alzheimer disease (Cho & Suh, 2016; Hou & others, 2016). To conduct a genome-wide association study, researchers obtain DNA from individuals who have the disease and those who don't have it. Then, each participant's complete set of DNA, or genome, is purified from the blood or other cells and scanned on machines to determine markers of genetic variation. If the genetic variations occur more frequently in people who have the disease than in those who don't have it, the variations point to the region in the human genome where the disease-causing problem exists. Genome-wide association studies have recently been conducted for childhood obesity (Zandona & others, 2016); cancer (Johnson & others, 2016); cardiovascular disease (Schick & others, 2016); depression (Knowles & others, 2016; Nho & others, 2015); suicide (Sokolowski, Wasserman, & Wasserman, 2016); glaucoma (Bailey & others, 2016); and Alzheimer disease (Chauhan & others, 2015; Ramos Dos Santos & others, 2016).

One of the big surprises of the Human Genome Project was a report indicating that humans have only about 30,000 genes (U.S. Department of Energy, 2001). More recently, the number of human genes has been revised further downward, to approximately 20,700 (Flicek & others, 2013). Further recent analysis proposes that humans may actually have

fewer than 20,000 protein-producing genes (Ezkurida & others, 2014). Scientists had thought that humans had as many as 100,000 or more genes. They had also believed that each gene programmed just one protein. In fact, humans appear to have far more proteins than they have genes, so there cannot be a one-to-one correspondence between genes and proteins (Commoner, 2002). Each gene is not translated, in automaton-like fashion, into one and only one protein. A gene does not act independently, as developmental psychologist David Moore (2001) emphasized by titling his book *The Dependent Gene.* Rather than being a group of independent genes, the human genome consists of many genes that collaborate both with each other and with nongenetic factors inside and outside the body. The collaboration operates at many points. For example, the cellular "machinery" mixes, matches, and links small pieces of DNA to reproduce the genes, and that machinery is influenced by what is going on around it (Moore, 2015).

Whether a gene is turned "on"—that is, working to assemble proteins—is also a matter of collaboration. The activity of genes (*genetic expression*) is affected by their environment (Gottlieb, 2007; Moore, 2015). For example, hormones that circulate in the blood make their way into the cell, where they can turn genes "on" and "off." And the flow of hormones can be affected by environmental conditions such as light, day length, nutrition, and behavior.

Numerous studies have shown that external events outside of the original cell and the person, as well as events inside the cell, can excite or inhibit gene expression (Lickliter & Honeycutt, 2015; Moore, 2015). Recent research has documented that factors such as stress, exercise, nutrition, respiration, radiation, temperature, and sleep can influence gene expression (Craft & others, 2014; Dedon & Begley, 2014; Donnelly & Storchova, 2015; Giles & others, 2016; Lindholm & others, 2014; Ma & others, 2015; McInnis & others, 2015; Mychasiuk, Muhammad, & Kolb, 2016; Turecki & Meaney, 2016). For example, one study revealed that an increase in the concentration of stress hormones such as cortisol produced a fivefold increase in DNA damage (Flint & others, 2007). Another study also found that exposure to radiation changed the rate of DNA synthesis in cells (Lee & others, 2011). And recent research indicates that sleep deprivation can affect gene expression in negative ways such as increased inflammation, expression of stress-related genes, and impairment of protein functioning (da Costa Souza & Ribeiro, 2015).

Genes and Chromosomes

Genes are not only collaborative; they are enduring. How do they get passed from generation to generation and end up in all of the trillion cells in the body? Three processes are central to this story: mitosis, meiosis, and fertilization.

Mitosis, Meiosis, and Fertilization

All cells in your body, except the sperm and egg, have 46 chromosomes arranged in 23 pairs. These cells reproduce through a process called **mitosis.** During mitosis, the cell's nucleus—including the chromosomes—duplicates itself and the cell divides. Two new cells are formed, each containing the same DNA as the original cell, arranged in the same 23 pairs of chromosomes.

However, a different type of cell division—**meiosis**—forms eggs and sperm (which also are called *gametes*). During meiosis, a cell of the testes (in men) or ovaries (in women) duplicates its chromosomes but then divides *twice*, thus forming four cells, each of which has only half of the genetic material of the parent cell (Johnson, 2017). By the end of meiosis, each egg or sperm has 23 *unpaired* chromosomes.

mitosis Cellular reproduction in which the cell's nucleus duplicates itself with two new cells being formed, each containing the same DNA as the parent cell, arranged in the same 23 pairs of chromosomes.

meiosis A specialized form of cell division that occurs to form eggs and sperm (or gametes).

During *fertilization*, an egg and a sperm fuse to create a single cell, called a *zygote*. In the zygote, the 23 unpaired chromosomes from the egg and the 23 unpaired chromosomes from the sperm combine to form one set of 23 paired chromosomes—one chromosome of each pair from the mother's egg and the other from the father's sperm. In this manner, each parent contributes half of the offspring's genetic material.

Figure 3 shows 23 paired chromosomes of a male and a female. The members of each pair of chromosomes are both similar and different: Each chromosome in the pair contains varying forms of the same genes, at the same location on the chromosome. A gene that influences hair color, for example, is located on both members of one pair of chromosomes, at the same location on each. However, one of those chromosomes might carry the gene associated with blond hair; the other might carry the gene associated with brown hair.

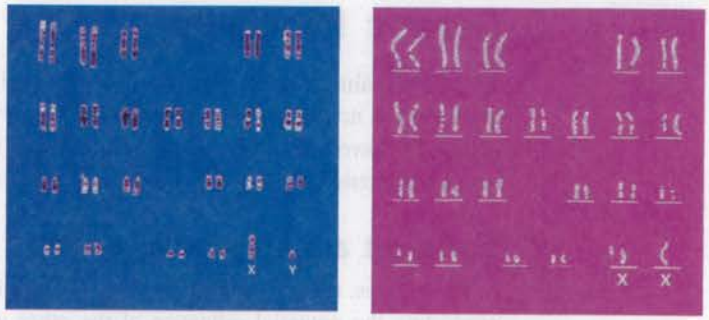


Figure 3 The Genetic Difference Between Males and Females
Set (a) shows the chromosome structure of a male, and set (b) shows the chromosome structure of a female. The last pair of 23 pairs of chromosomes is in the bottom right corner of each set. Notice that the Y chromosome of the male is smaller than the X chromosome of the female. To obtain this kind of chromosomal picture, a cell is removed from a person's body, usually from the inside of the mouth. The chromosomes are stained by chemical treatment, magnified extensively, and then photographed.

Do you notice any obvious differences between the chromosomes of the male and those of the female in Figure 3? The difference lies in the 23rd pair. Ordinarily, in females this pair consists of two chromosomes called *X chromosomes*; in males the 23rd pair consists of an X chromosome and a *Y chromosome*. The presence of a Y chromosome is one factor that makes a person male rather than female.

Sources of Variability

Combining the genes of two parents in their offspring increases genetic variability in the population, which is valuable for a species because it provides more characteristics on which natural selection can operate (Belk & Borden Maier, 2016; Simon, 2017). In fact, the human genetic process creates several important sources of variability.

First, the chromosomes in the zygote are not exact copies of those in the mother's ovaries and the father's testes. During the formation of the sperm and egg in meiosis, the members of each pair of chromosomes are separated, but which chromosome in the pair goes to the gamete is a matter of chance. In addition, before the pairs separate, pieces of the two chromosomes in each pair are exchanged, creating a new combination of genes on each chromosome. Thus, when chromosomes from the mother's egg and the father's sperm are brought together in the zygote, the result is a truly unique combination of genes.

Another source of variability comes from DNA. Chance events, a mistake by the cellular machinery, or damage caused by an environmental agent such as radiation may produce a *mutated gene*, a permanently altered segment of DNA (Bauman, 2015; Freeman & others, 2017).

Even when their genes are identical, however, as for the identical twins described at the beginning of the chapter, people vary. The difference between *genotypes* and *phenotypes* helps us understand this source of variability. All of a person's genetic material makes up his or her **genotype**. There is increasing interest in studying *susceptibility genes*, those that make the individual more vulnerable to specific diseases or accelerated aging, and *longevity genes*, those that make the individual less vulnerable to certain diseases and more likely to live to an older age (Cho & Suh, 2016; Dong & others, 2015; Sutphin & Korstanje, 2016). These are aspects of the individual's genotype.

However, not all of the genetic material is apparent in an individual's observed and measurable characteristics. A **phenotype** consists of observable characteristics, including physical characteristics (such as height, weight, and hair color) and psychological characteristics (such as personality and intelligence).

For each genotype, a range of phenotypes can be expressed, providing another source of variability (Klug & others, 2016; Solomon & others, 2015). An individual can inherit the genetic potential to grow very large, for example, but good nutrition, among other things, will be essential to achieving that potential.

genotype A person's genetic heritage; the actual genetic material.

phenotype The way an individual's genotype is expressed in observed and measurable characteristics.

Genetic Principles

What determines how a genotype is expressed to create a particular phenotype? This question has not yet been fully answered (Moore, 2015). However, a number of genetic principles have been discovered, among them those of dominant and recessive genes, sex-linked genes, and polygenically determined characteristics.

Dominant and Recessive Genes

In some cases, one gene of a pair always exerts its effects; in other words, it is *dominant*, overriding the potential influence of the other gene, which is called the *recessive* gene. This is the *dominant-and-recessive genes principle.* A recessive gene exerts its influence only if the two genes of a pair are both recessive. If you inherit a recessive gene for a trait from each of your parents, you will show the trait. If you inherit a recessive gene from only one parent, you may never know that you carry the gene. Brown hair, farsightedness, and dimples override blond hair, nearsightedness, and freckles in the world of dominant and recessive genes. Can two brown-haired parents have a blond-haired child? Yes, they can. Suppose that each parent has a dominant gene for brown hair and a recessive gene for blond hair. Since dominant genes override recessive genes, the parents have brown hair, but both are *carriers* of blondness and pass on their recessive genes for blond hair. With no dominant gene to override them, the recessive genes can make the child's hair blond.

Sex-Linked Genes

Most mutated genes are recessive. When a mutated gene is carried on the X chromosome, the result is called *X-linked inheritance*. It may have implications for males that differ greatly from those for females (Simon & others, 2016). Remember that males have only one X chromosome. Thus, if there is an absent or altered, disease-relevant gene on the X chromosome, males have no "backup" copy to counter the harmful gene and therefore may develop an X-linked disease. However, females have a second X chromosome, which is likely to be unchanged. As a result, they are not likely to have the X-linked disease. Thus, most individuals who have X-linked diseases are males. Females who have one abnormal copy of the gene on the X chromosome are known as carriers, and they usually do not show any signs of the X-linked disease. Fragile X syndrome, which we will discuss later in the chapter, is an example of X-linked inheritance (Karmiloff-Smith & others, 2016).

Polygenic Inheritance

Genetic transmission is usually more complex than the simple examples we have examined thus far (Moore, 2015). Few characteristics reflect the influence of only a single gene or pair of genes. Most are determined by the interaction of many different genes; they are said to be *polygenically* determined. Even a simple characteristic such as height reflects the interaction of many genes as well as the influence of the environment. Most diseases, such as cancer and diabetes, develop as a consequence of complex gene interactions and environmental factors.

The term *gene-gene interaction* is increasingly used to describe studies that focus on the interdependent process by which two or more genes influence characteristics, behavior, diseases, and development (Cho & Suh, 2016; Hodge, Hager, & Greenberg, 2016). For example, recent studies have documented gene-gene interaction in immune system functioning (Heinonen & others, 2015), asthma (Hua & others, 2016), alcoholism (Yokoyama & others, 2013), cancer (Wu & others, 2016), cardiovascular disease (Musameh & others, 2015), arthritis (Hohman & others, 2016), and Alzheimer disease (Ebbert & others, 2016).

Chromosome and Gene-Linked Abnormalities

In some (relatively rare) cases, genetic inheritance involves an abnormality. Some of these abnormalities come from whole chromosomes that do not separate properly during meiosis. Others are produced by defective genes.

Name	Description	Treatment	Incidence
Down syndrome	An extra chromosome causes mild to severe intellectual disabilities and physical abnormalities.	Surgery, early intervention, infant stimulation, and special learning programs	1 in 1,900 births at age 20 1 in 300 births at age 35 1 in 30 births at age 45
Klinefelter syndrome (XXY)	An extra X chromosome causes physical abnormalities.	Hormone therapy can be effective	1 in 1,000 male births
Fragile X syndrome	An abnormality in the X chromosome can cause intellectual disabilities, learning disabilities, or short attention span.	Special education, speech and language therapy	More common in males than in females
Turner syndrome (XO)	A missing X chromosome in females can cause intellectual disabilities and sexual underdevelopment.	Hormone therapy in childhood and puberty	1 in 2,500 female births
XYY syndrome	An extra Y chromosome can cause above-average height.	No special treatment required	1 in 1,000 male births

Figure 4 Some Chromosome Abnormalities
The treatments for these abnormalities do not necessarily erase the problem but may improve the individual's adaptive behavior and quality of life.

Chromosome Abnormalities

Sometimes a gamete is formed in which the combined sperm and ovum do not have their normal set of 23 chromosomes. The most notable examples involve Down syndrome and abnormalities of the sex chromosomes. Figure 4 describes some chromosome abnormalities, along with their treatment and incidence.

Down Syndrome **Down syndrome** is one of the most common genetically linked causes of intellectual disability; it is also characterized by certain physical features (Lewanda & others, 2016). An individual with Down syndrome has a round face, a flattened skull, an extra fold of skin over the eyelids, a thickened tongue, short limbs, and retardation of motor and mental abilities. The syndrome is caused by the presence of an extra copy of chromosome 21. It is not known why the extra chromosome is present, but the health of the male sperm or female ovum may be involved.

Down syndrome appears approximately once in every 700 live births. Women between the ages of 16 and 34 are less likely to give birth to a child with Down syndrome than are younger or older women. African American children are rarely born with Down syndrome.

These athletes, several of whom have Down syndrome, are participating in a Special Olympics competition. Notice the distinctive facial features of the individuals with Down syndrome, such as a round face and a flattened skull. *What causes Down syndrome?*

Sex-Linked Chromosome Abnormalities Recall that a newborn normally has either an X and a Y chromosome, or two X chromosomes. Human embryos must possess at least one X chromosome to be viable. The most common sex-linked chromosome abnormalities involve the presence of an extra chromosome (either an X or a Y) or the absence of one X chromosome in females.

Klinefelter syndrome is a chromosomal disorder in which males have an extra X chromosome, making them XXY instead of XY. Males with this disorder have undeveloped testes, and they usually have enlarged breasts and become tall (Lunenfeld & others, 2015). Klinefelter syndrome occurs approximately once in every 1,000 live male births. Only 10 percent of individuals with Klinefelter syndrome are diagnosed before puberty, with the majority not identified until adulthood (Aksglaede & others, 2013).

How Would You...?

As a **social worker,** how would you respond to a 33-year-old pregnant woman who is concerned about the risk of giving birth to a baby with Down syndrome?

Down syndrome A chromosomally transmitted form of intellectual disability, caused by the presence of an extra copy of chromosome 21.

Fragile X syndrome is a genetic disorder that results from an abnormality in the X chromosome, which becomes constricted and often breaks (Karmiloff-Smith & others, 2016). The outcome frequently takes the form of an intellectual disability, autism, a learning disability, or a short attention span (Hall & others, 2014). This disorder occurs more frequently in males than in females, possibly because the second X chromosome in females negates the effects of the other, abnormal X chromosome (McDuffie & others, 2015; Rocca & others, 2016).

Turner syndrome is a chromosomal disorder in females in which either an X chromosome is missing, making the person XO instead of XX, or part of one X chromosome is deleted. Females with Turner syndrome are short in stature and have a webbed neck (Miguel-Neto & others, 2016; Vlatkovic & others, 2014). In some cases, they are infertile. They have difficulty in mathematics, but their verbal ability is often quite good. Turner syndrome occurs in approximately 1 of every 2,500 live female births.

XYY syndrome is a chromosomal disorder in which the male has an extra Y chromosome (Lepage & others, 2014). Early interest in this syndrome focused on the belief that the extra Y chromosome found in some males contributed to aggression and violence. However, researchers subsequently found that XYY males are no more likely to commit crimes than are XY males (Witkin & others, 1976).

Gene-Linked Abnormalities

Abnormalities can be produced not only by an abnormal number of chromosomes, but also by defective genes. Figure 5 describes some gene-linked abnormalities and outlines their treatment and incidence.

Phenylketonuria (PKU) is a genetic disorder in which the individual cannot properly metabolize phenylalanine, an amino acid that naturally occurs in many food sources. It results from a recessive gene and occurs about once in every 10,000 to 20,000 live births. Today, phenylketonuria is easily detected in infancy, and it is treated by a diet that prevents an excess accumulation of phenylalanine (Rohde & others, 2014). If phenylketonuria is left untreated, however, excess phenylalanine

Name	Description	Treatment	Incidence
Cystic fibrosis	Glandular dysfunction that interferes with mucus production; breathing and digestion are hampered, resulting in a shortened life span.	Physical and oxygen therapy, synthetic enzymes, and antibiotics; most individuals live to middle age.	1 in 2,000 births
Diabetes	Body does not produce enough insulin, which causes abnormal metabolism of sugar.	Early onset can be fatal unless treated with insulin.	1 in 2,500 births
Hemophilia	Delayed blood clotting causes internal and external bleeding.	Blood transfusions/injections can reduce or prevent damage due to internal bleeding.	1 in 10,000 males
Huntington disease	Central nervous system deteriorates, producing problems in muscle coordination and mental deterioration.	Does not usually appear until age 35 or older; death likely 10 to 20 years after symptoms appear.	1 in 20,000 births
Phenylketonuria (PKU)	Metabolic disorder that, left untreated, causes intellectual disability.	Special diet can result in average intelligence and normal life span.	1 in 10,000 to 1 in 20,000 births
Sickle-cell anemia	Blood disorder that limits the body's oxygen supply; it can cause joint swelling, as well as heart and kidney failure.	Penicillin, medication for pain, antibiotics, and blood transfusions.	1 in 400 African American children (lower among other groups)
Spina bifida	Neural tube disorder that causes brain and spine abnormalities.	Corrective surgery at birth, orthopedic devices, and physical/medical therapy.	2 in 1,000 births
Tay-Sachs disease	Deceleration of mental and physical development caused by an accumulation of lipids in the nervous system.	Medication and special diet are used, but death is likely by 5 years of age.	1 in 30 American Jews is a carrier.

Figure 5 Some Gene-Linked Abnormalities

builds up in the child, producing intellectual disability and hyperactivity. Phenylketonuria accounts for approximately 1 percent of individuals who are institutionalized for intellectual disabilities, and it occurs primarily in Whites.

Sickle-cell anemia, which occurs most often in African Americans, is a genetic disorder that impairs functioning of the body's red blood cells. Red blood cells, which carry oxygen to the body's other cells, are usually shaped like a disk. In sickle-cell anemia, a recessive gene causes the red blood cell to become a hook-shaped "sickle" that cannot carry oxygen properly and dies quickly. As a result, the body's cells do not receive adequate oxygen, causing anemia and early death (Derebail & others, 2014). About 1 in 400 African American babies is affected by sickle-cell anemia. One in 10 African Americans is a carrier, as is 1 in 20 Latin Americans. Recent research strongly supports the use of hydroxyurea therapy for infants with sickle-cell anemia beginning at 9 months of age (Yawn & John-Sowah, 2015).

How Would You...?

As a **health-care professional,** how would you explain the heredity-environment interaction to new parents who are upset when they discover that their child has a treatable genetic defect?

Other diseases that result from genetic abnormalities include cystic fibrosis, some forms of diabetes, hemophilia, Huntington disease, Alzheimer disease, spina bifida, and Tay-Sachs disease. Someday, scientists may be able to determine why these and other genetic abnormalities occur and discover how to cure them (Capurro & others, 2015; Tai & others, 2015; Wang & others, 2016; Williams & others, 2016).

Genetic counselors, usually physicians or biologists who are well-versed in the field of medical genetics, may specialize in providing information to individuals who are at risk of giving birth to children with the kinds of genetic abnormalities just described (Stilwell, 2016). They can evaluate the degree of risk involved and offer helpful strategies for offsetting some of the effects of these diseases (Paneque, Sequeiros, & Skirton, 2015; Redlinger-Grosse & others, 2016). To read about the career and work of a genetic counselor, see *Careers in Life-Span Development.*

Careers in life-span development

Holly Ishmael, Genetic Counselor

Holly Ishmael is a genetic counselor at Children's Mercy Hospital in Kansas City. She obtained an undergraduate degree in psychology and then a master's degree in genetic counseling from Sarah Lawrence College.

Genetic counselors work as members of a health-care team, providing information and support to families with birth defects or genetic disorders. They identify families at risk by analyzing inheritance patterns and explore options with the family. Some genetic counselors, like Holly, become specialists in prenatal and pediatric genetics; others might specialize in cancer genetics or psychiatric genetic disorders.

Holly says, "Genetic counseling is a perfect combination for people who want to do something science-oriented, but need human contact and don't want to spend all of their time in a lab or have their nose in a book" (Rizzo, 1999, p. 3).

Genetic counselors hold specialized graduate degrees in the areas of medical genetics and counseling. They enter graduate school with undergraduate backgrounds from a variety of disciplines, including biology, genetics, psychology, public health, and social work. There are approximately 30 graduate genetic counseling programs in the United States. If you are interested in this profession, you can obtain further information from the National Society of Genetic Counselors at www.nsgc.org.

Holly Ishmael (left) in a genetic counseling session.

The Interaction of Heredity and Environment: The Nature-Nurture Debate

Is it possible to untangle the influence of heredity from that of environment and discover the role of each in producing individual differences in development? When heredity and environment interact, how does heredity influence the environment, and vice versa?

Behavior Genetics

Behavior genetics is the field that seeks to discover the influence of heredity and environment on individual differences in human traits and development. Behavior geneticists often study either twins or adoption situations (Jaffee, 2016; Lickliter & Honeycutt, 2015; Nes & Roysamb, 2016; South & Jarnecke, 2016).

In a **twin study,** the behavioral similarities between identical twins (who are genetically identical) are compared with the behavioral similarities between fraternal twins. Recall that although fraternal twins share the same womb, they are no more genetically alike than are non-twin siblings. By comparing groups of identical and fraternal twins, behavior geneticists capitalize on this basic knowledge that identical twins are more similar genetically than are fraternal twins: If they observe that a behavioral trait is more often shared by identical twins than by fraternal twins, they can infer that the trait has a genetic basis (Jansen & others, 2015; Tan & others, 2015). For example, one study revealed a higher incidence of conduct problems shared by identical twins than by fraternal twins, and the researchers discerned an important role for heredity in conduct problems (Scourfield & others, 2004).

However, several issues complicate the interpretation of twin studies. For example, perhaps the environments of identical twins are more similar than those of fraternal twins. Parents and caregivers might stress the similarities of identical twins more than those of fraternal twins, and identical twins might perceive themselves as a "set" and play together more than fraternal twins do. If so, the observed similarities between identical twins might have a significant environmental basis.

In an **adoption study,** investigators seek to discover whether the behavior and psychological characteristics of adopted children are more like those of their adoptive parents, who have provided a home environment, or more like those of their biological parents, who have contributed their heredity (McAdams & others, 2015). Another form of the adoption study compares adoptees with their adoptive siblings and their biological siblings (Kendler & others, 2016).

behavior genetics The field that seeks to discover the influence of heredity and environment on individual differences in human traits and development.

twin study A study in which the behavioral similarity of identical twins is compared with the behavioral similarity of fraternal twins.

adoption study A study in which investigators seek to discover whether, in behavior and psychological characteristics, adopted children are more like their adoptive parents, who provided a home environment, or more like their biological parents, who contributed their heredity. Another form of the adoption study compares adoptive and biological siblings.

Heredity-Environment Correlations

The difficulties that researchers encounter in interpreting the results of twin and adoption studies reflect the complexities of heredity-environment interactions. Some of these interactions are heredity-environment correlations, which means that individuals' genes may influence the types of environments to which they are exposed. In a sense, individuals "inherit" environments that may be related or linked to genetic "propensities" (Klahr & Burt, 2014; Jaffee, 2016). Behavior geneticist Sandra Scarr (1993) described three ways in which heredity and environment are correlated:

- *Passive genotype-environment correlations* occur because biological parents, who are genetically related to the child, provide a rearing environment for the child. For example, the parents might have a genetic predisposition to be intelligent and read skillfully. Because they read well and enjoy reading, they provide their children with books to read. The likely outcome is that their children, given their own inherited predispositions from their parents and their book-filled environment, will become skilled readers.

- *Evocative genotype-environment correlations* occur because a child's characteristics elicit certain types of environments. For example, active, smiling children receive more social stimulation than passive, quiet children do. Cooperative, attentive children evoke more pleasant and instructional responses from the adults around them than uncooperative, distractible children do.
- *Active (niche-picking) genotype-environment correlations* occur when children seek out environments that they find compatible and stimulating. *Niche-picking* refers to finding a setting that is suited to one's abilities. Children select from their surrounding environment specific aspects that they respond to, learn about, or ignore. Their active selections of environments are related to their particular genotype. For example, outgoing children tend to seek out social contexts in which to interact with people, whereas shy children don't. Children who are musically inclined are likely to select musical environments in which they can successfully perform their skills.

The Epigenetic View and Gene × Environment (G × E) Interaction

Notice that Scarr's view gives the preeminent role in development to heredity: her analysis describes how heredity may influence the types of environments that children experience. Critics argue that the concept of heredity-environment correlation gives heredity too great an influence in determining development because it does not consider the role of prior environmental influences in shaping the correlation itself (Gottlieb, 2007; Moore, 2015). In this section we look at some approaches that place greater emphasis on the role of the environment.

The Epigenetic View

In line with the concept of a collaborative gene, Gilbert Gottlieb (2007) proposed an **epigenetic view,** which states that development is the result of an ongoing, bidirectional interchange between heredity and the environment. Figure 6 compares the heredity-environment correlation and epigenetic views of development.

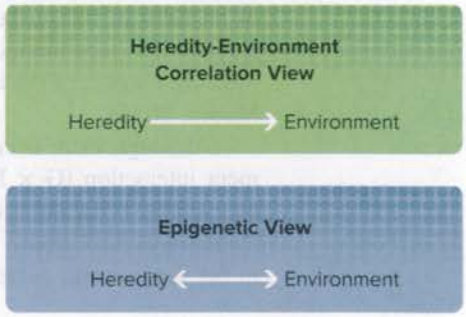


Figure 6 Comparison of the Heredity-Environment Correlation and Epigenetic Views

How Would You...?

As a **human development and family studies professional,** how would you apply the epigenetic view to explain why one identical twin can develop alcoholism while the other twin does not?

Let's look at an example that reflects the epigenetic view. A baby inherits genes from both parents at conception. During prenatal development, toxins, nutrition, and stress can influence some genes to stop functioning while others become stronger or weaker. During infancy, additional environmental experiences, such as exposure to toxins, nutrition, stress, learning, and encouragement, continue to modify genetic activity and the activity of the nervous system that directly underlies behavior. Heredity and environment thus operate together—or collaborate—to produce a person's well-being, intelligence, temperament, health, ability to pitch a baseball, ability to read, and so on (Gottlieb, 2007; Moore, 2015; Szyf & Pluess, 2016).

To what extent are this young girl's piano skills likely due to heredity, environment, or both?

Gene × Environment (G × E) Interaction

epigenetic view Emphasizes that development is the result of an ongoing, bidirectional interchange between heredity and environment.

An increasing number of studies are exploring how the interaction between heredity and environment influences development, including interactions that involve specific DNA sequences (Grigorenko & others, 2016;

Hill & Roth, 2016; Pluess & Meaney, 2016). The epigenetic mechanisms involve the actual molecular modification of the DNA strand as a result of environmental inputs in ways that alter gene functioning (Moore, 2015).

One study found that individuals who have a short version of a gene labeled 5-HTTLPR (a gene involving the neurotransmitter serotonin) have an elevated risk of developing depression only if they *also* lead stressful lives (Caspi & others, 2003). Thus, the specific gene did not directly cause the development of depression; rather the gene interacted with a stressful environment in a way that allowed the researchers to predict whether individuals would develop depression. A recent meta-analysis indicated that the short version of 5-HTTLPR was linked with higher cortisol stress reactivity (Miller & others, 2013). Recent studies also have found support for the interaction between the 5-HTTLPR gene and stress levels in predicting depression in adolescents and older adults (Petersen & others, 2012; Zannas & others, 2012).

Other research involving interaction between genes and environmental experiences has focused on attachment, parenting, and supportive child-rearing environments (Brody & others, 2016; Hostinar, Cicchetti, & Rogosch, 2014; Mileva-Seitz, Bakermans-Kranenburg, & van IJzendoom, 2016; Naumova & others, 2016). In one study, adults who experienced parental loss as young children were more likely to have unresolved attachment issues as adults only when they had the short version of the 5-HTTLPR gene (Caspers & others, 2009). The long version of the serotonin transporter gene apparently provided some protection and ability to cope better with parental loss. Other recent research has found that variations in dopamine-related genes interact with supportive or unsupportive rearing environments to influence children's development (Bakermans-Kranenburg & van IJzendoorn, 2011). The type of research just described is referred to as studies of **gene × environment (G × E) interaction**—the interaction of a specific measured variation in DNA and a specific measured aspect of the environment (Grigorenko & others, 2016; Hill & Roth, 2016; Moore, 2015).

Although there is considerable enthusiasm about the concept of gene x environment interaction (G × E), a recent research review concluded that this approach is plagued by difficulties in replicating results, inflated claims, and other weaknesses (Manuck & McCaffery, 2014). The science of G × E interaction is very young, and in the next several decades it will likely produce more precise findings.

Conclusions About Heredity-Environment Interaction

If an attractive, popular, intelligent girl is elected president of her high school senior class, is her success due to heredity or to environment? Of course, the answer is "both."

The relative contributions of heredity and environment are not additive. That is, we can't say that such-and-such a percentage of nature and such-and-such a percentage of experience make us who we are. Nor is it accurate to say that full genetic expression happens once, at the time of conception or birth, after which we carry our genetic legacy into the world to see how far it takes us. Genes produce proteins throughout the life span, in many different environments. Or they don't produce these proteins, depending in part on how harsh or nourishing those environments are.

The emerging view is that complex behaviors are influenced by genes in ways that give people a propensity for a particular developmental trajectory (Reiss, 2016). However, the individual's actual development requires more: a particular environment. And that environment is complex, just like the mixture of genes we inherit (O'Connor, 2016; Toth & others, 2016). Environmental influences range from the things we lump together under "nurture" (such as culture, parenting, family dynamics, schooling, and neighborhood quality) to biological encounters (such as viruses, birth complications, and even biological events in cells).

gene × environment (G × E) interaction The interaction of a specified measured variation in DNA and a specific measured aspect of the environment.

In developmental psychologist David Moore's (2013, 2015) view, the biological systems that generate behaviors are extremely complex but too often these systems have been described in overly simplified ways that can

be misleading. Thus, although genetic factors clearly contribute to behavior and psychological processes, they don't determine these phenotypes independently from the contexts in which they develop. From Moore's (2013, 2015) perspective, it is misleading to talk about "genes for" eye color, intelligence, personality, or other characteristics. Moore commented that in retrospect we should not have expected to be able to make the giant leap from DNA's molecules to a complete understanding of human behavior any more than we should anticipate being able to easily link air molecules in a concert hall with a full-blown appreciation of a symphony's wondrous experience.

Imagine for a moment that there is a cluster of genes that are somehow associated with youth violence. (This example is hypothetical because we don't know of any such combination.) The adolescent who carries this genetic mixture might experience a world of loving parents, regular nutritious meals, lots of books, and a series of competent teachers. Or the adolescent's world might include parental neglect, a neighborhood in which gunshots and crime are everyday occurrences, and inadequate schooling. In which of these environments are the adolescent's genes likely to manufacture the biological underpinnings of criminality?

If heredity and environment interact to determine the course of development, is that all there is to answering the question of what causes development? Are humans completely at the mercy of their genes and their environment as they develop through the life span? Genetic heritage and environmental experiences are pervasive influences on development. But in thinking about what causes development, recall our discussion of development as the co-construction of biology, culture, *and* the individual. Not only are we the outcomes of our heredity and the environment we experience, but we also can author a unique developmental path by changing our environment. As one psychologist recently concluded:

> In reality, we are both the creatures and creators of our worlds. We are . . . the products of our genes and environments. Nevertheless, . . . the stream of causation that shapes the future runs through our present choices . . . Mind matters . . . Our hopes, goals, and expectations influence our future. (Myers, 2010, p. 168)

Prenatal Development

We turn now to a description of how the process of development unfolds from its earliest moment—the moment of conception—when two parental cells, with their unique genetic contributions, merge to create a new individual.

Conception occurs when a single sperm cell from a male unites with an ovum (egg) in a female's fallopian tube in a process called fertilization. Over the next few months the genetic code discussed earlier directs a series of changes in the fertilized egg, but many events and hazards will influence how that egg develops and becomes a person.

The Course of Prenatal Development

Prenatal development lasts approximately 266 days, beginning with fertilization and ending with birth. Pregnancy can be divided into three periods: germinal, embryonic, and fetal.

The Germinal Period

The **germinal period** is the period of prenatal development that takes place in the first two weeks after conception. It includes the creation of the fertilized egg (the zygote), cell division, and the attachment of the multicellular organism to the uterine wall.

germinal period The period of prenatal development that takes place during the first two weeks after conception. It includes the creation of the zygote, continued cell division, and the attachment of the zygote to the uterine wall.

Rapid cell division by the zygote begins the germinal period. (Recall from earlier in the chapter that this cell division occurs through a process called mitosis.) Within one week after conception, the differentiation of

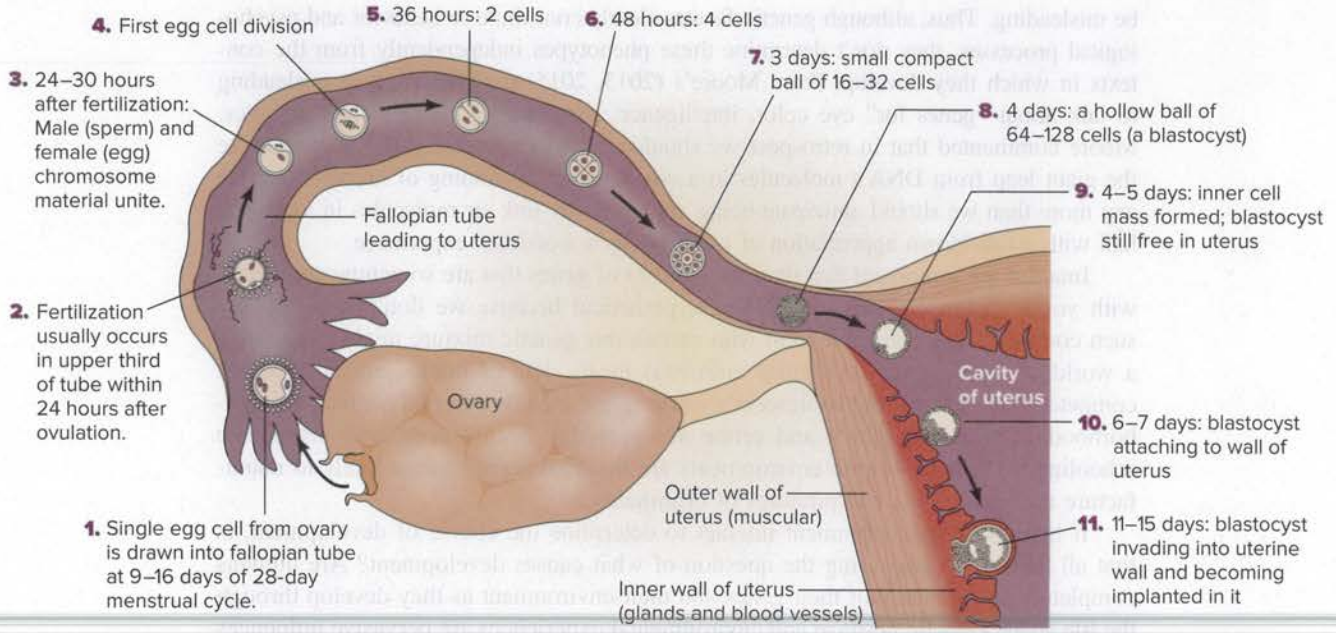


Figure 7 Major Developments in the Germinal Period

these cells—their specialization for different tasks—has already begun. At this stage the organism, now called the blastocyst, consists of a hollow ball of cells that will eventually develop into the embryo, and the trophoblast, an outer layer of cells that later provides nutrition and support for the embryo. Implantation, the embedding of the blastocyst in the uterine wall, takes place during the second week after conception. Figure 7 summarizes these significant developments in the germinal period.

The Embryonic Period

The **embryonic period** is the period of prenatal development that occurs from two to eight weeks after conception. During the embryonic period, the rate of cell differentiation intensifies, support systems for cells form, and organs develop.

The mass of cells is now called an *embryo*, and three layers of cells form. The embryo's *endoderm* is the inner layer of cells, which will develop into the digestive and respiratory systems. The *ectoderm* is the outermost layer, which will become the nervous system, sensory receptors (ears, nose, and eyes, for example), and skin parts (hair and nails, for example). The *mesoderm* is the middle layer, which will become the circulatory system, bones, muscles, excretory system, and reproductive system. Every body part eventually develops from these three layers. The endoderm primarily produces internal body parts, the mesoderm primarily produces parts that surround the internal areas, and the ectoderm primarily produces surface parts. **Organogenesis** is the name given to the process of organ formation during the first two months of prenatal development. While they are being formed, the organs are especially vulnerable to environmental influences.

As the embryo's three layers form, life-support systems for the embryo develop rapidly. These systems include the amnion, the umbilical cord (both of which develop from the fertilized egg, not the mother's body), and the placenta. The amnion is like a bag or an envelope; it contains a clear fluid in which the developing embryo floats. The amniotic fluid provides an environment that is temperature- and humidity-controlled, as well as shockproof. The *umbilical cord*, which typically contains two arteries and one vein, connects the baby to the placenta. The *placenta* consists of a disk-shaped group of tissues in which small blood vessels from the mother and the offspring intertwine but do not join.

embryonic period The period of prenatal development that occurs two to eight weeks after conception. During the embryonic period, the rate of cell differentiation intensifies, support systems for the cells form, and organs appear.

organogenesis Organ formation that takes place during the first two months of prenatal development.

How Would You...?

As a **human development and family studies professional,** how would you characterize the greatest risks at each period of prenatal development?

Very small molecules—oxygen, water, salt, and nutrients from the mother's blood, as well as carbon dioxide and digestive wastes from the baby's blood—pass back and forth between the mother and the embryo or fetus. Large molecules cannot pass through the placental wall; these include red blood cells and some harmful substances, such as most bacteria, maternal wastes, and hormones (Holme & others, 2015; Pfeifer & Bunders, 2016). Virtually any drug or chemical substance a pregnant woman ingests can cross the placenta to some degree, unless it is metabolized or altered during passage, or is too large (Burton & Jauniaux, 2015).

A recent study confirmed that ethanol crosses the human placenta and primarily reflects maternal alcohol use (Matlow & others, 2013). Another study revealed that cigarette smoke weakened and increased the oxidative stress of fetal membranes from which the placenta develops (Menon & others, 2011). The stress hormone cortisol also can cross the placenta (Parrott & others, 2014). The mechanisms that govern the transfer of substances across the placental barrier are complex and not yet entirely understood (Kohan-Ghadr & others, 2016; Lecarpentier & others, 2016; Mandelbrot & others, 2015).

The Fetal Period

The **fetal period**, which lasts about seven months, is the prenatal period that extends from two months after conception until birth in typical pregnancies. Growth and development continue their dramatic course during this time.

Three months after conception, the fetus is about 3 inches long and weighs about 1 ounce. It has become active, moving its arms and legs, opening and closing its mouth, and moving its head. The face, forehead, eyelids, nose, and chin are distinguishable, as are the upper arms, lower arms, hands, and lower limbs. In most cases, the genitals can be identified as male or female. By the end of the fourth month of pregnancy, the fetus has grown to 6 inches in length and weighs 4 to 7 ounces. At this time, a growth spurt occurs in the body's lower parts. For the first time, the mother can feel arm and leg movements.

By the end of the fifth month, the fetus is about 12 inches long and weighs close to a pound. Structures of the skin have formed—including toenails and fingernails. The fetus is more active, showing a preference for a particular position in the womb. By the end of the sixth month, the fetus is about 14 inches long and has gained another 6 to 12 ounces. The eyes and eyelids are completely formed, and a fine layer of hair covers the head. A grasping reflex is present and irregular breathing movements occur.

As early as six months of pregnancy (about 24 to 25 weeks after conception), the fetus for the first time has a chance of surviving outside the womb—that is, it is *viable.* Infants that are born early, or between 24 and 37 weeks of pregnancy, usually need help breathing because their lungs are not yet fully mature. By the end of the seventh month, the fetus is about 16 inches long and weighs about 3 pounds.

During the last two months of prenatal development, fatty tissues develop and the functioning of various organ systems—heart and kidneys, for example—steps up. During the eighth and ninth months, the fetus grows longer and gains substantial weight—about 4 more pounds. At birth, the average American baby weighs 7½ pounds and is about 20 inches long.

In addition to describing prenatal development in terms of germinal, embryonic, and fetal periods, prenatal development also can be divided into equal three-month periods called *trimesters.* Figure 8 gives an overview of the main events during each trimester. Remember that the three trimesters are not the same as the three prenatal periods we have discussed. The germinal and embryonic periods occur in the first trimester. The fetal period begins toward the end of the first trimester and continues through the second and third trimesters.

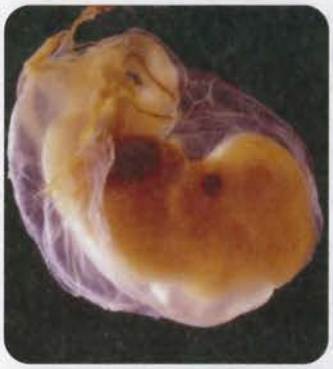
The Brain

One of the most remarkable aspects of the prenatal period is the development of the brain (Bale, 2015; Stiles & others, 2015). By the time babies are born, they have approximately 100 billion **neurons,** or nerve cells, which handle information processing at the cellular level in the brain.

fetal period The prenatal period of development that begins two months after conception and usually lasts for seven months.

neurons Nerve cells that handle information processing at the cellular level in the brain.

First trimester (first 3 months)



Conception to 4 weeks

- Is less than 1/10 inch long
- Beginning development of spinal cord, nervous system, gastrointestinal system, heart, and lungs
- Amniotic sac envelops the preliminary tissues of entire body
- Is called a "zygote," then a "blastocyst"

8 weeks

- Is just over 1 inch long
- Face is forming with rudimentary eyes, ears, mouth, and tooth buds
- Arms and legs are moving
- Brain is forming
- Fetal heartbeat is detectable with ultrasound
- Is called an "embryo"

12 weeks

- Is about 3 inches long and weighs about 1 ounce
- Can move arms, legs, fingers, and toes
- Fingerprints are present
- Can smile, frown, suck, and swallow
- Sex is distinguishable
- Can urinate
- Is called a "fetus"

Second trimester (middle 3 months)

16 weeks

- Is about 6 inches long and weighs about 4 to 7 ounces
- Heartbeat is strong
- Skin is thin, transparent
- Downy hair (lanugo) covers body
- Fingernails and toenails are forming
- Has coordinated movements; is able to roll over in amniotic fluid

20 weeks

- Is about 12 inches long and weighs close to 1 pound
- Heartbeat is audible with ordinary stethoscope
- Sucks thumb
- Hiccups
- Hair, eyelashes, eyebrows are present

24 weeks

- Is about 14 inches long and weighs about 1 to 1½ pounds
- Skin is wrinkled and covered with protective coating (vernix caseosa)
- Eyes are open
- Waste matter is collected in bowel
- Has strong grip

Third trimester (last 3 months)

28 weeks

- Is about 16 inches long and weighs about 3 pounds
- Is adding body fat
- Is very active
- Rudimentary breathing movements are present

32 weeks

- Is 16½ to 18 inches long and weighs 4 to 5 pounds
- Has periods of sleep and wakefulness
- Responds to sounds
- May assume the birth position
- Bones of head are soft and flexible
- Iron is being stored in liver

36 to 38 weeks

- Is 19 to 20 inches long and weighs 6 to 7½ pounds
- Skin is less wrinkled
- Vernix caseosa is thick
- Lanugo is mostly gone
- Is less active
- Is gaining immunities from mother

Figure 8 Growth and Development in the Three Trimesters of Prenatal Development

(*Top*) © David Spears/PhotoTake, Inc.; (*middle*) © Neil Bromhall/Science Source; (*bottom*) © Brand X Pictures/PunchStock RF

During prenatal development, neurons move to specific locations and start to become connected. The basic architecture of the human brain is assembled during the first two trimesters of prenatal development. In typical development, the third trimester of prenatal development and the first two years of postnatal life are characterized by connectivity and functioning of neurons (Nelson, 2012).

Four important phases of the brain's development during the prenatal period involve (1) formation of the neural tube; (2) neurogenesis; (3) neural migration, and (4) neural connectivity.

As the human embryo develops inside its mother's womb, the nervous system begins forming as a long, hollow tube located on the embryo's back. This pear-shaped *neural tube*, which forms at about 18 to 24 days after conception, develops out of the ectoderm. The tube closes at the top and bottom ends at about 24 days after conception. Figure 9 shows that the nervous system still has a tubular appearance 6 weeks after conception.

Two birth defects related to a failure of the neural tube to close are anencephaly and spina bifida. When a fetus has anencephaly (that is, when the head end of the neural tube fails to close), the highest regions of the brain fail to develop and the baby dies in the womb, during childbirth, or shortly after birth (Steric & others, 2015). Spina bifida,

an incomplete development of the spinal cord, results in varying degrees of paralysis of the lower limbs. Individuals with spina bifida usually need assistive devices such as crutches, braces, or wheelchairs. Both maternal diabetes and obesity also place the fetus at risk for developing neural tube defects (McMahon & others, 2013; Yu, Wu, & Yang, 2016). Further, a recent study revealed that a high level of maternal stress during pregnancy was associated with neural tube defects in offspring (Li & others, 2013). A strategy that can help to prevent neural tube defects is for women to take adequate amounts of the B vitamin folic acid (Bergman & others, 2016). A recent large-scale study in Brazil found that when flour was fortified with folic acid it produced a significant reduction in neural tube defects (Santos & others, 2016).

In a normal pregnancy, once the neural tube has closed, a massive proliferation of new immature neurons begins to take place about the fifth prenatal week and continues throughout the remainder of the prenatal period. The production of new neurons is called *neurogenesis.* At the peak of neurogenesis, it is estimated that as many as 200,000 neurons are being generated every minute.

At approximately 6 to 24 weeks after conception, *neuronal migration* occurs (Nelson, 2012). Cells begin moving outward from their point of origin to their appropriate locations and creating the different levels, structures, and regions of the brain (Miyazaki, Song, & Takahashi, 2016; Zeisel, 2011). Once a cell has migrated to its target destination, it must mature and develop a more complex structure.

At about the 23rd prenatal week, connections between neurons begin to form, a process that continues postnatally (Kostovic, Judas, & Sedmak, 2011; Miller, Huppi, & Mallard, 2016). We will have much more to say about the structure of neurons, their connectivity, and the development of the infant brain.

Figure 9 Early Formation of the Nervous System
The photograph shows the primitive, tubular appearance of the nervous system at six weeks in the human embryo.

Prenatal Tests

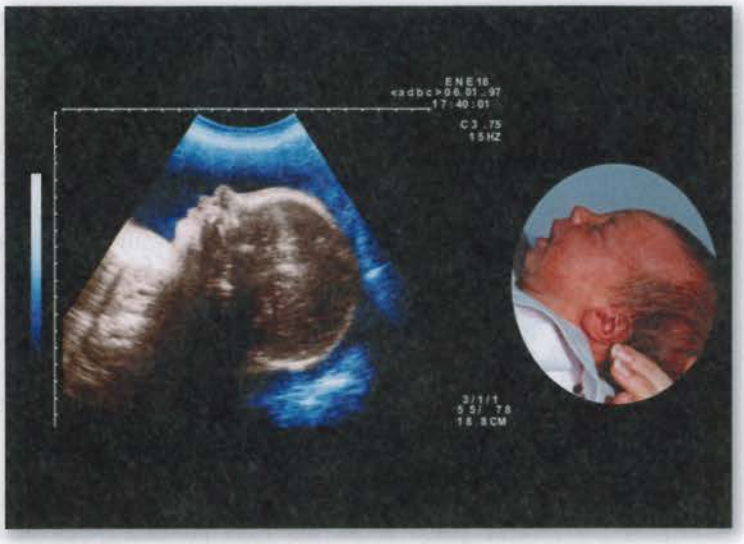
Together with her doctor, a pregnant woman will decide the extent to which she should undergo prenatal testing. A number of tests can indicate whether a fetus is developing normally; these include ultrasound sonography, fetal MRI, chorionic villus sampling, amniocentesis, maternal blood screening, and noninvasive prenatal diagnosis. The decision to have a given test depends on several criteria, such as the mother's age, medical history, and genetic risk factors.

Ultrasound Sonography

An ultrasound test is generally performed 7 weeks into a pregnancy and at various times later in pregnancy. *Ultrasound sonography* is a noninvasive prenatal medical procedure in which high-frequency sound waves are directed into the pregnant woman's abdomen (Goncalves, 2016; Li & others, 2015). The echo from the sounds is transformed into a visual representation of the fetus's inner structures. This technique can detect many structural abnormalities in the fetus, including microencephaly, a form of intellectual disability involving an abnormally small brain; it can also give clues to the baby's sex and indicate whether there is more than one fetus (Calvo-Garcia, 2016; Rink & Norton, 2016). A recent research review concluded that many aspects of the developing prenatal brain can be detected by ultrasound in the first trimester and that about 50 percent of spina bifida cases can be identified at this time, most of these being severe cases (Engels & others, 2016). There is virtually no risk to the woman or fetus in using ultrasound.

Chorionic Villus Sampling

At some point between the 10th and 12th weeks of pregnancy, chorionic villus sampling may be used to screen for genetic defects and chromosome abnormalities. *Chorionic villus sampling (CVS)* is a prenatal medical procedure in which a tiny tissue sample from the placenta is removed and analyzed (Lankford & others, 2015; Monni & others, 2016). The results are available in about 10 days.



A 6-month-old poses with the ultrasound image taken four months into the baby's prenatal development. *What is ultrasound sonography and what can it detect?*

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Amniocentesis

Between the 15th and 18th weeks of pregnancy, *amniocentesis* may be performed. In this procedure, a sample of amniotic fluid is withdrawn by syringe and tested for chromosomal or metabolic disorders (Ekblad & others, 2015; Lehmann, 2016). The later in the pregnancy amniocentesis is performed, the better its diagnostic potential. However, the earlier it is performed, the more useful it is in deciding how to handle a pregnancy when the fetus is found to have a disorder. It may take two weeks for enough cells to grow so that amniocentesis test results can be obtained. Amniocentesis brings a small risk of miscarriage: about 1 woman in every 200 to 300 miscarries after amniocentesis.

Maternal Blood Screening

During the 16th to 18th weeks of pregnancy, maternal blood screening may be performed. *Maternal blood screening* identifies pregnancies that have an elevated risk for birth defects such as spina bifida and Down syndrome (Charkiewicz & others, 2016; Cuckle & Maymon, 2016), as well as congenital heart disease risk for children (Sun & others, 2016). The current blood test is called the *triple screen* because it measures three substances in the mother's blood. After an abnormal triple screen result, the next step is usually an ultrasound examination. If an ultrasound does not explain the abnormal triple screen results, amniocentesis typically is used.

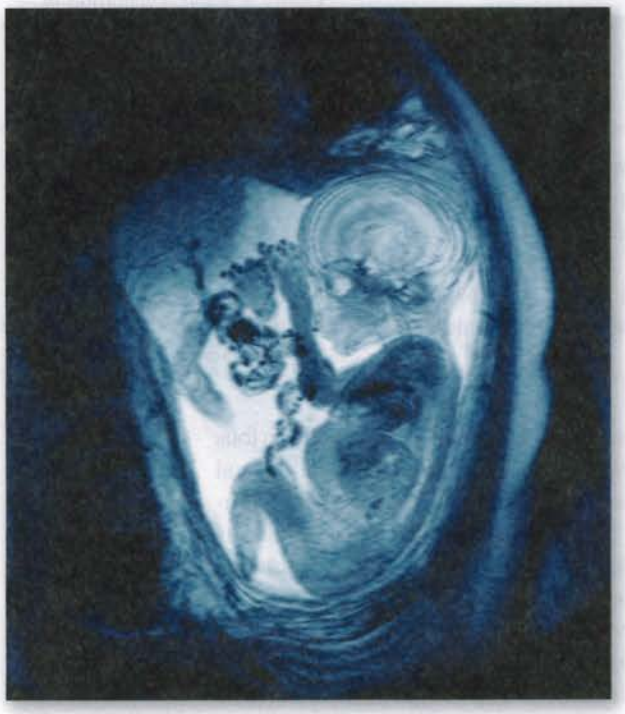

Figure 10 A Fetal MRI
Increasingly, MRI is being used to diagnose fetal malformations.

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Fetal MRI

The development of brain-imaging techniques has led to increasing use of *fetal MRI* to diagnose fetal malformations (Gat & others, 2016; Sanz-Cortes & others, 2015; You & others, 2016) (see Figure 10). MRI, which stands for magnetic resonance imaging, uses a powerful magnet and radio images to generate detailed images of the body's organs and structures. Currently, high-quality ultrasound is still the first choice in fetal screening, but fetal MRI can provide more detailed images than ultrasound (Wataganara & others, 2016). In many instances, ultrasound will indicate a possible abnormality and fetal MRI will then be used to obtain a clearer, more detailed image

(Milani & others, 2015; Tee & others, 2016). Among the fetal malformations that fetal MRI may be able to detect better than ultrasound sonography are certain abnormalities of the central nervous system, chest, gastrointestinal tract, genital/urinary organs, and placenta (Malinger & Lerman-Sagie, 2015). In a recent research review, it was concluded that fetal MRI often does not provide good results in the first trimester of pregnancy because of small fetal structures and movement artifacts (Wataganara & others, 2016). Also, in this review, it was argued that fetal MRI can be especially beneficial in assessing central nervous system abnormalities in the third trimester of pregnancy.

Fetal Sex Determination

Chorionic villus sampling has often been used to determine the sex of the fetus at some point between 11 and 13 weeks of gestation. Also, in a recent study, ultrasound accurately identified the sex of the fetus between 11 and 13 weeks of gestation (Manzanares & others, 2016). Recently, though, some noninvasive techniques, such as cell-free DNA analysis in blood plasma, have been able to detect the sex of the fetus at an earlier point (Breveglieri & others, 2016; Koumbaris & others, 2016; Moise & others, 2013). A meta-analysis of studies confirmed that a baby's sex can be detected as early as 7 weeks into pregnancy (Devaney & others, 2011). Being able to detect an offspring's sex as well as the presence of various diseases and defects at such an early stage raises ethical concerns about couples' motivation to terminate a pregnancy (Browne, 2016; Lewis & others, 2012).

Infertility and Reproductive Technology

Recent advances in biological knowledge have also opened up many choices for infertile people (Asero & others, 2014). Approximately 10 to 15 percent of couples in the United States experience infertility, which is defined as the inability to conceive a child after 12 months of regular intercourse without contraception. The cause of infertility can rest with either the woman or the man, or both (Brazdova & others, 2016; Zhou & others, 2016). The woman may not be ovulating (releasing eggs to be fertilized); she may be producing abnormal ova; her fallopian tubes (by which ova normally reach the womb) may be blocked; or she may have a condition that prevents implantation of the embryo into the uterus. The man may produce too few sperm; the sperm may lack motility (the ability to move adequately); or he may have a blocked passageway (Takasaki & others, 2014).

Surgery can correct some causes of infertility; for others, hormone-based drugs may be effective. Of the 2 million U.S. couples who seek help for infertility every year, about 40,000 try assisted reproduction technologies. *In vitro fertilization (IVF)*, the technique that produced the world's first "test tube baby" in 1978, involves eggs and sperm being combined in a laboratory dish. If any eggs are successfully fertilized, one or more of the resulting fertilized eggs is transferred into the woman's uterus.

How Would You...?

As a **psychologist,** how would you advise a 25-year-old mother who is concerned about the possibility of birth defects but has no genetic history of these types of problems?

The creation of families by means of assisted reproduction techniques raises important questions about the physical and psychological consequences for children (March of Dimes, 2016). For example, one result of fertility treatments is an increase in multiple births (De Neubourg & others, 2016). Twenty-five to 30 percent of pregnancies achieved by fertility treatments—including in vitro fertilization—result in multiple births. Fertility drugs are more likely to produce multiple births than in vitro fertilization (March of Dimes, 2016). Any multiple birth increases the likelihood that the babies will have life-threatening and costly problems, such as extremely low birth weight (March of Dimes, 2016).

Hazards to Prenatal Development

For most babies, the course of prenatal development goes smoothly. Their mother's womb protects them as they develop. Despite this protection, however, the environment can affect the embryo or fetus in many well-documented ways.

General Principles

A **teratogen** is any agent that can potentially cause a birth defect or negatively alter cognitive and behavioral outcomes. The field of study that investigates the causes of birth defects is called *teratology* (Eltonsy & others, 2016; Kaushik & others, 2016; Stancil & others, 2016). Teratogens include drugs, incompatible blood types, environmental pollutants, infectious diseases, nutritional deficiencies, maternal stress, advanced maternal and paternal age, and environmental pollutants.

The dose, genetic susceptibility, and time of exposure to a particular teratogen influence both the severity of the damage to an embryo or fetus and the type of defect: (1) *Dose*—The dose effect is rather obvious—the greater the dose of an agent, such as a drug, the greater the effect. (2) *Genetic susceptibility*—The type or severity of abnormalities caused by a teratogen is linked to the genotype of the pregnant woman and the genotype of the embryo or fetus (de Planell-Saguer, Lovinsky-Desir, & Miller, 2014). (3) *Time of exposure*—Teratogens do more damage when they occur at some points in development than at others. The probability of a structural defect is greatest early in the embryonic period, when organs are being formed (Holmes, 2011). After organogenesis is complete, teratogens are less likely to cause anatomical defects. Instead, exposure during the fetal period is more likely to stunt growth or create problems in the way organs function. To examine some key teratogens and their effects, let's begin with drugs.

Prescription and Nonprescription Drugs

Prescription drugs that can function as teratogens include antibiotics, such as streptomycin and tetracycline; some antidepressants; certain hormones, such as progestin and synthetic estrogen; and isotretinoin (often prescribed for acne) (Gonzalez-Echavarri & others, 2015). In a recent study, isotretinoin was the fourth most common drug given to female adolescents who were seeking contraception advice from a physician (Stancil & others, 2016). However, physicians did not give the adolescent girls adequate information about the negative effects of isotretinoin on offspring if the girls become pregnant. In a recent review of teratogens that should never be taken during the first trimester of pregnancy, isotreninoin was on the prohibited list (Eltonsy & others, 2016). Nonprescription drugs that can be harmful include diet pills and high doses of aspirin.

Psychoactive Drugs

Psychoactive drugs act on the nervous system to alter states of consciousness, modify perceptions, and change moods. Examples include caffeine, alcohol, and nicotine, as well as illegal drugs such as cocaine, marijuana, and heroin.

Caffeine People often consume caffeine by drinking coffee, tea, or colas, or by eating chocolate. Research has been mixed on the effects of caffeine intake by pregnant women on the fetus (Chen & others, 2016; Hahn & others, 2015; Sengpiel & others, 2013). However, the influence of increased consumption of energy drinks that typically have extremely high levels of caffeine on the development of offspring has not yet been studied. The U.S. Food and Drug Administration recommends that pregnant women either not consume caffeine or consume it only sparingly.

Alcohol Heavy drinking by pregnant women can be devastating to offspring (Alexander, Dasinger, & Intapad, 2015; Valenzuela & others, 2016). **Fetal alcohol spectrum disorders (FASD)** are a cluster of abnormalities and problems that appear in the offspring of mothers who drink alcohol heavily during pregnancy (Coles & others, 2016; Roozen & others, 2016). The abnormalities include facial deformities and defective limbs, face, and heart (Arnold & others, 2013; Cook & others, 2016). Most children with FASD have learning problems, and many are below average in intelligence; some have an intellectual disability (Harper & others, 2014; Khoury & Milligan, 2016). A recent study revealed that children with FASD have deficiencies in the brain pathways involved in working memory (Diwadkar & others, 2012). A recent research review concluded that FASD is linked

teratogen Any agent that can potentially cause a birth defect or negatively alter cognitive and behavioral outcomes.

fetal alcohol spectrum disorders (FASD) A cluster of abnormalities that appears in the offspring of mothers who drink alcohol heavily during pregnancy.

to a lower level of executive function in children, especially in planning (Kingdon, Cardoso, & McGrath, 2016). And in a recent study, FASD was associated with both externalized and internalized behavior problems in childhood (Tsang & others, 2016). Also, in a recent study in the United Kingdom, the life expectancy of individuals with FASD was only 34 years of age, about 42 percent of the life expectancy of the general population (Thanh & Jonsson, 2016). In this study, the most common causes of death among individuals with FASD were suicide (15 percent), accidents (14 percent), and poisoning by illegal drugs or alcohol (7 percent). Although mothers of FASD infants are heavy drinkers, many mothers who are heavy drinkers may not have children with FASD or may have one child with FASD and other children who do not have it.

What are some guidelines for alcohol use during pregnancy? Even drinking just one or two servings of beer or wine or one serving of hard liquor a few days a week can have negative effects on the fetus, although it is generally agreed that this level of alcohol use will not cause fetal alcohol spectrum disorders (Valenzeula & others, 2012). The U.S. Surgeon General recommends that no alcohol be consumed during pregnancy, as does the French Alcohol Society (Rolland & others, 2016). And research suggests that it may not be wise to consume alcohol at the time of conception. One study revealed that intakes of alcohol by both men and women during the weeks of conception increased the risk of early pregnancy loss (Henriksen & others, 2004).

Fetal alcohol spectrum disorders (FASD) are characterized by a number of physical abnormalities and learning problems. Notice the wide-set eyes, flat cheekbones, and thin upper lip in this child with FASD.

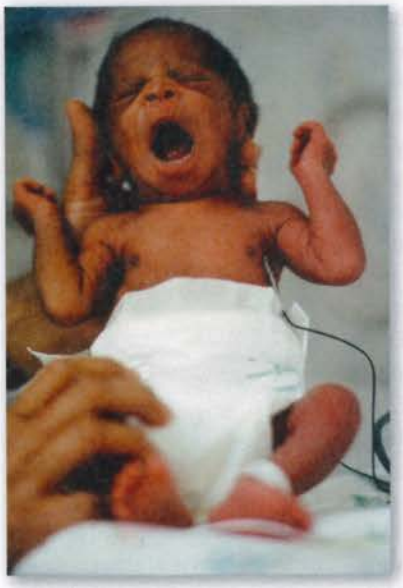
© Streissguth, AP, Landesman-Dwyer S, Martin, JC, & Smith, DW (1980). Teratogenic effects of alcohol in humans and laboratory animals. Science, 209, 353–361.

However, in Great Britain, the National Institutes of Care and Health Excellence have concluded that consuming one to two drinks not more than twice a week is safe during pregnancy (O'Keeffe, Greene, & Kearney, 2014). Also, a recent study of more than 7,000 7-year-olds found that children born to mothers who were light drinkers during pregnancy (up to two drinks per week) did not show more developmental problems than children born to non-drinking mothers (Kelly & others, 2013).

Nicotine Cigarette smoking by pregnant women can also adversely influence prenatal development, birth, and postnatal development (Ekblad, Korkeila, & Lehtonen, 2015; Palmer & others, 2016). Preterm births and low birth weights, fetal and neonatal deaths, respiratory problems, sudden infant death syndrome (SIDS, also known as crib death), and cardiovascular problems are all more common among the offspring of mothers who smoked during pregnancy (Grabenhenrich & others, 2014; Zhang & others, 2016). Prenatal smoking has been implicated in as many as 25 percent of infants being born with a low birth weight (Brown & Graves, 2013).

Researchers also have found that maternal smoking during pregnancy is a risk factor for the development of attention deficit hyperactivity disorder in children (Knopik & others, 2016). And in a recent study, maternal cigarette smoking during pregnancy was linked with offspring being more likely to smoke cigarettes at 16 years of age (De Genna & others, 2016). Further, a recent study found that maternal smoking during pregnancy was associated with increased risk of asthma and wheezing of offspring during adolescence (Hollams & others, 2014). And in a recent research review, it was concluded that maternal cigarette use during pregnancy is linked to alterations in a number of neurotransmitters in offspring, including serotonin and dopamine, as well as elevated blood pressure in offspring when they are adults (Suter & others, 2015).

Researchers have documented that environmental tobacco smoke is linked to negative outcomes for offspring (Vardavas & others, 2016). In one study, environmental tobacco smoke led to an increased risk of low birth weight in offspring (Salama & others, 2013) and to diminished ovarian functioning in female offspring (Kilic & others, 2012). Also, one study revealed that environmental tobacco smoke was associated with 114 deregulations, especially those involving immune functioning, in the fetal cells of offspring (Votavova & others, 2012). Another recent study found that maternal exposure to environmental tobacco smoke during prenatal development increased the risk of stillbirth (Varner & others, 2014).



This baby was exposed to cocaine prenatally. *What are some of the possible effects on development of being exposed to cocaine prenatally?*

A final point about nicotine use during pregnancy involves the recent dramatic increase in the use of e-cigarettes (Spindel & McEvoy, 2016). A recent study found that misconceptions about e-cigarettes were common among pregnant women (Mark & others, 2015). The most common reasons pregnant women gave for using e-cigarettes were the perceptions that they are less harmful than regular cigarettes (74 percent) and that they promote smoking cessation (72 percent).

Cocaine Does cocaine use during pregnancy harm the developing embryo and fetus? A recent research study found that cocaine quickly crossed the placenta to reach the fetus (De Giovanni & Marchetti, 2012). The most consistent finding is that cocaine exposure during prenatal development is associated with reduced birth weight, length, and head circumference (Gouin & others, 2011). In other studies, prenatal cocaine exposure has been linked to lower arousal, less effective self-regulation, higher excitability, and lower quality of reflexes at 1 month of age (Ackerman, Riggins, & Black, 2010); impaired motor development at 2 years of age and a slower rate of growth through 10 years of age (Richardson, Goldschmidt, & Willford, 2008); impaired language development and information processing, including attention deficits (especially impulsivity) (Accornero & others, 2006; Richardson & others, 2011); attention deficit hyperactivity disorder (Richardson & others, 2016); increased behavioral problems, especially externalizing problems such as high rates of aggression, oppositional defiant disorder, and delinquency (Minnes & others, 2010; Richardson & others, 2011, 2016); posttraumatic stress disorder (PTSD) (Richardson & others, 2016), and increased likelihood of being in a special education program that involves support services (Levine & others, 2008).

Some researchers argue that these findings should be interpreted cautiously (Accornero & others, 2006). Why? Because other factors in the lives of pregnant women who use cocaine (such as poverty, malnutrition, and other substance abuse) often cannot be ruled out as possible contributors to the problems found in their children (Hurt & others, 2005; Messiah & others, 2011). For example, cocaine users are more likely than nonusers to smoke cigarettes, use marijuana, drink alcohol, and take amphetamines.

Despite these cautions, the weight of research evidence indicates that children born to mothers who use cocaine are likely to have neurological, medical, and cognitive deficits (Cain, Bornick, & Whiteman, 2013; Field, 2007; Mayer & Zhang, 2009; Richardson & others, 2011, 2016). Cocaine use by pregnant women is never recommended.

How Would You...?

As a **social worker,** what advice would you offer to women in their childbearing years who frequently abuse drugs and other psychoactive substances?

Marijuana An increasing number of studies find that marijuana use by pregnant women has negative outcomes for offspring. In a recent meta-analysis, marijuana use during pregnancy was linked to offsprings' low birth weight and a greater likelihood of being placed in a neonatal intensive care unit (NICU) (Gunn & others, 2016). A recent study also revealed that marijuana use by pregnant women was associated with stillbirth (Varner & others, 2014). Another study found that prenatal marijuana exposure was related to lower intelligence in children (Goldschmidt & others, 2008). And one study indicated that prenatal exposure to marijuana was linked to marijuana use at 14 years of age (Day, Goldschmidt, & Thomas, 2006). In sum, marijuana use is not recommended for pregnant women.

Heroin It is well documented that infants whose mothers are addicted to heroin show several behavioral difficulties at birth (Lindsay & Burnett, 2013). The difficulties include withdrawal symptoms, such as tremors, irritability, abnormal crying, disturbed sleep, and impaired motor control. Many still show behavioral problems at their first birthday, and attention deficits may appear later in development. The most common

treatment for heroin addiction, methadone, is associated with very severe withdrawal symptoms in newborns (Blandthorn, Forster, & Love, 2011). Increasingly, buprenorphine is being used to treat heroin use during pregnancy (Krans & others, 2016).

Environmental Hazards

Many aspects of our modern industrial world can endanger the embryo or fetus. Some specific hazards to the embryo or fetus include radiation, toxic wastes, and other environmental pollutants (Dursun & others, 2016; Ornoy, Weinstein-Fudim, & Ergaz, 2015).

X-ray radiation can affect the developing embryo or fetus, especially in the first several weeks after conception, when women do not yet know they are pregnant. Women and their physicians should weigh the risk of an X-ray when the woman is or might be pregnant (Rajaraman & others, 2011). However, a routine diagnostic X-ray of a body area other than the abdomen, with the woman's abdomen protected by a lead apron, is generally considered safe (Brent, 2009, 2011).

Maternal Diseases

Maternal diseases and infections can produce defects in offspring by crossing the placental barrier, or they can cause damage during birth (Brunell, 2014). Rubella (German measles) is one disease that can cause prenatal defects. In a recent research review, rubella exposure during pregnancy is most likely to cause impairments involving the cardiovascular system, the pulmonary system, and microcephaly (Yazigi & others, 2016). Women who plan to have children should have a blood test before they become pregnant to determine whether they are immune to the disease (Ogbuanu & others, 2014).

Syphilis (a sexually transmitted infection) is more damaging later in prenatal development—four months or more after conception. Damage includes eye lesions, which can cause blindness, and skin lesions (Braccio, Sharland, & Ladhani, 2016). Penicillin is the only known treatment for syphilis during pregnancy (Moline & Smith, 2016).

Another infection that has received widespread attention is genital herpes. Newborns contract this virus when they are delivered through the birth canal of a mother with genital herpes (Sampath, Maduro, & Schillinger, 2016). About one-third of babies delivered through an infected birth canal die; another one-fourth suffer brain damage. If an active case of genital herpes is detected in a pregnant woman close to her delivery date, a cesarean section can be performed (in which the infant is delivered through an incision in the mother's abdomen) to keep the virus from infecting the newborn (Pinninti & Kimberlin, 2013).

AIDS is a sexually transmitted infection that is caused by the human immunodeficiency virus (HIV), which destroys the body's immune system. A mother can infect her offspring with HIV/AIDS in three ways: (1) across the placenta during gestation, (2) through contact with maternal blood or fluids during delivery, and (3) through breast feeding. The transmission of AIDS through breast feeding is a particular problem in many developing countries. Babies born to HIV-infected mothers can be (1) infected and symptomatic (show HIV symptoms), (2) infected but asymptomatic (not show HIV symptoms), or (3) not infected at all. An infant who is infected and asymptomatic may still develop HIV symptoms up to 15 months of age.

The more widespread disease of diabetes, characterized by high levels of sugar in the blood, also affects offspring (Bider-Canfield & others, 2016; Eriksson, 2016). Women who have gestational diabetes (a condition in which women without previously diagnosed diabetes develop high blood glucose levels during pregnancy) have an increased risk of having very large infants (weighing 10 pounds or more), and the infants themselves are at risk for diabetes (Mitanchez & others, 2015). Also, a recent research review concluded that pregestational diabetes increases the risk of fetal heart disease (Pauliks, 2015). Further, a recent study found that maternal pregnancy diabetes was linked to offspring having an increased risk for fatty liver disease at 18 years of age (Patel & others, 2016). And another recent study revealed that maternal pregnancy diabetes was associated with an increased risk of autism in offspring (Xiang & others, 2015).

Other Parental Factors

So far we have discussed a number of drugs, environmental hazards, maternal diseases, and incompatible blood types that can harm the embryo or fetus. Now we will explore other characteristics of the mother and father that can affect prenatal and child development, including nutrition, age, and emotional states and stress.

Maternal Diet and Nutrition A developing embryo or fetus depends completely on its mother for nutrition, which comes from the mother's blood. The nutritional status of the embryo or fetus is determined by the mother's total caloric intake as well as her intake of proteins, vitamins, and minerals. Children born to malnourished mothers are more likely than other children to be malformed.

Maternal obesity adversely affects pregnancy outcomes through increased rates of hypertension, diabetes, respiratory complications, and infections in the mother (Kominiarek & Chauhan, 2016; Ojha & others, 2015; Stang & Huffman, 2016). Research studies have found that maternal obesity is linked to an increase in stillbirth (Gardosi & others, 2013), preterm birth (Cnattingius & others, 2013), and increased likelihood that the newborn will be placed in a neonatal intensive care unit (Minsart & others, 2013). A recent study revealed that at 14 weeks following conception fetuses of obese pregnant women had less efficient cardiovascular functioning (Ingul & others, 2016). Further, a longitudinal study revealed that obesity during pregnancy was associated with long-term cardiovascular morbidity in adults (Yaniv-Salem & others, 2016). Further, two recent research reviews concluded that maternal obesity during pregnancy is associated with an increased likelihood of offspring being obese in childhood and adulthood (Pinto Pereira & others, 2016; Santangeli, Sattar, & Huda, 2015). Management of obesity that includes weight loss and increased exercise prior to pregnancy is likely to benefit both the mother and the baby (Ingul & others, 2016).

Because the fetus depends entirely on its mother for nutrition, it is important for the pregnant woman to have good nutritional habits. In Kenya, this government clinic provides pregnant women with information about how their diet can influence the health of their fetus and offspring. *What might the information about diet be like?*

One aspect of maternal nutrition that is important for normal prenatal development is folic acid, a B-complex vitamin (Atta & others, 2016). A study of more than 34,000 women found that taking folic acid either alone or as part of a multivitamin for at least one year prior to conceiving was linked with a 70 percent lower risk of delivering at 20 to 28 weeks and a 50 percent lower risk of delivering at 28 to 32 weeks (Bukowski & others, 2008). Another study revealed that toddlers of mothers who did not use folic acid supplements in the first trimester of pregnancy had more behavioral problems (Roza & others, 2010). Also, as indicated earlier in the chapter, lack of folic acid is related to neural tube defects in offspring (Chitayat & others, 2016; Kondo & others, 2015). The U.S. Department of Health and Human Services (2016) recommends that pregnant women consume a minimum of 400 micrograms of folic acid per day (about twice the amount the average woman gets in one day). Orange juice and spinach are examples of foods that are rich in folic acid. Also, a recent research study in China found that folic acid supplementation during pregnancy reduced the risk of preterm birth (Liu & others, 2015).

Fish is often recommended as part of a healthy diet and in general fish consumption during pregnancy has positive benefits for children's development (Golding & others, 2016; Julvez & others, 2016). The Federal Drug Administration (FDA) (2016) recommends that pregnant women increase their consumption of fish especially because they contain vital

nutrients such as omega-3 fatty acids, protein, vitamins, and minerals such as iron. However, pollution has made some kinds of fish a risky choice for pregnant women. Some fish contain high levels of mercury, which is released into the air both naturally and by industrial processes (Wells & others, 2011). Mercury that falls into the water can accumulate in large fish, such as shark, swordfish, king mackerel, and some species of large tuna (American Pregnancy Association, 2016; Mayo Clinic, 2016). Researchers have found that prenatal mercury exposure is linked to adverse outcomes, including miscarriage, preterm birth, and lower intelligence (Xue & others, 2007).

Recently, the American Pregnancy Association (2016) revised its conclusions about fish consumption during pregnancy, although still recommending avoidance of high-mercury-content fish such tilefish from the Gulf of Mexico, swordfish, shark, and king mackerel. The association and the FDA now recommend that pregnant women increase their consumption of low-mercury-content fish such as salmon, shrimp, tilapia, and cod.

Maternal Age When possible harmful effects on the fetus and infant are considered, two maternal age categories are of special interest: adolescence and 35 years and older (Ben David & others, 2016; de Jongh & others, 2015; Gockley & others, 2016; Kawakita & others, 2016; Tearne & others, 2016). The mortality rate of infants born to adolescent mothers is double that of infants born to mothers in their twenties. Adequate prenatal care decreases the probability that a child born to an adolescent girl will have physical problems. However, adolescents are the least likely of women in all age groups to obtain prenatal assistance from clinics and health services.

Maternal age is also linked to the risk that a child will have Down syndrome (Ghosh & others, 2010; Rumi Kataguiri & others, 2014). A baby with Down syndrome rarely is born to a mother 16 to 34 years of age. However, when the mother reaches 40 years of age, the probability is slightly higher than 1 in 100 that a baby born to her will have Down syndrome, and by age 50 it is almost 1 in 10. When mothers are 35 years and older, risks also increase for low birth weight, preterm delivery, and fetal death (Koo & others, 2012). A recent Norwegian study found that maternal age of 30 years or older was linked to the same level of increased risk for fetal deaths as 25- to 29-year-old pregnant women who were overweight/obese or were smokers (Waldenstrom & others, 2014). Also, in two recent studies, very advanced maternal age (40 years and older) was linked to adverse perinatal outcomes, including spontaneous abortion, preterm birth, stillbirth, and fetal growth restriction (Traisrislip & Tongsong, 2015; Waldenstrom & others, 2015).

We still have much to learn about the role of the mother's age in pregnancy and childbirth. As women remain active, exercise regularly, and are careful about their nutrition, their reproductive systems may remain healthier at older ages than was thought possible in the past.

Emotional States and Stress When a pregnant woman experiences intense fears, anxieties, and other emotions or negative mood states, physiological changes occur that may affect her fetus. A mother's stress may also influence the fetus indirectly by increasing the likelihood that the mother will engage in unhealthy behaviors such as taking drugs and receiving poor prenatal care.

High maternal anxiety and stress during pregnancy can have long-term consequences for the offspring (Bauer, Knapp, & Parsonage, 2016; Brunton, 2015; Dalke, Wentzel, & Kim, 2016; Fan & others, 2016). A recent study found that high levels of depression, anxiety, and stress during pregnancy were linked to internalizing problems in adolescence (Betts & others, 2014). A research review indicated that pregnant women with high levels of stress are at increased risk for having a child with emotional or cognitive problems, attention deficit hyperactivity disorder (ADHD), and language delay (Taige & others, 2007). Also, a large-scale study found that a higher level of maternal stress in the period immediately prior to conception posed a risk for infant mortality (Class & others, 2013). Another study revealed that maternal stressful life events prior to conception increased the risk of having a very low birth weight infant (Witt & others, 2014).

How Would You...?

As a **health-care professional,** what advice would you give to an expectant mother who is experiencing extreme psychological stress?

Might maternal depression also have an adverse effect on birth outcomes? A research review concluded that maternal depression is linked to preterm birth (Mparmpakas & others, 2013). And a recent study discovered that maternal depression during pregnancy was associated with low birth weight in full-term offspring (Chang & others, 2014). There is some concern about pregnant women taking antidepressant medication. For example, a recent research review concluded that antidepressant medication use during pregnancy is linked to slightly increased risks of cardiac malfunctions in the fetus and persistent pulmonary hypertension in the newborn (Pearlstein, 2015). Also, a recent study found that taking antidepressants early in pregnancy was linked to an increased risk of miscarriage (Almeida & others, 2016). Further, a recent study revealed that taking antidepressants in the second or third trimester of pregnancy was linked to an increased risk of autism spectrum disorders in children (Boukhris & others, 2016).

In one study, in China, the longer fathers smoked, the higher the risk that their children would develop cancer (Ji & others, 1997). *What are some other paternal factors that can influence the development of the fetus and the child?*

Paternal Factors So far, we have discussed how characteristics of the mother—such as drug use, disease, diet and nutrition, age, and emotional states—can influence prenatal development and the development of the child. Might there also be some paternal risk factors? Indeed, there are several. Men's exposure to lead, radiation, certain pesticides, and petrochemicals may cause abnormalities in sperm that lead to miscarriage or diseases such as childhood cancer (Cordier, 2008). The father's smoking during the mother's pregnancy also can cause problems for the offspring (Agricola & others, 2016; Han & others, 2015). In one study, heavy paternal smoking was associated with an increased risk of early miscarriage (Venners & others, 2005). This negative outcome may be related to the mother's exposure to secondhand smoke. And in a recent study, paternal smoking around the time of the child's conception was linked to an increased risk of the child developing leukemia (Milne & others, 2012). Researchers have found that increasing paternal age decreases the success rate of in vitro fertilization and increases the risk of preterm birth (Sharma & others, 2015). Also, a research review concluded that there is an increased risk of spontaneous abortion, autism, and schizophrenic disorders when the father is 40 years of age and older (Reproductive Endocrinology and Infertility Committee & others, 2012).

Another way that the father can influence prenatal and birth outcomes is through his relationship with the mother. By being supportive, helping with chores, and having a positive attitude toward the pregnancy, the father can improve the physical and psychological well-being of the mother. Negative behavior by the father also affects the mother: a recent study found that intimate partner violence increased the mother's stress level (Fonseca-Machado Mde & others, 2015).

Much of our discussion on prenatal development has focused on what can go wrong. Prospective parents should take steps to avoid the vulnerabilities to fetal development that we have described. But it is important to keep in mind that most of the time, prenatal development does not go awry and development occurs along a positive path.

Prenatal Care

Although prenatal care varies enormously from one woman to another, it usually involves a defined schedule of visits for medical care, which typically includes screening for manageable conditions and treatable diseases that can affect the baby or the mother. In addition to medical care, prenatal programs often include comprehensive educational, social, and nutritional services (Kroll-Desrosiers & others, 2016).

Information about pregnancy, labor, delivery, and caring for the newborn can be especially valuable for first-time mothers (McDonald & others, 2015). Prenatal care is also very important for women in poverty and immigrant women because it links them with

other social services (Mazul, Salm Ward, & Ngui, 2016). A recent study found that adequacy of prenatal care was associated with very low birth weight (Xaverius & others, 2016).

An innovative program that is rapidly expanding in the United States is CenteringPregnancy (Barger, Faucher, & Murphy, 2015; DeCesare & Jackson, 2015; Liu & others, 2016). This program is relationship-centered and provides complete prenatal care in a group setting (Heberlein & others, 2016). It replaces traditional 15-minute physician visits with 90-minute peer group support sessions and self-examination led by a physician or certified nurse-midwife. Groups of up to 10 women (and often their partners) meet regularly beginning at 12 to 16 weeks of pregnancy. The sessions emphasize empowering women to play an active role in experiencing a positive pregnancy. Research has revealed that CenteringPregnancy group prenatal care is associated with a reduction in preterm birth (Novick & others, 2013), as well as reductions in low birth weight and placement in a neonatal intensive care unit (Gareau & others, 2016). In another recent study with adolescent mothers, CenteringPregnancy was successful in getting participants to attend meetings, have appropriate weight gain, increase the use of highly effective contraceptive methods, and increase breast feeding (Trotman & others, 2015).

The increasingly widespread CenteringPregnancy program alters routine prenatal care by bringing women out of exam rooms and into relationship-oriented groups.

Some prenatal programs for parents focus on home visitation (Issel & others, 2011). A recent study found that use of home visiting services was associated with reduced risk of low birth weight (Shah & Austin, 2014). Research evaluations indicate that the Nurse-Family Partnership created by David Olds and his colleagues (2004, 2007, 2014) is successful. The Nurse-Family Partnership involves home visits by trained nurses beginning in the second or third trimester of prenatal development. The extensive program consists of approximately 50 home visits beginning during the prenatal period and extending through the child's first two years. Research has revealed that the Nurse-Family Partnership has numerous positive outcomes, including fewer pregnancies, better work circumstances, and stability in relationship partners for the mother, and improved academic success and social development for the child (Olds & others, 2004, 2007, 2014).

Exercise increasingly is recommended as part of a comprehensive prenatal care program (Barakat & others, 2015; Perales & others, 2016; Schmidt, Chari, & Davenport, 2016). Exercise during pregnancy helps prevent constipation, conditions the body, reduces excessive weight gain, and is associated with a more positive mental state, including a reduced level of depression (Marques & others, 2015; Shirazian & others, 2016). One study found that exercise during pregnancy improved mothers' perception of their health (Barakat & others, 2011). Further, a recent study indicated that pregnant women who did not exercise three or more times a week were more likely to develop hypertension (Barakat & others, 2016). And in one study, following 12 weeks of twice-weekly yoga or massage therapy, both therapy groups had a greater decrease in depression, anxiety, and back and leg pain than a control group (Field & others, 2013). Also, a recent study revealed that yoga participation provided immediate stress reduction for pregnant women (Kusaka & others, 2016). And a recent study revealed that physical exercise during pregnancy reduced the risk of cesarean delivery (Domenjoz, Kayser, & Boulvain, 2014).

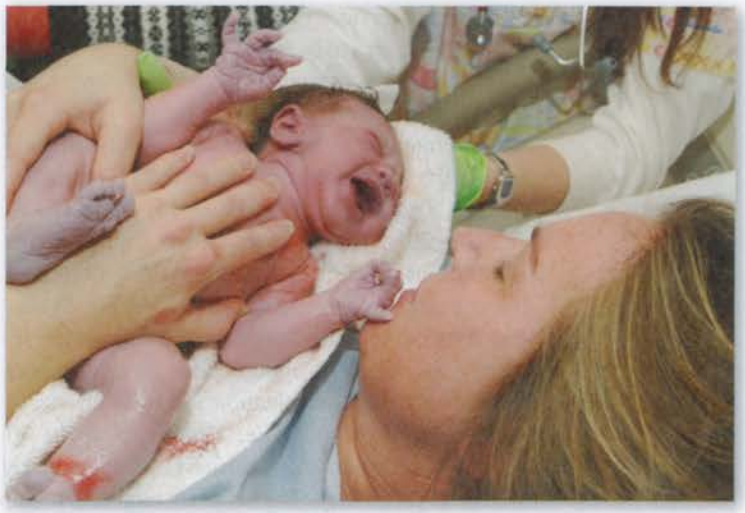
Birth and the Postpartum Period

The long wait for the moment of birth is over, and the infant is about to appear. What happens during childbirth, and what can be done to make the experience a positive one?

Nature writes the basic script for how birth occurs, but parents make important choices about the conditions surrounding birth. We look first at the sequence of physical steps through which a child is born.

The Birth Process

The birth process occurs in three stages. It may take place in different contexts and in most cases involves one or more attendants.



After the long journey of prenatal development, birth takes place. During birth the baby is on a threshold between two worlds. *What are the characteristics of the three stages of birth?*

Stages of Birth

The first stage of the birth process is the longest. Uterine contractions are 15 to 20 minutes apart at the beginning and last up to a minute each. These contractions cause the woman's cervix to stretch and open. As the first stage progresses, the contractions come closer together, occurring every two to five minutes. Their intensity increases. By the end of the first stage, contractions dilate the cervix to an opening of about 10 centimeters (4 inches) so that the baby can move from the uterus to the birth canal. For a woman having her first child, the first stage lasts an average of 6 to 12 hours; for subsequent children, this stage typically is much shorter.

The second birth stage begins when the baby's head starts to move through the cervix and the birth canal. It terminates when the baby completely emerges from the mother's body. With each contraction, the mother bears down hard to push the baby out of her body. By the time the baby's head is out of the mother's body, the contractions come almost every minute and last for about a minute. This stage typically lasts approximately 45 minutes to an hour.

Afterbirth is the third stage, during which the placenta, umbilical cord, and other membranes are detached and expelled. This final stage is the shortest of the three birth stages, lasting only minutes.

Childbirth Setting and Attendants

In 2013 in the United States, 98.6 percent of births took place in hospitals (Martin & others, 2015). Of the 1.4 percent of births occurring outside of a hospital, approximately two-thirds took place in homes and almost 30 percent in free-standing birthing centers. The percentage of U.S. births at home is the highest since reporting of this context began in 1989. An increase in home births has occurred mainly among non-Latino White women, especially those who are older and married. For these non-Latino White women, two-thirds of their home births are attended by a midwife.

The person who helps a mother during birth varies across cultures. In U.S. hospitals, it has become the norm for fathers or birth coaches to be with the mother throughout labor and delivery. In the East African Nigoni culture, by contrast, men are completely excluded from the childbirth process. When a woman is ready to give birth, female relatives move into the woman's hut and the husband leaves, taking his belongings (clothes, tools, weapons, and so on) with him. He is not permitted to return until after the baby is born. In some cultures, childbirth is an open, community affair. For example, in the Pukapukan culture in the Pacific Islands, women give birth in a shelter that is open to villagers, who may observe the birth.

Midwives *Midwifery* is a profession that provides health care to women during pregnancy, birth, and the postpartum period (Ekelin, Kvist, & Persson, 2016; Feijen-de Jong & others, 2015a, b; Reed, Rowe, & Barnes, 2016). Midwives also may give women information about reproductive health and annual gynecological examinations. They may refer women to general practitioners or obstetricians if a pregnant woman needs medical care beyond a midwife's expertise and skill.

Midwifery is practiced in most countries throughout the world (ten Hoope-Bender & others, 2016). In Holland, more than 40 percent of babies are delivered by midwives rather

than by doctors. However, in 2013 in the United States only 7.8 percent of women who delivered a baby were attended by a midwife, a figure that was unchanged since 2000 (Martin & others, 2015). Nevertheless, the 7.8 percent figure for 2013 represents a substantial increase from less than 1 percent in 1975. A research review concluded that for low-risk women, midwife-led care was characterized by a reduction in procedures during labor and increased satisfaction with care (Sutcliffe & others, 2012). Also, in this study no adverse outcomes were found for midwife-led care compared with physician-led care.

Doulas In some countries, a doula attends a childbearing woman. *Doula* is a Greek word that means "a woman who helps." A *doula* is a caregiver who provides continuous physical, emotional, and educational support for the mother before, during, and after childbirth (Kozhimannil & others, 2016). Doulas remain with the parents throughout labor, assessing and responding to their needs. Researchers have found positive effects when a doula is present at the birth of a child (Ahlemeyer & Mahon, 2015; Zielinski, Brody, & Low, 2016). A recent study also revealed that for Medicaid recipients the odds of having a cesarean delivery were 41 percent lower for doula-supported births in the United States (Kozhimmanil & others, 2013). Thus, increasing doula-supported births could substantially lower the cost of a birth by reducing cesarean rates.

In the United States, most doulas work as independent providers hired by the expectant parents. Doulas typically function as part of a "birthing team," serving as an adjunct to the midwife or the hospital's obstetric staff.

Methods of Childbirth

U.S. hospitals often allow the mother and her obstetrician a range of options regarding their method of delivery. Key choices involve the use of medication, whether to use any of a number of nonmedicated techniques to reduce pain, and when to have a cesarean delivery.

Medication Three basic kinds of drugs that are used for labor are analgesia, anesthesia, and oxytocin/Pitocin.

Analgesia is used to relieve pain. Analgesics include tranquilizers, barbiturates, and narcotics such as Demerol.

Anesthesia is used in late first-stage labor and during delivery to block sensation in an area of the body or to block consciousness. There is a trend toward not using general anesthesia, which blocks consciousness, in normal births because general anesthesia can be transmitted through the placenta to the fetus (Pennell & others, 2011). An *epidural block* is regional anesthesia that numbs the woman's body from the waist down.

Oxytocin is a hormone that promotes uterine contractions; a synthetic form called Pitocin™ is widely used to decrease the duration of the first stage of labor. The relative benefits and risks of administering synthetic forms of oxytocin during childbirth continue to be debated (Bell, Erickson, & Carter, 2014; Shiner, Many, & Maslovitz, 2016).

Predicting how a drug will affect an individual woman and her fetus is difficult (Ansari & others, 2016). A particular drug might have only a minimal effect on one fetus yet have a much stronger effect on another. The drug's dosage is also a factor. Stronger doses of tranquilizers and narcotics given to decrease the mother's pain potentially have a more negative effect on the fetus than do mild doses. It is important for the mother to assess her level of pain and have a voice in deciding whether she should receive medication.

Natural and Prepared Childbirth For a brief time not long ago, the idea of avoiding all medication during childbirth gained favor in the United States. Instead, many women chose to reduce the pain of childbirth through techniques known as natural childbirth and prepared childbirth. Today, at least some medication is used in the typical childbirth, but elements of natural childbirth and prepared childbirth remain popular (Podgurski, 2016).

natural childbirth A childbirth method in which no drugs are given to relieve pain or assist in the birth process. The mother and her partner are taught to use breathing methods and relaxation techniques during delivery.

How Would You...?

As a **health-care provider,** how would you advise a woman in her first trimester about the options available for her baby's birth and for her own comfort during the process?

Natural childbirth is a childbirth method in which no drugs are given to relieve pain or assist in the birth process. The mother and her partner are taught to use breathing methods and relaxation techniques during delivery. French obstetrician Ferdinand Lamaze developed a method similar to natural childbirth that is known as **prepared childbirth,** or the Lamaze method. It includes a special breathing technique to control pushing in the final stages of labor, as well as more detailed education about anatomy and physiology. The Lamaze method has become very popular in the United States. The pregnant woman's partner usually serves as a coach; the partner attends childbirth classes with her and helps her with her breathing and relaxation during delivery. In sum, proponents of current prepared childbirth methods conclude that when information and support are provided, women *know* how to give birth.

prepared childbirth Developed by French obstetrician Ferdinand Lamaze, this childbirth strategy is similar to natural childbirth but includes a special breathing technique to control pushing in the final stages of labor and more detailed anatomy and physiology instruction.

Other Nonmedicated Techniques to Reduce Pain The effort to reduce stress and control pain during labor has recently led to an increase in the use of some older and some newer nonmedicated techniques (Henderson & others, 2014). These include waterbirth, massage, and acupuncture.

What characterizes the use of waterbirth in delivering a baby?

Waterbirth involves giving birth in a tub of warm water. Some women go through labor in the water and get out for delivery; others remain in the water for delivery. The rationale for waterbirth is that the baby has been in an amniotic sac for many months and that delivery in a similar environment is likely to be less stressful for the baby and the mother (Kavosi & others, 2015; Taylor & others, 2016). An increasing number of studies are either showing no differences in neonatal and maternal outcomes for waterbirth and non-waterbirth deliveries or positive outcomes (Davies & others, 2015; Taylor & others, 2016). For example, a recent large-scale study of more than 16,000 waterbirth and non-waterbirth deliveries found fewer negative outcomes for the waterbirth newborns (Bovbjerg, Cheyney, & Everson, 2016). Further, a recent research review concluded that waterbirth is associated with high levels of maternal satisfaction with pain relief and the experience of childbirth (Nutter & others, 2015). Waterbirth has been practiced more often in European countries such as Switzerland and Sweden in recent decades than in the United States, but is increasingly being included in U.S. birth plans.

Massage is increasingly used during pregnancy, labor, and delivery (Frawley & others, 2016; Vargens, Silva, & Progianti, 2013). Two research reviews concluded that massage therapy reduced pain during labor (Jones & others, 2012; Smith & others, 2012).

Acupuncture, the insertion of very fine needles into specific locations in the body, is used as a standard procedure to reduce the pain of childbirth in China, although it only recently has begun to be used for this purpose in the United States (Moleti, 2009; Smith, Armour, & Ee, 2016). Research indicates that acupuncture can have positive effects on labor and delivery (Akbarzadeh & others, 2015; Smith & others, 2011). For example, in a recent study acupuncture was successful in reducing labor pain 30 minutes after the intervention (Allameh, Tehrani, & Ghasemi, 2015).

Cesarean Delivery

Normally, the baby's head comes through the vagina first. But if the baby is in a *breech position*, its buttocks are the first part to emerge from the vagina. In 1 of every 25 deliveries, the baby's head is still in the uterus when the rest of the body is out. Because breech births can cause respiratory problems, if the baby is in a breech position a surgical procedure known as a cesarean delivery is usually performed. In a *cesarean delivery* (or cesarean section), the baby is removed from the uterus through an incision made in the mother's abdomen. The benefits and risks of cesarean deliveries

continue to be debated (Furukawa, Sameshima, & Ikenoue, 2014). Some critics argue that far too many babies are delivered by cesarean section in the United States and around the world (Gibbons & others, 2012). The U.S. cesarean birth rate (38.7 percent) was essentially unchanged from 2010 through 2013 (Martin & others, 2015).

The Transition from Fetus to Newborn

Much of our discussion of birth so far has focused on the mother. However, birth also involves considerable stress for the baby. If the delivery takes too long, the baby can develop anoxia, a condition in which the fetus or newborn has an insufficient supply of oxygen. Anoxia can cause brain damage.

The baby has considerable capacity to withstand the stress of birth. Large quantities of adrenaline and noradrenaline, hormones that protect the fetus in the event of oxygen deficiency, are secreted in the newborn's body during the birth process.

Immediately after birth, the umbilical cord is cut and the baby is on its own. Before birth, oxygen came from the mother via the umbilical cord, but now the baby can breathe independently.

Almost immediately after birth, a newborn is taken to be weighed, cleaned up, and tested for signs of developmental problems that might require urgent attention. The **Apgar Scale** is widely used to assess the health of newborns at one and five minutes after birth. The Apgar Scale evaluates infants' heart rate, respiratory effort, muscle tone, body color, and reflex irritability. An obstetrician or nurse does the evaluation and gives the newborn a score, or reading, of 0, 1, or 2 on each of these five health signs. A total score of 7 to 10 indicates that the newborn's condition is good. A score of 5 indicates that there may be developmental difficulties. A score of 3 or below signals an emergency and warns that the baby might not survive. The Apgar Scale is especially good at assessing the newborn's ability to respond to the stress of delivery and its new environment (Miyakoshi & others, 2013). It also identifies high-risk infants who need resuscitation. Recent studies have found that low Apgar scores are associated with long-term additional support needs in education and educational attainment (Tweed & others, 2016), risk of developmental vulnerability at 5 years of age (Razaz & others, 2016), and risk of developing ADHD (Hanc & others, 2016).

Nurses often play important roles in the birth of a baby. To read about the work of a nurse who specializes in the care of women during labor and delivery, see *Careers in Life-Span Development.*

Apgar Scale A widely used assessment of the newborn's health at 1 and 5 minutes after birth.

Careers in life-span development

Linda Pugh, Perinatal Nurse

Perinatal nurses work with childbearing women to support health and growth during the childbearing experience. Linda Pugh, Ph.D., R.N.C., is a perinatal nurse on the faculty at The Johns Hopkins University School of Nursing. She is certified as an inpatient obstetric nurse and specializes in the care of women during labor and delivery. She teaches undergraduate and graduate students, educates professional nurses, and conducts research. In addition, Pugh consults with hospitals and organizations about women's health issues and many of the topics we discuss in this chapter.

Her research interests include nursing interventions with low-income breast-feeding women, discovering ways to prevent and ameliorate fatigue during childbearing, and using breathing exercises during labor.

Linda Pugh (right) with a mother and her newborn.

Low Birth Weight and Preterm Infants

Three related conditions pose threats to many newborns: low birth weight, preterm birth, and being small for date. *Low birth weight* infants weigh less than 5 pounds at birth. *Very low birth weight* newborns weigh under 3 pounds, and *extremely low birth weight* newborns weigh under 2 pounds. Preterm infants are born three weeks or more before the pregnancy has reached its full term—in other words, 35 or fewer weeks after conception. Small for date infants (also called *small for gestational age infants*) have a birth weight that is below normal when the length of the pregnancy is considered. They weigh less than 90 percent of all babies of the same gestational age. Small for date infants may be preterm or full term. One study found that small for date infants have a 400 percent greater risk of death (Regev & others, 2003).

In 2013, 11.4 percent of U.S. infants were born preterm—a 34 percent increase since the 1980s but a decrease of 1.4 percent since 2008 (Martin & others, 2015). The increase in preterm birth is likely due to such factors as the increasing number of births to women 35 years and older, increasing rates of multiple births, increased management of maternal and fetal conditions (for example, inducing labor preterm if medical technology indicates it will increase the likelihood of survival), increased substance abuse (tobacco, alcohol), and increased stress (Goldenberg & Culhane, 2007). Ethnic variations characterize preterm birth (Raglan & others, 2016; Sorbye, Wanigaratne, & Urgula, 2016). For example, in 2013, the likelihood of being born preterm was 11.4 percent for all U.S. infants and 10.4 percent for non-Latino White infants, but the rate was 16.8 percent for African American infants and 11.7 for Latino infants (Martin & others, 2015).

Incidence and Causes of Low Birth Weight

Most, but not all, preterm babies are also low birth weight babies. The incidence of low birth weight varies considerably from country to country. In some countries, such as India and Sudan, where poverty is rampant and the health and nutrition of mothers are poor, the percentage of low birth weight babies reaches as high as 31 percent. In the United States, there has been an increase in low birth weight infants in the last two decades, and the U.S. low birth weight rate of 8.02 percent in 2013 was considerably higher than that of many other developed countries (Martin & others, 2015). For example, only 4 percent of the infants born in Sweden, Finland, Norway, and Korea are low birth weight, and only 5 percent of those born in New Zealand, Australia, and France are low birth weight.

Consequences of Low Birth Weight

Many preterm and low birth weight infants are healthy, but as a group they have more health and developmental problems than do normal birth weight infants (Webb & others, 2014). The number and severity of these problems increase when infants are born very early and as their birth weight decreases (Griffin & others, 2015; Tchamo, Prista, & Leandro, 2016). Survival rates for infants who are born very early and very small have risen, but with this improved survival rate have come increased rates of severe brain damage (McNicholas & others, 2014).

A "kilogram kid," weighing less than 2.3 pounds at birth. *What are some long-term outcomes of weighing so little at birth?*

For preterm birth, the terms *extremely preterm* and *very preterm* are increasingly used (Kato & others, 2016; Ohlin & others, 2015). *Extremely preterm infants* are those born less than 28 weeks preterm, and *very preterm infants* are those born at less than 33 weeks of gestational age.

Low birth weight children are more likely than their normal birth weight counterparts to develop a learning disability, attention deficit

hyperactivity disorder, autism spectrum disorders, or breathing problems such as asthma (Leung & others, 2016; Schieve & others, 2016). Also, one study revealed that very preterm, low birth weight infants had abnormal axon development in their brain and impaired cognitive development at 9 years of age (Iwata & others, 2012). Approximately 50 percent of all low birth weight children are enrolled in special education programs.

Nurturing Low Birth Weight and Preterm Infants

Two increasingly used interventions in the neonatal intensive care unit (NICU) are kangaroo care and massage therapy. *Kangaroo care* involves skin-to-skin contact in which the baby, wearing only a diaper, is held upright against the parent's bare chest, much as a baby kangaroo is carried by its mother. Kangaroo care is typically practiced for two to three hours per day over an extended time in early infancy.

A new mother practices kangaroo care. *What is kangaroo care? What are some outcomes of kangaroo care?*

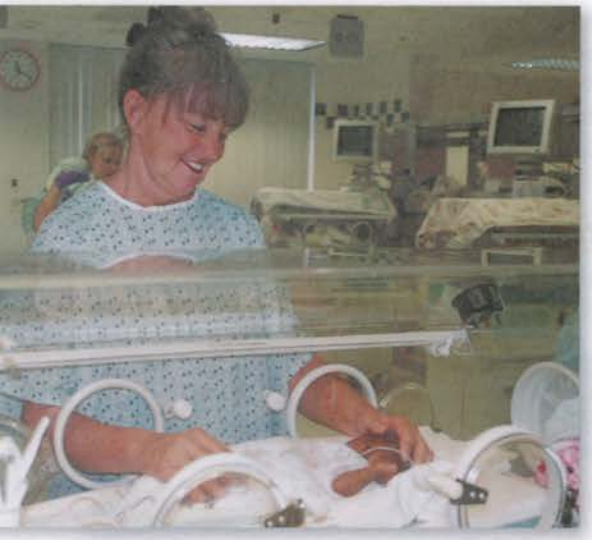
Why use kangaroo care with preterm infants? Preterm infants often have difficulty coordinating their breathing and heart rate, and the close physical contact with the parent provided by kangaroo care can help stabilize the preterm infant's heartbeat, temperature, and breathing (Boundy & others, 2016; Cho & others, 2016; Park & others, 2014). Preterm infants who experience kangaroo care also gain more weight than their counterparts who are not given this care (Faye & others, 2016). Also, a recent study discovered that preterm infants who experienced kangaroo care for 16 weeks had more complex electroencephalogram (EEG) patterns, which reflects neurological maturation) at 40 weeks of age than preterm infants who did not receive kangaroo care (Kaffashi & others, 2013).

And a recent study demonstrated the positive long-term benefits of kangaroo care (Feldman, Rosenthal, & Eidelman, 2014). In this study, maternal-newborn kangaroo care with preterm infants was linked to better respiratory and cardiovascular functioning, sleep patterns, and cognitive functioning from 6 months to 10 years of age. Further, a recent study in the United Kingdom found that the use of kangaroo care in neonatal units resulted in substantial cost savings mainly because of its reduction in diseases such as gastroenteritis and colitis (Lowson & others, 2016). And in another recent study, kangaroo care significantly reduced the amount of crying and improved heart rate stability in preterm infants (Choudhary & others, 2016).

A recent U.S. survey found that mothers had a much more positive view of kangaroo care than did neonatal intensive care nurses and that mothers were more likely to say that it should be provided daily (Hendricks-Munoz & others, 2013). There is concern that kangaroo care is not used more often in neonatal intensive care units (Kymre, 2014; Penn, 2015). Increasingly, kangaroo care is recommended as standard practice for all newborns (Seidman & others, 2015).

Many adults will attest to the therapeutic effects of receiving a massage. In fact, many will pay a premium to receive one at a spa on a regular basis. But can massage play a role in improving the developmental outcomes for preterm infants? A recent study found that both kangaroo care and massage therapy were equally effective in improving body weight and reducing length of hospital stay for low birth weight infants (Rangey & Sheth, 2015).

Many preterm infants experience less touch than full-term infants do because they are isolated in temperature-controlled incubators. Research by Tiffany Field and her colleagues (2001, 2007, 2010a; Diego, Field, & Hernandez-Reif, 2008, 2014; Field, Diego, & Hernandez-Reif, 2008, 2011) has led to a surge of interest in the role that massage might play in improving developmental outcomes for preterm infants. In Field's first study



Tiffany Field massages a newborn infant. *What types of infants has massage therapy been shown to help?*
© Dr. Tiffany Field

in this area, massage therapy consisting of firm stroking with the palms of the hands was given three times per day for 15-minute periods to preterm infants (Field & others, 1986). The massage therapy led to 47 percent greater weight gain than did standard medical treatment. The massaged infants also were more active and alert than preterm infants who were not massaged, and they performed better on developmental tests.

How Would You...?

As a **health-care professional,** how would you advise hospital administrators about implementing kangaroo care or massage therapy in the newborn intensive care unit?

In later studies, Field demonstrated the benefits of massage therapy for infants who faced a variety of problems. For example, preterm infants exposed to cocaine in utero who received massage therapy gained weight and improved their scores on developmental tests (Field, 2001). In other research, massage therapy improved the scores of HIV-exposed infants on both physical and mental scales, while also improving their hearing and speech (Perez & others, 2015). Also, one study investigated 1- to 3-month-old infants born to depressed adolescent mothers (Field & others, 1996). The infants of depressed mothers who received massage therapy had lower stress—as well as improved emotionality, sociability, and soothability—compared with non-massaged infants of depressed mothers. In a review of the use of massage therapy with preterm infants, Field and her colleagues (2004) concluded that the most consistent findings involve two positive results: (1) increased weight gain and (2) discharge from the hospital three to six days earlier. One study revealed that the mechanisms responsible for increased weight gain as a result of massage therapy were stimulation of the vagus nerve (one of 12 cranial nerves leading to the brain) and in turn the release of insulin (a food absorption hormone) (Field, Diego, & Hernandez-Reif, 2011). Another recent study found that both massage therapy (moderate-pressure stroking) and exercise (flexion and extension of the limbs) led to weight gain in preterm infants (Diego, Field, & Hernandez-Reif, 2014). In this study, massage was linked to increased vagal activity while exercise was associated with increased calorie consumption.

Bonding

A special component of the parent-infant relationship is *bonding*, the formation of a connection, especially a physical bond between parents and the newborn in the period shortly after birth. In the mid-twentieth century, U.S. hospitals seemed almost determined to deter bonding. Anesthesia given to the mother during delivery would make the mother drowsy, interfering with her ability to respond to and stimulate the newborn. Mothers and newborns were often separated shortly after delivery, and preterm infants were isolated from their mothers even more than full-term infants were separated from their mothers. In recent decades these practices have changed, but to some extent they are still followed in many hospitals.

Do these practices do any harm? Some physicians believe that during the "critical period" shortly after birth the parents and newborn need to form an emotional attachment as a foundation for optimal development in years to come (Kennell, 2006; Kennell & McGrath, 1999). Although some research supports this bonding hypothesis (Klaus & Kennell, 1976), a body of research challenges the significance of the first few days of life as a critical period (Bakeman & Brown, 1980; Rode & others, 1981). Indeed, the extreme form of the bonding hypothesis—the idea that the newborn *must* have close contact with the mother in the first few days of life to develop optimally—simply is not true.

Nevertheless, the weakness of the bonding hypothesis should not be used as an excuse to keep motivated mothers from interacting with their newborns. Such contact brings pleasure to many mothers and may dispel maternal anxiety about the baby's

health and safety. In some cases—including preterm infants, adolescent mothers, and mothers from disadvantaged circumstances—early close contact is key to establishing a climate for improved interaction after the mother and infant leave the hospital.

Many hospitals now offer a *rooming-in* arrangement in which the baby remains in the mother's room most of the time during its hospital stay. However, if parents choose not to use this rooming-in arrangement, the weight of the research suggests that this decision will not harm the infant emotionally (Lamb, 1994).

The Postpartum Period

The weeks after childbirth present challenges for many new parents and their offspring. This is the **postpartum period,** the period after childbirth or delivery that lasts for about six weeks or until the mother's body has completed its adjustment and has returned to a nearly prepregnant state. It is a time when the woman adjusts, both physically and psychologically, to the process of childbearing.

Physical Adjustments

A woman's body makes numerous physical adjustments in the first days and weeks after childbirth (Durham & Chapman, 2014). She may have a great deal of energy or feel exhausted and let down. Though these changes are normal, the fatigue can undermine the new mother's sense of well-being and confidence in her ability to cope with a new baby and a new family life (Runquist, 2007).

A concern is the loss of sleep that the primary caregiver experiences in the postpartum period (Bei, Coo, & Trinder, 2015; Thomas & Spieker, 2016). In the 2007 Sleep in America survey, a substantial percentage of women reported loss of sleep during pregnancy and in the postpartum period (National Sleep Foundation, 2007). The loss of sleep can contribute to stress, marital conflict, and impaired decision making (Meerlo, Sgoifo, & Suchecki, 2008). A recent study, though, linked postpartum depression to poor-quality sleep (such as disrupted, fragmented sleep) rather than to lesser amounts of sleep (Park, Meltzer-Brody, & Stickgold, 2013).

After delivery, the mother's body undergoes sudden and dramatic changes in hormone production. When the placenta is delivered, estrogen and progesterone levels drop steeply and remain low until the ovaries start producing hormones again.

Involution is the process by which the uterus returns to its prepregnant size five or six weeks after birth. Immediately following birth, the uterus weighs 2 to 3 pounds. By the end of five or six weeks, the uterus weighs 2 to 3½ ounces. Nursing the baby helps contract the uterus at a more rapid rate.

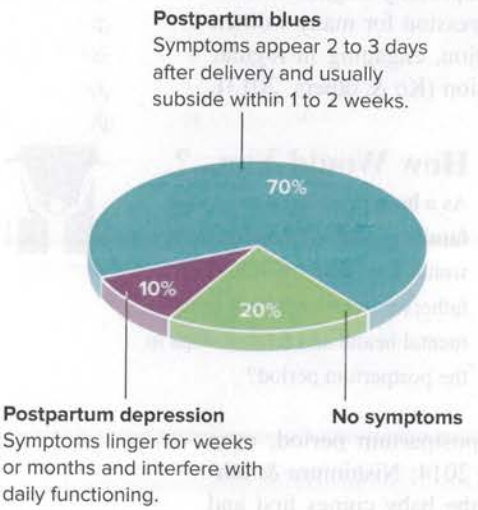


Figure 11 Postpartum Blues and Postpartum Depression Among U.S. Women. Some health professionals refer to the postpartum period as the "fourth trimester." Though the time span of the postpartum period does not necessarily cover three months, the term "fourth trimester" suggests continuity and emphasizes the importance of the first several months after birth for the mother.

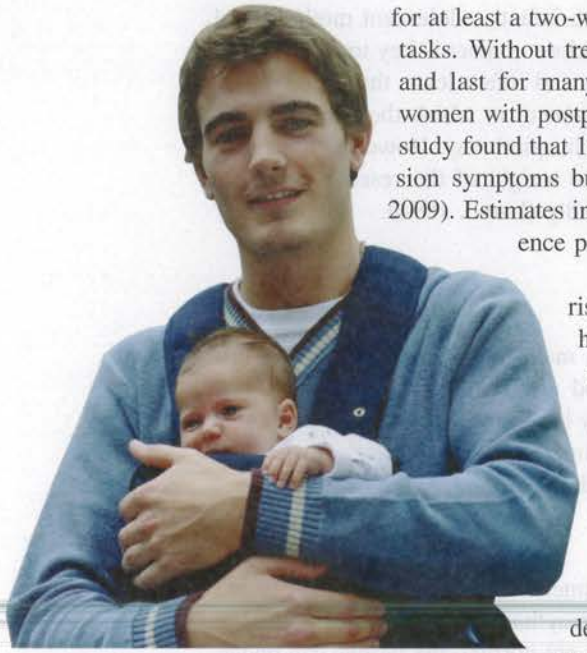
Emotional and Psychological Adjustments

Emotional fluctuations are common for mothers in the postpartum period (Haran & others, 2014). For some women, emotional fluctuations decrease within several weeks after the delivery, but other women experience more long-lasting emotional swings.

As shown in Figure 11, about 70 percent of new mothers in the United States have what are called the postpartum blues. About two to three days after birth, they begin to feel depressed, anxious, and upset. These feelings may come and go for several months after the birth, often peaking about three to five days after birth. Even without treatment, these feelings usually go away after one or two weeks.

However, some women develop postpartum depression, which involves a major depressive episode that typically occurs about four weeks after delivery (Brummelte & Galea, 2016). In other words, women with postpartum depression have such strong feelings of sadness, anxiety, or despair that

postpartum period The period after childbirth when the mother adjusts, both physically and psychologically, to the process of childbearing. This period lasts for about six weeks or until her body has completed its adjustment and returned to a nearly prepregnant state.



The postpartum period is a time of considerable adjustment and adaptation for both the mother and the father. Fathers can provide an important support system for mothers, especially in helping mothers care for young infants. *What kinds of tasks might the father of a newborn do to support the mother?*

for at least a two-week period they have trouble coping with their daily tasks. Without treatment, postpartum depression may become worse and last for many months (Di Florio & others, 2014). And many women with postpartum depression don't seek help. For example, one study found that 15 percent of the women reported postpartum depression symptoms but less than half sought help (McGarry & others, 2009). Estimates indicate that 10 to 14 percent of new mothers experience postpartum depression.

A recent research review identified the following risk factors for developing postpartum depression: a history of depression, depression and anxiety during pregnancy, neuroticism, low self-esteem, postpartum blues, poor marital relationship, and a low level of social support (O'Hara & McCabe, 2013). Also, in this research review, a number of perinatal-related stressors such as perinatal complications, infant health and temperament, and type of delivery (cesarean section, for example) were found to be potential risk factors for postpartum depression. A subset of women likely develop postpartum depression in the context of hormonal changes associated with late pregnancy and childbirth (O'Hara & McCabe, 2013). Also, a recent study found that depression during pregnancy, a history of physical abuse, migrant status, and postpartum physical complications were major risk factors for postpartum depression (Gaillard & others, 2014).

Several antidepressant drugs are effective in treating postpartum depression and appear to be safe for breast feeding women (Molyneaux, Trevillion, & Howard, 2015). Psychotherapy, especially cognitive therapy, also is effective in treating postpartum depression for many women (Carta & others, 2015; Sockol, 2015). In addition, engaging in regular exercise may help to relieve postpartum depression (Ko & others, 2013).

A mother's postpartum depression can affect the way she interacts with her infant (Giallo & others, 2015; Kerstis & others, 2016). A research review concluded that the interaction difficulties of depressed mothers and their infants occur across cultures and socioeconomic status groups, and encompass less sensitivity of the mothers and less responsiveness on the part of infants (Field, 2010b). Several caregiving activities also are compromised, including feeding, sleep routines, and safety practices.

How Would You...?

As a **human development and family studies professional,** how would you talk with mothers and fathers about vulnerabilities in mental health and relationships in the postpartum period?

Fathers also undergo considerable adjustment in the postpartum period, even when they work away from home all day (Gawlik & others, 2014; Nishimura & others, 2015; Paulson & others, 2016). Many fathers feel that the baby comes first and gets all of the mother's attention; some feel that they have been replaced by the baby.

The father's support and caring can play a role in whether the mother develops postpartum depression. One study revealed that higher support by fathers was related to lower incidence of postpartum depression in women (Smith & Howard, 2008).

Summary

The Evolutionary Perspective

- Darwin proposed that natural selection fuels evolution. In evolutionary theory, adaptive behavior is behavior that promotes the organism's survival in a natural habitat.
- Evolutionary psychology holds that adaptation, reproduction, and "survival of the fittest" are important in shaping behavior. Evolutionary developmental psychology emphasizes that humans need an extended

"juvenile" period to develop a large brain and learn the complexity of social communities.

Genetic Foundations of Development

- Except in the sperm and egg, the nucleus of each human cell contains 46 chromosomes, which are composed of DNA. Short segments of DNA constitute genes, the units of hereditary information that direct cells to reproduce and manufacture proteins. Genes act collaboratively, not independently.
- Genes are passed on to new cells when chromosomes are duplicated during the processes of mitosis and meiosis.
- Genetic principles include those involving dominant-recessive genes, sex-linked genes, and polygenic inheritance.
- Chromosome abnormalities can produce Down syndrome and other problems; gene-linked disorders, such as PKU, involve defective genes.

The Interaction of Heredity and Environment: The Nature-Nurture Debate

- Behavior geneticists use twin studies and adoption studies to determine the strength of heredity's influence on development.
- In Scarr's heredity-environment correlation view, heredity directs the types of environments that children experience. Scarr identified three types of genotype-environment interactions: passive, evocative, and active (niche-picking).
- The epigenetic view emphasizes that development is the result of an ongoing, bidirectional interchange between heredity and environment. Recently, interest has developed regarding how gene interaction influences development.
- The interaction of heredity and environment is complex, but we can create a unique developmental path by changing our environment.

Prenatal Development

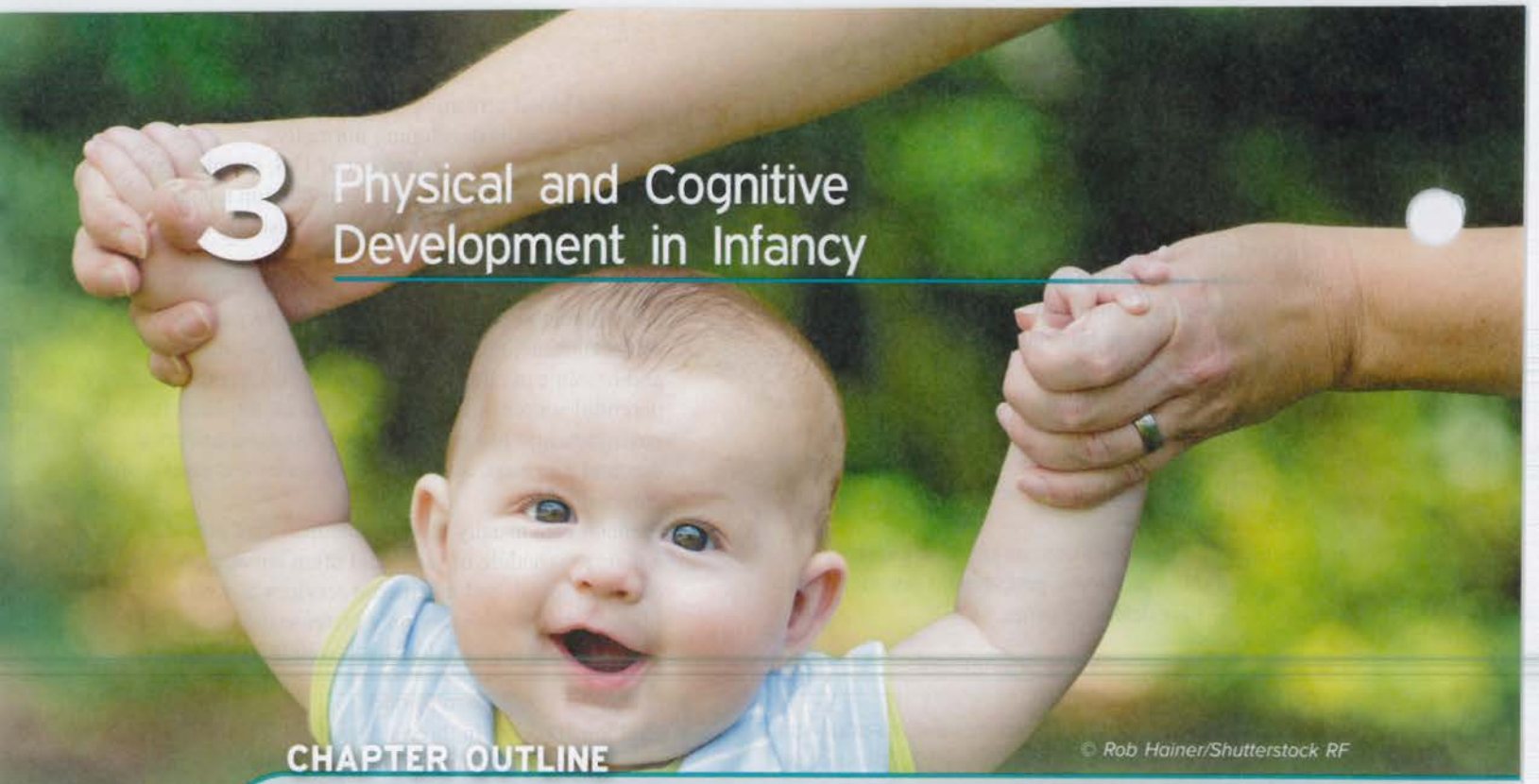
- Prenatal development can be divided into three periods: germinal, embryonic, and fetal. The growth of the brain during prenatal development is remarkable.
- A number of prenatal tests, including ultrasound sonography, chorionic villus sampling, amniocentesis, maternal blood screening, and fetal MRI, can reveal whether a fetus is developing normally.
- Approximately 10 to 15 percent of U.S. couples have infertility problems. Assisted reproduction techniques, such as in vitro fertilization, are increasingly being used by infertile couples.
- Some prescription drugs and nonprescription drugs can harm the unborn child. In particular, the psychoactive drugs caffeine, alcohol, nicotine, cocaine, marijuana, and heroin can endanger developing offspring. Other potential sources of harmful effects on the fetus include environmental hazards, maternal diseases, maternal diet and nutrition, age, emotional states and stress, and paternal factors.
- Prenatal care usually involves medical care services with a defined schedule of visits and often encompasses educational, social, and nutritional services as well. Inadequate prenatal care may increase the risk of infant mortality and result in low birth weight.

Birth and the Postpartum Period

- Childbirth occurs in three stages. Childbirth strategies involve the childbirth setting and attendants. In many countries, a midwife attends a childbearing woman. In some countries, a doula helps with the birth. Methods of delivery include medicated, natural and prepared, and cesarean.
- Being born involves considerable stress for the baby, but the baby is well prepared and adapted to handle the stress. Low birth weight, preterm, and small for date infants are at risk for developmental problems, although most of these infants are normal and healthy. Kangaroo care and massage therapy have been shown to produce benefits for preterm infants.
- Early bonding has not been found to be critical in the development of a competent infant, but close contact during the first few days after birth may reduce the mother's anxiety and lead to better interaction later.
- The postpartum period lasts for about six weeks after childbirth or until the body has returned to a nearly pre-pregnant state; postpartum depression is a serious condition that may become worse if not treated.

Key Terms

adoption study
Apgar Scale
behavior genetics
chromosomes
DNA
Down syndrome
embryonic period
epigenetic view
evolutionary psychology
fetal alcohol spectrum disorders (FASD)
fetal period
gene × environment (G × E) interaction
genes
genotype
germinal period
meiosis
mitosis
natural childbirth
neurons
organogenesis
phenotype
postpartum period
prepared childbirth
teratogen
twin study



3 Physical and Cognitive Development in Infancy

CHAPTER OUTLINE

Stories of Life-Span Development: Newborn Babies in Ghana and Nigeria

Latonya is a newborn baby in Ghana. During her first days of life she has been kept apart from her mother and bottle fed. Manufacturers of infant formula provide free or subsidized milk powder to the hospital where she was born. Latonya's mother has been persuaded to bottle feed rather than breast feed her. When her mother bottle feeds Latonya, she overdilutes the milk formula with unclean water and puts it in bottles that have not been sterilized. Latonya becomes very sick, and she dies before her first birthday.

Ramona was born in Nigeria in a "baby-friendly" program. In this program, babies are not separated from their mothers when they are born, and the mothers are encouraged to breast feed them. The mothers are told of the perils that bottle feeding can cause because of unsafe water and unsterilized bottles. They also are informed about the advantages of breast milk, which include its nutritious and hygienic qualities, its ability to immunize babies against common illnesses, and its role in reducing the mother's risk of breast and ovarian cancer. Ramona's mother is breast feeding her. At 1 year of age, Ramona is very healthy.

For many years, maternity units in hospitals favored bottle feeding and did not give mothers adequate information about the benefits of breast feeding. In recent years, the World Health Organization and UNICEF have tried to reverse the trend toward bottle feeding of infants in many impoverished countries. They instituted the "baby-friendly" program in many countries. They also persuaded the International Association of Infant Formula Manufacturers to stop marketing their baby formulas to hospitals in countries where governments support the baby-friendly initiatives (Grant, 1993). For the hospitals themselves, costs actually were reduced as infant formula, feeding bottles, and separate nurseries became unnecessary. For example, baby-friendly Jose Fabella Memorial Hospital in the Philippines reported saving 8 percent of its annual budget. Still, there are many places in the world where the baby-friendly initiatives have not been implemented.

(*Left*) An HIV-infected mother breast feeding her baby in Nairobi, Africa; (*Right*) A Rwandan mother bottle feeding her baby. *What are some concerns about breast versus bottle feeding in impoverished African countries?*

(Left) © Wendy Stone/Corbis; (right) © Dave Bartruff/Corbis

The advantages of breast feeding in impoverished countries are substantial (UNICEF, 2016; Williams & others, 2016; Woods, 2015). However, these advantages must be balanced against the risk of passing HIV to the baby through breast milk if the mother has the virus (Coovadia & Moodley, 2016; Fowler & others, 2014). The majority of mothers with HIV don't know that they are infected. In some areas of Africa more than 30 percent of mothers have the virus.

In the first two years of life, an infant's body and brain undergo remarkable growth and development. In this chapter we explore how this takes place: through physical growth, motor development, sensory and perceptual development, cognitive development, and language development. ■

Physical Growth and Development in Infancy

At birth, an infant has few of the physical abilities we associate with being human. Its head, which is huge relative to the rest of the body, flops around uncontrollably. Apart from some basic reflexes and the ability to cry, the newborn is unable to perform many actions. Over the next 12 months, however, the infant becomes capable of sitting, standing, stooping, climbing, and usually walking. During the second year, while growth slows, rapid increases in activities such as running and climbing take place. Let's now examine in greater detail the sequence of physical development in infancy.

Patterns of Growth

During prenatal development and early infancy, the head occupies an extraordinary proportion of the total body (see Figure 1). The **cephalocaudal pattern** is the sequence in which the earliest growth always occurs at the top—the head—with physical growth and differentiation of features gradually working their way down from top to bottom (shoulders, middle trunk, and so on). This same pattern occurs in the head area, as the top parts of the head—the eyes and brain—grow faster than the lower parts, such as the jaw.

cephalocaudal pattern The sequence in which the earliest growth always occurs at the top—the head—with physical growth in size, weight, and feature differentiation gradually working from top to bottom.

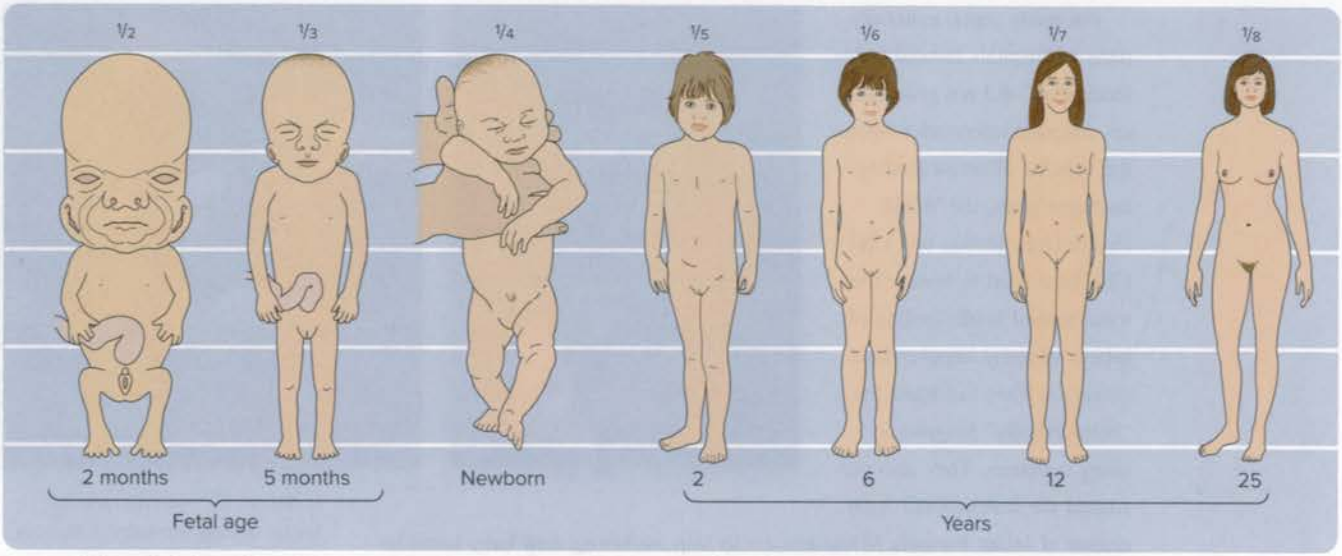


Figure 1 Changes in Proportions of the Human Body During Growth
As individuals develop from infancy through adulthood, one of the most noticeable physical changes is that the head becomes smaller in relation to the rest of the body. The fractions listed refer to head size as a proportion of total body length at different stages.

Sensory and motor development generally proceed according to the cephalocaudal pattern. For example, infants see objects before they can control their torso, and they can use their hands long before they can crawl or walk. However, development does not follow a rigid blueprint. One study found that infants reached for toys with their feet four weeks earlier, on average, than they reached for them with their hands (Galloway & Thelen, 2004).

Growth also follows the **proximodistal pattern,** a sequence in which growth starts at the center of the body and moves toward the extremities. For example, infants control the muscles of their trunk and arms before they control their hands, and they use their whole hands before they can control several fingers.

Height and Weight

The average North American newborn is 20 inches long and weighs 7½ pounds. Ninety-five percent of full-term newborns are 18 to 22 inches long and weigh between 5½ and 10 pounds.

In the first several days of life, most newborns lose 5 to 7 percent of their body weight before they adjust to feeding by sucking, swallowing, and digesting. They then grow rapidly, gaining an average of 5 to 6 ounces per week during the first month. They double their birth weight by the age of 4 months and nearly triple it by their first birthday. Infants grow about 3/4 inch per month during the first year, increasing their birth length by about 40 percent by their first birthday.

Growth slows considerably in the second year of life (Marcdante & Kliegman, 2015). By 2 years of age, children weigh approximately 26 to 32 pounds, having gained a quarter to half a pound per month during the second year; now they have reached about one-fifth of their adult weight. At 2 years of age, the average child is 32 to 35 inches tall, nearly half of his or her eventual adult height.

The Brain

At birth, the infant that began as a single cell has a brain that contains tens of billions of nerve cells, or neurons. Extensive brain development continues after birth, through infancy, and later (de Haan & Johnson, 2016; Denes, 2016; Monahan & others, 2016). Because the brain is developing so rapidly in infancy, the infant's head should be protected from falls or other injuries and the baby should never be shaken. *Shaken baby syndrome,* which includes brain swelling and hemorrhaging, affects hundreds of babies in the United States each year

proximodistal pattern The sequence in which growth starts at the center of the body and moves toward the extremities.

Figure 2 Measuring the Activity of the Infant's Brain
As shown here, a large number of electrodes are attached to a baby's scalp to measure the brain's activity as part of an EEG assessment.

(Bartschat & others, 2016; Mian & others, 2015). A recent analysis found that fathers were most often the perpetrators of shaken baby syndrome, followed by child-care providers and boyfriends of the victims' mothers (National Center on Shaken Baby Syndrome, 2012).

The Brain's Development

At birth, the brain weighs about 25 percent of its adult weight. By the second birthday, it is about 75 percent of its adult weight. However, the brain's areas do not mature uniformly.

Assessing the infant's brain activity is not as easy as it might seem. Positron-emission tomography (PET) scans pose a radiation risk to babies, and sometimes infants wriggle too much to allow the technician to capture accurate brain images with magnetic resonance imaging (MRI). However, researchers have been successful in using the electroencephalogram (EEG), a measure of the brain's electrical activity, to learn about the brain's development in infancy (Kuhn-Popp & others, 2016; Perry & others, 2016) (see Figure 2). For example, a recent study found that higher-quality mother-infant interaction early in infancy predicted higher-quality frontal lobe functioning that was assessed with EEG later in infancy (Bernier, Calkins, & Bell, 2016).

Figure 3 Functional Near-Infrared Spectroscopy (fNRIS)
This brain-imaging technology is increasingly being used to assess infants' brain activity as they move about their environment.

Researchers also are increasingly studying infants' brain activity by using functional near-infrared spectroscopy (fNIRS), which uses very low levels of near-infrared light to monitor changes in blood oxygen (see Figure 3) (Brigadoi & Cooper, 2015; de Haan & Johnson, 2016; Ravicz & others, 2015). Unlike fMRI, which uses magnetic fields or electrical activity, fNIRS is portable and allows the infants to be assessed as they explore the world around them.

Mapping the Brain Scientists analyze and categorize areas of the brain in numerous ways (de Haan & Johnson, 2016; Hensch, 2016; Richards & others, 2015). Of greatest interest is the portion farthest from the spinal cord, known as the *forebrain,* which includes the cerebral cortex and several structures beneath it. The *cerebral cortex* covers the forebrain like a wrinkled cap. It has two halves, or hemispheres. Based on ridges and valleys in the cortex, scientists distinguish four main areas, called lobes, in each hemisphere: the *frontal lobes,* the *occipital lobes,* the *temporal lobes,* and the *parietal lobes* (see Figure 4).

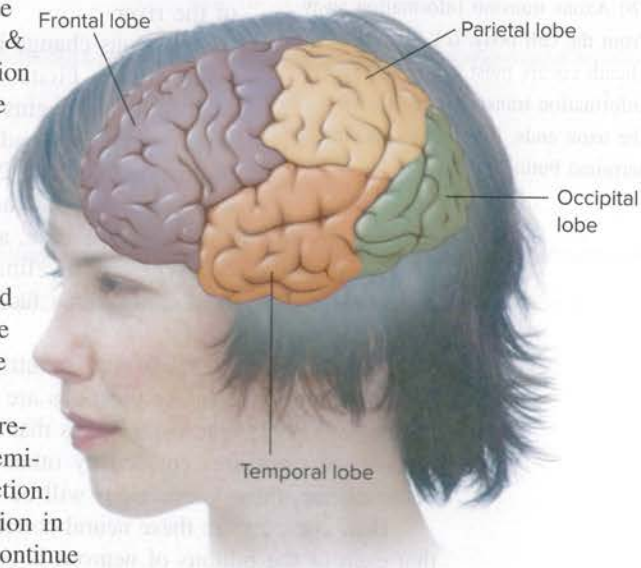


Figure 4 The Brain's Four Lobes
Shown here are the locations of the brain's four lobes: frontal, occipital, temporal, and parietal.

Although these areas are found in the cerebral cortex of each hemisphere, the two hemispheres are not identical in anatomy or function. **Lateralization** is the specialization of function in one hemisphere or the other. Researchers continue to explore the degree to which each is involved in various aspects of thinking, feeling, and behavior (Steri & de Hevia, 2015). At birth, the hemispheres of the cerebral cortex have already started to specialize: Newborns show greater electrical brain activity in the left hemisphere than in the right hemisphere when listening to speech sounds (Hahn, 1987).

lateralization Specialization of function in one hemisphere of the cerebral cortex or the other.

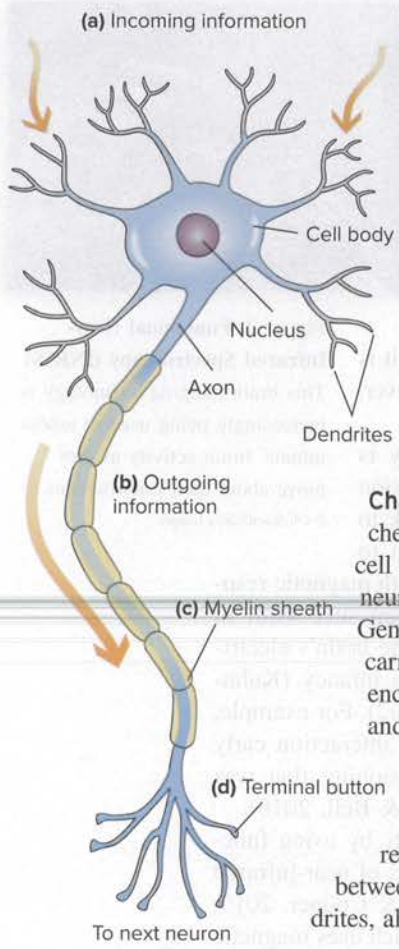


Figure 5 The Neuron
(*a*) The dendrites of the cell body receive information from other neurons, muscles, or glands through the axon. (*b*) Axons transmit information away from the cell body. (*c*) A myelin sheath covers most axons and speeds information transmission. (*d*) As the axon ends, it branches out into terminal buttons.

The most extensive research on brain lateralization has focused on language. Speech and grammar are localized in the left hemisphere in most people, but some aspects of language, such as appropriate language use in different contexts and the use of metaphor and humor, involve the right hemisphere (Moore, Brendel, & Fiez, 2014). Thus, language is not controlled exclusively by the brain's left hemisphere. Further, most neuroscientists agree that complex functions—such as reading, performing music, and creating art—are the outcome of communication between the two sides of the brain (Ries, Dronkers, & Knight, 2016).

How do the areas of the brain in the newborn and the infant differ from those of an adult, and why do the differences matter? Important differences have been documented at both the cellular and the structural levels.

Changes in Neurons Within the brain, neurons send electrical and chemical signals, communicating with each other. A *neuron* is a nerve cell that handles information processing (see Figure 5). Extending from the neuron's cell body are two types of fibers, known as *axons* and *dendrites*. Generally, the axon carries signals away from the cell body and dendrites carry signals toward it. A *myelin sheath,* which is a layer of fat cells, encases many axons (see Figure 5). The myelin sheath provides insulation and helps electrical signals travel faster down the axon (Tomassy, Dershowitz, & Arlotta, 2016). Myelination also is involved in providing energy to neurons and in facilitating communication (Kiray & others, 2016). At the end of the axon are terminal buttons, which release chemicals called *neurotransmitters* into *synapses,* tiny gaps between neurons. Chemical interactions in synapses connect axons and dendrites, allowing information to pass from one neuron to another (Beart, 2016).

Think of the synapse as a river that blocks a road. A grocery truck arrives at one bank of the river, crosses by ferry, and continues its journey to market. Similarly, a message in the brain is "ferried" across the synapse by a neurotransmitter, which pours out information contained in chemicals when it reaches the other side of the river.

Neurons change in two very significant ways during the first years of life. First, *myelination,* the process of encasing axons with fat cells, begins prenatally and continues throughout childhood, even into adolescence (Galvan & Tottenham, 2016; Monahan & others, 2016). Second, connectivity among neurons increases, creating new neural pathways. New dendrites grow, connections among dendrites increase, and synaptic connections between axons and dendrites proliferate. Whereas myelination speeds up neural transmissions, the expansion of dendritic connections facilitates the spreading of neural pathways in infant development.

Researchers have discovered an intriguing aspect of synaptic connections: Nearly twice as many of these connections are made as will ever be used (Huttenlocher & Dabholkar, 1997). The connections that are used become stronger and survive, while the unused ones are replaced by other pathways or disappear. In the language of neuroscience, these connections will be "pruned" (Selemon, 2016).

How complex are these neural connections? In a recent analysis, it was estimated that each of the billions of neurons is connected to as many as 1,000 other neurons, producing neural networks with trillions of connections (de Haan, 2015).

Changes in Regions of the Brain Figure 6 vividly illustrates the dramatic growth and later pruning of synapses in the visual, auditory, and prefrontal cortex (Huttenlocher & Dabholkar, 1997). Notice that "blooming and pruning" vary considerably by brain region. In the prefrontal cortex, the area of the brain where higher-level thinking and

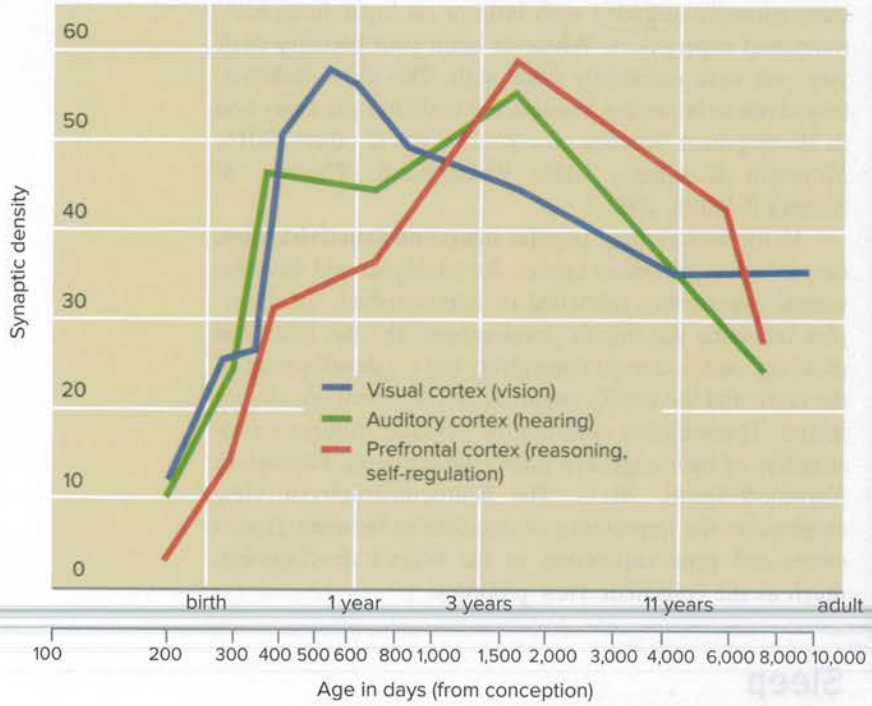


Figure 6 Synaptic Density in the Human Brain from Infancy to Adulthood
The graph shows the dramatic increase and then pruning in synaptic density for three regions of the brain: visual cortex, auditory cortex, and prefrontal cortex. Synaptic density is believed to be an important indication of the extent of connectivity between neurons.

self-regulation occur, the peak of overproduction occurs at just over 3 years of age; it is not until middle to late adolescence that the adult density of synapses is achieved (Monahan & others, 2016). Both heredity and environment are thought to influence the timing and course of synaptic overproduction and subsequent retraction.

Meanwhile, the pace of myelination also varies in different areas of the brain (Croteau-Chonka & others, 2016; Gogtay & Thompson, 2010). Myelination for visual pathways occurs rapidly after birth and is completed in the first six months. Auditory myelination is not completed until 4 or 5 years of age.

Early Experience and the Brain

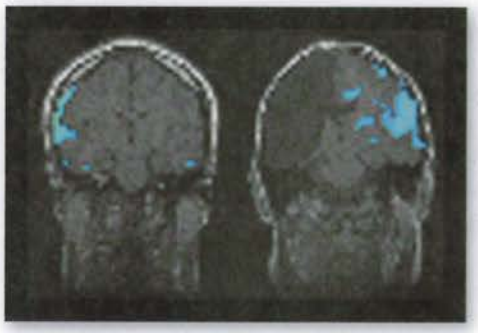
What determines how these changes in the brain occur? The infant's brain is literally waiting for experiences to determine how connections are made. Before birth, it appears that genes mainly direct how the brain establishes basic wiring patterns; after birth, environmental experiences guide the brain's development. The inflowing stream of sights, sounds, smells, touches, language, and eye contact help shape neural connections (Gao & others, 2016; Nelson, 2013). It may not surprise us, then, that depressed brain activity has been found in children who grow up in a deprived environment (Berens & Nelson, 2015; Nelson, Fox, & Zeanah, 2014). Infants whose caregivers expose them to a variety of stimuli—talking, touching, playing—are most likely to develop to their full potential.

The profusion of neural connections described earlier provides the growing brain with flexibility and resilience (de Haan & Johnson, 2016). As an extreme example, consider 16-year-old Michael Rehbein. When Michael was 4½, he began to experience uncontrollable seizures—from 60 to 400 a day. Doctors said that the only solution was to remove the left hemisphere of his brain, where the seizures were occurring. Michael had his first major surgery at age 7 and another at age 10. Although recovery was slow, his right hemisphere began to reorganize and eventually took over functions, such as speech, that normally occur in the brain's left hemisphere (see Figure 7). Individuals like Michael are living proof of the growing brain's remarkable ability to adapt and recover from a loss of brain tissue.

The Neuroconstructivist View

Not long ago, scientists thought that our genes determined how our brains were "wired" and that the cells in the brain responsible for processing information just

(a)



(b)

Figure 7 Plasticity in the Brain's Hemispheres.

(*a*) Michael Rehbein at 14 years of age. (*b*) Brain scans of an intact brain (left) and Michael Rehbein's brain (right). Michael's right hemisphere has reorganized to take over the language functions normally carried out by corresponding areas in the left hemisphere of an intact brain. However, the right hemisphere is not as efficient as the left, and more areas of the brain are recruited to process speech.

maturationally unfolded with little or no input from environmental experiences. Whatever brain your heredity dealt you, you were essentially stuck with. This view, however, turned out to be wrong. Instead, the brain has plasticity and its development depends on context (Gao & others, 2016; Monahan & others, 2016; Westermann, Thomas, & Karmiloff-Smith, 2011).

In the increasingly popular **neuroconstructivist view,** (a) biological processes (genes, for example) and environmental experiences (enriched or impoverished, for example) influence the brain's development; (b) the brain has plasticity and is context dependent; and (c) development of the brain and the child's cognitive development are closely linked. These factors constrain or advance children's construction of their cognitive skills (Westermann, Thomas, & Karmiloff-Smith, 2011). The neuroconstructivist view emphasizes the importance of interactions between experiences and gene expression in the brain's development, much as the epigenetic view proposes.

Sleep

When we were infants, sleep consumed more of our time than it does now (Lushington & others, 2014). The typical newborn sleeps 16 to 17 hours a day, but there is considerable individual variation in how much infants sleep. For newborns, the range is from about 10 hours to about 21 hours per day. A recent research review concluded that infants 0 to 2 years of age slept an average of 12.8 hours out of the 24, within a range of 9.7 to 15.9 hours (Galland & others, 2012). A recent study also revealed that by 6 months of age the majority of infants slept through the night, awakening their parents only once or twice a week (Weinraub & others, 2012).

The most common infant sleep-related problem reported by parents is nighttime waking (Hospital for Sick Children & others, 2010). Surveys indicate that 20 to 30 percent of infants have difficulty going to sleep at night and staying asleep until morning (Sadeh, 2008). A recent study found that nighttime wakings at 1 year of age predicted lower sleep efficiency at 4 years of age (Tikotzky & Shaashua, 2012). Infant nighttime waking problems have consistently been linked to excessive parental involvement in sleep-related interactions with their infant (Sadeh, 2008).

REM Sleep

A much greater amount of time is taken up by *REM (rapid eye movement)* sleep in infancy than at any other point in the life span (Funk & others, 2016). Unlike adults, who spend about one-fifth of their night in REM sleep, infants spend about half of their sleep time in REM sleep, and they often begin their sleep cycle with REM sleep rather than non-REM sleep. By the time infants reach 3 months of age, the percentage of time they spend in REM sleep decreases to about 40 percent, and REM sleep no longer begins their sleep cycle.

Why do infants spend so much time in REM sleep? Researchers are not certain. The large amount of REM sleep may provide infants with

neuroconstructivist view
Developmental perspective in which biological processes and environmental conditions influence the brain's development; the brain has plasticity and is context dependent; and cognitive development is closely linked with brain development.

added self-stimulation, since they spend less time awake than do older children. REM sleep also might promote the brain's development in infancy (Graven, 2006).

SIDS

Sudden infant death syndrome (SIDS) is a condition that occurs when an infant stops breathing, usually during the night, and dies suddenly without an apparent cause. SIDS remains one of the main causes of infant death in the United States, with more than 2,000 infant deaths annually attributed to SIDS (Heron, 2016). Risk of SIDS is highest at 2 to 4 months of age (NICHD, 2016). In 1992, the American Academy of Pediatrics (AAP) began recommending that infants be placed to sleep on their backs to reduce the risk of SIDS, and since then far fewer infants have been placed on their stomachs to sleep (AAP, 2000). Researchers have found that SIDS does indeed decrease when infants sleep on their backs rather than on their stomachs or sides (Elder, 2015; Moon, Hauck, & Colson, 2016). Why? Because sleeping on their backs increases their access to fresh air and reduces their chances of getting overheated.

Is this a good sleep position for infants? Why or why not?

SIDS also occurs more often in infants with abnormal brain stem functioning involving the neurotransmitter serotonin (Rognum & others, 2014). Also, heart arrhythmias are estimated to occur in as many as 10 to 15 percent of SIDS cases and research indicates that gene mutations are linked to the occurrence of these arrhythmias in SIDS cases (Sarquella-Brugada & others, 2016). SIDS also is less common in infants who are breast fed (Wennergren & others, 2015). SIDS occurs more in infants whose mothers smoke and infants who are exposed to secondhand smoke in general (Salm Ward & Balfour, 2016). Further, SIDS is more likely to occur in low birth weight infants, African American and Eskimo infants, infants who are passively exposed to cigarette smoke, infants who sleep with their parents in the same bed, infants who don't use a pacifier when they go to sleep, and infants who sleep in a bedroom without a fan (Adams, Ward, & Garcia, 2015; Alm & others, 2016; Jarosinska & others, 2014; Mollborg & others, 2015). In a recent analysis, it was concluded that after prone sleeping, the two factors that best predict SIDS are (1) maternal smoking, and (2) bed sharing (Mitchell & Krous, 2015).

How Would You...?

As a **health-care provider,** what advice would you provide to parents about preventing SIDS?

Sleep and Cognitive Development

Might infant sleep be linked to children's cognitive development? A recent study revealed that children who had done most of their sleeping at night during infancy engaged in a higher level of executive function at age 4 (Bernier & others, 2013). The link between infant sleep and children's cognitive functioning likely occurs because of sleep's role in brain maturation and memory consolidation, which may improve daytime alertness and learning (Sadeh, 2007). Another study found that poor sleep consolidation in infancy was associated with language delays in early childhood (Dionne & others, 2011). And in recent research, infant sleep difficulties were linked to negative outcomes later in development. For example, in one study lower quality of sleep at 1 year of age was linked to lower attention regulation and more behavior problems at 3 to 4 years of age (Sadeh & others, 2015). In another study, newborns who showed poorer sleep patterns were more likely to have attention orienting difficulties at 4 months of age and attention distractibility problems at 18 months of age (Geva, Yaron, & Kuint, 2016). And in a longitudinal study, infants who had more sleep problems were more likely to have emotional dysregulation at 2 to 3 years of age, which in turn was related to poor attention functioning in elementary school (Williams & Sciberras, 2016).

sudden infant death syndrome (SIDS) A condition that occurs when an infant stops breathing, usually during the night, and suddenly dies without an apparent cause.

Nutrition

From birth to 1 year of age, human infants nearly triple their weight and increase their length by 40 percent. What kind of nourishment do they need to sustain this rapid growth?

Breast Feeding Versus Bottle Feeding

For the first four to six months of life, human milk or an alternative formula is the baby's source of nutrients and energy. For years, debate has focused on whether breast feeding is better for the infant than bottle feeding. The growing consensus is that breast feeding is better for the baby's health (Gertosio & others, 2017). Since the 1970s, breast feeding by U.S. mothers has become widespread. In 2011 more than 79 percent of U.S. mothers breast fed their newborns, and 49 percent breast fed their 6-month-olds (Centers for Disease Control and Prevention, 2014).

What are some of the benefits of breast feeding? During the first two years of life and beyond, benefits include appropriate weight gain and reduced risk of child and adult obesity (Carling & others, 2015); reduced risk of SIDS (Wennergen & others, 2015); fewer gastrointestinal infections (Le Doare & Kampmann, 2014); and fewer lower respiratory tract infections (Prameela, 2011). Further, a recent study of more than 500,000 Scottish children found that those who were breast fed exclusively at 6 to 8 weeks of age were less likely to have ever been hospitalized through early childhood than their formula-fed counterparts (Ajetunmobi & others, 2015). However, a recent Danish study found that breast feeding did not protect against allergic sensitization in early childhood and allergy-related diseases at 7 years of age (Jelding-Dannemand, Malby Schoos, & Bisgaard, 2015). And in a large-scale review, no evidence for the benefits of breast feeding was found for children's cognitive development and cardiovascular functioning (Agency for Healthcare Research and Quality, 2007). However, a recent study did find that breast feeding resulted in a small increase in children's intelligence (Kanazawa, 2015). Benefits of breast feeding for the mother include a lower incidence of breast cancer (Akbari & others, 2011) and a reduction in ovarian cancer (Stuebe & Schwartz, 2010).

Human milk or an alternative formula is a baby's source of nutrients for the first four to six months. The growing consensus is that breast feeding is better for the baby's health, although controversy still swirls about breast versus bottle feeding. *What do research studies indicate are the outcomes of breast feeding for children and mothers?*

Many health professionals have argued that breast feeding facilitates the development of an attachment bond between mother and infant (Wittig & Spatz, 2008). However, a recent research review found that the positive effect of breast feeding on the mother-infant relationship is not supported by research (Jansen, de Weerth, & Riksen-Walraven, 2008). The review concluded that recommending breast feeding should not be based on its role in improving the mother-infant relationship but rather on its positive effects on infant and maternal health.

The American Academy of Pediatrics Section on Breastfeeding (2012) reconfirmed its recommendation of exclusive breast feeding in the first six months followed by continued breast feeding as complementary foods are introduced, and further breast feeding for one year or longer as mutually desired by the mother and infant.

Are there circumstances when mothers should not breast feed? Yes. A mother should not breast feed if she (1) is infected with AIDS or any other infectious disease that can be transmitted through her milk, (2) has active tuberculosis, or (3) is taking any drug that may not be safe for the infant (Fowler & others, 2014).

Some women cannot breast feed their infants because of physical difficulties; others feel guilty if they terminate breast feeding early. Mothers also may worry that they are depriving their infants of important emotional and psychological benefits if they bottle feed rather than breast feed. Some researchers have found, however, that there are few, if any,

long-term physical and psychological differences between breast fed and bottle fed infants (Colen & Ramey, 2014; Ferguson, Harwood, & Shannon, 1987; Young, 1990).

A further issue in interpreting the benefits of breast feeding was underscored in a recent large-scale research review (Agency for Healthcare Research and Quality, 2007). While highlighting a number of benefits of breast feeding for children and mothers, the report issued a caution about research on breast feeding: None of the findings imply causality. Breast feeding versus bottle feeding studies are correlational, not experimental, and women who breast feed tend to be wealthier, older, and better educated, and are likely to be more health-conscious than those who bottle feed, which could explain why breast fed children are healthier.

Nutritional Needs

Individual differences among infants in terms of their nutrient reserves, body composition, growth rates, and activity patterns make it difficult to define actual nutrient needs (Blake, Munoz, & Volpe, 2016; Schiff, 2016). However, because parents need guidelines, nutritionists recommend that infants consume approximately 50 calories per day for each pound they weigh—more than twice an adult's requirement per pound.

A national study of more than 3,000 randomly selected 4- to 24-month-olds documented that many U.S. parents are feeding their babies too few fruits and vegetables and too much junk food (Fox & others, 2004). Up to one-third of the babies ate no vegetables and fruit; almost half of the 7- to 8-month-old babies were fed desserts, sweets, or sweetened drinks. By 15 months, French fries were the most common vegetables the babies ate.

Caregivers play very important roles in infants' early development of eating patterns (Christian & others, 2015; Kitsantas & others, 2016; Montano & others, 2015). Caregivers who are not sensitive to developmental changes in infants' nutritional needs, neglectful caregivers, and conditions of poverty can contribute to the development of eating problems in infants (Black & Lozoff, 2008; Robinson, 2015; Virudachalam & others, 2016). One study found that low maternal sensitivity when infants were 15 and 24 months of age was linked to a higher risk of obesity in adolescence (Anderson & others, 2012).

In sum, adequate early nutrition is an important aspect of healthy development (Ejlerskov & others, 2015). To be healthy, children need a nurturant, supportive environment. One individual who has stood out as an advocate of caring for children is T. Berry Brazelton, who is featured in *Careers in Life-Span Development.*

Careers in life-span development

T. Berry Brazelton, Pediatrician

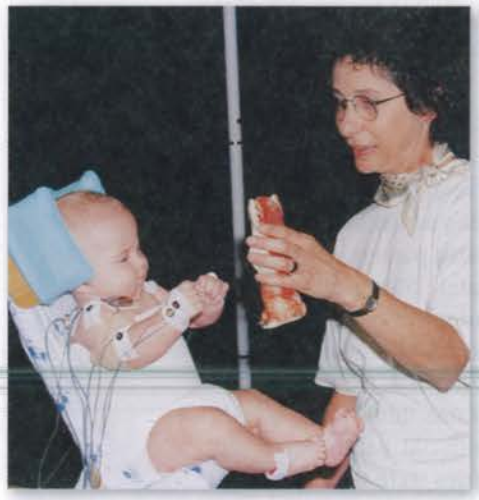
T. Berry Brazelton is America's best-known pediatrician as a result of his numerous books, television appearances, and newspaper and magazine articles about parenting and children's health. He takes a family-centered approach to child development issues and communicates with parents in easy-to-understand ways.

Dr. Brazelton founded the Child Development Unit at Boston Children's Hospital and created the Brazelton Neonatal Behavioral Assessment Scale, a widely used measure of the newborn's health and well-being. He also has conducted a number of research studies on infants and children and has been president of the Society for Research in Child Development, a leading research organization.

T. Berry Brazelton with a young child.

Motor Development

Meeting infants' nutritional needs helps them to develop the strength and coordination required for motor development. How do infants develop their motor skills, and which skills do they develop when?



Esther Thelen conducts an experiment to discover how infants learn to control their arms to reach and grasp for objects. A computer device monitors the infant's arm movements and tracks muscle patterns. Thelen's research is conducted from a dynamic systems perspective. *What is the nature of this perspective?*

Dynamic Systems Theory

Developmentalist Arnold Gesell (1934) thought his painstaking observations had revealed how people develop their motor skills. He had discovered that infants and children develop rolling, sitting, standing, and other motor skills in a fixed order and within specific time frames. These observations, said Gesell, show that motor development comes about through the unfolding of a genetic plan, or maturation.

Later studies, however, demonstrated that the sequence of developmental milestones is not as fixed as Gesell indicated and not due as much to heredity as Gesell argued (Adolph & Berger, 2016; Adolph & Robinson, 2015). In the last two decades, the study of motor development underwent a renaissance as psychologists developed new insights about *how* motor skills develop (Kretch & Adolph, 2016). One increasingly influential perspective is dynamic systems theory, proposed by Esther Thelen (Thelen & Smith, 1998, 2006).

According to **dynamic systems theory,** infants assemble motor skills for perceiving and acting. In other words, perception and action are coupled (Thelen & Smith, 2006). In order to develop motor skills, infants must perceive something in the environment that motivates them to act, then use their perceptions to fine-tune their movements. Motor skills thus represent pathways to the infant's goals (Adolph & Robinson, 2015).

How is a motor skill developed, according to this theory? When infants are motivated to do something, they might create a new motor behavior. The new behavior is the result of many converging factors: the development of the nervous system, the body's physical properties and its possibilities for movement, the goal the child is motivated to reach, and environmental support for the skill. For example, babies will learn to walk only when their nervous system has matured sufficiently to allow them to control certain leg muscles, their legs have grown enough to support their weight, and they have decided they want to walk (Adolph & Berger, 2016).

Mastering a motor skill requires the infant's active efforts to coordinate several components of the skill (Chen, Jeka, & Clark, 2016). Infants explore and select possible solutions to the demands of a new task, and they assemble adaptive patterns by modifying their current movement patterns. The first step, for example, occurs when the infant is motivated by a new challenge—such as the desire to cross a room—and initiates this task by taking a few stumbling steps. The infant then "tunes" these movements to make them smoother and more effective. The tuning is achieved through repeated cycles of action and perception of the consequences of that action. According to the dynamic systems view, even universal milestones such as crawling, reaching, and walking are learned through this process of adaptation: Infants modulate their movement patterns to fit a new task by exploring and selecting possible configurations (Adolph & Robinson, 2015).

Thus, according to dynamic systems theory, motor development is not a passive process in which genes dictate the unfolding of a sequence of skills. Rather, the infant actively puts together a skill in order to achieve a goal within the constraints set by the infant's body and environment. Nature and nurture, the infant and the environment, are all working together as part of an ever-changing system.

As we examine the course of motor development, we will describe how dynamic systems theory applies to some specific skills. First, though, let's examine how the story of motor development begins with reflexes.

dynamic systems theory The perspective on motor development that seeks to explain how motor behaviors are assembled for perceiving and acting.

Reflexes

The newborn is not completely helpless. Among other things, the newborn has some basic reflexes. Reflexes are built-in reactions to stimuli, and they govern the newborn's movements. Reflexes are genetically carried survival mechanisms that are automatic and involuntary. They allow infants to respond adaptively to their environment before they have had the opportunity to learn. For example, if immersed in water, the newborn automatically holds its breath and contracts its throat to keep water out.

Other important examples are the rooting and sucking reflexes. Both have survival value for newborn mammals, who must find a mother's breast to obtain nourishment. The *rooting reflex* occurs when the infant's cheek is stroked or the side of the mouth is touched. In response, the infant turns its head toward the side that was touched in an apparent effort to find something to suck. The *sucking reflex* occurs when newborns automatically suck an object placed in their mouth. This reflex enables newborns to get nourishment before they have associated a nipple with food.

Another example is the *Moro reflex,* which occurs in response to a sudden, intense noise or movement. When startled, the newborn arches its back, throws back its head, and flings out its arms and legs. Then the newborn rapidly closes its arms and legs. The Moro reflex is believed to be a way of grabbing for support while falling; it would have had survival value for our primate ancestors. An overview of the reflexes we have discussed, along with others, is presented in Figure 8.

Some reflexes—coughing, sneezing, blinking, shivering, and yawning, for example—persist throughout life. They are as important for the adult as they are for the infant. Other reflexes, though, disappear several months after birth, as the infant's brain matures and voluntary control over many behaviors develops. The rooting, sucking, and Moro reflexes, for example, all tend to disappear when the infant is 3 to 4 months old.

The movements of some reflexes eventually become incorporated into more complex, voluntary actions. One important example is the *grasping reflex,* which occurs when something touches the infant's palm. The infant responds by grasping tightly.

Reflex	Stimulation	Infant's Response	Developmental Pattern
Blinking	Flash of light, puff of air	Closes both eyes	Permanent
Babinski	Sole of foot stroked	Fans out toes, twists foot in	Disappears after 9 months to 1 year
Grasping	Palms touched	Grasps tightly	Weakens after 3 months, disappears after 1 year
Moro (startle)	Sudden stimulation, such as hearing loud noise or being dropped	Startles, arches back, throws head back, flings out arms and legs and then rapidly closes them to center of body	Disappears after 3 to 4 months
Rooting	Cheek stroked or side of mouth touched	Turns head, opens mouth, begins sucking	Disappears after 3 to 4 months
Stepping	Infant held above surface and feet lowered to touch surface	Moves feet as if to walk	Disappears after 3 to 4 months
Sucking	Object touching mouth	Sucks automatically	Disappears after 3 to 4 months
Swimming	Infant put face down in water	Makes coordinated swimming movements	Disappears after 6 to 7 months
Tonic neck	Infant placed on back	Forms fists with both hands and usually turns head to the right (sometimes called the "fencer's pose" because the infant looks like it is assuming a fencer's position)	Disappears after 2 months

Figure 8 Infant Reflexes

gross motor skills Motor skills that involve large-muscle activities, such as walking.

By the end of the third month, the grasping reflex diminishes, and the infant shows a more voluntary grasp. For example, when an infant sees a mobile turning slowly above a crib, it may reach out and try to grasp it. As its motor development becomes smoother, the infant will grasp objects, carefully manipulate them, and explore their qualities.

The old view of reflexes is that they were exclusively genetic, built-in mechanisms that govern the infant's movements. The new perspective on infant reflexes is that they are not automatic or completely beyond the infant's control. For example, infants can control such movements as alternating their legs to make a mobile jiggle or changing their sucking rate to listen to a recording (Adolph & Robinson, 2015).

Gross Motor Skills

Gross motor skills are skills that involve large-muscle activities, such as moving one's arms and walking. Newborn infants cannot voluntarily control their posture. Within a few weeks, though, they can hold their heads erect, and soon they can lift their heads while prone. By 2 months of age, babies can sit while supported on a lap or an infant seat, but they cannot sit independently until they are 6 or 7 months of age. Standing also develops gradually during the first year of life. By about 8 months of age, infants usually learn to pull themselves up and hold on to a chair, and by about 10 to 12 months of age they can often stand alone.

Locomotion and postural control are closely linked, especially in walking upright (Soska & Adolph, 2014). To walk upright, the baby must be able both to balance on one leg as the other is swung forward and to shift its weight from one leg to the other (Thelen & Smith, 2006).

Infants must also learn what kinds of places and surfaces are safe for crawling or walking (Adolph & Robinson, 2015; Ishak, Franchak, & Adolph, 2014). Karen Adolph (1997) investigated how experienced and inexperienced crawling and walking infants go down steep slopes (see Figure 9). Newly crawling infants, who averaged about 8 months in age, rather indiscriminately went down the steep slopes, often falling in the process (with their mothers standing next to the slope to catch them). After weeks of practice, the crawling babies became more adept at judging which slopes were too steep to crawl down and which ones they could navigate safely.

You might expect that babies who learned that a slope was too steep for crawling would know when they began walking whether a slope was safe. But Adolph's research indicated that newly walking infants could not judge the safety of the slopes. Only when infants became experienced walkers were they able to accurately match their skills with the steepness of the slopes. They rarely fell downhill, either refusing to go down the steep slopes or going down backward in a cautious manner. Experienced walkers

Figure 9 The Role of Experience in Crawling and Walking Infants' Judgments of Whether to Go Down a Slope

Karen Adolph (1997) found that locomotor experience rather than age was the primary predictor of adaptive responding on slopes of varying steepness. Newly crawling and walking infants could not judge the safety of the various slopes. With experience, they learned to avoid slopes where they would fall. When expert crawlers began to walk, they again made mistakes and fell, even though they had judged the same slope accurately when crawling. Adolph referred to this as the specificity of learning because it does not transfer across crawling and walking.

Newly crawling infant

Experienced walker

assessed the situation perceptually—looking, swaying, touching, and thinking before they moved down the slope. With experience, both crawlers and walkers learned to avoid the risky slopes where they would fall, integrating perceptual information with the development of a new motor behavior. In this research, we again see the importance of perceptual-motor coupling in the development of motor skills.

Practice is especially important in learning to walk (Adolph & Berger, 2016). Infants and toddlers accumulate an immense number of experiences with balance and locomotion (Cole, Robinson, & Adolph, 2016). For example, the average toddler traverses almost 40 football fields a day and has 15 falls an hour (Adolph, 2010).

Might the development of walking be linked to advances in other aspects of development? Walking experience leads to being able to gain contact with objects that were previously out of reach and to initiate interaction with parents and other adults, thereby promoting language development (Adolph & Robinson, 2015; He, Walle, & Campos, 2015). Thus, just as with advances in postural skills, walking skills can produce a cascade of changes in the infant's development.

The First Year: Milestones and Variations

Figure 10 summarizes important accomplishments in gross motor skills during the first year, culminating in the ability to walk easily. The timing of these milestones, especially the later ones, may vary by as much as two to four months, and experiences can modify the onset of these accomplishments. For example, since 1992, when pediatricians began recommending that parents put their infants to sleep on their backs, there has been an increase in the number of babies who skip the stage of crawling (Davis & others, 1998). In the African Mali tribe, most infants do not crawl (Bril, 1999).

According to Karen Adolph and Sarah Berger (2005), "The old-fashioned view that growth and motor development reflect merely the age-related output of maturation is, at best, incomplete. Rather, infants acquire new skills with the help of their caregivers in a real-world environment of objects, surfaces, and planes" (p. 273).

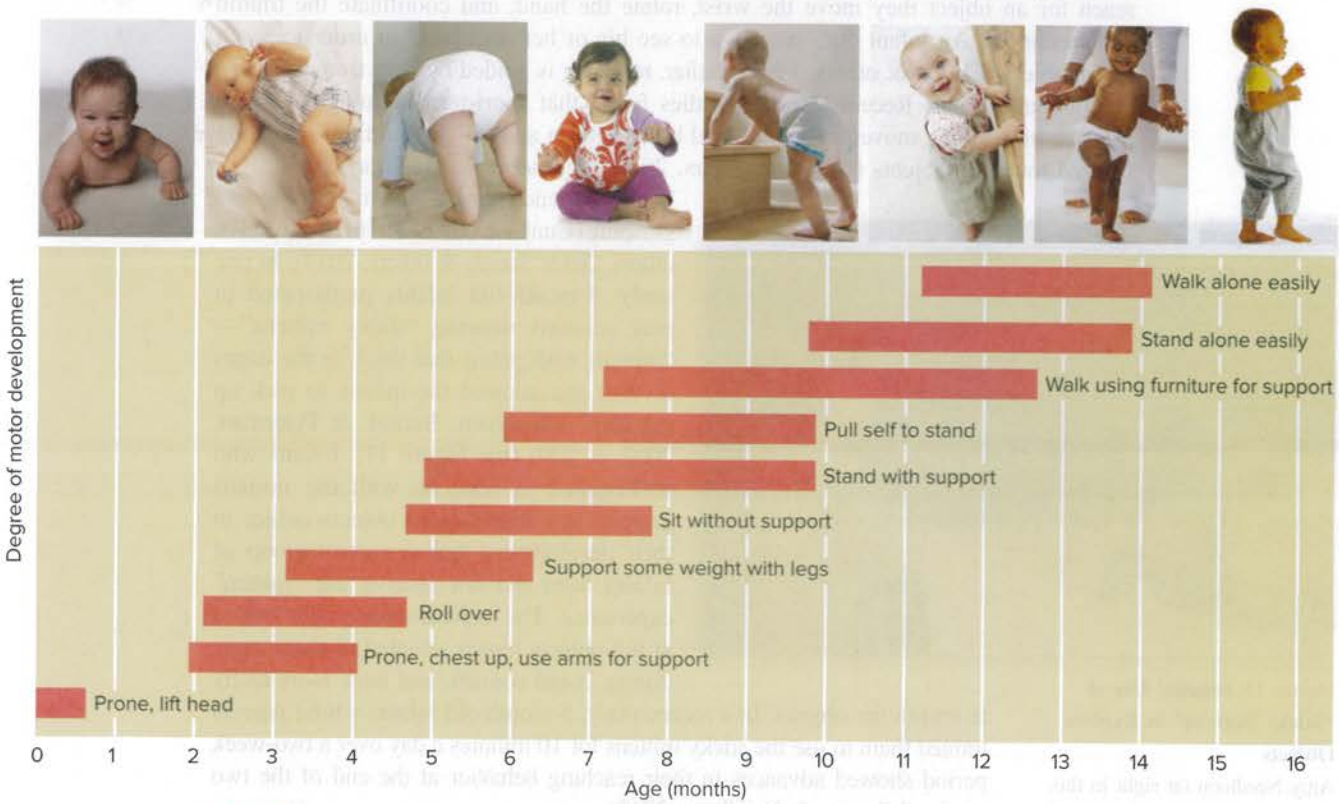


Figure 10 Milestones in Gross Motor Development.
The horizontal red bars indicate the range in which most infants reach various milestones in gross motor development.

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How Would You...?

As a **human development and family studies professional,** how would you advise parents who are concerned that their infant is one or two months behind the average gross motor milestones?

Development in the Second Year

fine motor skills Motor skills that involve more finely tuned movements, such as finger dexterity.

The motor accomplishments of the first year bring increasing independence, allowing infants to explore their environment more extensively and to initiate interaction with others more readily. In the second year of life, toddlers become more mobile as their motor skills are honed. Child development experts believe that motor activity during the second year is vital to the child's competent development and that few restrictions, except those having to do with safety, should be placed on their adventures (Fraiberg, 1959).

By 13 to 18 months, toddlers can pull a toy attached to a string and use their hands and legs to climb up steps. By 18 to 24 months, toddlers can walk quickly or run stiffly for a short distance, balance on their feet in a squatting position while playing with objects on the floor, walk backward without losing their balance, stand and kick a ball without falling, stand and throw a ball, and jump in place.

Fine Motor Skills

Whereas gross motor skills involve large-muscle activity, **fine motor skills** involve finely tuned movements. Grasping a toy, using a spoon, buttoning a shirt, or anything that requires finger dexterity demonstrates fine motor skills. At birth, infants have very little control over fine motor skills, but they do have many components of what will become finely coordinated arm, hand, and finger movements (McCormack, Hoerl, & Butterfill, 2012).

The onset of reaching and grasping marks a significant achievement in infants' ability to interact with their surroundings (Greif & Needham, 2012). During the first two years of life, infants refine how they reach and grasp. Initially, they reach by moving the shoulder and elbow crudely, swinging toward an object. Later, when they reach for an object they move the wrist, rotate the hand, and coordinate the thumb and forefinger. An infant does not have to see his or her own hand in order to reach for an object (Clifton & others, 1993); rather, reaching is guided by cues from muscles, tendons, and joints. Recent research studies found that short-term training involving practice of reaching movements increased both preterm and full-term infants' reaching for and touching objects (Cunha & others, 2016; Guimaraes & Tudellia, 2015).

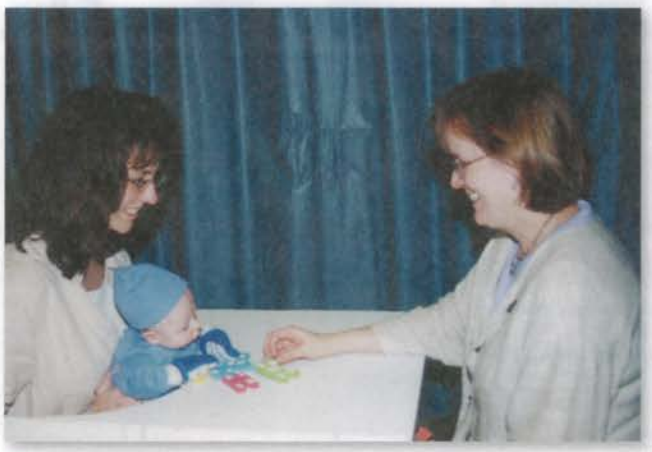

Figure 11 Infants' Use of "Sticky Mittens" to Explore Objects

Amy Needham (at right in this photo) and her colleagues (2002) found that "sticky mittens" enhanced young infants' object exploration skills.

Experience plays a role in reaching and grasping (Cunha & others, 2016; Rachwani & others, 2015; Sacrey & others, 2014). In one study, 3-month-old infants participated in play sessions wearing "sticky mittens"—"mittens with palms that stuck to the edges of toys and allowed the infants to pick up the toys" (Needham, Barrett, & Peterman, 2002, p. 279) (see Figure 11). Infants who participated in sessions with the mittens grasped and manipulated objects earlier in their development than a control group of infants who did not receive the "mitten" experience. The experienced infants looked at the objects longer, swatted at them more during visual contact, and were more likely to mouth the objects. In a recent study, 5-month-old infants whose parents trained them to use the sticky mittens for 10 minutes a day over a two-week period showed advances in their reaching behavior at the end of the two weeks (Libertus & Needham, 2010).

Rachel Keen (2011; Keen, Lee, & Adolph, 2014) emphasizes that tool use is an excellent context for studying problem solving in infants because tool use provides information about how infants plan to reach a goal. Researchers in this area have studied infants' intentional actions,

which range from picking up a spoon in different orientations to retrieving rakes from inside tubes. A recent study explored motor origins of tool use by assessing developmental changes in banging movements in 6- to 15-month-olds (Kahrs, Jung, & Lockman, 2013). In this study, younger infants were inefficient and variable when banging an object but by 1 year of age infants showed consistent straight up-and-down hand movements that resulted in precise aiming and consistent levels of force.

Just as infants need to exercise their gross motor skills, they also need to exercise their fine motor skills (Cunha & others, 2016; Loucks & Sommerville, 2012). Especially when they can manage a pincer grip, infants delight in picking up small objects. Many develop the pincer grip and begin to crawl at about the same time, and infants at this time pick up virtually everything in sight, especially on the floor, and put the objects in their mouth. Thus, parents need to be vigilant in monitoring objects within the infant's reach.

Sensory and Perceptual Development

Can a newborn see? If so, what can it perceive? How do sensations and perceptions develop? Can an infant put together information from two modalities, such as sight and sound? These are among the intriguing questions that we explore in this section.

Exploring Sensory and Perceptual Development

How does a newborn know that her mother's skin is soft rather than rough? How does a 5-year-old know what color his hair is? Infants and children "know" these things as a result of information that comes through the senses.

Sensation occurs when information interacts with sensory *receptors*—the eyes, ears, tongue, nostrils, and skin. The sensation of hearing occurs when waves of pulsating air are collected by the outer ear and transmitted through the bones of the inner ear to the auditory nerve. The sensation of vision occurs as rays of light contact the eyes, become focused on the retina, and are transmitted by the optic nerve to the visual centers of the brain.

Perception is the interpretation of what is sensed. The air waves that contact the ears might be interpreted as noise or as musical sounds, for example. The physical energy transmitted to the retina of the eye might be interpreted as a particular color, pattern, or shape, depending on how it is perceived.

The Ecological View

In recent decades, much of the research on perceptual development in infancy has been guided by the ecological view proposed by Eleanor and James J. Gibson (E. Gibson, 1969, 1989, 2001; J. Gibson, 1966, 1979). They argue that we do not have to take bits and pieces of data from sensations and build up representations of the world in our minds. Instead, our perceptual system can select from the rich information that the environment itself provides.

According to the Gibsons' **ecological view,** we directly perceive information that exists in the world around us. Perception brings us into contact with the environment in order to interact with and adapt to it. Perception is designed for action. It gives people information such as when to duck, when to turn their bodies as they move through a narrow passageway, and when to put their hands up to catch something (Adolph & Kretch, 2015; Kretch & Adolph, 2016).

sensation The product of the interaction between information and the sensory receptors—the eyes, ears, tongue, nostrils, and skin.

perception The interpretation of what is sensed.

ecological view The view that perception functions to bring organisms in contact with the environment and to increase adaptation.

Studying the Infant's Perception

Studying the infant's perception is not an easy task. Unlike most research participants, infants cannot write, type on a computer keyboard, or speak well enough to explain to an experimenter what their responses are to a given stimulus or condition. Yet scientists have developed several ingenious research methods to examine infants' sensory and perceptual development (Bendersky & Sullivan, 2007).

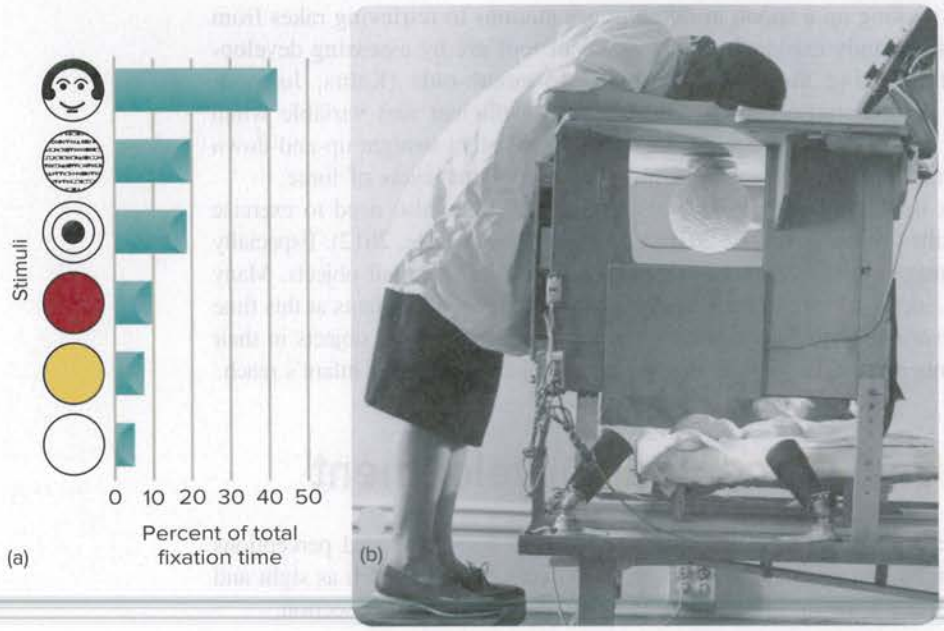

Figure 12 Fantz's Experiment on Infants' Visual Perception
(*a*) Infants 2 to 3 weeks old preferred to look at some stimuli more than others. In Fantz's experiment, infants preferred to look at patterns rather than at color or brightness. For example, they looked longer at a face, a piece of printed matter, or a bull's-eye than at red, yellow, or white discs. (*b*) Fantz used a "looking chamber" to study infants' perception of stimuli.

The Visual Preference Method Robert Fantz (1963), a pioneer in this effort, made an important discovery: Infants look at different things for different lengths of time. Fantz placed infants in a "looking chamber," which had two visual displays on the ceiling above the infant's head. An experimenter viewed the infant's eyes by looking through a peephole. If the infant was gazing at one of the displays, the experimenter could see the display's reflection in the infant's eyes. This allowed the experimenter to determine how long the infant looked at each display. Fantz (1963) found that infants only 2 days old would gaze longer at patterned stimuli (such as faces or concentric circles) than at red, white, or yellow discs. Similar results were found with infants 2 to 3 weeks old (see Figure 12). Fantz's research method—studying whether infants can distinguish one stimulus from another by measuring the length of time they attend to different stimuli—is referred to as the **visual preference method.**

Habituation and Dishabituation Another way in which researchers study infant perception is to present a stimulus (such as a sight or a sound) a number of times. If the infant decreases its response to the stimulus after several presentations, this indicates that the infant is no longer interested in the stimulus. If the researcher now presents a new stimulus, the infant's response will recover—indicating the infant could discriminate between the old and new stimuli (Baker, Pettigrew, & Poulin-Dubois, 2014).

Habituation is the name given to decreased responsiveness to a stimulus after repeated presentations of the stimulus. **Dishabituation** is the recovery of a habituated response after a change in stimulation. Newborn infants can habituate to repeated sights, sounds, smells, or touches (Bendersky & Sullivan, 2007). Among the measures researchers use in habituation studies are sucking behavior (sucking behavior stops when the infant attends to a novel object), heart and respiration rates, and the length of time the infant looks at an object.

visual preference method A method developed by Fantz to determine whether infants can distinguish one stimulus from another by measuring the length of time they attend to different stimuli.

habituation Decreased responsiveness to a stimulus after repeated presentations of the stimulus.

dishabituation Recovery of a habituated response after a change in stimulation.

Equipment Technology can facilitate the use of most methods for investigating the infant's perceptual abilities. Videotape equipment allows researchers to investigate elusive behaviors. High-speed computers make it possible to perform complex data analysis in minutes. Other equipment records respiration, heart rate, body movement, visual fixation, and sucking behavior, which provide clues to what the infant is perceiving.

Eye Tracking The most important recent advance in measuring infant perception is the development of sophisticated eye-tracking equipment (Eisner & others, 2013; Franchak & others, 2016; Kretch, Franchak, &

Adolph, 2014). Eye tracking consists of measuring eye movements that follow (track) a moving object and can be used to evaluate an infant's early visual ability (Bendersky & Sullivan, 2007).

Figure 13 shows an infant wearing eye-tracking headgear in a recent study on visually guided motor behavior and social interaction.

One of the main reasons that infant perception researchers are so enthusiastic about the recent availability of sophisticated eye-tracking equipment is that looking time is among the most important measures of infant perceptual and cognitive development (Aslin, 2012). The new eye-tracking equipment allows for far greater precision in assessing various aspects of infant looking and gaze than is possible with human observation (Franchak & others, 2016; Liu & others, 2015; Richmond, Zhao, & Burns, 2015). Among the areas of infant perception in which eye-tracking equipment is being used are attention (Schmitow & Stenberg, 2015; Yu & Smith, 2016), memory (Kingo & Krojgaard, 2015), and face processing (Jakobsen, Umstead, & Simpson, 2016; Xiao & others, 2015). Further, eye-tracking equipment is improving our understanding of atypically developing infants, such as those with autism (Chita-Tegmark, 2016; Elsabbagh & Johnson, 2016; Thorup & others, 2016).

Figure 13 An Infant Wearing Eye-Tracking Headgear
Photo from Karen Adolph's laboratory at New York University.

One eye-tracking study shed light on the effectiveness of TV programs and DVDs that claim to educate infants (Kirkorian, Anderson, & Keen, 2012). In this study, 1-year-olds, 4-year-olds, and adults watched *Sesame Street* and the eye-tracking equipment recorded precisely what they looked at on the screen. The 1-year-olds were far less likely to consistently look at the same part of the screen as their older counterparts, suggesting that the 1-year-olds showed little understanding of the Sesame Street video but instead were more likely to be attracted by what was salient than by what was relevant.

Visual Perception

Psychologist William James (1890/1950) called the newborn's perceptual world a "blooming, buzzing confusion." A century later, we can safely say that he was wrong (De Heering & others, 2016; Johnson & Hannon, 2015). Even the newborn perceives a world with some order.

Visual Acuity and Color

Just how well can infants see? The newborn's vision is estimated to be 20/600 on the well-known Snellen eye examination chart (Banks & Salapatek, 1983). This means that an object 20 feet away is only as clear to the newborn's eyes as it would be if it were viewed from a distance of 600 feet by an adult with normal vision (20/20). By 6 months of age, though, an average infant's vision is 20/40 (Aslin & Lathrop, 2008). Figure 14 shows a computer estimation of what a picture of a face looks like to an infant at different ages from a distance of about 6 inches.

Faces are possibly the most important visual stimuli in children's social environment, and it is important that they extract key information from others' faces (Cashon & Holt, 2015; Jakobsen, Umstead, & Simpson, 2016; Otte & others, 2015). Infants show an interest in human faces soon after birth (Johnson & Hannon, 2015; Liu & others, 2015). Within hours after they are born, research shows that infants prefer to look at faces rather than other objects and to look at attractive faces more than at unattractive ones (Lee & others, 2013).

The infant's color vision also improves. By 8 weeks, and possibly even by 4 weeks, infants can discriminate among some colors (Kelly, Borchert, & Teller, 1997).

Figure 14 Visual Acuity During the First Months of Life
The four photographs represent a computer estimation of what a picture of a face looks like to a 1-month-old, 2-month-old, 3-month-old, and 1-year-old (which approximates the visual acuity of an adult).

Perceiving Occluded Objects

Take a moment to look at your surroundings. You will likely see that some objects are partly occluded by other objects that are in front of them—possibly a desk behind a chair, some books behind a computer, or a car parked behind a tree. Do infants perceive an object as complete when it is occluded by an object in front of it?

In the first two months of postnatal development, infants do not perceive occluded objects as complete, instead only perceiving what is visible. Beginning at about 2 months of age, infants develop the ability to perceive that occluded objects are whole (Slater, Field, & Hernandez-Reif, 2007). How does perceptual completion develop? In Scott Johnson's (2010, 2011, 2013; Johnson & Hannon, 2015) research, learning, experience, and self-directed exploration via eye movements play key roles in the development of perceptual completion in young infants.

Many objects that are occluded appear and disappear behind closer objects, as when you are walking down the street and see cars appear and disappear behind buildings. Infants develop the ability to track briefly occluded moving objects at about 3 to 5 months (Bertenthal, 2008). A recent study explored the ability of 5- to 9-month-old infants to track moving objects that disappeared gradually behind an occluded partition, disappeared abruptly, or imploded (shrank quickly) (Bertenthal, Longo, & Kenny, 2007) (see Figure 15). In this study, the infants were more likely to accurately track the moving object when it disappeared gradually rather than vanishing abruptly or imploding.

Depth Perception

To investigate whether infants have depth perception, Eleanor Gibson and Richard Walk (1960) constructed a miniature cliff with a drop-off covered by glass. They placed 6- to 12-month-old infants on the edge of this visual cliff and had their mothers coax them to crawl onto the glass (see Figure 16). Most infants would not crawl out on the glass, choosing instead to remain on the shallow side, an indication that they could perceive depth, according to Gibson and Walk. Although researchers do not know exactly how early in life infants can perceive depth, they have found that infants develop the ability to use binocular (two-eyed) cues to depth by about 3 to 4 months of age.

Other Senses

Other sensory systems besides vision also develop during infancy. In this section, we explore development in hearing, touch and pain, smell, and taste.

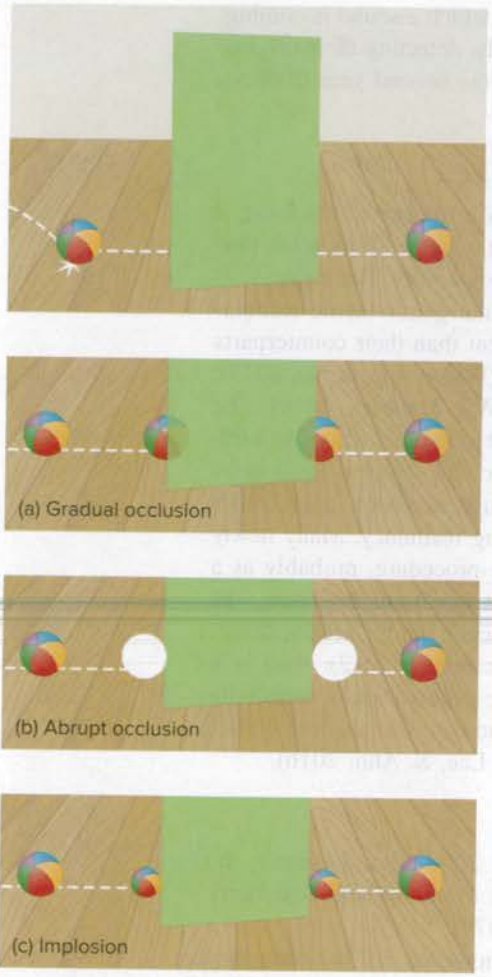

Figure 15 Infants' Predictive Tracking of a Briefly Occluded Moving Ball

The top drawing shows the visual scene that infants experienced. At the beginning of each event, a multicolored ball bounced up and down with an accompanying bouncing sound, and then rolled across the floor until it disappeared behind the partition. The bottom drawings show the three stimulus events that the 5- to 9-month-old infants experienced: (*a*) gradual occlusion—the ball gradually disappears behind the right side of the occluding partition located in the center of the display; (*b*) abrupt occlusion—the ball abruptly disappears when it reaches the location of the white circle and then abruptly reappears 2 seconds later at the location of the second white circle on the other side of the occluding partition; (*c*) implosion—the rolling ball quickly decreases in size as it approaches the occluding partition and rapidly increases in size as it reappears on the other side of the occluding partition.

Figure 16 Examining Infants' Depth Perception on the Visual Cliff

Eleanor Gibson and Richard Walk (1960) found that most infants would not crawl out on the glass, which, according to Gibson and Walk, indicated that they had depth perception. However, critics point out that the visual cliff is a better indication of the infant's social referencing and fear of heights than of the infant's perception of depth.

Hearing

During the last two months of pregnancy, as the fetus nestles in its mother's womb, it can hear sounds such as the mother's voice (Kisilevsky & others, 2009). In one study, researchers had 16 women read *The Cat in the Hat* aloud to their fetuses during the last months of pregnancy (DeCasper & Spence, 1986). Then, shortly after their babies were born, the mothers read aloud either *The Cat in the Hat* or a story with a different rhyme and pace, *The King, the Mice and the Cheese* (which had not been read during prenatal development). The infants sucked on a nipple in a different way when the mothers read the two stories, suggesting that the infants recognized the pattern and tone of *The Cat in the Hat*. A recent fMRI study confirmed that the fetus can hear at 33 to 34 weeks into the prenatal period by assessing fetal brain response to auditory stimuli (Jardri & others, 2012).

Newborns are especially sensitive to human speech sounds (Saffran, Werker, & Werner, 2006). Just a few days after birth, newborns will turn toward the sound of a familiar caregiver's voice.

What changes in hearing take place during infancy? They involve perception of a sound's loudness, pitch, and localization. Immediately after birth, infants cannot hear soft sounds quite as well as adults can; a stimulus must be louder for the newborn to hear it (Trehub & others, 1991). By 3 months of age, infants' perception of sounds improves, although some aspects of loudness perception do not reach adult levels until 5 to 10 years of age (Trainor & He, 2013). Infants are also less sensitive to the pitch of a sound than adults are. *Pitch* is the frequency of a sound; a soprano voice sounds high-pitched, a bass voice low-pitched. Infants are less sensitive to low-pitched sounds and are more likely to hear high-pitched sounds (Aslin, Jusczyk, & Pisoni, 1998). By 2 years of age, infants have considerably improved their ability to distinguish sounds with different pitches.

Even newborns can determine the general location from which a sound is coming, but by 6 months they are more proficient at localizing sounds, detecting their origins. The ability to localize sounds continues to improve during the second year (Saffran, Werker, & Werner, 2006).

Touch and Pain

Newborns respond to touch. A touch to the cheek produces a turning of the head; a touch to the lips produces sucking movements. Regular gentle tactile stimulation during prenatal development may have positive developmental outcomes. For example, a recent study found that 3-month-olds who had received regular gentle tactile stimulation as fetuses were more likely to have an easy temperament than their counterparts who had irregular gentle or no tactile stimulation as fetuses (Wang, Hua, & Xu, 2015).

Newborns can also feel pain (Bellini & others, 2016; Witt & others, 2016). The issue of an infant's pain perception often becomes important to parents who give birth to a son and need to consider whether he should be circumcised. An investigation by Megan Gunnar and her colleagues (1987) found that although newborn infant males cry intensely during circumcision, they also display amazing resiliency. Many newly circumcised infants go into a deep sleep not long after the procedure, probably as a coping mechanism. Also, once researchers discovered that newborns feel pain, the practice of operating on newborns without anesthesia began to be reconsidered. Anesthesia is now used in some circumcisions (Morris & others, 2012). And in a recent study, kangaroo care was very effective in reducing neonatal pain, especially indicated by the significantly lower level of crying when the care was instituted after the newborn's blood had been drawn by a heel stick (Seo, Lee, & Ahn, 2016).

Smell

Newborns can differentiate among odors (Doty & Shah, 2008). For example, the expressions on their faces indicate that they like the scents of vanilla and strawberry but do not like the scent of rotten eggs or fish (Steiner, 1979).

It may take time to develop other odor preferences, however. By the time they were 6 days old, breast-fed infants in one study showed a clear preference for smelling their mother's breast pad rather than a clean breast pad (MacFarlane, 1975). When they were 2 days old they did not show this preference, indicating that they require several days of experience to recognize this scent.

Taste

Sensitivity to taste might be present even before birth (Doty & Shah, 2008). In one very early experiment, when saccharin was added to the amniotic fluid of a near-term fetus, swallowing increased (Windle, 1940). In another study, even at only 2 hours of age, babies made different facial expressions when they tasted sweet, sour, and bitter solutions (Rosenstein & Oster, 1988). At about 4 months, infants begin to prefer salty tastes, which as newborns they had found to be aversive (Harris, Thomas, & Booth, 1990).

Intermodal Perception

How do infants put all these stimuli together? Imagine yourself playing basketball or tennis. You are experiencing many visual inputs: the ball coming and going, other players moving around, and so on. However, you are experiencing many auditory inputs as well: the sound of the ball bouncing or being hit, the grunts and groans of the participants, and so on. There is good correspondence between much of the visual and auditory information: When you see the ball bounce, you hear a bouncing sound; when a player stretches to hit a ball, you hear a groan. When you look at and listen to what is going on, you do not experience just the sounds or just the sights; you put all these things together. You experience a unitary episode. This is **intermodal perception,** which involves integrating information from two or more sensory modalities, such as vision and hearing (Bremner & others, 2012). Most perception is intermodal (Bahrick, 2010).

intermodal perception The ability to relate and integrate information from two or more sensory modalities, such as vision and hearing.

Early, exploratory forms of intermodal perception exist even in newborns (Bahrick & Hollich, 2008). For example, newborns turn their eyes and their head toward the sound of a voice or rattle when the sound is maintained for several seconds (Clifton & others, 1981). Intermodal perception becomes sharper with experience in the first year of life (Kirkham & others, 2012). In the first six months, infants have difficulty connecting sensory input from different modes (such as vision and sound), but in the second half of the first year they show an increased ability to make this connection mentally.

Nature, Nurture, and Perceptual Development

Now that we have discussed many aspects of perceptual development, let's explore one of developmental psychology's key issues as it relates to perceptual development: the nature-nurture issue. There has been a longstanding interest in how strongly infants' perception is influenced by nature or nurture (Johnson & Hannon, 2015; Slater & others, 2011). In the field of perceptual development, those who emphasize nature are referred to as *nativists* and those who emphasize learning and experience are called *empiricists*.

In the nativist view, the ability to perceive the world in a competent, organized way is inborn or innate. At the beginning of our discussion of perceptual development, we examined the Gibsons' ecological view because it has played such a pivotal role in guiding research in perceptual development. This approach leans toward a nativist explanation of perceptual development because it holds that perception is direct and evolved over time to allow the detection of size and shape constancy, a three-dimensional world, intermodal perception, and so on early in infancy. However, the Gibsons' view is not entirely nativist because they emphasized that perceptual development involves distinctive features that are detected at different ages (Slater & others, 2011).

The Gibsons' ecological view is quite different from Piaget's constructivist view, which reflects an empiricist approach to explaining perceptual development. According to Piaget, much of perceptual development in infancy must await the development of a sequence of cognitive stages in which infants become able to construct more complex perceptual tasks. Thus, in Piaget's view the ability to perceive size and shape constancy, a three-dimensional world, intermodal perception, and so on develops later in infancy than the Gibsons envision.

The longitudinal research of Daphne Maurer and her colleagues (Lewis & Maurer, 2005, 2009; Maurer & Lewis, 2013; Maurer & others, 1999) has focused on infants born with cataracts—a thickening of the lens of the eye that causes vision to become cloudy, opaque, and distorted and thus severely restricts these infants' ability to experience their visual world. Studying infants whose cataracts were removed at different points in development, they discovered that those whose cataracts were removed and new lenses placed in their eyes in the first several months after birth showed a normal pattern of visual development. However, the longer the delay in removing the cataracts, the more their visual development was impaired. In their research, Maurer and her colleagues (2007) have found that experiencing patterned visual input early in infancy is important for holistic and detailed face processing after infancy. Maurer's research program illustrates how deprivation and experience influence visual development, including an early sensitive period in which visual input is necessary for normal visual development (Maurer & Lewis, 2013).

What roles do nature and nurture play in the infant's perceptual development?
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Today it is clear that an extreme empiricist position on perceptual development is unwarranted. Much of early perception develops from innate (nature) capabilities, and the

basic foundation of many perceptual abilities can be detected in newborns, whereas others unfold through maturation (Bornstein, Arterberry, & Mash, 2011). However, as infants develop, environmental experiences (nurture) refine or calibrate many perceptual functions, and they may be the driving force behind some functions (Johnson & Hannon, 2015). The accumulation of experience with and knowledge about their perceptual world contributes to infants' ability to perceive coherent impressions of people and things (Slater & others, 2011). Thus, a full portrait of perceptual development includes the influence of nature, nurture, and a developing sensitivity to information (Arterberry, 2008).

Perceptual Motor Coupling

A central theme of the ecological approach is the interplay between perception and action. Action can guide perception, and perception can guide action. Only by moving one's eyes, head, hands, and arms and by moving from one location to another can an individual fully experience his or her environment and learn how to adapt to it. Thus, perception and action are coupled (Adolph & Robinson, 2015).

Babies, for example, continually coordinate their movements with perceptual information to learn how to maintain balance, reach for objects in space, and move across various surfaces and terrains (Thelen & Smith, 2006). They are motivated to move by what they perceive. Consider the sight of an attractive toy across the room. In this situation, infants must perceive the current state of their bodies and learn how to use their limbs to reach the toy. Although their movements at first are awkward and uncoordinated, babies soon learn to select patterns that are appropriate for reaching their goals.

Equally important is the other part of the perception-action coupling. That is, action educates perception (Adolph & Berger, 2016). For example, watching an object while exploring it manually helps infants discover its texture, size, and hardness. Moving around in their environment teaches babies about how objects and people look from different perspectives, or whether surfaces will support their weight. In short, infants perceive in order to move and move in order to perceive. Perceptual and motor development do not occur in isolation from each other but instead are coupled.

Cognitive Development

The competent infant not only develops motor and perceptual skills, but also develops cognitive skills. Our coverage of cognitive development in infancy focuses on Piaget's theory and sensorimotor stages as well as on how infants learn, remember, and conceptualize.

Piaget's Theory

Piaget's theory is a general, unifying story of how biology and experience sculpt cognitive development. The Swiss child psychologist Jean Piaget thought that, just as our physical bodies have structures that enable us to adapt to the world, we build mental structures that help us to adapt to the world. *Adaptation* involves adjusting to new environmental demands. Piaget stressed that children actively construct their own cognitive worlds; information is not just poured into their minds from the environment. He sought to discover how children at different points in their development think about the world and how systematic changes in their thinking occur.

Processes of Development

What processes do children use as they construct their knowledge of the world? Piaget developed several concepts to answer this question.

Schemes According to Piaget (1954), as the infant or child seeks to construct an understanding of the world, the developing brain creates **schemes.**

schemes In Piaget's theory, actions or mental representations that organize knowledge.

These are actions or mental representations that organize knowledge. In Piaget's theory, infants create behavioral schemes (physical activities), whereas toddlers and older children create mental schemes (cognitive activities) (Lamb, Bornstein, & Teti, 2002). A baby's schemes are structured by simple actions that can be performed on objects, such as sucking, looking, and grasping. Older children's schemes include strategies and plans for solving problems.

In Piaget's view, what is a scheme? What schemes might this young infant be displaying?

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Assimilation and Accommodation To explain how children use and adapt their schemes, Piaget offered two concepts: assimilation and accommodation. **Assimilation** occurs when children use their existing schemes to deal with new information or experiences. **Accommodation** occurs when children adjust their schemes to account for new information and experiences.

Think about a toddler who has learned the word *car* to identify the family's automobile. The toddler might call all moving vehicles on roads "cars," including motorcycles and trucks; the child has assimilated these objects to his or her existing scheme. But the child soon learns that motorcycles and trucks are not cars and fine-tunes the category to exclude those vehicles. The child has accommodated the scheme.

Organization To make sense out of their world, said Piaget, children cognitively organize their experiences. **Organization,** in Piaget's theory, is the grouping of isolated behaviors and thoughts into a higher-order system. Continual refinement of this organization is an inherent part of development. A child who has only a vague idea about how to use a hammer may also have a vague idea about how to use other tools. After learning how to use each one, she relates these uses to one another, thereby organizing her knowledge.

Equilibration and Stages of Development Assimilation and accommodation always take the child to a higher level, according to Piaget. In trying to understand the world, the child inevitably experiences cognitive conflict, or *disequilibrium.* That is, the child is constantly faced with inconsistencies and counterexamples to his or her existing schemes. For example, if a child believes that pouring water from a short, wide container into a tall, narrow container changes the amount of water in the container, the child might wonder where the "extra" water came from and whether there is actually more water to drink. This puzzle creates disequilibrium; and in Piaget's view the resulting search for equilibrium creates motivation for change. The child assimilates and accommodates, adjusting old schemes, developing new schemes, and organizing and reorganizing the old and new schemes. Eventually the organization is fundamentally different from the old organization; it becomes a new way of thinking.

Equilibration is the name Piaget gave to this mechanism by which children shift from one stage of thought to the next. Equilibration does not, however, happen all at once. There is considerable movement between states of cognitive equilibrium and disequilibrium as assimilation and accommodation work in concert to produce cognitive change.

A result of these processes, according to Piaget, is that individuals go through four stages of development. A different way of understanding the world makes one stage more advanced than another. Cognition is *qualitatively* different in one stage compared with another. In other words, the way children reason at one stage is different from the way they reason at another stage. Here our focus is on Piaget's stage of infant cognitive development.

assimilation Piagetian concept of using existing schemes to deal with new information or experiences.

accommodation Piagetian concept of adjusting schemes to fit new information and experiences.

organization Piaget's concept of grouping isolated behaviors and thoughts into a higher-order, more smoothly functioning cognitive system.

equilibration A mechanism that Piaget proposed to explain how children shift from one stage of thought to the next.

sensorimotor stage The first of Piaget's stages, which lasts from birth to about 2 years of age; during this stage, infants construct an understanding of the world by coordinating sensory experiences with motoric actions.

The Sensorimotor Stage

The **sensorimotor stage** lasts from birth to about age 2. In this stage, infants construct an understanding of the world by coordinating sensory

experiences (such as seeing and hearing) with physical, motor actions—hence the term *sensorimotor.* At the beginning of this stage, newborns have little more than reflexes to work with. At the end of the sensorimotor stage, 2-year-olds can produce complex sensorimotor patterns and use primitive symbols. We first summarize Piaget's descriptions of how infants develop. Later we consider criticisms of his view.

object permanence The Piagetian term for understanding that objects and events continue to exist, even when they cannot directly be seen, heard, or touched.

A-not-B error This term is used to describe the tendency of infants to reach where an object was located earlier rather than where the object was last hidden.

Object Permanence **Object permanence** is the understanding that objects continue to exist even when they cannot be seen, heard, or touched. Acquiring the sense of object permanence is one of the infant's most important accomplishments, according to Piaget.

How could anyone know whether or not an infant had a sense of object permanence? The principal way in which object permanence is studied is by watching an infant's reaction when an interesting object disappears (see Figure 17). If infants search for the object, it is inferred that they know it continues to exist.

Evaluating Piaget's Sensorimotor Stage Piaget opened up a new way of looking at infants with his view that their main task is to coordinate their sensory impressions with their motor activity. However, the infant's cognitive world is not as neatly packaged as Piaget portrayed it, and some of Piaget's explanations for the cause of change are debated. In the past several decades, there have been many research studies on infant development using sophisticated experimental techniques (Gerson & others, 2015; Huang & Spelke, 2015). Much of the new research suggests that Piaget's view of sensorimotor development needs to be modified (Adolph & Berger, 2016; Johnson & Hannon, 2015; Stiles & others, 2015).

Figure 17 Object Permanence
Piaget argued that object permanence is one of infancy's landmark cognitive accomplishments. For this 5-month-old boy, "out of sight" is literally out of mind. The infant looks at the toy monkey (top), but when his view of the toy is blocked (bottom), he does not search for it. Several months later, he will search for the hidden toy monkey, an action reflecting the presence of object permanence.

A-not-B error is the term used to describe the tendency of infants to reach where an object was located earlier rather than where the object was last hidden. Older infants are less likely to make the A-not-B error because their concept of object permanence is more complete.

Researchers have found, however, that the A-not-B error does not show up consistently (Sophian, 1985). The evidence indicates that A-not-B errors are sensitive to the delay between hiding the object at B and the infant's attempt to find it (Diamond, 1985). Thus, the A-not-B error might be due to a failure in memory. Another explanation is that infants tend to repeat a previous motor behavior (Clearfield & others, 2006).

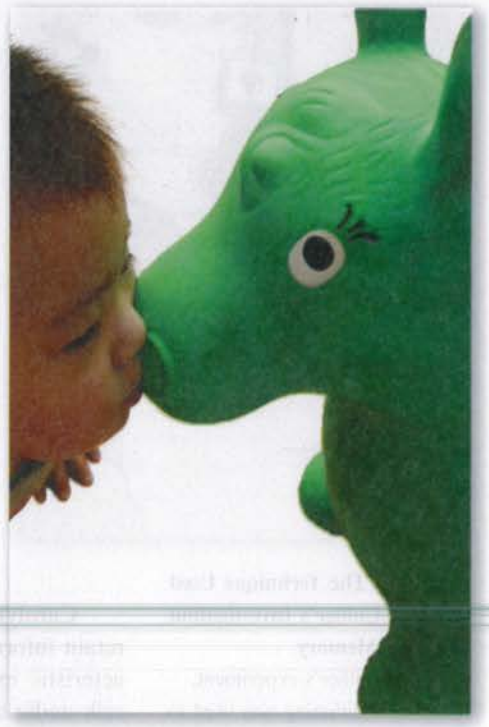
A number of theorists, such as Eleanor Gibson (1989) and Elizabeth Spelke (2004, 2011, 2013), have concluded that infants' perceptual abilities are highly developed very early in life. For example, intermodal perception—the ability to coordinate information from two or more sensory modalities, such as vision and hearing—develops much earlier than Piaget would have predicted (Spelke & Owsley, 1979).

Object permanence also develops earlier than Piaget thought. In his view, object permanence does not develop until approximately 8 to 9 months. However, research by Renée Baillargeon and her colleagues (2004, 2014; Baillargeon & others, 2012) documents that infants as young as 3 to 4 months expect objects to be *substantial* (in the sense that other objects cannot move through them) and *permanent* (in the sense that they continue to exist when they are hidden).

Today researchers believe that infants see objects as bounded, unitary, solid, and separate from their background, possibly at birth or shortly thereafter, but definitely by 3 to 4 months, much earlier than Piaget envisioned. Young infants still have much to learn about objects, but the world appears both stable and orderly to them.

core knowledge approach States that infants are born with domain-specific innate knowledge systems.

In considering the big issue of whether nature or nature plays a more important role in infant development, Elizabeth Spelke (2011, 2013; Huang & Spelke, 2015; Spelke, Bernier, & Snedeker, 2013) comes down clearly on the side of nature. Spelke endorses a **core knowledge approach,** which states that infants are born with domain-specific innate knowledge systems. Among these knowledge systems are those involving space, number sense, object permanence, and language (which we will discuss later in this chapter). Strongly influenced by evolution, the core knowledge domains are theorized to be "prewired" to allow infants to make sense of their world (Coubart & others, 2014). After all, Spelke concludes, how could infants possibly grasp the complex world in which they live if they did not come into the world equipped with core sets of knowledge? In this approach, the innate core knowledge domains form a foundation around which more mature cognitive functioning and learning develop. The core knowledge approach argues that Piaget greatly underestimated the cognitive abilities of infants, especially young infants (Huang & Spelke, 2015).



What are some conclusions that can be reached about infant learning and cognition?

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Recently, researchers also have explored whether preverbal infants might have a built-in, innate sense of morality (Steckler & Hamlin, 2016; Van de Vondervoort & Hamlin, 2016a, b). In this research, infants as young as 4 months of age are more likely to make visually guided reaches toward a puppet who has acted as a helper (such as helping someone get up a hill, assisting in opening a box, or giving a ball back) rather than toward a puppet who has hindered others' efforts to achieve such goals (Hamlin, 2013, 2014).

In criticizing the core knowledge approach, British developmental psychologist Mark Johnson (2008) says that the infants Spelke assesses in her research have already accumulated hundreds, and in some cases even thousands, of hours of experience in grasping what the world is about, which gives considerable room for the environment's role in the development of infant cognition (Highfield, 2008). According to Johnson (2008), infants likely come into the world with "soft biases to perceive and attend to different aspects of the environment, and to learn about the world in particular ways." A major criticism is that nativists completely neglect the infant's social immersion in the world and instead focus only on what happens inside the infant's head apart from the environment (Nelson, 2013).

In sum, many researchers conclude that Piaget wasn't specific enough about how infants learn about their world and that infants, especially young infants, are more competent than Piaget thought (Adolph & Berger, 2016; Johnson & Hannon, 2015; Needham, 2016). As these researchers have examined the specific ways that infants learn, the field of infant cognition has become very specialized. There are many researchers working on different questions, with no general theory emerging that can connect all of the different findings. Their theories often are local theories, focused on specific research questions, rather than grand theories like Piaget's (Kuhn, 1998). Among the unifying themes in the study of infant cognition are seeking to understand more precisely how developmental changes in cognition take place, considering the big issue of nature and nurture, and examining the brain's role in cognitive development (Aslin, 2012; Gliga & others, 2016; Perry & others, 2016). Recall that exploring connections between brain, cognition, and development is the focus of the recently emerging field of *developmental cognitive neuroscience* (Anzures & others, 2016; Berens & Nelson, 2015; de Haan & Johnson, 2016; Smith & others, 2016).

Learning, Remembering, and Conceptualizing

Earlier we described the behavioral and social cognitive theories, as well as information-processing theory. These theories emphasize that cognitive development

Figure 18 The Technique Used in Rovee-Collier's Investigation of Infant Memory

In Rovee-Collier's experiment, operant conditioning was used to demonstrate that infants as young as 2½ months of age can retain information from the experience of being conditioned. *What did infants recall in Rovee-Collier's experiment?*

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does not unfold in a stage-like process as Piaget proposed, but rather advances more gradually (Diamond, 2013). In this section we explore what researchers using these approaches can tell us about how infants learn, remember, and conceptualize.

Conditioning

We have discussed Skinner's theory of operant conditioning, in which the consequences of a behavior influence the probability of the behavior's recurrence. Infants can learn through operant conditioning: If an infant's behavior is followed by a rewarding stimulus, the behavior is likely to recur.

Operant conditioning has been especially helpful to researchers in their efforts to determine what infants perceive (Rovee-Collier & Barr, 2010). For example, infants will suck faster on a nipple when the sucking behavior is followed by a visual display, music, or a human voice (Rovee-Collier, 2008).

Carolyn Rovee-Collier (1987) has demonstrated that infants can retain information from the experience of being conditioned. In a characteristic experiment, Rovee-Collier places a 2½-month-old baby in a crib under an elaborate mobile (see Figure 18). She then ties one end of a ribbon to the baby's ankle and the other end to the mobile. Subsequently, she observes that the baby kicks and makes the mobile move. The movement of the mobile is the reinforcing stimulus (which increases the baby's kicking behavior) in this experiment. Weeks later, the baby is returned to the crib, but its foot is not tied to the mobile. The baby kicks, suggesting that it has retained the information that if it kicks a leg, the mobile will move.

Attention

Attention, the focusing of mental resources on select information, improves cognitive processing on many tasks (Ristic & Enns, 2015; Reynolds & Romano, 2016; Rothbart & Posner, 2015). Even newborns can detect a contour and fix their attention on it. Older infants scan patterns more thoroughly. By 4 months, infants can selectively attend to an object. A longitudinal study found that 5-month-olds who were more efficient in processing information quickly had better higher-level cognitive functioning in the preschool years (Cuevas & Bell, 2014). Another recent study examined 7- and 8-month-old infants' visual attention to sequences of events that varied in complexity (Kidd, Piantadosi, & Aslin, 2012). The infants tended to look away from events that were overly simple or complex, preferring instead to attend to events of intermediate complexity.

Closely linked with attention are the processes of habituation and dishabituation, which we discussed earlier in this chapter (Columbo & Salley, 2015). Infants' attention is strongly governed by novelty and habituation. When an object becomes familiar, attention becomes shorter, making infants more vulnerable to distraction (Kavsek, 2013).

Another aspect of attention that plays an important role in infant development is **joint attention,** in which individuals focus on the same object or event (Hoehl & Striano, 2015; Yu & Smith, 2016). Joint attention requires (1) the ability to track each other's behavior, such as following someone's gaze; (2) one person directing another's attention; and (3) reciprocal interaction. Early in infancy, joint attention usually involves a caregiver pointing or using words to direct an infant's attention. Emerging forms of joint attention occur at about 7 to 8 months, but it is not until 10 to 11 months that joint attention skills are frequently observed (Meltzoff & Brooks, 2009). By their first birthday, infants have begun to direct adults' attention to objects that capture their interest (Heimann & others, 2006). And a

attention The focusing of mental resources on select information.

joint attention Process that occurs when (1) individuals focus on the same object and track each other's behavior, (2) one individual directs another's attention, and (3) reciprocal interaction takes place.

recent study found that problems in joint attention as early as 8 months of age were linked to a child having been diagnosed with autism by 7 years of age (Veness & others, 2014).

Joint attention plays important roles in many aspects of infant development and considerably increases infants' ability to learn from other people (Abels & Hutman, 2015; Brooks & Meltzoff, 2014; Yu & Smith, 2016). Nowhere is this more apparent than in observations of interchanges between caregivers and infants as infants are learning language (Igualada, Bosch, & Prieto, 2015; Tomasello, 2011, 2014). When caregivers and infants frequently engage in joint attention, infants say their first word earlier and develop a larger vocabulary (Beuker & others, 2013; Flom & Pick, 2003; Mastin & Vogt, 2016). Joint attention skills in infancy also are associated with the development of self-regulation later in childhood. For example, one study revealed that responding to joint attention at 12 months of age was linked to self-regulation skills at 3 years of age that involved delaying gratification for an attractive object (Van Hecke & others, 2012). In another study, infants who initiated joint attention at 14 months of age had higher executive function at 18 months of age (Miller & Marcovitch, 2015).

How Would You...?

As a **human development and family studies professional,** what strategies would you recommend to parents who are want to foster their infant's development of attention?

Imitation

Infant development researcher Andrew Meltzoff (2004, 2007, 2011) has conducted numerous studies of infants' imitative abilities. He sees infants' imitative abilities as biologically based, because infants can imitate a facial expression within the first few days after birth. He also emphasizes that the infant's imitative abilities do not resemble a hardwired response but rather involve flexibility and adaptability. In Meltzoff's observations of infants during the first 72 hours of life, the infants gradually displayed more complete imitation of an adult's facial expression, such as protruding the tongue or opening the mouth wide (see Figure 19).

Meltzoff (2007, 2011) concludes that infants don't blindly imitate everything they see and often make creative errors. He also argues that beginning at birth there is an interplay between learning by observing and learning by doing (Piaget emphasized learning by doing).

Not all experts on infant development accept Meltzoff's conclusion that newborns are capable of imitation. Some say that these babies were engaging in little more than automatic responses to a stimulus.

Meltzoff (2005, 2011; Meltzoff & Williamson, 2013) has also studied **deferred imitation,** which occurs after a time delay of hours or days. Piaget held that deferred imitation does not occur until about 18 months. Meltzoff's research suggested that it occurs much earlier. In one study, Meltzoff (1988) demonstrated that 9-month-old infants could imitate actions—such as pushing a recessed button in a box, which produced a beeping sound—that they had seen performed 24 hours earlier.

Figure 19 Infant Imitation
Infant development researcher Andrew Meltzoff protrudes his tongue in an attempt to get the infant to imitate his behavior. *How do Meltzoff's findings about imitation compare with Piaget's descriptions of infants' abilities?*
© Dr. Andrew Meltzoff

Memory

Meltzoff's studies of deferred imitation suggest that infants have another important cognitive ability: **memory,** which involves the retention of information over time. Sometimes information is retained only for a few seconds, and at other times it is retained for a lifetime. What can infants remember, and when?

Some researchers, such as Rovee-Collier (2008), have concluded that infants as young as 2 to 6 months can remember some experiences through 1½ to 2 years of age.

deferred imitation Imitation that occurs after a delay of hours or days.

memory A central feature of cognitive development, pertaining to all situations in which an individual retains information over time.

However, critics such as Jean Mandler (2000), a leading expert on infant cognition, argue that the infants in Rovee-Collier's experiments are displaying only implicit memory.

Implicit memory refers to memory without conscious recollection—memories of skills and routine procedures that are performed automatically. In contrast, **explicit memory** refers to conscious memory of facts and experiences.

implicit memory Memory without conscious recollection; involves skills and routine procedures that are automatically performed.

explicit memory Memory of facts and experiences that individuals consciously know and can state.

concepts Cognitive groupings of similar objects, events, people, or ideas.

When people think about memory, they are usually referring to explicit memory. Most researchers find that babies do not show explicit memory until the second half of the first year (Bauer, 2013; Bauer & Larkina, 2016). Explicit memory improves substantially during the second year of life (Bauer, 2013; Bauer & Leventon, 2015). In one longitudinal study, infants were assessed several times during their second year (Bauer & others, 2000). The older infants showed more accurate memory and required fewer prompts to demonstrate their memory than did younger infants. Figure 20 summarizes how long infants of different ages can remember information (Bauer, 2009). As indicated, researchers have documented that 6-month-olds can remember information for 24 hours but 20-month-old infants can remember information they encountered 12 months earlier.

Let's examine another aspect of memory. Do you remember your third birthday party? Probably not. Most adults can remember little, if anything, from the first 3 years of their life. This is called *infantile* or *childhood amnesia.* The few memories that adults are able to report of their life at age 2 or 3 are at best very sketchy (Fivush, 2011; Riggins, 2012).

Patricia Bauer and her colleagues (Bauer, 2015; Bauer & Larkina, 2016; Pathman, Doydum, & Bauer, 2013) have been recently studying when infantile amnesia begins to occur. In one study, children's memory for events that occurred at 3 years of age were periodically assessed through age 9 (Bauer & Larkina, 2014). By 8 to 9 years of age, children's memory of events that occurred at 3 years of age began to significantly fade away. In Bauer's (2015) view, the processes that account for these developmental changes are early, gradual development of the ability to form, retain, and later retrieve memories of personally relevant past events followed by an accelerated rate of forgetting in childhood.

What is the cause of infantile amnesia? One reason older children and adults have difficulty recalling events from their infant and early childhood years is that during these years the prefrontal lobes of the brain are immature, and this area of the brain is believed to play an important role in storing memories of events (Bauer, 2015).

In sum, most of young infants' conscious memories appear to be rather fragile and short-lived, although their implicit memory of perceptual-motor actions can be substantial (Bauer, 2015; Bauer & Fivush, 2014). By the end of the second year, long-term memory is more substantial and reliable (Bauer, 2015).

Age Group	Length of Delay
6-month-olds	24 hours
9-month-olds	1 month
10–11-month-olds	3 months
13–14-month-olds	4–6 months
20-month-olds	12 months

Figure 20 Age-Related Changes in the Length of Time Over Which Memory Occurs

Concept Formation and Categorization

Along with attention, imitation, and memory, concepts are a key aspect of infants' cognitive development (Quinn, 2016). **Concepts** are cognitive groupings of similar objects, events, people, or ideas. Without concepts, you would see each object and event as unique; you would not be able to make any generalizations.

Do infants have concepts? Yes, they do, although we do not know just how early concept formation begins (Quinn & Bhatt, 2015). Using habituation experiments like those described earlier in the chapter, some researchers have found that infants as young as 3 months of age can group together objects with similar appearances (Quinn & others, 2013). This research

capitalizes on the knowledge that infants are more likely to look at a novel object than at a familiar one.

Jean Mandler (2009) argues that these early categorizations are best described as *perceptual categorization*. That is, the categorizations are based on similar perceptual features of objects, such as size, color, and movement, as well as parts of objects, such as legs for animals. Mandler (2004) concludes that it is not until about 7 to 9 months that infants form *conceptual* categories rather than just making perceptual discriminations between different categories. In one study of 9- to 11-month-olds, infants classified birds as animals and airplanes as vehicles even though the objects were perceptually similar—airplanes and birds with their wings spread (Mandler & McDonough, 1993) (see Figure 21).

Figure 21 Categorization in 9- to 11-Month-Olds
These are the stimuli used in the study that indicated 9- to 11-month-old infants categorized birds as animals and airplanes as vehicles even though the objects were perceptually similar (Mandler & McDonough, 1993).

In addition to infants categorizing items on the basis of external, perceptual features such as shape, color, and parts, they also may categorize items on the basis of prototypes, or averages, that they extract from the structural regularities of items (Quinn & Bhatt, 2015).

Further advances in categorization occur in the second year of life (Booth, 2006). Many infants' "first concepts are broad and global in nature, such as 'animal' or 'indoor thing.' Gradually, over the first two years these broad concepts become more differentiated into concepts such as 'land animal,' then 'dog,' or to 'furniture,' then 'chair'" (Mandler, 2009, p. 1).

Learning to put things into the correct categories—what makes something one kind of thing rather than another kind of thing, such as what makes a bird a bird, or a fish a fish—is an important aspect of learning (Quinn, 2016; Rakison & Lawson, 2013). As infant development researcher Alison Gopnik (2010, p. 159) pointed out, "If you can sort the world into the right categories—put things in the right boxes—then you've got a big advance on understanding the world."

How Would You...?

As an **educator,** how would you talk with parents about the importance of concept development in their infants?

In sum, the infant's advances in processing information—through attention, imitation, memory, and concept formation—is much richer, more gradual and less stage-like, and occurs earlier than was envisioned by earlier theorists (Bauer, 2015; Quinn, 2016). As leading infant researcher Jean Mandler (2004) concluded, "The human infant shows a remarkable degree of learning power and complexity in what is being learned and in the way it is represented" (p. 304).

Language Development

In 1799, villagers in the French town of Aveyron observed a nude boy running through the woods and captured him. Known as the Wild Boy of Aveyron, he was judged to be about 11 years old and believed to have lived in the woods alone for six years (Lane, 1976). When found, he made no effort to communicate, and he never did learn to communicate effectively.

Sadly, a modern-day wild child was discovered in Los Angeles in 1970. Despite intensive intervention, the child, named Genie by researchers, never acquired more than a primitive form of language. Both of these cases—the Wild Boy of Aveyron and Genie—raise questions about the biological and environmental determinants of language, topics that we also examine later in the chapter. First, though, we need to define language.

Defining Language

Language is a form of communication—whether spoken, written, or signed—that is based on a system of symbols. Language consists of the words used by a community and the rules for varying and combining them. All human languages have some common characteristics, such as organizational rules and infinite generativity (Hoff, 2015; MacWhinney, 2015). Rules describe the way the language works. **Infinite generativity** is the ability to produce an endless number of meaningful sentences using a finite set of words and rules.

language A form of communication, whether spoken, written, or signed, that is based on a system of symbols. Language consists of the words used by a community and the rules for varying and combining them.

infinite generativity The ability to produce an endless number of meaningful sentences using a finite set of words and rules.

How Language Develops

Whatever language they learn, infants all over the world follow a similar path in language development. What are some key milestones in this development?

Babbling and Gestures

Babies actively produce sounds from birth onward. The effect of these early communications is to attract attention (Dimitrova, Moro, & Mohr, 2015; Masapolio, Polka, & Menard, 2016). Babies' sounds and gestures go through the following sequence during the first year:

- *Crying.* Babies cry even at birth. Crying can signal distress, but as we will discuss later, there are different types of cries that signal different things.
- *Cooing.* Babies first coo at about 2 to 4 months. Coos are gurgling sounds that are made in the back of the throat and usually express pleasure during interaction with the caregiver.
- *Babbling.* In the middle of the first year, babies babble—that is, they produce strings of consonant-vowel combinations such as "ba, ba, ba, ba."
- *Gestures.* Infants start using gestures, such as showing and pointing, at about 8 to 12 months (Goldin-Meadow, 2015, 2017). They may wave bye-bye, nod to mean "yes," and show an empty cup to ask for more milk. Lack of pointing is a significant indicator of problems in the infant's communication system (Cartmill & Goldin-Meadow, 2015; Cooperrider & Goldin-Meadow, 2017; Demir & Goldin-Meadow, 2015).

Recognizing Language Sounds

Long before they begin to learn words, infants can make fine distinctions among the sounds of a language (Kuhl & Damasio, 2012). In Patricia Kuhl's (2000, 2009, 2011, 2012, 2015) research, *phonemes* (the basic sound units of a language) from languages all over the world are piped through a speaker for infants to hear (see Figure 22). A box with a toy bear in it is placed where the infant can see it. A string of identical syllables is played; then the syllables are changed (for example, *ba ba ba ba,* and then *pa pa pa pa*). If the infant turns its head when the syllables change, the box lights up and the bear dances and drums, rewarding the infant for noticing the change.

Kuhl's research has demonstrated that from birth up to about 6 months, infants are "citizens of the world": They can tell when sounds change most of the time no matter what language the syllables come from. But over the next six months, infants get even better at perceiving

Figure 22 From Universal Linguist to Language-Specific Listener
In Patricia Kuhl's research laboratory babies listen to tape-recorded voices that repeat syllables. When the sounds of the syllables change, the babies quickly learn to look at the bear. Using this technique, Kuhl has demonstrated that babies are universal linguists until about 6 months of age, but in the next six months they become language-specific listeners. *Does Kuhl's research give support to the view that either "nature" or "nurture" is the source of language acquisition?*

changes in sounds from their "own" language, the one their parents speak, and gradually lose the ability to recognize differences that are not important in their own language (Kuhl, 2009, 2011, 2012, 2015). Recently, Kuhl (2015) has found that the age at which a baby's brain is most open to learning the sounds of a native language begins at 6 months for vowels and at 9 months for consonants.

Also, in the second half of their first year, infants begin to segment the continuous stream of speech they encounter into words (Stahl & others, 2014). Initially, they likely rely on statistical information such as the co-occurrence patterns of phonemes and syllables, which allows them to extract potential word forms. For example, discovering that the sequence *br* occurs more often at the beginning of words while *nt* is more common at the end of words helps infants detect word boundaries. And as infants extract an increasing number of potential word forms from the speech stream they hear, they begin to associate these with concrete, perceptually available objects in their world (Zamuner, Fais, & Werker, 2014).

First Words

Infants understand words before they can produce or speak them (Tamis-LeMonda & Bornstein, 2015). For example, as early as 5 months many infants recognize their name. However, the infant's first spoken word, a milestone eagerly anticipated by every parent, usually doesn't occur until 10 to 15 months of age and happens at an average of about 13 months. Yet long before babies say their first words, they have been communicating with their parents, often by gesturing and using their own special sounds. The appearance of first words is a continuation of this communication process.

A child's first words include those that name important people (*dada*), familiar animals (*kitty*), vehicles (*car*), toys (*ball*), food (*milk*), body parts (*eye*), clothes (*hat*), household items (*clock*), and greeting terms (*bye*). Children often express various intentions with their single words, so that "cookie" might mean, "That's a cookie" or "I want a cookie." Nouns are easier to learn because the majority of words in this class are more perceptually accessible than other types of words (Parish-Morris, Golinkoff, & Hirsh-Pasek, 2013). Think how the noun "car" is so much more concrete and imaginable than the verb "goes," making the word "car" much easier to acquire than the word "goes."

As indicated earlier, children understand their first words earlier than they speak them. On average, infants understand about 50 words at the age of 13 months, but they can't say that many words until about 18 months. Thus, in infancy *receptive vocabulary* (words the child understands) considerably exceeds *spoken vocabulary* (words the child uses). A recent study revealed that 6-month-olds understand words that refer to body parts, such as "hand" and "feet," but of course, they cannot yet speak these words (Tincoff & Jusczyk, 2012).

The infant's spoken vocabulary rapidly increases once the first word is spoken (Waxman & Goswami, 2012). Whereas the average 18-month-old can speak about 50 words, a 2-year-old can speak about 200 words. This rapid increase in vocabulary that begins at approximately 18 months is called the *vocabulary spurt* (Bloom, Lifter, & Broughton, 1985).

Like the timing of a child's first word, the timing of the vocabulary spurt varies (Dale & Goodman, 2004). Figure 23 shows the range for these two language milestones in 14 children. On average, these children said their first word at 13 months and had a vocabulary spurt at 19 months. However, the ages for the first word of individual children varied from 10 to 17 months and, for their vocabulary spurt, from 13 to 25 months.

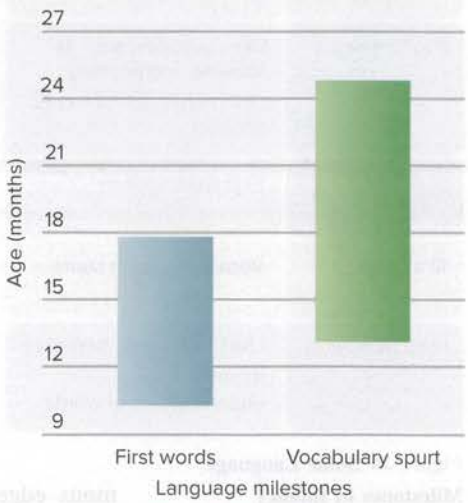


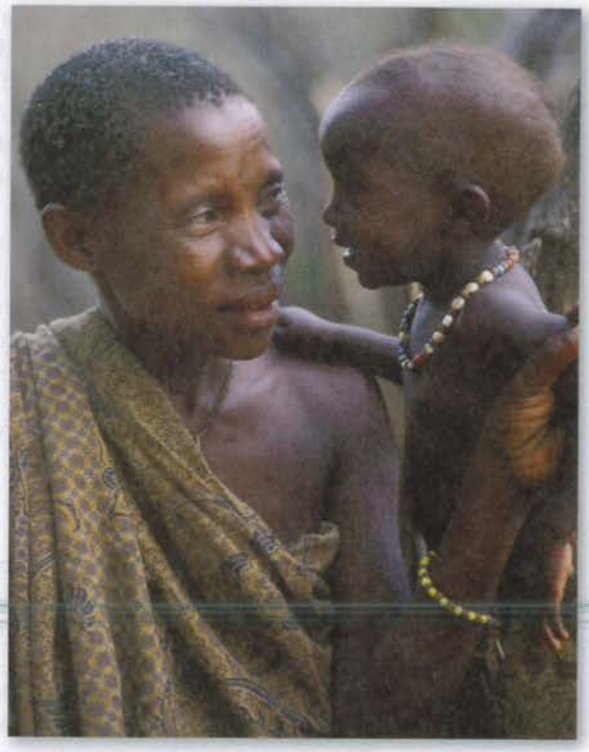
Figure 23 Variation in Language Milestones. *What are some possible explanations for variations in the timing of these milestones?*

Does early vocabulary development predict later language development? A recent study found that infant vocabulary development at 16 to 24 months of age was linked to vocabulary, phonological awareness, reading accuracy, and reading comprehension five years later (Duff & others, 2015).

Two-Word Utterances

By the time children are 18 to 24 months of age, they usually produce two-word utterances. To convey meaning with just two words, the child relies heavily on gesture, tone, and context. The wealth of meaning children can communicate with a two-word utterance includes the following (Slobin, 1972): identification—"See doggie"; location—"Book there"; repetition—"More milk"; negation—"Not wolf"; possession—"My candy"; attribution—"Big car"; and question—"Where ball?" These examples are from children whose first language is English, German, Russian, Finnish, Turkish, or Samoan.

Notice that two-word utterances omit many parts of speech and are remarkably succinct. In fact, in every language a child's first combinations of words have this economical quality; they are telegraphic. **Telegraphic speech** is the use of short, precise words without grammatical markers such as articles, auxiliary verbs, and other connectives. Telegraphic speech is not limited to two words; "Mommy give ice cream" and "Mommy give Tommy ice cream" are also examples of telegraphic speech.



Around the world, most young children learn to speak in two-word utterances at about 18 to 24 months of age. *What are some examples of these two-word utterances?*

Typical Age	Language Milestones
Birth	Crying
2 to 4 months	Cooing begins
5 months	Understands first word
6 months	Babbling begins
7 to 11 months	Change from universal linguist to language-specific listener
8 to 12 months	Uses gestures, such as showing and pointing Comprehension of words appears
13 months	First word spoken
18 months	Vocabulary spurt starts
18 to 24 months	Uses two-word utterances Rapid expansion of understanding of words

Figure 24 Some Language Milestones in Infancy
Despite substantial variations in the language input received by infants, around the world they follow a similar path in learning to speak.

Biological and Environmental Influences

We have discussed a number of language milestones in infancy; Figure 24 summarizes the ages at which infants typically reach these milestones. But what makes this amazing development possible? Everyone who uses language in some way "knows" its rules and has the ability to create an infinite number of words and sentences. Where does this knowledge come from? Is it the product of biology, or is language learned and influenced by experiences?

Biological Influences

The ability to speak and understand language requires a certain vocal apparatus as well as a nervous system with specific capabilities. The nervous system and vocal apparatus of humans' predecessors changed over hundreds of thousands, or millions, of years. With advances in the nervous system and vocal structures, *Homo sapiens* went beyond the grunting and shrieking of other animals to develop speech (Lieberman, 2016). Although estimates vary, many experts believe that humans acquired language about 100,000 years ago, which in evolutionary time represents a very recent acquisition. It gave humans an enormous edge over other animals and increased the chances of human survival (McMurray, 2016; Pinker, 2015).

Some language scholars view the remarkable similarities in how children acquire language all over the world as strong evidence that language has a biological basis. There is evidence that particular regions of the brain are

telegraphic speech The use of short and precise words without grammatical markers such as articles, auxiliary verbs, and other connectives.

predisposed to be used for language (Dubois & others, 2016; Roehrich-Gascon, Small, & Tremblay, 2015). Two regions involved in language were first discovered in studies of brain-damaged individuals: *Broca's area,* an area in the left frontal lobe of the brain that is involved in producing words; and *Wernicke's area,* a region of the brain's left hemisphere that is involved in language comprehension (see Figure 25). Damage to either of these areas produces types of *aphasia,* a loss or impairment of language processing. Individuals with damage to Broca's area have difficulty producing speech but can comprehend what others say; those with damage to Wernicke's area have poor comprehension and often produce fluent but nonsensical speech.

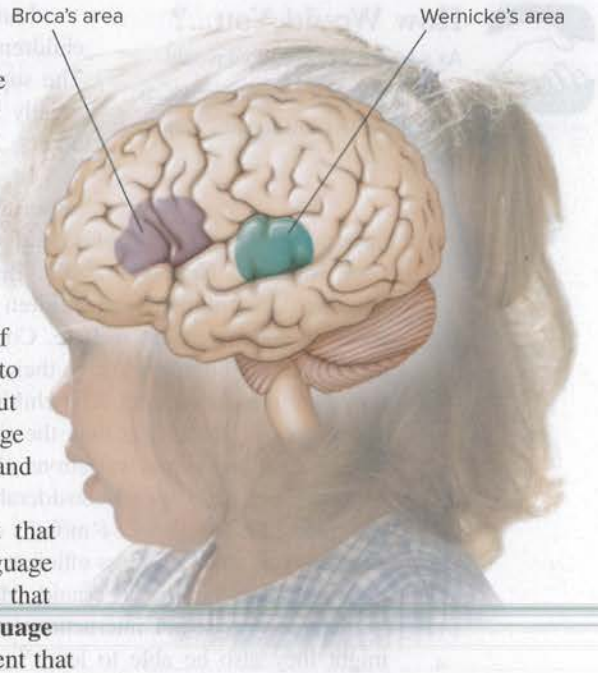


Figure 25 Broca's Area and Wernicke's Area
Broca's area is located in the frontal lobe of the brain's left hemisphere, and it is involved in the control of speech. Wernicke's area is a portion of the left hemisphere's temporal lobe that is involved in understanding language. *How does the role of these areas of the brain relate to lateralization?*

Linguist Noam Chomsky (1957) proposed that humans are biologically "prewired" to learn language at a certain time and in a certain way. He said that children are born into the world with a **language acquisition device (LAD),** a biological endowment that enables the child to detect the various features and rules of language. Children are prepared by nature with the ability to detect the sounds of language, for example, and follow linguistic rules such as those governing how to form plurals and ask questions.

Chomsky's LAD is a theoretical construct, not a physical part of the brain. Is there evidence for the existence of a LAD? Supporters of the LAD concept cite the uniformity of language milestones across languages and cultures, evidence that children create language even in the absence of well-formed input, and the importance of language's biological underpinnings. But as we will see, critics argue that even if infants have something like a LAD, it cannot explain the whole process of language acquisition.

Environmental Influences

Decades ago, behaviorists opposed Chomsky's hypothesis and argued that language represents nothing more than chains of responses acquired through reinforcement (Skinner, 1957). A baby happens to babble "Ma-ma"; Mama rewards the baby with hugs and smiles; the baby says "Mama" more and more frequently. Bit by bit, said the behaviorists, the baby's language is built up in this way. According to behaviorists, language is a complex, learned skill, much like playing the piano or dancing.

The behavioral view of language learning has problems. First, it does not explain how people create novel sentences—sentences they have never heard or spoken before. Second, it does not account for how children learn the syntax of their native language even if they are not reinforced for doing so. Social psychologist Roger Brown (1973) spent long hours observing parents and their young children. He found that parents did not directly or explicitly reward or correct the syntax of most children's utterances. That is, parents did not say "good," "correct," "right," "wrong," and so on. Parents also did not offer direct corrections such as "You should say 'two shoes,' not 'two shoe.'" However, as we will see shortly, many parents do expand on their young children's grammatically incorrect utterances and recast many of those that contain grammatical errors.

The behavioral view is no longer considered a viable explanation of how children acquire language. But a great deal of research describes ways in which children's environmental experiences influence their language skills (Houston & others, 2016). Many language experts argue that a child's experiences, the particular language to be learned, and the context in which learning takes place can strongly influence language acquisition (Bornstein & others, 2015; Pace & others, 2016).

language acquisition device (LAD) Chomsky's term that describes a biological endowment enabling the child to detect the features and rules of language, including phonology, syntax, and semantics.

How Would You...?

As a **social worker,** how would you intervene in a family in which a child has lived in social isolation for years?

Language is not learned in a social vacuum. Most children are bathed in language from a very early age. The support and involvement of caregivers and teachers greatly facilitate a child's language learning (Houston & others, 2016; Pace & others, 2016).

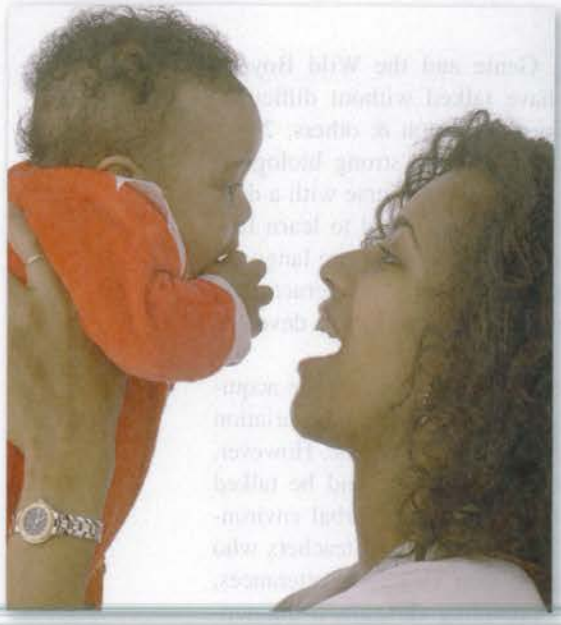
In particular, researchers have documented the important effect that early speech input and poverty can have on the development of a child's language skills (Hoff, 2015; NICHD Early Child Care Research Network, 2005). Betty Hart and Todd Risley (1995) observed the language environments of children whose parents were professionals and children whose parents were on welfare. Compared with the professional parents, the parents on welfare talked much less to their young children, talked less about past events, and provided less elaboration. The children of the professional parents had a much larger vocabulary at 36 months than the children of the welfare parents did. Keep in mind, though, that individual variations characterize language development and that some welfare parents do spend considerable time talking to their children. A recent study also found that at 18 to 24 months of age, infants in low-SES families already had a smaller vocabulary and less efficient language processing than their infant counterparts in middle-SES families (Fernald, Marchman, & Weisleder, 2013).

Given that social interaction is critical for infants to learn language effectively, might they also be able to learn language effectively through television and videos? Researchers have found that infants and young children cannot effectively learn language (phonology or words) from television or videos (Kuhl, 2007; Roseberry & others, 2009). A recent study of toddlers found that frequent viewing of television increased the risk of delayed language development (Lin & others, 2015). Thus, just hearing language is not enough even when infants seemingly are fully engaged in the experience. However, a recent study revealed that Skype provides some improvement in child language learning over videos and TV (Roseberry & others, 2014), and older children can use information provided from television in their language development.

One intriguing component of the young child's linguistic environment is **child-directed speech** (also referred to as "parentese"), which is language spoken in a higher-than-usual pitch, slower tempo, and exaggerated intonation, with simple words and sentences (Golinkoff & others, 2015; Houston & others, 2016). It is hard for most adults to use child-directed speech when not in the presence of a baby. As soon as adults start talking to a baby, though, they often shift into child-directed speech. Much of this is automatic and something most parents are not aware they are doing. Even 4-year-olds speak in simpler ways to 2-year-olds than to their 4-year-old friends. Child-directed speech has the important function of capturing the infant's attention and maintaining communication (Ratner, 2013). A recent study found that child-directed speech in a one-to-one social context at 11 to 14 months of age was linked to greater word production at 2 years of age than standard speech and speech in a group setting (Ramirez-Esparza, Garcia-Sierra, & Kuhl, 2014). Another recent study of low-SES Spanish-speaking families revealed that infants who experienced more child-directed speech were better at processing words in real time and had larger vocabularies at 2 years of age (Weisleder & Fernald, 2013).

Adults often use strategies other than child-directed speech to enhance the child's acquisition of language, including recasting, expanding, and labeling. *Recasting* is rephrasing something the child has said, perhaps turning it into a question or restating the child's immature utterance in the form of a fully grammatical sentence. For example, if the child says, "The dog was barking," the adult can respond by asking, "When was the dog barking?" Effective recasting lets the child indicate an interest and then elaborates on that interest. *Expanding* is restating, in a linguistically sophisticated form, what a child has said. For example, a child says, "Doggie eat," and the parent replies, "Yes, the doggie is eating." *Labeling* is identifying the names of objects. Young children are forever being asked to identify the names of objects. Roger Brown (1958) called this "the original word game" and claimed that much of a child's early vocabulary learning is motivated by this adult pressure to identify the words associated with objects.

child-directed speech Also called parentese, language spoken in a higher pitch, slower tempo, and exaggerated intonation than normal with simple words and sentences.



Parents should begin talking to their babies at the start. The best language teaching occurs when the talking is begun before the infant becomes capable of intelligible speech. *What are some other guidelines for parents to follow to help their infants and toddlers develop their language skills?*

How Would You...?

As a **human development and family studies professional,** how would you encourage parents to talk with their infants and toddlers?

Parents use these strategies naturally and in meaningful conversations. Parents do not (and should not) use any deliberate method to teach their children to talk, even with children who are slow in learning language. Children usually benefit when parents guide their discovery of language rather than overloading them; "following in order to lead" helps a child learn language. If children are not ready to take in some information, they are likely to indicate this, perhaps by turning away. Thus, giving the child more information is not always better.

Infants, toddlers, and young children benefit when adults read books to and with them, a process called shared reading (Hirsh-Pasek & Golinkoff, 2014). In one study, reading daily to children at 14 to 24 months was positively related to the children's language and cognitive development at 36 months (Raikes & others, 2006).

Michael Tomasello (2003, 2006, 2011, 2014) stresses that young children are intensely interested in their social world and that early in their development they can understand the intentions of other people. He emphasizes that children learn language in specific contexts. For example, when a toddler and a father are jointly focused on a book, the father might say, "See the birdie." In this case, even a toddler understands that the father intends to name something and knows to look in the direction of the pointing. Through this kind of joint attention, early in their development children are able to use their social skills to acquire language (Mastin & Vogt, 2016; Tomasello, 2014). One study revealed that joint attention at 12 and 18 months predicted language skills at 24 months of age (Mundy & others, 2007).

What are some effective ways that parents can facilitate their children's language development? They include the following strategies (Baron, 1992; Galinsky, 2010):

- *Be an active conversational partner.* Initiate conversation with the baby.
- *Talk in a slowed-down pace and don't worry about how you sound to other adults when you talk to your baby.* Talking in a slowed-down pace will help your baby detect words in the sea of sounds they experience.
- *Use parent-look and parent-gesture, and name what you are looking at.* When you want your child to pay attention to something, look at it and point to it. Then name it—for example, by saying "Look, Alex, it's an airplane."
- *When you talk with infants and toddlers, be simple, concrete, and repetitive.* Don't try to talk to them in abstract, high-level ways and think you have to say something new or different all of the time. Using familiar words often will help them remember the words.
- *Play games.* Use word games like peek-a-boo and pat-a-cake to help infants learn words.
- *Remember to listen.* Since toddlers' speech is often slow and laborious, parents are often tempted to supply words and thoughts for them. Be patient and let toddlers express themselves.
- *Expand and elaborate language abilities and horizons with infants and toddlers.* Ask questions that encourage answers other than "Yes" and "No." Actively repeat, expand, and recast the utterances. Your toddler might say, "Dada." You could follow with, "Where's Dada?," and then you might continue, "Let's go find him."

An Interactionist View

If language acquisition depended only on biology, Genie and the Wild Boy of Aveyron (discussed earlier in the chapter) should have talked without difficulty. A child's experiences do influence language acquisition (Houston & others, 2016; Pace & others, 2016). But we have seen that language also has strong biological foundations (Dubois & others, 2016); no matter how much you converse with a dog, it won't learn to talk. Unlike dogs, children are biologically equipped to learn language (McMurray, 2016; Pinker, 2015). Children all over the world acquire language milestones at about the same time and in about the same order. An interactionist view emphasizes that both biology and experience contribute to language development (Hoff, 2015; Tomasello, 2014).

This interaction of biology and experience can be seen in variations in the acquisition of language. Children vary in their ability to acquire language, and this variation cannot be completely explained by differences in environmental input alone. However, virtually every child benefits enormously from opportunities to talk and be talked with. Children whose parents and teachers provide them with a rich verbal environment show many positive outcomes (Beaty & Pratt, 2015). Parents and teachers who pay attention to what children are trying to say, expand their children's utterances, read to them, and label things in the environment, are providing valuable, if unintentional, benefits (Hirsh-Pasek & Golinkoff, 2014).

Summary

Physical Growth and Development in Infancy

- Most development follows cephalocaudal and proximodistal patterns.
- Physical growth is rapid in the first year, but the rate of growth slows in the second year.
- Dramatic changes characterize the brain's development in the first two years. The neuroconstructivist view is an increasingly popular view of the brain's development.
- Newborns usually sleep 16 to 17 hours a day, but by 4 months many American infants approach adult-like sleeping patterns. Sudden infant death syndrome (SIDS) is a condition that occurs when a sleeping infant suddenly stops breathing and dies without an apparent cause.
- Infants need to consume about 50 calories per day for each pound they weigh. The growing consensus is that breast feeding is more beneficial than bottle feeding.

Motor Development

- Dynamic systems theory seeks to explain how motor behaviors are assembled for perceiving and acting. This theory emphasizes that experience plays an important role in motor development, and that perception and action are coupled.
- Reflexes—automatic movements—govern the newborn's behavior.
- Key gross motor skills, which involve large-muscle activities, developed during infancy include control of posture and walking.
- Fine motor skills involve finely tuned movements. The onset of reaching and grasping marks a significant accomplishment, and this becomes more refined during the first two years of life.

Sensory and Perceptual Development

- Sensation occurs when information interacts with sensory receptors. Perception is the interpretation of sensation.
- Created by the Gibsons, the ecological view states that perception brings people into contact with the environment to interact with and adapt to it.
- The infant's visual acuity increases dramatically in the first year of life. By 3 months of age, infants show size and shape constancy. In Gibson and Walk's classic study, infants had depth perception as young as 6 months of age.
- The fetus can hear several weeks prior to birth. Just after being born, infants can hear but their sensory threshold is higher than that of adults. Newborns can respond to touch, feel pain, differentiate among odors, and may be sensitive to taste at birth.
- A basic form of intermodal perception is present in newborns and sharpens over the first year of life.
- In perception, nature advocates are referred to as nativists and nurture proponents are called empiricists. A strong empiricist approach is unwarranted. A full account of perceptual development includes the roles of nature, nurture, and the infant's developing sensitivity to information.

Cognitive Development

- In Piaget's theory, children construct their own cognitive worlds, building mental structures to adapt to their world. Schemes, assimilation and accommodation, organization, and equilibration are key processes in Piaget's theory. According to Piaget, there are four qualitatively different stages of thought. In sensorimotor thought, the

first of Piaget's four stages, the infant organizes and coordinates sensations with physical movements. The stage lasts from birth to about 2 years of age. One key accomplishment of this stage is object permanence. In the past several decades, revisions of Piaget's view have been proposed based on research.

- An approach different from Piaget's focuses on infants' operant conditioning, attention, imitation, memory, and concept formation.

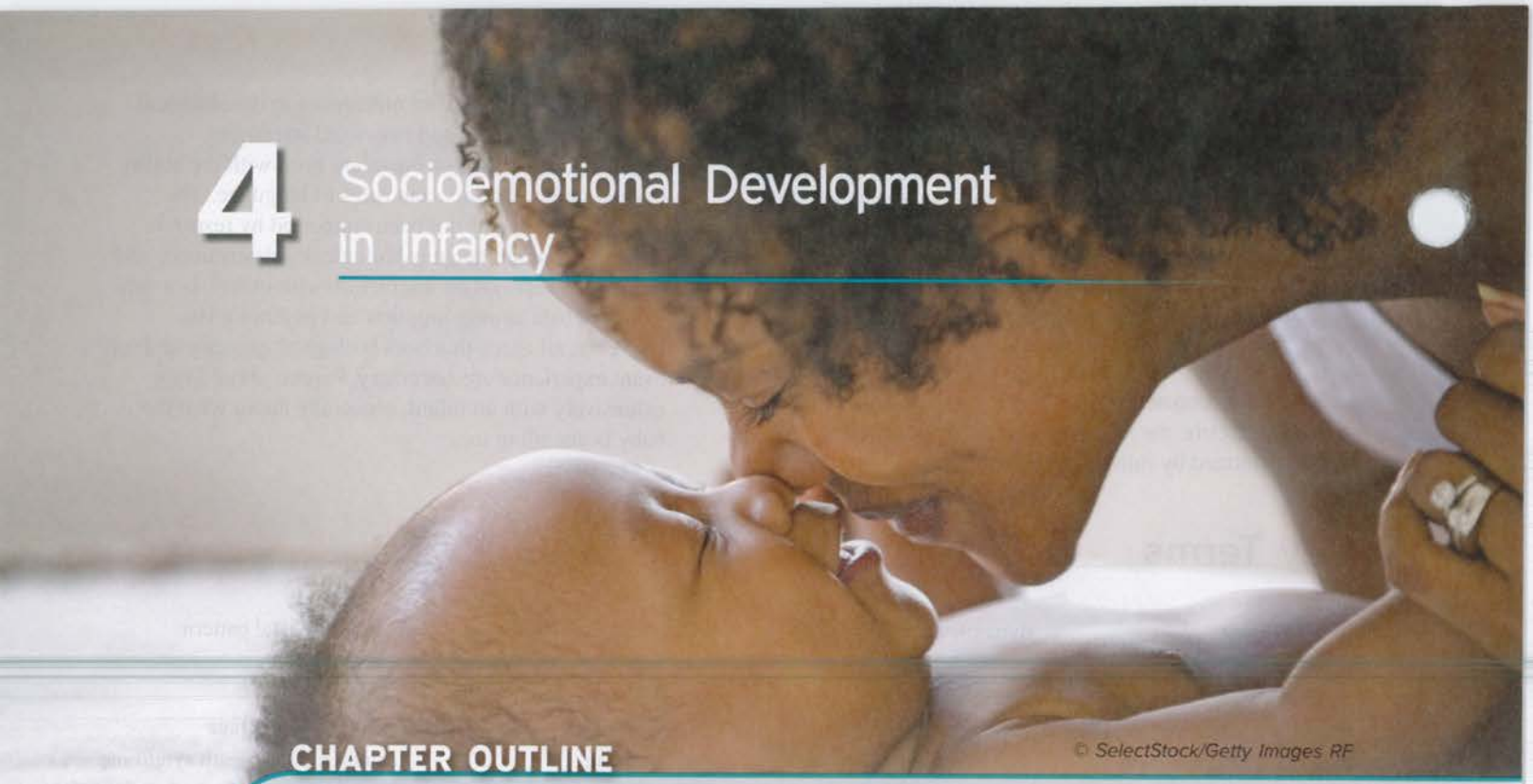
Language Development

- Rules describe the way language works. Language is characterized by infinite generativity.
- Infants reach a number of milestones in development, including first words and two-word utterances.
- Chomsky argues that children are born with the ability to detect basic features and rules of language. The behavioral view has not been supported by research. How much of language is biologically determined, and how much depends on interaction with others, is a subject of debate among linguists and psychologists. However, all agree that both biological capacity and relevant experience are necessary. Parents should talk extensively with an infant, especially about what the baby is attending to.

Key Terms

A-not-B error
accommodation
assimilation
attention
cephalocaudal pattern
child-directed speech
concepts
core knowledge approach
deferred imitation
dishabituation
dynamic systems theory
ecological view
equilibration
explicit memory
fine motor skills
gross motor skills
habituation
implicit memory
infinite generativity
intermodal perception
joint attention
language
language acquisition device (LAD)
lateralization
memory
neuroconstructivist view
object permanence
organization
perception
proximodistal pattern
schemes
sensation
sensorimotor stage
sudden infant death syndrome (SIDS)
telegraphic speech
visual preference method

4 Socioemotional Development in Infancy



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CHAPTER OUTLINE

EMOTIONAL AND PERSONALITY DEVELOPMENT
Emotional Development
Temperament
Personality Development

SOCIAL ORIENTATION AND ATTACHMENT
Social Orientation and Understanding
Attachment

SOCIAL CONTEXTS
The Family
Child Care

Stories of Life-Span Development: Darius and His Father

An increasing number of fathers are staying home to care for their children (Brott, 2015; Dette-Hagenmeyer, Erzinger, & Reichle, 2016; Lamb, 2013). Consider 17-month-old Darius. On weekdays, Darius' father, a writer, cares for him during the day while his mother works full-time as a landscape architect. Darius' father is doing a great job of caring for him. He keeps Darius nearby while he is writing and spends lots of time talking to him and playing with him. From their interactions, it is clear that they genuinely enjoy each other's company.

Last month, Darius began spending one day a week at a child-care center. His parents selected the center after observing a number of centers and interviewing teachers and center directors. His parents placed him in the center because they wanted him to get some experience with peers and his father to have some time out from caregiving.

Darius' father looks to the future and imagines the Little League games Darius will play in and the many other activities he can enjoy with his son. Remembering how little time his own father spent with him, he is dedicated to making sure that Darius has an involved, nurturing relationship with his father.

When Darius' mother comes home in the evening, she spends considerable time with him. Darius is securely attached to both his mother and his father.

How might fathers influence their infants' and children's development?

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