PART II

Infancy and Toddlerhood

This two-chapter part is devoted to infancy and toddlerhood. How does a helpless newborn become a walking, talking, loving child?

Chapter 3—**Physical and Cognitive Development in Infants and Toddlers** starts by offering an overview of brain development, then explores those basic newborn states: feeding, crying, and sleeping. Next, I chart sensory and motor development: What do babies see? How do newborns develop from lying helplessly to being able to walk? What can caregivers do to keep babies safe as they travel into the world? Finally, I'll offer an overview of infants' blossoming cognition and their first steps toward language, the capacity that allows us to enter the human community.

Chapter 4—**Emotional and Social Development in Infants and Toddlers** looks at what makes us human: our relationships. First, I'll explore the attachment bond between caregiver and child, then examine poverty and day care. The final part of this chapter focuses on toddlerhood—from age 1 to 2½. Toddlers are intensely attached to their caregivers and passionate to be independent. During this watershed age, when children are walking and beginning to talk, we first learn the rules of the human world.

Application to Developing Lives Parenting Simulation: *Babies and Toddlers*

Below is a list of questions you will answer in the Babies and Toddlers simulation module. As you answer these questions, consider the impact your choice will have on the physical, cognitive, and social and emotional development of your child.

Physical	Cognitive	Social and Emotional
• Will you get your baby vaccinated? • Will you breast-feed your baby? If so, for how long? • What kind of foods will you feed your baby during the first year? • How will you encourage motor development? • How does your baby's height and weight compare to national norms?	• What kind of activities are you going to expose your baby to (music class, reading, educational videos)? • What kind of activities will you do to promote language development? • What stage of Piaget's cognitive stages of development is your child in?	• How will you soothe your baby when he or she is crying? • Can you identify your baby's temperament? • Can you identify your baby's attachment style? • What kind of discipline will you use with your child?

Left: Nicole Hill/Rubber Ball/Age Fotostock

CHAPTER 3

CHAPTER OUTLINE

Physical and Cognitive Development in Infants and Toddlers

In Chapter 2, I talked to Kim at the beginning of the third trimester, anxiously waiting for her child's birth. Now, let's pay her a visit and meet Elissa, her baby girl.

She's been here for 5 months and 10 days, and I feel like she's been here forever. For me, it was love at first sight and, of course, the same for Jeff. But the thrill is watching a wonderful person emerge day by day. Take what's happening now. At first, she couldn't care less, but a month ago, it was like, "Wow, there's a world out there!" See that baby seat? Elissa can make the colored buttons flash by moving her legs. When I put her in it, she bats her legs like crazy. She can't get enough of the lights and sounds. Now that she is finally able to reach, notice her hunger to grab for everything and the way she looks at your face—like she can get into your soul. Sometimes, I think she understands what I'm feeling . . . but I know she must be way too young for this.

Elissa doesn't cry much—nothing like other babies during the first three months. Actually, I was worried. I asked the doctor whether there was something wrong. Crying is vital to communicating what you need! The same is true of sleeping. I'm almost embarrassed to tell you that I have the only baby in history who has been regularly giving her mother a good night's sleep since she was 2 months old.

Breast-feeding is indescribable. It feels like I am literally making her grow. But, here I also was concerned. Could I do this? What helped me persevere through the painful first week was my supportive husband—and most important, the fact that my boss gave me paid time off from work. I feel sad for my friend, Nora, who had to abandon this incredible experience when she needed to go back to her job right after her son's birth.

Pick her up. Feel what it's like to hold her—how she melts into you. But notice how she squirms to get away. It's as if she is saying, "Mom, my agenda is to get moving into the world." I plan to YouTube every step now that she's traveling into life.

At 5 months of age, Elissa has reached a milestone. She is poised to physically encounter life. This chapter charts the transformation from lying helplessly to moving into the world and the other amazing physical and cognitive changes that occur during infancy and toddlerhood—that remarkable first two years of life.

To set the context, I'll first spell out some brain changes (and principles) that program development. Then, I'll chart those basic newborn states—eating, crying, and sleeping—and track babies' emerging vision and motor skills. The final sections of this chapter tour cognition and language, the capacity that makes our species unique.

Left: Kiyoko Fukuda/a.collectionRF/amana images RF/Getty Images

Setting the Context

LEARNING OUTCOME

- Define synaptogenesis, neural pruning, myelination, and brain plasticity.

Peter Correz/The Image Bank/Getty Images

What does this young baby see and understand about the tremendous loving object he is facing? That is the mystery we will be exploring in this chapter.

What causes the remarkable changes—from seeing to walking to speaking—that unfold during infancy and toddlerhood? Answers come from scanning development in that masterpiece structure—the human brain.

The Expanding Brain

The **cerebral cortex,** the outer, furrowed mantle of the brain, is the site of every conscious perception, action, and thought. With a surface area 10 times larger than the monkey's and 1,000 times larger than the rat's, the cortex is what makes human beings different from any other species on earth.

Because of our immense cortex, humans are also unique in the amount of brain growth that occurs outside the womb. During the first four years of life, brain volume quadruples (Stiles & Jernigan, 2010). It takes more than two decades for the brain to fully mature. Actually, the cortex only starts taking over behavior a few months *after* birth.

During the fetal period and first year of life, the cells composing the brain migrate to the top of the neural tube (Paredes and others, 2016). When they reach this staging area, they explode into their mature form. The cells form long **axons—**fibers that conduct impulses away from the cell body. They sprout **dendrites—**treelike, branching ends. As the dendrites proliferate at junctions, or **synapses,** the axons and dendrites interconnect (see Figure 3.1).

Synaptogenesis, the process of making myriad connections, programs every skill—from Elissa's vigorous push-ups to composing symphonies or solving problems in math. Another critical transformation is called **myelination:** The axons form a fatty layer around their core. Just as a stream of water prevents us from painfully bumping down a water park slide, the myelin sheath is the lubricant that permits the neural impulses to speedily flow. This insulating layer may also determine which cells thrive (Stiles & Jernigan, 2010).

Synaptogenesis and myelination occur at different rates in specific brain areas (Dean and others, 2014). In the visual cortex, the part of the brain responsible for interpreting visual stimuli, the axons are myelinated by about age 1. In the frontal lobes, the brain region involved in reasoning, the myelin sheath is still forming into our twenties.

This makes sense. Seeing is a skill we need soon after birth. Visual abilities, as you will learn in this chapter, develop rapidly during our first year of life. But we won't need the skills to compose symphonies, do higher math, or competently make our way in the world until we become adults. So there are parallels between our unfolding abilities and the way our brain matures.

Neural Pruning and Brain Plasticity

So far, you might imagine that more neural connections equal superior skills. Not so! Neural loss is critical to development, too. Following a phase of lavishly producing synapses, each cortical region undergoes synaptic pruning and neural death. This shedding timetable also reflects our expanding abilities. It begins around age 1 in the visual cortex. It starts during late childhood in the frontal lobes. Just as weeding is critical to sculpting a beautiful garden, we need to get rid of the unnecessary neurons to permit the essential cells to flower.

Why does the brain undergo this frantic overproduction, followed by cutting back? Clues come from research suggesting that during infancy, synaptic connections progressively strengthen in more distant areas of the brain (Damaraju and others, 2014). Perhaps having an oversupply of connections

cerebral cortex The outer, folded mantle of the brain, responsible for thinking, reasoning, perceiving, and all conscious responses.

axon A long nerve fiber that usually conducts impulses away from the cell body of a neuron.

dendrite A branching fiber that receives information and conducts impulses toward the cell body of a neuron.

synapse The gap between the dendrites of one neuron and the axon of another, over which impulses flow.

synaptogenesis Forming of connections between neurons at the synapses. This process, responsible for all perceptions, actions, and thoughts, is most intense during infancy and childhood but continues throughout life.

myelination Formation of a fatty layer encasing the axons of neurons. This process, which speeds the transmission of neural impulses, continues from birth to early adulthood.

allows us to "recruit" from this wider pool and redirect these extra neurons to perform other functions, should we have a major sensory deficit or brain insult early in life (Fox, Levitt, & Nelson, 2010; Stiles & Jernigan, 2010). Actually, our cortex is malleable, or **plastic** (able to be changed), particularly during infancy and the childhood years.

Using brain scans, which measure the brain's energy consumption, researchers find that among people blind from birth, activity in the visual cortex is intense while reading Braille and localizing sounds in space. This suggests that, without environmental stimulation from the eye, the neurons programmed for vision are captured, or taken over, to strengthen hearing and touch (Collignon and others, 2011; Fox, Levitt, & Nelson, 2010).

A similar process occurs with language, normally represented in the left hemisphere of the brain. If an infant has a left-hemisphere stroke, with intense verbal stimulation the right hemisphere takes over, and language develops normally (Rowe and others, 2009). Compare this to what happens when a person has a left-hemisphere stroke after language is located firmly in its appropriate places. The result can be devastating—a permanent loss in understanding speech or forming words.

So, brain plasticity highlights the basic nature-combines-with-nurture principle that governs human life. Yes, the blueprint for our cortex is laid out at conception. But environmental stimulation is vital in strengthening specific neural networks and determining which connections will be pruned (Fox, Levitt, & Nelson, 2010). Before the pruning phase, the brain is particularly malleable—permitting us to grow a somewhat different garden should disaster strike. Still, as synaptogenesis is a lifelong process, we continue to grow, to learn, to develop intellectually from age 1 to age 101.

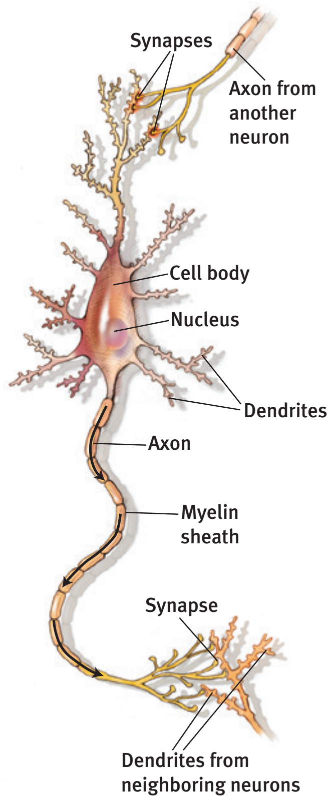


FIGURE 3.1: **The neuron and synapses** Here is an illustration of the remarkable structure that programs every developing skill, perception, and thought. Notice the dendrites receiving information at the synapses and how impulses flow down the long axon to connect up with the dendrites of the adjoining cells.

Susan Watts/NY Daily News Archive via Getty Images

This resilient baby has survived major surgeries in which large sections of his brain had to be removed. Remarkably—because the cortex is so *plastic* at this age—he is expected to be left with few, if any, impairments.

plastic Malleable, or capable of being changed (refers to neural or cognitive development).

Table 3.1: Brain-Busting Facts to Wrap Your Head Around

- Our adult brain is composed of more than 1 billion neurons and, via synaptogenesis, makes roughly 60 trillion neural connections.
- As preschoolers, we have roughly double the number of synapses we have as adults—because, as our brain develops, roughly 40 percent of our synapses are ultimately pruned (see the text). So, ironically, the overall cortical thinning during elementary school and adolescence is a symptom of brain maturation.
- Specific abilities, such as language, that scientists had believed were localized in one part of the cortex are dependent on many brain regions. Moreover, the cortical indicators of "being advanced" in an ability shift in puzzling ways as a child gets older. For instance, while rapid myelination in the left frontal lobe predicts language abilities at age 1, by age 4 this relationship reverses, with linguistically advanced preschoolers showing more myelin in the right frontal lobe. Although there is a steeper-than-normal loss in cortical thickness when children show rapid IQ declines, boys and girls whose intelligence scores rise show no special cortical changes.
- Boys' brains, on average, are 10 percent larger than girls' brains, even during childhood, when both sexes are roughly the same size, body-wise.
- The most amazing finding relates to the surprising, dramatic variability in brain size from child to child. Two normal 10-year-old boys might have a twofold difference in brain volume, without having any difference in intellectual abilities!

Information from Dean and others, 2014; Giedd and others, 2010; Stiles & Jernigan, 2010.

Table 3.1 offers additional fascinating facts about neurons, synaptogenesis, and the pruning phase. Notice from the last item that, in the same way as the houses in your subdivision look different—although they may have had the same original plan (as each owner took charge of decorating his personal space)—scientists find remarkable variability in the brains of *normally* developing girls and boys (Giedd and others, 2010). And why should these variations be a surprise, given the diversity of interests and talents we develop in life!

Now keeping in mind the basic brain principles—(1) development unfolds "in its own neurological time" (you can't teach a baby a skill before the relevant part of the brain comes on-line); (2) stimulation sculpts neurons (our wider-world experiences physically change our brain); and (3) the brain is still "under construction" (and shaped by those same experiences) for as long as we live—let's explore how the expanding cortex works magic during the first years of life.

Tying It All Together

1. Cortez and Ashley are arguing about what makes our brain unique. Cortez says it's the size of our cortex. Ashley says it's the fact that we "grow" most of our brain after birth and that the cortex continues to mature for at least two decades. Who is right—Cortez, Ashley, or both students?
2. Latisha tells you that the myelin sheath speeds neural impulses and the more synaptic connections, the higher the level of development. Is Latisha totally correct? If not, describe how she is wrong.
3. When babies have a stroke, they may end up (choose one) *more/less* impaired than they would be as adults, due to brain (choose one) *myelination/plasticity*.
4. Which neural process is occurring in babies, mothers, and grandmas alike? (Choose one) *myelination/synaptogenesis*

Answers to the Tying It All Together questions can be found at the end of this chapter.

Basic Newborn States

Visit a newborn and you will see simple activities: She eats, she cries, she sleeps. In this section, I'll spotlight each state.

LEARNING OUTCOMES

- Identify the purpose of newborn reflexes.
- Name two issues that limit breast-feeding.
- Describe the prevalence of undernutrition and food insecurity.
- List techniques to quiet a crying baby.
- Outline infant sleep changes and offer a strategy to promote baby sleep.
- Describe sudden infant death syndrome (SIDS).

Eating: The Basis of Living

Eating patterns undergo amazing changes during the first two years of life. Let's scan these transformations and then discuss nutritional topics that loom large in the first years of life.

Developmental Changes: From Newborn Reflexes to 2-Year-Old Food Cautions

Newborns seem to be eating even when sleeping—a fact vividly brought home to me by the loud smacking that erupted from my son's bassinet. The reason is that babies are born with a powerful **sucking reflex**—they suck virtually all the time. Newborns also are born with a **rooting reflex.** If *anything* touches their cheek, they turn their head in that direction and suck.

Reflexes are automatic activities. Because they do not depend on the cortex, they are not under conscious control. It is easy to see why the sucking and rooting reflexes are vital to surviving after we exit the womb. If newborns had to learn to suck, they might starve before mastering that skill. Without the rooting reflex, babies would have trouble finding the breast.

Sucking and rooting have clear functions. What about the other infant reflexes shown in Figure 3.2? Do you think the grasping reflex may have helped newborns survive during hunter-gatherer times? Can you think of why newborns, when adults stand them on a table, take little steps (the stepping reflex)? Whatever their value, these reflexes, and a few others, must be present at birth. They must disappear as the cortex grows.

As the cortex matures, voluntary processes replace these newborn reflexes. By month 4 or 5, babies no longer suck continually. Their sucking is governed by *operant conditioning.* When the breast draws near, they suck in anticipation of that delicious reinforcer: "Mealtime has arrived!" Still, Sigmund Freud named infancy the oral stage for good reason: During the first years of life, the theme is "Everything in the mouth."

This impulse to taste everything leads to scary moments as children crawl and walk. There is nothing like the sickening sensation of seeing a baby put a forgotten pin in his mouth or taste your possibly poisonous plant. My personal heart-stopping experience occurred when my son was almost 2. I'll never forget the frantic race to the emergency room after Thomas toddled in to joyously share a treasure, an open vial of pills!

sucking reflex The automatic, spontaneous sucking movements newborns produce, especially when anything touches their lips.

rooting reflex Newborns' automatic response to a touch on the cheek, involving turning toward that location and beginning to suck.

reflex A response or action that is automatic and programmed by noncortical brain centers.

Rooting Whenever something touches their cheek, newborns turn their head in that direction and make sucking movements.

Sucking Newborns are programmed to suck, especially when something enters their mouth.

Grasping Newborns automatically vigorously grasp anything that touches the palm of their hand. If the baby's brain is developing normally, each of these reflexes is present at birth and gradually disappears after the first few months of life.

FIGURE 3.2: **Some newborn reflexes** In addition to the reflexes illustrated here, other newborn reflexes include the Babinski reflex (stroke a baby's foot and her toes turn outward), the stepping reflex (place a baby's feet on a hard surface and she takes small steps), and the swimming reflex (if placed under water, newborns can hold their breath and make swimming motions).

Luckily, a mechanism may protect toddlers from sampling every potentially lethal substance during their first travels into the world. Between ages 1½ and 2, children can revert to eating a few familiar foods, such as peanut butter sandwiches and apple juice. Evolutionary psychologists believe that, like morning sickness, this behavior is adaptive. Sticking to foods they know reduces the risk of children poisoning themselves when they begin to walk (Bjorklund & Pellegrini, 2002). Because this *2-year-old food caution* gives caregivers headaches, we need to reassure frantic parents: Picky eating can be *normal* during the second year of life (as long as a child eats a reasonable amount of food).

What is the best diet during a baby's first months? When is not having enough food a widespread problem? These questions bring up breast-feeding and global malnutrition.

Breast Milk: Nature's First Food

For most of human history, as I discussed in Chapter 1, babies faced perils right after birth. Infectious diseases and impure food and water ensured that many newborns did not survive beyond age 1 (Gordon, 2015). Before the early-twentieth-century public-health miracles, breast-feeding—for as long as possible—was a life-saving act (Preston, 1991).

Breast-feeding is a life-saver in poor nations today. In Southern Africa—Zambia, Zimbabwe, and Swaziland—mothers who nurse (without offering other liquids or foods) increase their infants' survival odds (Motsa, Ibisomi, & Odimegwu, 2016). In the developed world, exclusive breast-feeding is linked to widespread benefits, from making toddlers more resistant to the flu (McNiel, Labbok, & Abrahams, 2010) to accelerating myelin formation (Deoni and others, 2013) to producing 1-year-olds who are less reactive to stress (Beijers, Riksen-Walraven, & de Weerth, 2013). In one sophisticated longitudinal study, women who nursed for longer had kindergarteners with fewer disruptive behaviors—such as aggression and tantrums—if these children were genetically at-risk (Jackson, 2016).

But these findings involve correlations. And just because a relationship exists between two variables does not mean one *causes* the other. The research exploring breast milk's benefits does not control for maternal motivation (Sulaiman, Liamputtong, & Amir, 2016). In the study just mentioned, wouldn't a woman's passion to breast-feed a "fussy" infant suggest that she is generally a more committed mother (Chong and others, 2016)? Perhaps this intense commitment to caregiving mutes a child's temperamental tendency to misbehave.

The "correlation-is-not-causation" issue is especially problematic because, in the developed world, breast-feeding is *strongly* linked to social class. Women who nurse for months tend to be well-educated and affluent (Dennis and others, 2013). They spend more time in hands-on infant care (Smith & Ellwood, 2011). Is it really breast *milk* that promotes health, or the extra love that goes along with providing this natural food?

Halfpoint/Shutterstock.com

This woman has the luxury of nursing her infant for months because she is affluent and doesn't need to return to work full-time after giving birth.

Despite these issues, for decades every public health organization has vigorously urged exclusive breast-feeding during the first six months of life (American Academy of Pediatrics [AAP], 2005; UNICEF, 2009). But, from Asia (Sulaiman and others, 2016) to the United States (Chong and others, 2016; Johnson and others, 2016), most new mothers don't follow this advice. Even in hunter-gatherer societies such as the Amazonian Tsimani, where 8 in 10 women still nurse their toddlers, women routinely supplement breast milk with other foods (Martin and others, 2016). Why?

Work Demands

One reason for abandoning the breast-feeding advice—particularly in the United States—is the need to work (Flower and others, 2008; Vaughn and others, 2010). Women with paid-for maternity leave nurse their babies for longer (Mirkovic, Perrine, & Scanlon, 2016); work conflict dampens down the motivation to persist (Chong and others, 2016). In one striking comparison, U.S. mothers who returned to work full-time within three months after a child's birth breast-fed their babies an average 15 weeks *less* than their counterparts with part-time jobs (Lubold, 2016).

Imagine being a restaurant server or supermarket clerk who needs to work 40 or 50 hours per week to make ends meet (Guendelman and others, 2009). Would you have time to nurse your baby, no matter what the experts advised?

Physical Pain

But even when a woman has the luxury of breast-feeding for months, she can be let down by her body. This "natural" activity can be painful to carry out (Martin and others, 2016; Brown, Rance, & Bennett, 2016). As one new mother reported: "I never realized . . . that I would be reduced to tears every time I fed" (Sheehan, Schmied, & Barclay, 2013, p. 23). Another woman, forced to abandon the breast because of pain, anguished: "I felt so horrible . . . that I couldn't do this for my child" (quoted in Andrews & Knaak, 2013, p. 95).

Yes, exclusive breast-feeding for as long as possible is vital in nations where water and food are still impure (such as in Africa). But, because so many contemporary women cannot follow the six-month advice, it seems unfair to make mothers feel guilty when things don't work out. And rather than a person's milk delivery method, what's *really* important is the way a mother bonds with her child.

Malnutrition: A Serious Developing-World Concern

Breast-feeding gives *every* newborn a chance to thrive. However, there comes a time—at around 6 months of age—when babies need solid food. That's when the horrifying developing-world inequalities, described in the Experiencing Childhood box, hit (Caulfield and others, 2006).

Experiencing Childhood: A Passion to Eradicate Malnutrition: A Career in Public Health

What is it like to battle malnutrition in the developing world? Listen to Richard Douglass describe his career:

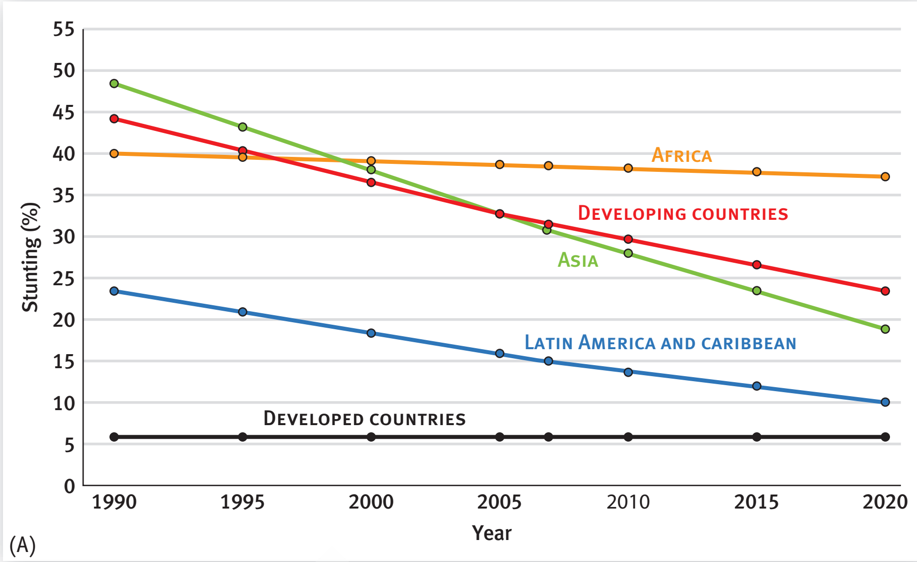
I grew up on the South Side of Chicago—my radius was maybe 4 or 5 blocks in either direction. Then, I spent my junior year in college in Ethiopia, and it changed my life. I lived across the street from the hospital, and every morning I saw a flood of people standing in line. They would wait all day . . . , and eventually a cart would come and take away the dead. When I saw the lack of doctors, I realized I needed to get my master's and Ph.D. in public health.

In public health we focus on primary prevention, how to prevent diseases and save thousands of people from getting ill. My interest was in helping to eradicate Kwashiorkor in Ghana. What the name literally means is "the disease that happens when the second child is born." The first child is taken off the breast too soon and given a porridge that doesn't have amino acids, and so the musculature and the diaphragm break down. You get a bloated look (swollen stomach), and then you die. If a child does survive, he ends up stunted, and so looks maybe 5 years younger.

Once someone gets the disease, you can save their life. But it's a 36-month rehabilitation that requires taking that child to the clinic for treatment every week. In Ghana it can mean traveling a dozen miles by foot. So a single mom with two or three kids is going to drop out of the program as soon as the child starts to look healthy. Because of male urban migration, the African family is in peril. If a family has a grandmother or great-auntie, the child can make it because this woman can take care of the children. So the presence of a grandma saves kids' lives.

Most malnutrition shows up after wars. In Ghana there is tons of food. So it's a problem of ignorance, not poverty. The issue is partly cultural. First, among some groups, the men eat, then women, then older children, then the babies get what is left. So the meat is gone, the fish is gone, and then you just have that porridge. We have been trying to impose a cultural norm that everyone sits around the dining table for meals, thereby ensuring that all the children get to eat. The other issue is just pure public health education—teaching families "just because your child looks fat doesn't mean that he is healthy."

I feel better on African soil than anywhere else. With poor people in the developing world who are used to being exploited, they are willing to write you off in a heartbeat if you give them a reason; but if you make a promise and follow through, then you are part of their lives. I keep going back to my college experience in Ethiopia . . . watching those people standing at the hospital, waiting to die. Making a difference for them is the reason why I was born.



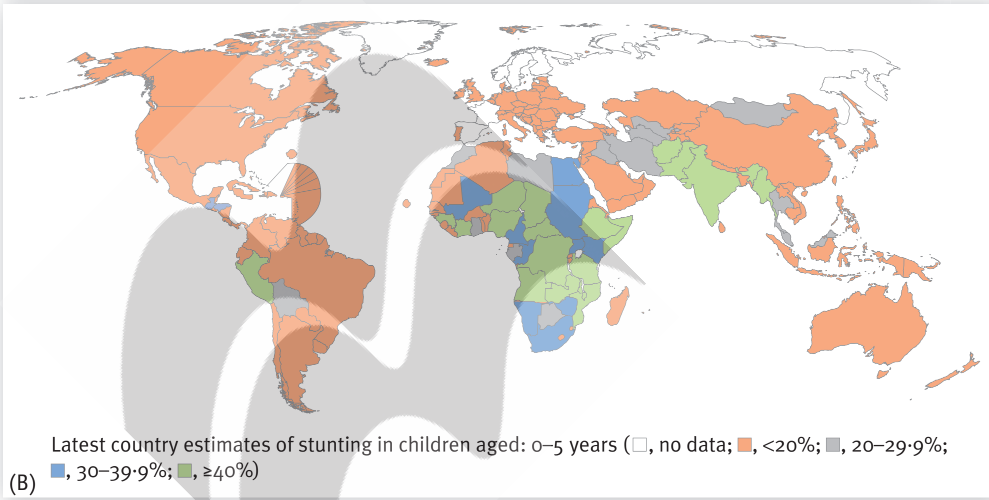


FIGURE 3.3: (A) Trends in stunting in different world regions, 1990–2020 (B) Stunting prevalence in different world regions today The good news is that stunting has dramatically declined in Asia, Latin America, and the Caribbean (see chart A), although, as you can see on the map (B), this sign of severe malnutrition is still unacceptably high in Africa, Southeast Asia, and South Central Asia.

Data from de Onis, Blössner, & Borghi, 2012.

undernutrition A chronic lack of adequate food.

stunting Excessively short stature in a child, caused by chronic lack of adequate nutrition.

micronutrient deficiency Chronically inadequate level of a specific nutrient important to development and disease prevention, such as vitamin A, zinc, and/or iron.

food insecurity According to U.S. Department of Agriculture surveys, the number of households that report needing to serve unbalanced meals, worrying about not having enough food at the end of the month, or having to go hungry due to lack of money (latter is *severe food insecurity*).

How many young children suffer from **undernutrition,** having a serious lack of adequate food? For answers, epidemiologists measure **stunting,** the percentage of children under age 5 in a given region who rank below the fifth percentile in height, according to the norms for their age. This very short stature is a symptom of *chronic* inadequate nutrition, which compromises every aspect of development and activity of life (Abubakar and others, 2010; UNICEF, 2009).

The good news is that, as Figure 3.3A shows, stunting rates have dramatically declined in Asia, Latin America, and the Caribbean. The tragedy, as you can see in Figure 3.3B, is that in sub-Saharan Africa and South Asia, malnutrition still affects an alarming 2 in 5 girls and boys. In the developing world, **micronutrient deficiencies**—inadequate levels of nutrients such as iron, zinc, or vitamin A—are rampant. Disorders, such as Kwashiorkor (described in the Experiencing Childhood box on the previous page), can even strike when there is ample food.

How many young children are stunted or chronically hungry in the United States? In 2015, more than 1 in 6 (17 percent) of U.S. households with children was **food insecure.** Caregivers reported not having the money to provide a balanced

Table 3.2: Major U.S. Federal Nutrition Programs Serving Young Children†

Food Stamp Program (now called SNAP, Supplemental Nutrition Assistance Program): This mainstay federal nutrition program provides electronic cards that participants can use like a debit card to buy food. Families with young children make up the majority of food stamp recipients.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC): This federally funded grant program is specifically for low-income pregnant women and mothers with children under age 5. WIC offers a monthly package of supplements tailored to the family's unique nutritional needs (such as infant formula and baby cereals) plus nutrition education and breast-feeding support.

Child and Adult Care Food Program (CACFP): This program reimburses child-care facilities, day-care providers, after-school programs, and providers of various adult services for the cost of serving high-quality meals. Surveys show that children in participating programs have higher intakes of key nutrients and eat fewer servings of fats and sweets than those who attend facilities that do not participate.

Information from U.S. Department of Agriculture, Food and Nutrition Service, 2014.

†This information was correct as of 2017; however, as the new Congress may cut funding for these services, the status of some programs may have changed by the time you are reading this book.

diet, or being worried that their funds for food might run out. About 1 in 11 families reported *severe food insecurity*. They sometimes went hungry due to lack of money.

While rates of U.S. food insecurity vary—from more than 1 in 3 families in an impoverished Mississippi County, to under 1 in 25 in an affluent Virginia suburb—as of this writing (2017), low-income children have access to the nutrition-related entitlement programs described in Table 3.2 (Hunger and Poverty Facts and Statistics, 2016). So—at least for now—in the United States, this developing-world scourge is rare.

Crying: The First Communication Signal

> At 2 months, when Jason cried, I was clueless. I picked him up, rocked him, and kept a pacifier glued to his mouth; I called my mother, the doctor, even my local pharmacist, for advice. Since it put Jason to sleep, my husband and I took car rides at three in the morning—the only people on the road were teenagers and other new parents like us. Now that my little love is 10 months old, I know why he is crying, and those lonely countryside tours are long gone.

Crying, that vital way we communicate our feelings, reaches its lifetime peak at around one month after birth (St. James-Roberts, 2007). However, a distinctive change in crying occurs at about month 4. As the cortex blossoms, crying rates decline, and babies use this communication to express their needs.

It's tempting to think of crying as a negative state. However, because crying is as vital to survival as sucking, when babies cry too little, this can signal a neurological problem (Zeskind & Lester, 2001). When babies cry, we pick them up, rock them, and give them loving care. So, up to a point, crying cements the infant–parent bond.

Still, there is a limit. When a baby cries continually, she may have that bane of early infancy—**colic.** Despite what some "friends" (unhelpfully) tell new mothers, it's a myth that inept parents produce colicky babies. Colic is caused by an immature nervous system. After they exit the cozy womb, some babies get unusually distressed when bombarded by stimuli, such as being handled or fed (St. James-Roberts, 2007). So we need to back off from blaming stressed-out caregivers for this biological problem of early infant life.

colic A baby's frantic, continual crying during the first three months of life; caused by an immature nervous system.

Imagine having a baby with colic. You feel helpless. You cannot do anything to quiet the baby down. There are few things more damaging to parental self-efficacy than an infant's out-of-control crying (Keefe and others, 2006).

The good news is that colic is short-lived. Most parents find that around month 4, their baby suddenly becomes a new, pleasant person overnight. For this reason, there is only cause for concern when a baby cries excessively *after* this age (Schmid and others, 2010).


Burger/Phanie/Science Source

Because it promotes intense skin-to-skin bonding, kangaroo care is an effective baby-calming technique.

skin-to-skin contact An effective calming strategy that involves holding a young infant next to a caregiver's body.

kangaroo care Carrying a young baby in a sling close to the caregiver's body. This technique is most useful for soothing an infant.

INTERVENTIONS: What Quiets a Young Baby?

What calms a crying newborn? The familiar answer: Pick up the baby, hold her, rock her, feed her, provide a pacifier or anything that satisfies the need to suck.

Skin-to-skin contact, holding a baby close, has a clear physiological effect. It reduces newborn's levels of the stress hormone *cortisol* (Beijers, Cillessen, & Zijlmans, 2016). The best real-world evidence comes from the !Kung San hunter-gatherers of Botswana. In this culture, where mothers strap infants to their chests and feed them on demand, the frequency of colic is dramatically reduced.

Kangaroo care, using a baby sling, can even help premature infants grow (World Health Organization [WHO], 2003b). In one experiment, developmentalists had mothers with babies in an intensive care unit carry their infants in baby slings for one hour each day. At 6 months of age, compared to a group given standard care, the kangaroo-care babies scored higher on developmental tests. Their parents were rated as providing a more nurturing home environment, too (Feldman & Eidelman, 2003).

Imagine having your newborn whisked away to spend weeks with strangers. Now, think of being able to caress his tiny body, the sense of self-efficacy that would flow from helping him thrive. So it makes sense that any cuddling intervention can have an impact on the baby and the parent–child bond.

Another baby-calming strategy is infant massage. From helping premature infants gain weight to treating toddler (and adult) sleep problems, massage enhances well-being from the beginning to the end of life (Field, Diego, & Hernandez-Reif, 2007, 2011).

We all know the power of a cuddle or a relaxing massage to soothe our troubles. Can holding and stroking in early infancy *generally* insulate children against stress? Consider this study with rats.

Because rodent mothers (like humans) differ in the "hands-on" contact they give their babies, researchers classified rats who had just given birth into one of three groups: high licking and grooming, average licking and grooming, and low licking and grooming. As adults, the lavishly licked and groomed rats reacted in a more placid way when exposed to stress (Menard & Hakvoort, 2007). We need to be cautious about generalizing this finding to humans. Advocating for the !Kung San approach to caregiving might be asking too much of modern moms. Still, the implication is clear: During the first months of life (or, for as long as you can), keep touching and loving 'em up!

Cuddles calm us from day 1 to age 101. However, as children get older, the reasons for their crying undergo fascinating changes. The long car ride that magically quieted a 2-month-old evokes agony in a toddler who cannot stand to be confined. First, it's swaddling, then watching a mobile, then seeing Mom enter the room that has the power to soothe. In preschool, it's monsters that cause wailing; during elementary school and teenager-hood, it's failing or being rejected by our social group. As emerging adults, we weep for a lost job or love. Our crying shows just where we are emotionally as we travel from babyhood until adult life!

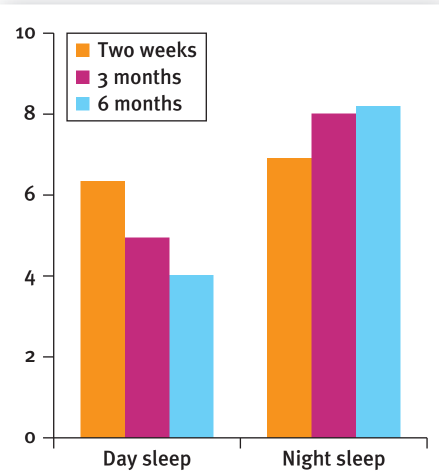


FIGURE 3.4: Mean number of hours babies sleep during the day and night, at 2 weeks, 3 months, and 6 months of age This chart shows that particularly during the first three months of life, babies shift their cycle to mainly nighttime slumber (but unfortunately, infants continue to wake up several times each night).
Data from Figueiredo and others, 2016.

Sleeping: The Main Newborn State

If crying is a crucial baby (and adult) communication signal, sleep is the quintessential newborn state. Visit a relative who has recently given birth. Will her baby be crying or eating? No, she is almost certain to be asleep. Two-week-old babies typically sleep for almost 14 hours out of a 24-hour day (Figueiredo and others, 2016, see Figure 3.4). And there is a reason for the saying, "She sleeps like a baby." Perhaps because it mirrors the whooshing sound in the womb, noise helps newborns zone out. The problem for parents is that babies wake up and start wailing, like clockwork, every 3 to 4 hours.

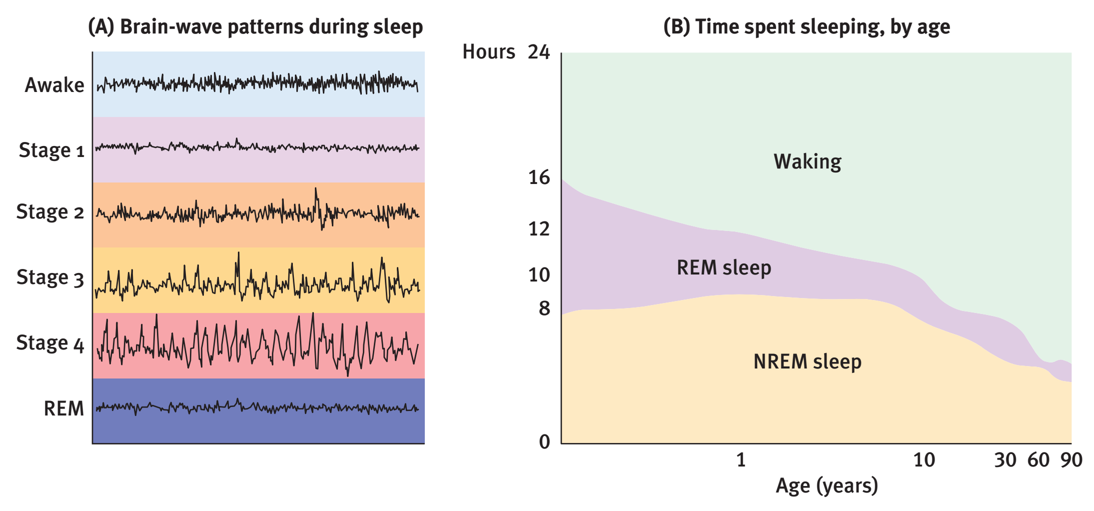


FIGURE 3.5: Sleep brain waves and lifespan changes in sleep and wakefulness In chart A, you can see the EEG patterns associated with the four stages of sleep that first appear during adolescence. After we fall asleep, our brain waves get progressively slower (these are the four stages of non-REM sleep) and then we enter the REM phase during which dreaming is intense. Now, notice in chart B the time young babies spend in REM. As REM sleep helps consolidate memory, is the incredible time babies spend in this phase crucial to absorbing the overwhelming amount of information that must be mastered during the first years of life?

Data from Roffwarg, Muzio, & Dement, 1966.

Developmental Changes: From Signaling to Self-Soothing to Shifts in REM Sleep

During the first year of life, infant sleep patterns adapt to the human world. Within the first three months of life, as Figure 3.4 shows, sleep shifts toward nighttime hours. Then, by about 6 months of age, there is a milestone. The typical baby sleeps for 6 hours a night. At age 1, the typical pattern is roughly 12 hours of sleep a night, with an additional morning and afternoon nap. During year 2, the caretaker's morning respite to do housework or rest is regretfully lost, as children give up the morning nap. Finally, by late preschool, sleep often (although not always) occurs only at night (Anders, Goodlin-Jones, & Zelenko, 1998).

In addition to its duration and on-again/off-again pattern, infant sleep differs physiologically from our adult pattern. When we fall asleep, we descend through four stages, involving progressively slower brain-wave frequencies, and then cycle back to **REM sleep**—a phase of rapid eye movement, when dreaming is intense and our brain-wave frequencies look virtually identical to when we are in the lightest sleep stage (see Figure 3.5). When infants fall asleep, they immediately enter REM and spend most of their time in this state. It is not until adolescence that we undergo the adult sleep cycle, with four distinct stages (Anders, Goodlin-Jones, & Zelenko, 1998).

Although parents are thrilled to say, "My child is sleeping through the night," this statement is false. Babies *never* sleep continuously through the night. However, by about 6 months of age, many have the skill to become **self-soothing.** They put themselves back to sleep when they wake up (Goodlin-Jones and others, 2001).

Imagine being a new parent. Your first challenge is to get your baby to develop the skill of nighttime self-soothing. Around age 1, because your child is now put into the crib while still awake, there may be issues getting your baby to *go* to sleep. During preschool and elementary school, the sleep problem shifts again. Now, it concerns getting the child *into* bed: "Mommy, can't I stay up later? Do I *have* to turn off the lights?"

Although it may make them cranky, parents expect to be sleep-deprived with a young baby; but once a child has passed the 5- or 6-month milestone, parents get agitated if an infant has never permitted them a full night's sleep. Parents expect sleep problems when their child is ill or under stress, but not the zombielike irritability

REM sleep The phase of sleep involving rapid eye movements, when the EEG looks almost like it does during waking. REM sleep decreases as infants mature.

self-soothing Children's ability, usually beginning at about 6 months of age, to put themselves back to sleep when they wake up during the night.

that comes from being chronically sleep-deprived for years. There is a poisonous bidirectional effect here: Children with chronic sleep problems produce irritable, stressed-out parents. Irritable, stressed-out parents produce childhood problems with sleep (Goldberg and others, 2013).

There are interesting variations. Some women get unusually agitated when a 1-year-old wakes up repeatedly during the night. Other mothers don't seem to mind. Based on measuring pregnant mothers' sleep, researchers discovered that how a person reacts depends on her unique sleep style. Women who needed a lot of sleep while their baby was in utero tended to get unusually depressed when their toddler woke up frequently. Their counterparts who slept less during pregnancy felt more upset when a child slept *through the night* (Newland and others, 2016)!

So, with sleep, it's important to have the right *person–environment fit*—a baby's behavior should mesh with the wider world (in this case, the parent world). Still, I don't want to minimize the impact of enduring sleep issues. One longitudinal study suggested chronic sleep problems that continue into preschool put children at risk for having difficulties regulating their emotions in elementary school (Williams and others, 2016).

INTERVENTIONS: What Helps a Baby Self-Soothe?

Returning to infancy, what should parents do when their baby signals (cries out) from the crib? At one end of the continuum stand the behaviorists: "Don't reinforce crying by responding—and be consistent. Never go in and comfort the baby lest you let a variable reinforcement schedule unfold, and the child will cry longer." At the other pole, we have John Bowlby with his emphasis on the attachment bond, or Erik Erikson with his concept of *basic trust* (see Table 3.3). During the first year of life, both Bowlby and Erikson imply that caregivers should sensitively respond when an infant cries. These contrasting points of view evoke passions among parents, too:

> I feel the basic lesson parents need to teach children is how to be independent, not to let your child rule your life, give him time to figure things out on his own, and not be attended to with every whimper.

> I am going with my instincts and trying to be a good, caring mommy. Putting a baby in his crib to "cry it out" seems cruel. There is no such thing as spoiling an infant!

Where do you stand on this "Teach 'em" versus "Give unconditional love" controversy? Given that in a young baby the cortex has not fully come on-line, the behavioral "teach 'em not to cry" doesn't work during early infancy (Douglas & Hill, 2013; Stremler and others, 2013). But, by about month 7 or 8, it may be better

Table 3.3: Erikson's Psychosocial Stages of Childhood, Adolescence, and Emerging Adulthood

Life Stage	Primary Task
Infancy (birth to 1 year)	**Basic trust versus mistrust**
Toddlerhood (1 to 2 years)	Autonomy versus shame and doubt
Early childhood (3 to 6 years)	Initiative versus guilt
Middle childhood (7 to 12 years)	Industry versus inferiority
Adolescence and emerging adulthood (teens into twenties)	Identity versus role confusion
Emerging adulthood (twenties)	Intimacy versus isolation

According to Erikson, in the first year of life, our mission is to feel confident that the human world will lovingly satisfy our needs. Basic trust is the foundation for the challenges we face at every life stage.

to hang back, as babies who are quickly picked up may have more trouble learning to self-soothe (St. James-Roberts, 2007). So, if parents care vitally about getting a good night's sleep, it's best not to react to every nighttime whimper—but only when an infant approaches age 1 and can "learn" to get to sleep on her own.

Vigorous "settling activities"—carrying a child around at bedtime, making a big deal of an infant's getting to sleep—are correlated with sleep difficulties at age 5 (Sheridan and others, 2013). Therefore, new parents might metaphorically err on the side of letting sleeping dogs lie, meaning not make excessive efforts to quiet the child. Still, this doesn't mean don't get involved!

Rolf Bruderer/Blend Images/Getty Images

By lovingly preparing his baby for bed, this man is helping ensure a better night's sleep for *both* father and child. He also may be fostering basic trust—according to Erikson, the foundation for having a good life.

Research suggests that parents who use gentle, sensitive, and loving bedtime routines tend to have babies with fewer sleep problems (Teti and others, 2010). When caregivers spend ample time gently lulling infants to sleep, bedtime cortisol levels slide down (Philbrook & Teti, 2016). So, rather than any specific sleep strategy, the real key to promoting infant sleep is to put a child to bed with love.

And notice that when you feel disconnected from loved ones, you too may have trouble sleeping. To sleep soundly at *any age*, we need to feel cushioned by love.

The principle that love cushions sleep raises that controversial issue: Should parents have a baby regularly sleep with them in their bed?

To Co-Sleep or Not to Co-Sleep?

co-sleeping The standard custom, in collectivist cultures, of having a child and parent share a bed.

How do you feel about **co-sleeping**, or sharing a bed with a child? In the past, experts in our individualistic society strongly cautioned against co-sleeping (see Ferber, 1985). Behaviorists warned that bed sharing could produce "excessive dependency." Freudian theorists implied that co-sleeping might place a child at risk for sexual abuse. To ward off these evils, the standard practice was to place an infant's crib in a separate room.

In collectivist cultures, this solo sleep arrangement would qualify as infant abuse! (See Latz, Wolf, & Lozoff, 1999; Yang & Hahn, 2002.) Japanese parents, for instance, often separate to give each child a sleeping partner, because they believe co-sleeping is crucial to babies developing into caring, loving adults (Kitahara, 1989).

Who is right? As the research about co-sleeping is inconclusive (see Belsky, 2016, for a review), the key, again, is to arrange the right person–environment fit—that is, do what works best for you, but with this caution: In families where bed sharing is not part of the traditional culture, continual co-sleeping may be a symptom of marital distress. In one rural Pennsylvania survey, mothers who reported that they always had their babies share the family bed were more apt to report unhappy marriages, to (erroneously) see their babies as frequently waking up at night, and, ironically, were less emotionally available to their infants at bedtime than a comparison group whose babies slept alone (Teti and others, 2016).

What do U.S. parents do? National polls show most couples adopt a midway approach: They usually room share, but not bed share. They follow the professional advice that the best way to promote breast-feeding (and possibly guard against SIDS) is *not* to isolate infants in a separate room (Smith and others, 2016). What is *sudden infant death syndrome (SIDS)?*

Hot in Developmental Science: SIDS

sudden infant death syndrome (SIDS) The unexplained death of an apparently healthy infant, often while sleeping, during the first year of life.


studiomoment/iStock/Getty Images

This portable sleeping basket is user friendly around the world, but in the Maori culture, it qualifies as culture friendly, too.

Sudden infant death syndrome (SIDS) refers to the unexplained death of an apparently healthy infant, often while sleeping, during the first months of life. Although it strikes only about 1 in 1,000 U.S. babies, SIDS is a top-ranking cause of infant mortality in the developed world (Karns, 2001).

What causes SIDS? In autopsying infants who died during the peak risk zone for SIDS (about 1 to 10 months), researchers targeted abnormalities in a particular region of the brain. Specifically, SIDS infants had either too many or too few neurons in a section of the brain stem involved in coordinating tongue movements and maintaining the airway when we inhale (Lavezzi and others, 2010). SIDS has been linked to pathologies in the part of the brain stem producing cerebrospinal fluid, too (Lavezzi and others, 2013).

But even if SIDS is caused by biological pre-birth problems, this tragedy can have post-birth environmental causes. In particular, SIDS is linked to infants being inadvertently smothered, by being placed face down in a "fluffy" crib. During the early 1990s, this evidence prompted the American Academy of Pediatrics to urge parents to put infants to sleep on their backs. The "Back to Sleep" campaign worked, because from 1992 to 1997, there was a 43 percent reduction in SIDS deaths in the United States (Gore & DuBois, 1998).

Still, because placing babies on their backs requires that infants sleep separately in a crib, the "Back to Sleep" public health message contradicts the strong pro co-sleeping culture among non-Western groups. To circumvent this barrier, New Zealand scientists devised a strategy to permit Maori mothers to follow their traditional sleeping style and minimize the SIDS risk. They encouraged these women to return to another old-style practice—weaving a baby sleeping-basket. By placing this basket on parents' beds, co-sleeping has now become scientifically "correct" (Ball & Volpe, 2013)!

Table 3.4 offers a section summary in the form of practical tips for caregivers dealing with infants' eating, crying, and sleeping. Now it's time to move on to sensory development and moving into the world.

Table 3.4: Infants' Basic States: Summary Tips for Caregivers (and Others)

Eating

- Don't worry about continual newborn sucking and rooting. These are normal reflexes, and they disappear after the first months of life.
- As the baby becomes mobile, be alert to the child's tendency to put everything into the mouth and baby-proof the home (see the next section's discussion).
- Try to breast-feed, but if you need to work full-time or if nursing is too painful, don't berate yourself. The main benchmark of good motherhood is providing a child with loving care.
- Employers should make efforts to support nursing in the workplace. To really promote breast-feeding, *society* should offer mothers universal paid family leave!
- After the child is weaned, provide a balanced diet. But don't get frantic if a toddler limits her intake to a few "favorite foods" at around age 1½—this pickiness is normal and temporary.

Crying

- Appreciate that crying is crucial—it's the way babies communicate their needs—and realize that this behavior is at its peak during the first months of life. The frequency of crying declines and the reasons why a child is crying become clearer after early infancy.
- If a baby has colic, hang in there. This condition typically ends at month 4. Moreover, understand that colic has nothing to do with insensitive mothering.

- During the day, carry a young infant around in a "baby sling" as much as possible. In addition, employ infant massage to soothe the baby.

Sleeping

- Expect to be sleep-deprived for the first few months, until the typical infant learns to self-soothe; meanwhile, take regular naps. After that, expect periodic sleep problems and understand that children will give up their daytime nap at around age 2.
- After about 6 to 8 months of age, to promote self-soothing, don't pick up a sleeping infant at the first whimper. But the choice is really up to you—as the best way to promote sleep is to put a baby to bed with love.
- Co-sleeping is a personal decision; but the safest policy may be to room share, yet not routinely to have a baby sleep in a family bed.
- For sleep troubles occurring regularly into preschool, seek professional help.

Tying It All Together

1. You're a nurse in the obstetrics ward, and new parents often ask you why their babies turn their heads toward anything that touches their cheek and then suck. You say (pick two): *This is called the rooting reflex; This behavior is programmed by the lower brain centers to automatically occur at birth and disappear as the brain matures; This is a sign of early intelligence.*
2. Elaine tells you that breast-feeding is more difficult than medical authorities suggest. Make her argument, drawing on the points in this section.
3. Your sister and her husband are under enormous stress because of their 1-month-old's crying. Based on this section, give your relatives advice for soothing their child.
4. Jorge tells you that he's thrilled because last night his 6-month-old finally slept through the night. Is Jorge's child *ahead of schedule*, *behind schedule*, or *on time* for this milestone? Is Jorge right in saying, "My child is sleeping *through* the night"?
5. Poll your classmates, asking them if they believe in co-sleeping and whether they would immediately go in to quiet a crying infant. Do you find any differences in their answers by ethnicity, by gender, or by age?

Answers to the Tying It All Together questions can be found at the end of this chapter.

Sensory and Motor Development

LEARNING OUTCOMES

- Explain how scientists find out what infants can see.
- Describe the face perception findings and the purpose of the visual cliff study.
- Name three core principles of motor development.
- Trace how motor development unfolds and its impact on caregivers.

Sleeping, eating, and crying are easy to observe; but suppose you could time-travel back to your first days of life. What would you experience through your senses?

One sense is operational before we leave the womb. Using ultrasound, researchers can see startle reactions in fetuses in response to noise, showing that rudimentary hearing capacities exist before birth. As I mentioned in the previous chapter, the basics of vision may also be in place by about the seventh month of fetal life.

Table 3.5 on page 86 lists other interesting facts about newborn senses. Now, let's focus on vision because the research in this area is so extensive, the findings are so astonishing, and the studies devised to get into babies' heads are so brilliantly planned.

What Do Newborns See?

Imagine you are a researcher who wants to figure out what a newborn can see. What do you do? You put the baby into an apparatus, present images, and watch his eyes move. Specifically, researchers use the **preferential-looking paradigm**—the principle

preferential-looking paradigm A research technique to explore early infant sensory capacities and cognition, drawing on the principle that we are attracted to novelty and prefer to look at new things.

Table 3.5: Some Interesting Facts About Other Newborn Senses

Hearing: Fetuses can discriminate different tones in the womb (Lecanuet and others, 2000). Newborns prefer women's voices, as they are selectively sensitive to higher-pitched tones. At less than 1 week of age, babies recognize their mother's voice (DeCasper & Fifer, 1980). By 1 month of age, they tune in to infant-directed speech (described on page 98) communications tailored to them.

Smell: Newborns prefer the odor of breast milk to that of amniotic fluid (Marlier, Schaal, & Soussignan, 1998). Plus, smelling breast milk has a soothing effect; newborns cry more vigorously when facing a scentless breast (one covered with a transparent film) (Doucet and others, 2007).

Taste: Newborns are sensitive to basic tastes. When they taste a bitter, sour, or salty substance, they stop sucking and wrinkle their faces. They suck more avidly on a sweet solution, although they will stop if the substance grows too sweet. Having babies suck a sweet solution before a painful experience, such as an injection, reduces agitation and so is a helpful pain-management technique (Fernandez and others, 2003; Gibbins & Stevens, 2001).

habituation The predictable loss of interest that develops once a stimulus becomes familiar; used to explore infant sensory capacities and thinking.

face-perception studies Research using preferential looking and habituation to explore what very young babies know about faces.

that human beings are attracted to novelty and look selectively at new things. They draw on a process called **habituation**—the fact that we naturally lose interest in a new object after some time.

You can notice preferential looking and habituation in operation right now in your life. If you see or hear something new, you look up with interest. After a minute, you habituate and return to reading this book.

By showing newborns small- and large-striped patterns and measuring preferential looking, researchers find that at birth the ability to see clearly at distances is very poor. With a visual acuity score of roughly 20/400 (versus our ideal adult 20/20), a newborn would qualify as legally blind in many states (Kellman & Banks, 1998). But because the visual cortex matures quickly, vision improves rapidly, and by about age 1, infants see just like adults.

What visual capacities *do* we have at birth? A century ago, the first American psychologist, William James, described the inner life of the newborn as "one buzzing, blooming confusion." Studies exploring **face perception** (making sense of human faces) offer scientific data about the truth of James's ideas.

Focusing on Faces

Actually, when babies emerge from the womb, they selectively attend to the social world. When presented with the paired stimuli in Figure 3.6, newborns spend more time looking at the face pattern than at the scrambled pattern. They follow that facelike stimulus longer when it is moved from side to side (Farroni, Massaccesi, & Simion, 2002; Slater and others, 2010).

Newborns can make amazing distinctions. They prefer to look at a photo of their mother compared to one of a stranger (Bushnell, 1998). They also gravitate toward attractive-looking people!

Researchers selected photos of attractive and unattractive women, then took infants from the maternity ward and measured preferential looking. Babies looked at the attractive faces for significantly longer—61 percent of the time (Slater and others, 2010). Unhappily, our tendency to prefer people based on their looks seems somewhat biologically built in. (In case you are interested, more symmetrical faces tend to be rated as better-looking.)

Face preferences sharpen over time. Two-month-old infants preferentially look at speaking faces (those that move or make sounds) versus still faces (Bahrick and others, 2016). When researchers show photos of entrancing colored objects, 4-month-old babies gravitate to these visually captivating images rather than scanning a drabber face. But, no matter how exciting the competing stimulus, 8-month-olds prefer to gaze at a face (Kwon and others, 2016).

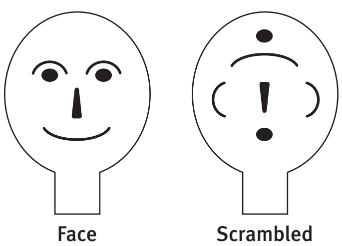


FIGURE 3.6: **Babies prefer faces** When shown these illustrations, newborns looked most at the facelike drawing. Might the fact that infants are biologically programmed to selectively look at faces be built into evolution to help ensure that adults give babies loving care?

At around the same age, an important lifelong pattern locks in. Infants selectively look at photos showing fearful expressions (versus happy or angry faces) (Grossman & Jessen, 2017). This **fear bias—**or hypersensitivity to facial expressions of fear, as you will learn in the next chapter—seems built into our species to keep us safe from harm.

A related, selective perception has not-so-nice effects. At approximately 9 months of age, infants around the world become less sensitive to facial differences in other ethnic groups (Kobayashi and others, 2016).

In a classic study demonstrating this visual narrowing, researchers tested European American babies at different points during the first year of life for their ability to discriminate between different faces within their own racial group and those belonging to other ethnicities (African American, Middle Eastern, and Chinese). While the 3-month-olds preferentially looked at "new faces" of every ethnicity, showing they could see the differences between individuals in each group, by 9 months of age, the babies could only discriminate between faces of their own ethnicity.

Why did this skill disappear? The cause, as you may have guessed, is cortical pruning—the fact that unneeded synapses in our visual system atrophy, or are lost (Slater and others, 2010). So if you have wondered why other races look more alike (compared to your own ethnic group, of course!), it's a misperception. You learned not to see these differences during your first year of life!

Randy Faris/Corbis/VCG/Getty Images

While we might think this adorable 8-month-old child would be entranced by these paintings, her attention is apt to be riveted on the human (facial) scene.

fear bias The human tendency to be hypersensitive to fearful facial cues that, by alerting us to danger, may prevent us from getting injured or killed.

depth perception The ability to see (and fear) heights.

visual cliff A table that appears to "end" in a drop-off at its midpoint; used to test infant depth perception.

Is Prejudice Partly Prewired?

This tantalizing research suggests that spending our first years of life in a racially homogenous environment might promote prejudice because the resulting neural atrophy could blunt our ability to decode the emotions of other ethnic groups. Amazingly, in testing U.S. teens adopted from Eastern European or Asian orphanages (places where infants are only exposed to caregivers of their ethnicity), scientists discovered that this was true. The longer a child lived in an orphanage, the less sensitive that adolescent was at picking up facial expressions of people from other races. Moreover, brain scans showed an unusual spike in the amygdala (our brain's fear center) when these young people viewed "foreign" faces. Therefore, simply being born in a multicultural city, such as New York or Chicago, might make us more tolerant because that experience prewires us *visually* to be more sensitive to the feelings of other races (Telzer and others, 2013)!

The main conclusion, however, is that William James was wrong. Newborns don't experience the world as a "blooming, buzzing confusion." We arrive in life with built-in antennae to tune into the human world. But visual skills change as we mature, in sometimes surprising ways.

Now let's trace another visual capacity as it comes on-line—the ability to see and become frightened of heights.

Seeing Depth and Fearing Heights

Imagine you are a researcher facing a conundrum: How can I find out when babies develop **depth perception—**the ability to "see" variations in heights—without causing them harm? Elinor Gibson's ingenious solution was to develop an apparatus called the **visual cliff.** As Figure 3.7 shows, Gibson and her colleague placed infants on one end of a table with a checkerboard pattern while their mothers stood at the opposite end (Gibson & Walk, 1960). At the table's midpoint, the checkerboard design moved from table to floor level, so it appeared to the babies that if they crawled beyond that point, they would fall. Even when parents encouraged their children to venture beyond what appeared to be the drop-off, 8-month-old babies refused to move—showing that depth perception fully comes on-line, but only when infants begin to crawl.

FIGURE 3.7: The visual cliff
Even though his mother is on the other side, this 8-month-old child gets anxious about venturing beyond what looks like the drop-off point in the table—demonstrating that by this age babies have depth perception.

In sum, the sick feeling we have when leaning over a balcony—"Wow, I'd better avoid falling into that space below"—emerged when we started moving into the world and needed that fear to protect us from getting hurt. How does mobility unfold?

Expanding Body Size

Our brain may expand dramatically after birth. Still, it's outpaced by the blossoming of the envelope in which we live. Our bodies grow to 21 times their newborn size by the time we reach adulthood (Slater, 2001). This growth is most dramatic during infancy, slows down during childhood, and speeds up again during the preadolescent years. Still, looking at overall height and weight statistics is not that revealing. This body sculpting occurs in a definite way.

Imagine taking time-lapse photographs of a baby's head from birth to adulthood and comparing your photos to snapshots of the body. While you would not see much change in the size and shape of the head, the body would elongate and thin out. Newborns start out with tiny "frog" legs timed to slowly straighten out by about month 6. Then comes the stocky, bowlegged toddler, followed by the slimmer child of kindergarten and elementary school. So during childhood, growth follows the same principle as inside the womb: Development, as Figure 3.8 suggests, proceeds according to the *cephalocaudal sequence*—from the head to the feet.

Now think of Mickey Mouse, Big Bird, and Elmo. They, too, have relatively large heads and small bodies. Might our favorite cartoon characters be enticing because they mimic the proportions of a baby? Did the deliciously rounded infant shape evolve to seduce adults into giving babies special care?

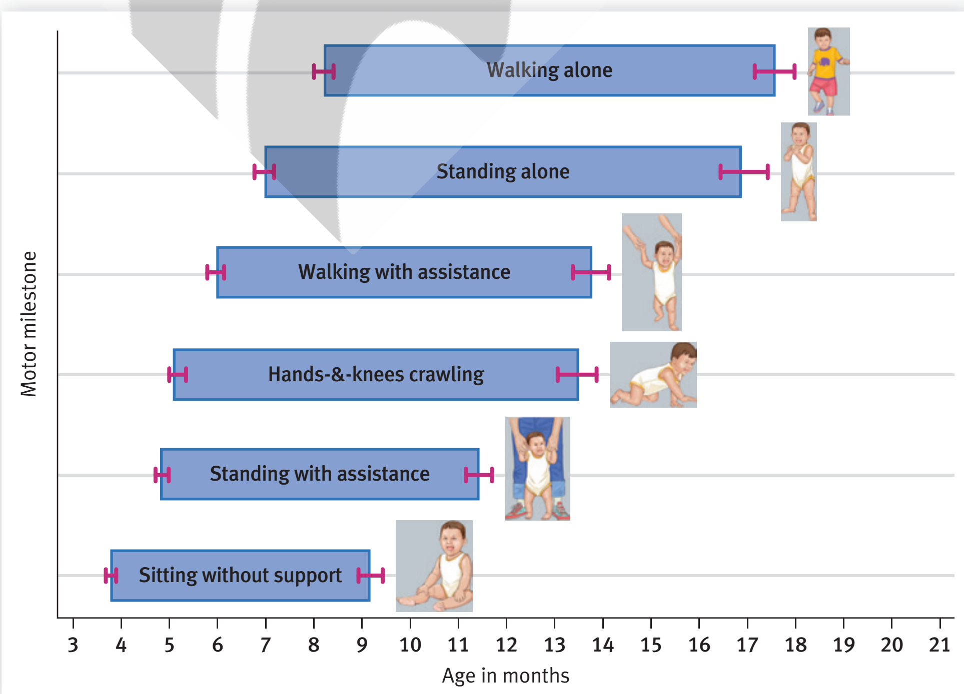


FIGURE 3.8: Approximate age ranges for reaching five motor milestones Notice how motor development follows the cephalocaudal principle, and the remarkable age gaps in the times at which babies *normally* reach each skill.

Data from World Health Organization, 2006.

Mastering Motor Milestones

moodboard/Corbis

At 8 or 10 months of age, getting around is a challenge that babies approach in creative, unique ways.

Actually, all three growth principles spelled out in the previous chapter—*cephalocaudal*, *proximodistal*, and *mass-to-specific*—apply to infant *motor milestones*, the exciting progression of physical abilities during the first year of life. First, babies lift their head, then pivot their upper body, then sit up without support, and finally stand (the cephalocaudal sequence). Infants have control of their shoulders before they can make their arms and fingers obey their commands (proximodistal sequence, from interior to outer parts).

But the most important principle in programming motor abilities throughout childhood is the *mass-to-specific* sequence (large before small and detailed). From the wobbly first step at age 1 to the home run out of the ballpark during the teenage years—as the neurons myelinate—big, uncoordinated movements are honed and perfected as children grow.

Variations (and Joys) Related to Infant Mobility

Charting these milestones does not speak to the joy of witnessing them unfold—that landmark moment when your daughter masters turning over, after those practice "push-ups," or first connects with the bottle, grasps it, and awkwardly moves it to her mouth. I'll never forget when my son, after what seemed like years of cruising around holding onto the furniture, finally ventured (so gingerly) out into the air, flung up his hands, and, *yes*, *yes*, took his ecstatic first step!

The charts don't mention the hilarious glitches that happen when a skill is emerging—the first days of "creeping," when a baby can only move backward and you find him huddled in the corner in pursuit of objects that get farther way. Or when a child first pulls herself to a standing position in the crib, and her triumphant expression changes to bewilderment: "Whoops, now tell me, Mom, *how do I get down?*"

Actually, rather than viewing motor development in static stages, researchers stress the variability and ingenuity of babies' passion to get moving into life (Adolph, 2008). Consider the creeping or belly-crawling stage. Some babies scoot; others hunch over or launch themselves forward from their knees, roll from side to side, or scrape along with a cheek on the floor (Adolph & Berger, 2006). And can I *really* say that there was a day when my son mastered walking? When walking, or any other major motor skill, first occurs, children do not make steady progress (Adolph & Berger, 2006). They may take their first solo step on Monday and then revert to crawling for a week or so before trying, oh so tentatively, to tackle toddling again.

But suppose a child is behind schedule. Let's say your son is almost 15 months old and has yet to take his first solo step. And what about the fantasies that set in when an infant is ahead? "Only 8 months old, and he's walking. Perhaps my baby is special—a genius!"

What typically happens is that, within weeks, the worries become a memory and the fantasies about the future are shown to be completely wrong. Except in the case of children who have developmental disorders, the rate at which babies master motor milestones has no relation to their later intelligence. Since different regions of the cortex develop at different times, why should our walking or grasping-an-object timetable predict development in a complex function such as grasping the point of this book?

But even if a baby's early locomotion (physically getting around) does not mean he will end up an Einstein, each motor achievement provokes other advances.

Motor Milestones Have Widespread Effects

Consider, for instance, that landmark event: reaching. Because it allows babies to physically make contact with the world, the urge to grasp objects propels sitting, as a child will tolerate plopping over in her hunger to touch everything she can (Harbourne and others, 2013).

Now consider how crawling changes the parent–child bond (Campos and others, 2000). When infants crawl, parents see their children as more independent—people with a mind of their own. Many say this is the first time they discipline their child. So as babies get mobile, our basic child-rearing agenda emerges: Children's mission is to explore the world. Adults' job, for the next two decades, lies in limiting exploration—as well as giving love.

INTERVENTIONS: Baby-Proofing, the First Person–Environment Fit

Motor development presents perils. Now safety issues become a concern. How can caretakers encourage these emerging skills and protect children from getting hurt? The answer is to strive for the right person–environment fit—that is, to **baby-proof** the house.

baby-proofing Making the home safe for a newly mobile infant.

Get on the floor and look at life from the perspective of the child. Cover electrical outlets and put dangerous cleaning substances on the top shelf. Unplug countertop appliances. Take small objects off tables. Perhaps pad the furniture corners, too. The challenge is to anticipate possible dangers and stay one step ahead. There will come a day when that child can pry out those outlet covers or ascend to the top of the cleanser-laden cabinet. Unfortunately, those exciting motor milestones have a downside, too!

Tying It All Together

1. Your 3-month-old perks up when you start the vacuum cleaner, and then after a moment, loses interest. You are using a kind of ________________ paradigm; and the scientific term for when your baby loses interest is ________________.
2. Tania says, "Visual capacities improve dramatically during the first year of life." Thomas replies, "No, in some ways our vision gets worse." Who is correct: Tania, Thomas, or both students? Why?
3. One implication of the face perception studies is that the roots of adult prejudice begin (choose one) *at birth/during the second 6 months of life/after age 2*.
4. If Alicia's 8-month-old daughter is participating in a visual cliff study, when she approaches the drop-off, she should (choose one): *crawl over it/be frightened*.
5. What steps would you take to baby-proof the room you are sitting in right now?

Answers to the Tying It All Together questions can be found at the end of this chapter.

Cognition

LEARNING OUTCOMES

- Describe the purpose of Piaget's sensorimotor stage.
- Outline the development of objective permanence.
- List two critiques of Piaget's theory.
- Explain some findings relating to social cognition.

Why *do* infants have an incredible hunger to explore, to reach, to touch, to get into every cleanser-laden cabinet and remove outlet plugs? For the same reason that, if you landed on a different planet, you would need to get the basics of reality down.

Imagine stepping out onto Mars. You would roam the new environment, exploring the rocks and the sand. While exercising your *walking schema*, or habitual way of physically navigating, you would need to make drastic changes. On Mars, with its minimal gravity, when you took your normal earthling stride, you would probably bounce up 20 feet. Just like a newly crawling infant, you would have to accommodate, and in the process reach a higher mental equilibrium, or a better understanding of

Table 3.6: Piaget's Stages: Focus on Infancy

Age (years)	Name of Stage	Description
0–2	Sensorimotor	The baby manipulates objects to pin down the basics of physical reality. This stage ends with the development of language.
2–7	Preoperations	Children's perceptions are captured by their immediate appearances. "What they see is what is real." They believe, among other things, that inanimate objects are really alive and that if a liquid looks visually different (for example, if it is poured from a short, wide glass into a tall, thin one), the amount actually becomes different.
8–12	Concrete operations	Children have a realistic understanding of the world. Their thinking is on the same wavelength as that of adults. While they can reason conceptually about concrete objects, however, they cannot think abstractly in a scientific way.
12+	Formal operations	Reasoning is at its pinnacle: hypothetical, scientific, flexible, fully adult. Children's full cognitive potential is reached.

life. Moreover, as a scientist, you would not be satisfied to perform each movement only once. The way to pin down the physics of this planet would be to repeat each action over and over again. Now you have the basic principles of Jean Piaget's **sensorimotor stage** (see Table 3.6).

sensorimotor stage Piaget's first stage of cognitive development, lasting from birth to age 2, when babies' agenda is to pin down the basics of physical reality.

Piaget's Sensorimotor Stage

Specifically, Piaget believed that during our first two years on this planet, our mission is to make sense of physical reality by exploring the world through our senses. Just as in the earlier Mars example, as infants *assimilate*, or fit the outer world to what they are capable of doing, they *accommodate* and so gradually mentally advance.

Let's take the "everything into the mouth" schema that figures so prominently during the first year of life. As babies mouth each new object—or, in Piaget's words, assimilate everything to their mouthing schema—they realize that objects have different characteristics. Some are soft or prickly. Others taste terrible or great. Through continual assimilation and accommodation, by age 2, babies make a dramatic mental leap—from relying on reflexes to reasoning and using symbolic thought.

Circular Reactions: Habits That Pin Down Reality

By observing his own children, Piaget discovered that driving all these advances were what he called **circular reactions**—habits, or action-oriented schemas, the child repeats again and again.

From the newborn reflexes, during months 1 to 4, **primary circular reactions** develop. These are repetitive actions centered on the child's body. A thumb randomly makes contact with his mouth, and a 2-month-old removes that interesting object, observes it, and moves it in and out. Waving her legs captivates a 3-month-old for hours.

At approximately 4 months of age, **secondary circular reactions** appear. As the cortex blossoms and the child begins to reach, action-oriented schemas become centered on the *outside* world. Here is how Piaget described his daughter Lucienne's first secondary circular reactions:

> Lucienne at 0:4 [4 months] is lying in her bassinet. I hang a doll over her feet which . . . sets in motion the schema of shakes. Her feet reach the doll . . . and give it a violent movement which Lucienne surveys with delight. . . . After the first shakes, Lucienne makes slow foot movements as though to grasp and explore. . . . When she tries to kick the doll, and misses . . . she begins again very slowly until she succeeds [without looking at her feet].
>
> (Piaget, 1950, p. 159 [as cited in Flavell, 1963, p. 103])

circular reactions In Piaget's framework, repetitive action-oriented schemas (or habits) characteristic of babies during the sensorimotor stage.

primary circular reactions In Piaget's framework, the first infant habits during the sensorimotor stage, centered on the body.

secondary circular reactions In Piaget's framework, habits of the sensorimotor stage lasting from about 4 months of age to the baby's first birthday, centered on exploring the external world.

tertiary circular reactions In Piaget's framework, "little-scientist" activities of the sensorimotor stage, beginning around age 1, involving flexibly exploring the properties of objects.

little-scientist phase The time around age 1 when babies use tertiary circular reactions to actively explore the properties of objects, experimenting with them like scientists.

During the next few months, secondary circular reactions become better coordinated. By about 8 months of age, babies can simultaneously employ two circular reactions, using both grasping and kicking together to explore the world.

Then, around a baby's first birthday, **tertiary circular reactions** appear. Now, the child is not constrained by stereotyped schemas. He can operate like a real scientist, flexibly changing his behavior to make sense of the world. A toddler becomes captivated by the toilet, throwing toys and different types of paper into the bowl. At dinner, he gleefully spits his food out at varying velocities and hurls his bottle off the high chair in different directions to see where it lands.

How important are circular reactions in infancy? Spend time with a young baby, as she bats at her mobile or joyously pinwheels her legs. Try to prevent a 1-year-old from hurling plates from a high chair, flushing money down the toilet, or inserting bits of cookie into a USB slot. Then you will understand: Infancy is all about the insatiable drive to repeat interesting acts. (See Table 3.7 for a recap of the circular reactions, as well as a look at the sensorimotor substages.)

Piaget's concept of circular reactions offers a new perspective on those obsessions that drive adults crazy during what researchers call the **little-scientist phase** (and parents call the "getting into everything" phase). This is the time, around age 1, when the child begins experimenting with objects in a way that mimics how a scientist behaves: "Let me try this, then that, and see what happens." The reason you can't derail a 1-year-old from putting oatmeal into the computer, or

Table 3.7: The Circular Reactions: A Summary Table (with a Look at Piaget's Sensorimotor Substages)

PRIMARY CIRCULAR REACTIONS: 1–4 MONTHS

Description: Repetitive habits center around the child's own body.

Examples: Sucking toes; sucking thumb.

Rommel/Masterfile

SECONDARY CIRCULAR REACTIONS: 4 MONTHS–1 YEAR

Description: Child "wakes up to wider world." Habits center on environmental objects.

Examples: Grabbing for toys; batting mobiles; pushing one's body to activate the lights and sounds on a swing.

Substages: From 4 to 8 months, children use single secondary circular reactions such as those above; from 8 to 12 months, they employ two circular reactions in concert to attain a goal (that is, they may grab a toy in each hand, bat a mobile back and forth, coordinate the motions of toys).

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TERTIARY CIRCULAR REACTIONS: 1–2 YEARS

Description: Child flexibly explores the properties of objects, like a "little scientist."

Examples: Exploring the various dimensions of a toy; throwing a bottle off the high chair in different directions; putting different kinds of food in the computer; flushing dollars down the toilet.

Substages: From 12 to 18 months, the child experiments with concrete objects; from 18 to 24 months, his little-scientist behavior transcends what is observable and involves using symbols to stand for something else. (I'll be describing the many advances ushered in by this ability to reason symbolically in later chapters.)

American Images Inc/Photodisc/Getty Images clogging the toilet with your hard-earned wages (making a plumber a parent's new best friend) is that circular reactions allow infants to pin down the basic properties of the world.

Why do *specific* circular reactions, such as flushing dollar bills down the toilet, become irresistible during the little-scientist phase? This question brings me to Piaget's ideas about how babies progress from reflexes to the ability to think.

Tracking Early Thinking

How do we know when infants think? According to Piaget, one hallmark of thinking is deferred imitation—repeating an action that the baby witnessed at an earlier time. When Piaget saw Lucienne, at 16 months of age, mimic a tantrum she had seen another child have days earlier, he realized she had the mental skills to keep that image in her mind, mull it over, and translate it into action on her own. Another sign of reasoning is make-believe play. To pretend you are cleaning the house or talking on the phone like Mommy, babies must realize that something *signifies*, or stands for, something else.

But the most important sign of emerging reasoning is **means–end behavior**—when the child is able to perform a separate, or different, action to get to a goal. Pushing the toilet lever to make the water swirl down, manipulating a switch to turn on the light, screwing open a bottle to extract the juice—all are examples of "doing something different" to reach a particular end.

If you have access to a 1-year-old, you might try to construct your own means–end task. First, show the child something she wants, such as a cookie or a toy. Then, put the object in a place where the baby must perform a different action to get the treat. For instance, you might put the cookie in a clear container and cover the top with Saran Wrap. Will the baby ineffectively bang the side of the container, or will she figure out the *different* step (removing the cover) essential to retrieving what she wants? If you conduct your test by putting the cookie in an opaque container, the baby must have another basic understanding: She must realize that—although she doesn't see it—the cookie still exists.

means–end behavior In Piaget's framework, performing a different action to get to a goal—an ability that emerges in the sensorimotor stage as babies approach age 1.

object permanence In Piaget's framework, the understanding that objects continue to exist even when we can no longer see them, which gradually emerges during the sensorimotor stage.

A-not-B error In Piaget's framework, a classic mistake made by infants in the sensorimotor stage, whereby babies approaching age 1 go back to the original hiding place to look for an object even though they have seen it get hidden in a second place.

Object Permanence: Believing in a Stable World

Object permanence refers to knowing that objects exist when we no longer see them—a perception that is, obviously, fundamental to our sense of living in a stable world. Suppose you felt that this book disappeared when you averted your eyes or that your house rematerialized out of nothing when you entered your driveway. Piaget believed that object permanence is not inborn. This perception develops gradually throughout the sensorimotor stage.

Piaget's observations suggested that during early infancy, life is a series of disappearing pictures. If an enticing image, such as her mother, passed her line of sight, Lucienne would stare at the place from which the image had vanished as if it would reappear out of thin air. (The relevant phrase here is "out of sight, out of mind.") Then, around month 5, when the *secondary circular reactions* are first flowering, there was a milestone. An object dropped out of sight and Lucienne leaned over to look for it, suggesting that she knew it existed independently of her gaze. Still, this sense of a stable object was fragile. The baby quickly abandoned her search after Piaget covered that object with his hand.

Hunting for objects under covers becomes an absorbing game as children approach age 1. Still, around 9 or 10 months of age, children make a surprising mistake called the **A-not-B error:** Put an object in full view of a baby into one out-of-sight

Doug Goodman/Science Source

A minute ago, this 4-month-old girl was delightedly grabbing this little dog, but when this barrier blocked her vision, it was "out of sight, out of mind." If you have access to a young baby, can you perform this test to track the beginning of *object permanence?*

location, have the baby get it, and then move it to another place while the child is watching, and she will look for it in the initial place!

See if you can perform this classic test if you have access to a 10-month-old: Place an object, such as a toy, under a piece of paper (A). Then have the baby find it in that place a few times. Next, remove the toy as the infant watches and put it under a *different* piece of paper (B). What happens? Even though the child saw you put the toy in the new location, he will probably look under the A paper again, as if it had migrated unseen to its original place!

By their first birthday, children seem to master the basic principle. Move an object to a new hiding place and they look for it in the correct location. However, as Piaget found when he used this strategy but *covered* the object with his hand, object permanence does not fully emerge until children are almost 2 years old.

Emerging object permanence explains many puzzles about development. Why does peek-a-boo become a favorite activity at around 8 months? The reason is that a child now thinks there is *probably* still someone behind those hands, but doesn't know for sure.

Emerging object permanence offers a wonderful perspective on why younger babies are so laid back when you remove an interesting object, but then become possessive by their second year of life. Those toddler tantrums do not signal a new, awful personality trait called "the terrible twos." They simply show that children are smarter. They now have the cognitive skills to know that objects still exist when you take them away.

Finally, the concept of object permanence, or fascination with disappearing objects, plus means–end behavior makes sense of a 1-year-old's passion to flush dollar bills down the toilet or the compulsion to stick bits of cookie in a USB port. What could be more tantalizing during the little-scientist phase than taking a new action to get to a goal and causing things to disappear and possibly reappear? It also explains why you can't go wrong if you buy your toddler nephew a pop-up toy.

But during the first year of life, there is no need to arrive with any toy. Buy a toy for an infant and he will push it aside to play with the box. Your niece probably prefers fiddling with the TV remote to any object from Toys R Us. Toys only become interesting once we realize that they are different from real life. So a desire for dolls or action figures—or for anything that requires make-believe play—shows that a child is making the transition from the sensorimotor period to symbolic thought. With the concepts of circular reactions, emerging object permanence, and means–end behavior, Piaget masterfully made sense of the puzzling passions of infant life!

Critiquing Piaget

Piaget's insights transformed the way psychologists think about childhood. Research confirms the fact that children are, at heart, little scientists. The passion to decode the world is built into being human from our first months of life (Gopnik, 2010). However, Piaget's timing was seriously off. Piaget's trouble was that he had to rely on babies' actions (for instance, taking covers off hidden objects) to figure out what they knew. He did not have creative strategies, like preferential looking and habituation, to decode what babies understand before they can physically respond. Using these techniques, researchers realized that young infants know far more about life than this master theorist ever believed (Baillargeon, Scott, & Bian, 2016). Specifically, scientists now understand that:

- **Infants grasp the basics of physical reality well before age 1.** To demonstrate this point, developmentalist Renée Baillargeon (1993) presented young babies with physically impossible events, such as showing a traveling rabbit puppet that never appeared in a gap it had to pass through to reach its place on the other side (illustrated in Figure 3.9A). Even 5-month-olds looked astonished when they saw these impossible events. You could almost hear them thinking, "I know that's not the way objects should behave."

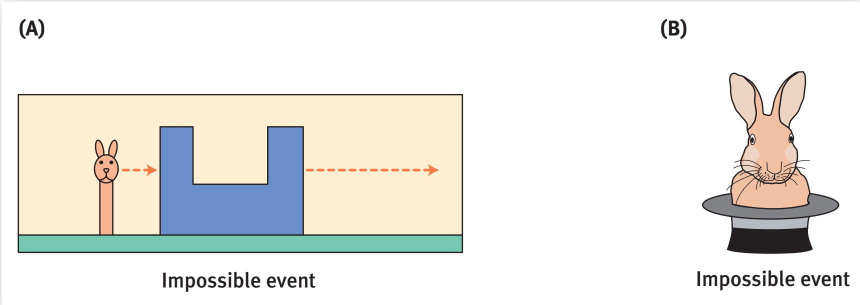


FIGURE 3.9: **Two impossible events** At about 5 months of age, babies were surprised by the physically impossible sequence in part A—but they did not look surprised by the event in part B until about age 1. The bottom line: Infants understand the physical world far earlier than Piaget believed, but this knowledge occurs gradually.

Information from Baillargeon, 1993; Baillargeon & DeVos, 1991; Baillargeon & Graber, 1987.

information-processing approach A perspective on understanding cognition that divides thinking into specific steps and component processes, much like a computer.

social cognition Any skill related to understanding feelings and negotiating interpersonal interactions.

- **Infants' understanding of physical reality develops gradually.** For instance, while Baillargeon discovered that the impossible event of the traveling rabbit in the figure provoked astonishment around month 5, other research shows it takes until age 1 for babies to master fundamental realities, such as the fact that you cannot take a large rabbit out of a little container (shown in Figure 3.9B). (As an aside, that explains why "magic" suddenly becomes interesting around age 2 or 3.) Therefore, rather than viewing development in huge qualitative stages, contemporary researchers decode step by step how cognition *gradually* emerges.

Information-processing researchers use the metaphor of a computer with separate processing steps to decode children's (and adults') intellectual skills. For instance, instead of seeing means–end behavior as a capacity that suddenly emerges at age 1, a psychologist using this approach would isolate the talents involved in this milestone—memory, attention, the ability to inhibit one's immediate perceptions—and chart how each skill develops over time.

Table 3.8 on the next page showcases insights about babies' memories and mathematical capacities, derived from using this gradual, specific approach. In Chapter 6, I will describe how information-processing perspectives shed light on memory and thinking during elementary school. Now, it's time to tackle another question: What do babies understand about human minds?

LivingImages/istockphoto/Thinkstock/Getty Images

For this 1-year-old, pushing the buttons on the TV remote is utterly captivating. Information-processing researchers want to understand what specific skills made this boy capable of achieving this miraculous means–end feat.

Tackling the Core of What Makes Us Human: Infant Social Cognition

Social cognition refers to any skill related to managing and decoding people's emotions, and getting along with other human beings. One hallmark of being human is that we are always making inferences about people's feelings and goals, based on their actions. ("He's running, so he must be late"; "She slammed the door in my face, so she must be angry.") When do these judgments first occur? Piaget would say not before age 2 (or much later) because infants in the sensorimotor period can't think conceptually. Here, too, Piaget was incorrect. Babies make sophisticated judgments about intentions at an incredibly young age (Baillargeon, Scott, & Bian, 2016).

Table 3.8: Infant Memory and Conceptual Abilities: Some Interesting Findings

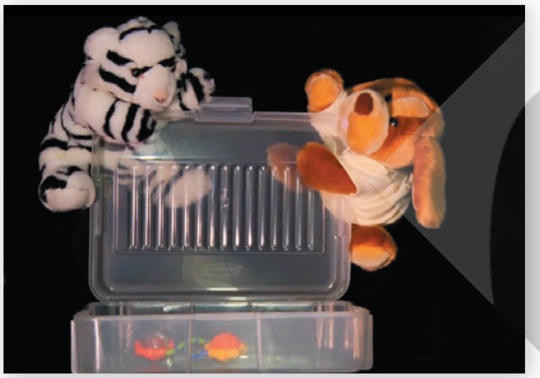
Memory: Researchers find that babies as young as 9 months of age can "remember" events from the previous day. Infants will push a button if they saw an adult performing that act 24 hours earlier. In another study, most 10-month-olds imitated an action they saw one month earlier. There even have been cases where babies this age saw an action and then remembered it a *year* later.*

Forming categories: By 7 to 9 months of age, babies are able to distinguish between animals and vehicles. They will feed an animal or put it to bed, but even if they watch an adult put a car to bed, they will not model her action. So the first classification babies make is between something that moves by itself or cannot move on its own. (Is it alive, like an animal, or inanimate?) Then, categorization abilities get more refined depending on familiarity. For example, 11-month-old infants can often distinguish between dogs and cats but not among dogs, rabbits, and fish.

Understanding numbers: By about 5 months of age, infants can make differentiations between different numbers—for instance, after seeing three dots on a screen, they will look preferentially at a subsequent screen showing four dots. Infants also have an implicit understanding of addition and subtraction. If they see someone add one doll to another, or take away a doll from a set, they look surprised when they see an image on a screen showing the incorrect number of dolls.

Information from Mandler, 2007.

*Because memory is central to cognition, a preverbal baby's skill in this area predicts the rapidity of language development and scores on intelligence tests.



PBS Courtesy of Karen Wynn

PBS Courtesy of Karen Wynn

After seeing this video sequence of events, even infants under 6 months of age preferentially reached for the "nice" tiger rather than the "mean" dog—showing that the fundamental human *social-cognitive* awareness that "he's acting mean or nice" emerges at a remarkably young age.

In one classic example, researchers first showed infants a video of a puppet or stuffed animal helping another puppet complete a challenging task (the nice puppet). In the next scene, another puppet hindered the stuffed animal from reaching his goal (the mean puppet). Then the experimenter offered the baby both puppets. And guess what? By the time they could reach (at about month 5), most infants grasped the "nice" stuffed animal rather than the puppet that acted "mean" (Hamlin & Wynn, 2011; Hamlin, 2013b).

This remarkable finding suggests we clue into motivations such as "She's not nice!" months before we begin to speak (Hamlin, 2013b). More astonishing, 8-month-old babies can make adult-like judgments about intentions. They preferentially reach for a stuffed animal that tries to help a puppet but fails. Here the reasoning may be: "He is a good guy. Even though he didn't succeed, he tried" (Hamlin, 2013a). Notice that these infants have intuitively mastered modern legal concepts we use in assessing criminal intent. Our system must determine: Was this an accident or did he mean it? He should only be punished if he *meant* to do harm.

But I cannot leave you with the sense that our species is primed to be mini-biblical King Solomons, behaving in a wise, ethical way. Some not-so-appealing human tendencies also erupt before age 1.

Using a similar procedure, the same research group found that 8-month-olds reach for a puppet they previously viewed hindering (acting mean) to another puppet if they view that puppet as different from themselves (Hamlin, 2013b; Hamlin and others, 2013). The principle here seems to be: "The enemy of my enemy is my friend." Or put more graphically: "I *like* people who are mean to people who are different than me." (In the next chapter, you will learn that a fear of anyone different—meaning, not a baby's primary caregiver—kicks in at exactly 8 months of age!)

In sum, during their second six months on this planet, babies can decode intentions—inferring underlying motivations from the way people behave. This mind-reading talent paves the way for that related human milestone: language, communicating our thoughts through words.

Tying It All Together

1. You are working at a child-care center, and you notice Darien repeatedly opening and closing a cabinet door. Then Jai comes over and pulls open the door. You decide to latch it. Jai—undeterred—pulls on the door and, when it doesn't open, begins jiggling the latch. And then he looks up, very pleased, as he manages to figure out how to open the latch. Finally, you give up and decide to play a game with Sam. You hide a stuffed bear in a toy box while Sam watches. Then Sam throws open the lid of the box and scoops out the bear. Link the appropriate Piagetian term to each child's behavior: *circular reaction; object permanence; means–end behavior.*
2. Jose, while an avid Piaget fan, has to admit that in important ways, this master theorist was wrong. Jose can legitimately make which two criticisms? (1) Cognition develops gradually, not in stages; (2) Infants understand human motivations; (3) Babies understand the basic properties of objects at birth.
3. Baby Sara watches her big brother hit the dog. Based on the research in this section, Sara might first understand her brother is being "mean" (choose one) *months before/at/months after age 1.*

Answers to the Tying It All Together questions can be found at the end of this chapter.

Language: The Endpoint of Infancy

LEARNING OUTCOMES

- Define the language acquisition device (LAD).
- List the stages of language development.
- Describe the function and features of infant directed speech (IDS).

Piaget believed that language signals the end of the sensorimotor period because this ability requires understanding that a symbol stands for something else. True, in order to master language, you must grasp the idea that the abstract word-symbol *textbook* refers to what you are reading now. But the miracle of language is that we string together words in novel, understandable ways. What causes us to master this feat, and how does language evolve?

Nature, Nurture, and the Passion to Learn Language

The essential property of language is elasticity. How can I come up with this new sentence, and why can you understand its meaning, although you have never seen it before? Why does every language have a **grammar**, with nouns, verbs, and rules for organizing words into sentences? According to the linguist Noam Chomsky, the reason is that humans are biologically programmed to make "language," via what he labeled the **language acquisition device (LAD).**

Chomsky developed his nature-oriented concept of a uniquely human LAD in reaction to the behaviorist B. F. Skinner's nurture-oriented proposition that we learn to speak through being reinforced for producing specific words (for instance, Skinner argued that we learn to say "I want cookie" by being rewarded for producing those sounds by getting that treat). This pronouncement was another example of the traditional behaviorist principle that "all actions are driven by reinforcement" run amok (see Chapter 1). It defies common sense to suggest that we can generate billions of new sentences by having people reinforce us for every word!

Still, Skinner is correct in one respect. I speak English instead of Mandarin Chinese because I grew up in New York City, not Beijing. So the way our genetic program for making language gets expressed depends on our environment. Again, nature plus nurture work together to explain every activity of life.

Currently, developmentalists adopt a **social-interactionist perspective** on this core skill. They focus on the motivations that propel language (Hoff-Ginsberg, 1997). Babies are passionate to communicate. Adults are passionate to help babies learn to talk. How does the infant passion to communicate evolve?

grammar The rules and word-arranging systems that every human language employs to communicate meaning.

language acquisition device (LAD) Chomsky's term for a hypothetical brain structure that enables our species to learn and produce language.

social-interactionist perspective An approach to language development that emphasizes its social function, specifically that babies and adults have a mutual passion to communicate.

Table 3.9: Language Milestones from Birth to Age 2*

Age	Language Characteristic
2–4 months	*Cooing:* First sounds growing out of reflexes *Example:* "ooooh"
5–11 months	*Babbling:* Alternate vowel–consonant sounds *Examples:* "ba-ba-ba," "da-da-da"
12 months	*Holophrases:* First one-word sentences *Example:* "ja" ("I want juice.")
18 months–2 years	*Telegraphic speech:* Two-word combinations, often accompanied by an explosion in vocabulary *Example:* "Me juice"

*Babies vary a good deal in the ages at which they begin to combine words.

Tracking Emerging Language

The pathway to producing language occurs in stages. Out of the reflexive crying of the newborn period comes *cooing* ("oooh" sounds) at about month 4. At around month 6, delightful vocal circular reactions called **babbling** emerge. Babbles are alternating consonant and vowel sounds, such as "da da da," that infants playfully repeat with variations of intonation and pitch.

babbling The alternating vowel and consonant sounds that babies repeat with variations of intonation and pitch and that precede the first words.

holophrase First clear evidence of language, when babies use a single word to communicate a sentence or complete thought.

The first word emerges out of the babble at around 11 months, although that exact landmark is difficult to define. There is little more reinforcing to paternal pride than when your 8-month-old genius repeats your name. But when does "da da da" really refer to Dad? In the first, **holophrase** stage of true speech, one word, accompanied by gestures, says it all. When your son says "ja" and points to the kitchen, you know he wants juice . . . or was it a jelly sandwich, or was he referring to his sister Jane?

Children accumulate their first 50 or so words, centering on the important items in their world (people, toys, and food), slowly (Nelson, 1974). Then, typically between ages 1½ and 2, there is a vocabulary explosion as the child begins to combine words. Because children pare down communication to its essentials, just like an old-style telegram ("Me juice"; "Mommy, no"), this first word-combining stage is called **telegraphic speech**. Table 3.9 summarizes these language landmarks and offers examples and the approximate time each milestone occurs.

telegraphic speech First stage of combining words in which a toddler pares down a sentence to its essential words.

Just as with the other infant achievements described in this chapter, developmentalists are passionate to trace language to its roots. It turns out that newborns are prewired to gravitate to the sounds of living things—as they suck longer when reinforced by hearing monkey and/or human vocalizations (versus pure tones). By 3 months of age, preferences get more selective. Now babies perk up *only* when they hear human speech (Vouloumanos and others, 2010).

By 8 months of age (notice the similarity to the visual-system atrophy research described earlier in this chapter), infants—like adults—lose their ability to hear sound tones in languages not their own (Gervain & Mehler, 2010). Simultaneously, a remarkable sharpening occurs. When language starts to explode, toddlers can hear the difference between similar sounds like "bih" and "dih" and link them to objects after *hearing this connection just once!*

Caregivers promote these achievements by continually talking to babies. Around the world, they train infants in language by using *infant-directed speech*. **Infant-directed speech (IDS)** (what you and I call *baby talk*) uses simple words, exaggerated tones, elongated vowels, and has a higher pitch than we use in speaking to adults (Hoff-Ginsberg, 1997). Although IDS sounds ridiculous ("Mooommy taaaaking baaaaby oooooout!" "Moommy loooooves baaaaby!"), infants perk up when they hear this conversational style (Santesso, Schmidt, & Trainor, 2007). So we naturally use infant-directed speech with babies, just as we are compelled to pick up and rock a

infant-directed speech (IDS) The simplified, exaggerated, high-pitched tones that adults and children use to speak to infants that function to help teach language.

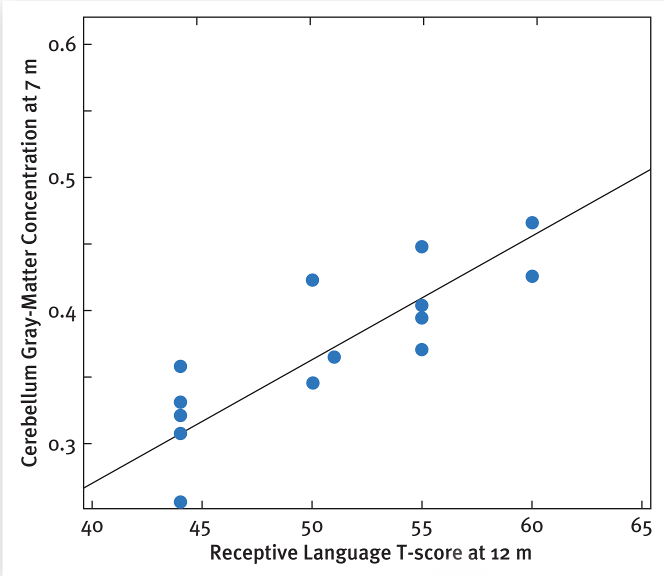


FIGURE 3.10: The relationship between gray matter (synaptogenesis) concentration in the cerebellum at 7 months of age and language comprehension at a child's first birthday This chart shows a close correlation between the quantity, or amount, of synaptogenesis in this particular brain region and a child's ability to understand language at age 1. The surprise is that this part of the brain—the cerebellum—does not qualify as a "higher brain center," as it programs balance and coordination.

Data from Deniz Can, Richards, & Kuhl, 2013.

child when she cries. Does IDS really help promote emerging language? The answer is yes.

Babies identify individual words better when they are uttered in exaggerated IDS tones (Thiessen, Hill, & Saffran, 2005). When adults are learning a new language, they benefit from the slow, repetitive IDS style. Therefore, rather than being just for babies, IDS is a strategy that teaches language across the board (Ratner, 2013). In fact, notice that when you are teaching a person *any* new skill you, too, are apt to automatically use IDS.

The close link between brain development at 7 months of age and children's speech understanding at age 1, shown in Figure 3.10, suggests that the neurological roots of language appear months before this capacity emerges (Deniz Can, Richards, & Kuhl, 2013; see also Dean and others, 2014). One surprising, observable sign of soon-to-emerge language is pointing with the right hand. Babies who demonstrate this pointing preference at an early age (let's say around 10 months of age) have larger later vocabularies because right-hand pointing is a general tip-off showing that the left-brain language centers are coming on-line (Mumford & Kita, 2016).

But even though our unique language timetable is genetically programmed (meaning due to biological differences), parents who use more IDS communications have babies who speak at a younger age (Ratner, 2013).

IDS is different from other talk. You don't hear this speech style on TV, at the dinner table, or on videos designed to produce 8-month-old Einsteins. IDS kicks in *only* when we communicate with babies one on one. So, if parents are passionate to accelerate language, investing millions in learning tools seems a distant second best to spending time *talking* to a child (Ratner, 2013).

Consistently pointing with her right hand points to the fact that this adorable 8-month-old may have a world-class vocabulary at age 2 or 3.

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A basic message of this chapter is that—from language to face perception to social cognition—our main agenda is to connect with the human world. The next chapter focuses on this number-one infant (and human) agenda by exploring attachment relationships during the first two years of life.

Tying It All Together

1. (a) "We learn to speak by getting reinforced for saying what we want." (b) "We are biologically programmed to learn language." (c) "Babies are passionate to communicate." Identify the theoretical perspective reflected in statements (a), (b), and (c): *Skinner's operant conditioning perspective; Chomsky's language acquisition device; a social-interactionist perspective on language.*
2. Baby Ginny is 4 months old; baby Jamal is about 7 months old; baby Sam is 1 year old; baby David is 2 years old. Identify each child's probable language stage by choosing from the following items: *babbling; cooing; telegraphic speech; holophrases.*
3. A friend makes fun of adults who use baby talk. Given the information in this section, is her teasing justified?

Answers to the Tying It All Together questions can be found at the end of this chapter.

SUMMARY

Setting the Context

Because our large **cerebral cortex** develops mainly after birth, during the first two years of life, the brain mushrooms. **Axons** elongate and develop a fatty cover called myelin. **Dendrites** sprout branches and at **synapses** link up with other cells. **Synaptogenesis** and **myelination** program every ability and human skill. Although the brain matures for decades, we do not simply "develop more synapses." Each region undergoes rapid synaptogenesis, followed by pruning (or cutting back). Before pruning, the brain is particularly **plastic,** allowing us to compensate for early brain insults—but synaptogenesis and learning occur throughout life.

Basic Newborn States

Eating patterns undergo dramatic changes during infancy. We emerge from the womb with **sucking** and **rooting reflexes,** which jump-start eating, as well as other **reflexes,** which disappear after the early months of life. Although the "everything into the mouth" phase of infancy can make life scary for caregivers, a 2-year-old's food caution can protect toddlers from poisoning themselves.

Breast-feeding is vital to survival in regions of the world without clean water and food. Although the link between nursing and infant health in developed nations can often be explained by confounding forces, such as greater maternal commitment and high social class, every public health organization advocates exclusive breast-feeding for the first 6 months of life. Most women, however, don't follow this advice. Breast-feeding is difficult when women need to work full-time or find nursing physically painful. The benchmark of being a good mother is unrelated to offering the breast; it's providing love.

Undernutrition, in particular **stunting** and **micronutrient deficiencies,** affect a significant fraction of young children in impoverished areas of the world. Although families with children in the United States may suffer from **food insecurity,** stunting is rare in the United States, thanks to government entitlement programs.

Crying is at its height during early infancy, and declines around month 4 as the cortex develops. **Colic,** excessive crying that disappears after early infancy, is basically a biological problem. Strategies for quieting babies include rocking, **skin-to-skin** contact, and massage. **Kangaroo care** helps at-risk premature babies grow.

Sleep is the basic newborn state, and from the 14-hour, waking-every-few hours newborn pattern, babies gradually adjust to sleeping through the night. **REM sleep** lessens and shifts to the end of the cycle. Babies, however, really do not ever sleep through the night. At about 6 months, many learn **self-soothing,** the ability to put themselves back to sleep when they wake up. The decision about whether to "let a baby cry it out" or respond immediately at night is personal, because the best way to foster sleep is to provide a caring bedtime routine. **Co-sleeping**—the norm in collectivist cultures—is controversial; and U.S. parents today typically room share, rather than share a bed.

Sudden infant death syndrome (SIDS)—when a young baby stops breathing, often at night, and dies—is a main cause of developed-world infant mortality. Although SIDS may be caused by impairments in the developing fetal brain, it tends to occur most often when babies sleep facedown. Therefore, a late-twentieth-century SIDS campaign urging parents to put babies to sleep on their backs (not stomachs) has been effective, although delivering this message is difficult in cultures that prize co-sleeping.

Sensory and Motor Development

The **preferential-looking paradigm** (exploring what objects babies look at) and **habituation** (the fact that we get less interested in looking at objects that are no longer "new") are used to determine what very young babies can see. Although at birth visual acuity is poor, it improves very rapidly. **Face-perception studies** show that newborns look at facelike stimuli, recognize their mothers, and even prefer good-looking people from the first weeks of life. At the same time as infants get more adept at reading facial cues and develop a **fear bias,** neural pruning causes babies to become less able to see facial variations in people of other races and ethnic groups. Sadly, this loss of sensitivity may promote prejudice against people outside of our ethnic group. **Depth perception** studies using the **visual cliff** show that babies get frightened of heights around the time they begin to crawl.

Infants' bodies lengthen and thin out as they grow. The cephalocaudal, proximodistal, and mass-to-specific principles apply to how the body changes and to emerging infant motor milestones. Although they do progress through stages when getting to walking, babies show incredible creativity and variability when they first attain various skills. Earlier-than-normal motor development does not predict advanced cognition; but as babies get more mobile, parents need to discipline their children and **baby-proof** their home.

Cognition

During Piaget's **sensorimotor stage,** babies master the basics of physical reality through their senses and begin to symbolize and think. **Circular reactions** (habits the baby repeats) help babies pin down the basics of the physical world. **Primary circular reactions—**body-centered habits, such as sucking one's toes—emerge first. **Secondary circular reactions,** habits centered on making interesting external stimuli last (for example, batting mobiles), begin around month 4. **Tertiary circular reactions,** also called **"little-scientist"** activities—like spitting food at different velocities just to see where the oatmeal lands—are the hallmark of the toddler years. A major advance in reasoning that occurs around age 1 is **means–end behavior—**understanding the need to do something different to achieve a goal.

Piaget's most compelling concept is **object permanence**—knowing that objects exist when you no longer see them. According to Piaget, this understanding develops gradually during the first years of life. When this knowledge is developing, infants make the **A-not-B error,** looking for an object in the place where they first found it, even if it has been hidden in another location before their eyes.

Using preferential looking, and watching babies' expressions of surprise at impossible events, researchers now know that babies understand physical reality far earlier than Piaget believed. Because Piaget's stage model also does not fit the gradual way cognition unfolds, contemporary developmentalists may adopt an **information-processing approach,** breaking thinking into separate components and steps. Scientists studying **social cognition** find that babies understand people's motivations (and prefer people, based on judging their inner intentions) remarkably early in life.

Language: The Endpoint of Infancy

Language, specifically our use of **grammar** and our ability to form infinitely different sentences, sets us apart from any other animal. Although B. F. Skinner believed that we learn to speak through being reinforced, the more logical explanation is Chomsky's idea that we have a biologically built-in **language acquisition device (LAD). Social-interactionists** focus on the mutual passion of babies and adults to communicate.

First, babies coo, then **babble,** then use one-word **holophrases,** and finally, at age 1½ or 2, progress to two-word combinations called **telegraphic speech.** Caregivers naturally use **infant-directed speech** (IDS; exaggerated intonations and simpler phrases) when they talk to babies. Talking to babies in **IDS** is better than any baby-genius tape in promoting this vital human skill.

KEY TERMS

A-not-B error, p. 93
axon, p. 72
babbling, p. 98
baby-proofing, p. 90
cerebral cortex, p. 72
circular reactions, p. 91
colic, p. 79
co-sleeping, p. 83
dendrite, p. 72
depth perception, p. 87
face-perception studies, p. 86
fear bias, p. 87
food insecurity, p. 78
grammar, p. 97
habituation, p. 86
holophrase, p. 98
infant-directed speech (IDS), p. 98
information-processing approach, p. 95
kangaroo care, p. 80
language acquisition device (LAD), p. 97
little-scientist phase, p. 92
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synapse, p. 72
synaptogenesis, p. 72
telegraphic speech, p. 98
tertiary circular reactions, p. 92
undernutrition, p. 78
visual cliff, p. 87

ANSWERS TO **Tying It All Together** QUIZZES

Setting the Context

1. Both Cortez and Ashley are right. We are unique in our massive cerebral cortex, in growing most of our brain outside of the womb, and in the fact that the human cortex does not reach its adult form for more than two decades.
2. Latisha is only partly right. Synaptic loss and neural pruning are essential to fostering babies' emerging abilities.
3. When babies have a stroke, they may end up *less* impaired than during adulthood, due to *brain plasticity*.
4. *Synaptogenesis* is occurring in babies, mothers, and grandmas alike. *Myelination* (or formation of the myelin sheath) ends by the mid-twenties.

Basic Newborn States

1. You need to pick the first two statements: The rooting reflex is programmed by the low brain centers to appear at birth and then go away as the cortex matures. Its appearance is definitely *not* a sign of early intelligence.
2. Elaine should say that breast-feeding is difficult if women need to work full-time. It also can be physically painful. This explains why many women don't follow the professional advice.
3. Tell your relatives to carry the child around in a baby sling (kangaroo care). Also, perhaps make heavy use of a pacifier and employ baby massage.
4. Jorge's child is right on schedule, but he's wrong to say his child is sleeping through the night. The baby has simply learned to self-soothe.
5. The answers here will depend on the class.

Sensory and Motor Development

1. You are using a kind of *preferential-looking* paradigm; the scientific term for when your baby loses interest is *habituation*.
2. Both Tania and Thomas are right. In support of Tania's "dramatic improvement" position, babies develop a remarkable sensitivity to facial nuances (such as their preference for good-looking people and the fear bias) early in life. Thomas is also correct that in some ways vision gets worse during infancy. He should mention the fact that by 9 months of age we have "unlearned" the ability to become as sensitive to facial distinctions in people of other ethnic groups.
3. The roots of adult prejudice may begin *during the second 6 months of life*.


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4. The child should *be frightened* of the cliff.
5. Your answers might include installing electrical outlet covers; putting sharp, poisonous, and breakable objects out of a baby's reach; carpeting hard floor surfaces; padding furniture corners; installing latches on cabinet doors; and so on.

Cognition

1. Circular reaction = Darien; means–end behavior = Jai; object permanence = Sam.
2. Cognition develops gradually rather than in distinct stages; infants understand human motivations.
3. Baby Sara should pick up this idea *months before* age 1.

Language: The Endpoint of Infancy

1. (a) The idea that we learn language by getting reinforced reflects Skinner's operant conditioning perspective; (b) Chomsky hypothesized that we are biologically programmed to acquire language; (c) the social-interactionist perspective emphasizes the fact that babies and adults have a passion to communicate.
2. Baby Ginny is cooing; baby Jamal is babbling; baby Sam is speaking in holophrases (one-word stage); and baby David is using telegraphic speech.
3. No, your friend is wrong! Baby talk—or in developmental science terms, infant-directed speech (IDS)—helps promote early language.

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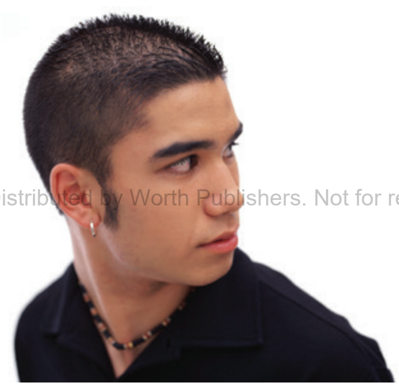
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