PART 2 INFANCY AND TODDLERHOOD

4 Physical and Cognitive Development in Infancy and Toddlerhood

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Growing

4.1 Explain factors promoting healthy patterns of growth and development during the first two years.

The Changing Brain

4.2 Explain the role of neurons and synapses in brain function during the first two years.

Sensing and Moving

4.3 Describe vision and hearing development in infancy.

4.4 Explain how the typical maturation of movement changes a baby's experience of the world.

Cognitive Development and Learning

4.5 Explain maturation in sensorimotor thinking, attention, and memory during infancy and toddlerhood.

4.6 Describe the factors influencing learning during the first two years.

Language Development

4.7 Describe the typical pattern of language development in the first two years.

Selected Resources from Achieve

Activities

Spotlight on Science: Using the Experimental Method to Fight Allergies

Concept Practice: Sequence of Motor Development

Assessments

LearningCurve

Practice Quiz

Videos

Scientific American Profiles

Observing Development: Language Development in Infancy and Toddlerhood

Marjorie and Dewey were excited to be parents. Before their daughter Telele arrived, they went to dozens of doctor's visits, read baby books, and picked a pediatrician. They wanted to make sure that their daughter had the best beginning possible.

Marjorie and Dewey knew that learning is important even in the first few years of life. As members of their Iñupiaq and Denaakk'e Alaskan communities, they wanted Telele to know from the beginning that she was linked to her people and their land. They wanted to welcome their daughter with the beauty of their culture: Marjorie even had Iñupiaq symbols tattooed on her legs so that they were the first images Telele saw as she was born. And the first words Telele heard were in Iñupiaq and Denaakk'e: "We love you baby. Welcome, welcome."

Marjorie and Dewey fell in love through a shared commitment to their Indigenous community, speaking their native languages and living close to the land. When they met, Dewey was teaching Denaakk'e at a Head Start center, and Marjorie was in graduate school and working as an artist. Marjorie, whose background is Iñupiaq and Kiowa, had been speaking Iñupiaq since she was a teenager. Dewey became passionate about learning and teaching Denaakk'e after he finished college.

Like many caregivers, Marjorie and Dewey have big dreams for their child. They want Telele to identify as a proud, Indigenous adult and to feel connected to their communities. They want to teach her to fish for salmon, collect berries, and bead intricate designs like her great-grandmothers. They also want to ensure that Telele is healthy and can make her way in an English-speaking world. Therefore,

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Telele is learning not only Denaakk'e and Iñupiaq but also English and a little sign language. Like one in five American children, Telele will be *multilingual*, a speaker of more than one language (ACS, 2015).

In the nearly two years since her birth, Telele has grown from a newborn small enough to hold with one arm to a toddler who is nearly too heavy to carry. She has learned how to move, eat pancakes and blueberries, and (most of the time) sleep through the night, as well as how to talk and understand her surroundings. Telele's brain has gotten bigger, too, more than doubling in size and sending signals up to 100 times faster (Johnson & deHaan, 2015; Zhang et al., 2019). Telele is now a *toddler*, a term that refers to the wobbly toddling movements of 1- to 3-year-olds.

Like Telele, infants and toddlers are flexible in how they adapt, whether it is speaking one language or three, sleeping through the night or waking up to cuddle, or eating chili peppers or chocolate, depending on the expectations of their families and communities. The first years of life set the foundation for health and cognitive development later on. As you will learn, there are a variety of ways to support babies as they develop the healthy bodies and curious minds they will need to thrive.

Scientific American Profile

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Meet Telele

Growing

Learning Objective

4.1 Explain factors promoting healthy patterns of growth and development during the first two years.

Telele had a lot of doctor's visits in her first years of life. Pediatricians recommend infants and toddlers get weighed and measured frequently, because babies grow more rapidly than at any other point in the lifespan, and their health is more fragile (BrightFutures, 2021).

By their second birthday, babies nearly triple their birthweight and grow about a foot taller. When she was a month old, Telele weighed 8½ pounds (3.6 kg). A year later she weighed 20 pounds, and by age 2, she had added another 7 pounds (3.2 kg), a typical trajectory for babies as they quickly grow muscle, bone, and brain tissue. Their body shape changes, too. It takes a few weeks for newborns to take on the soft, round shape we think of as babyish. Infants get lankier and leaner again around 12 months as they begin moving around (Brown et al., 2016).

Babies grow up to be adults of different heights, but they are remarkably similar in size for the first two years of life (de Onis, 2017). Genes play a long-term role in height, but they don't make a major difference for infants' size. This is why health workers around the world use the same *growth charts* that track the optimal increase in babies' height and weight (see **Figure 4.1**). If babies are growing too quickly or not quickly enough, usually something in their environment or an illness is the culprit.

Around the globe, more than one in five infants experience **malnutrition**, or do not get enough food or nutrients to support their growth. That number is expected to increase in coming years as a result of disruptions caused by the COVID-19 pandemic (Headey et al., 2020). Before the pandemic, researchers found that about 7 percent of children worldwide were so seriously malnourished that they experienced **wasting** (UNICEF/WHO/World Bank Group, 2020). Children who have growth wasting are below the 5th **percentile** in the ratio of weight to height, or lighter than 95 percent of other children their age and height.

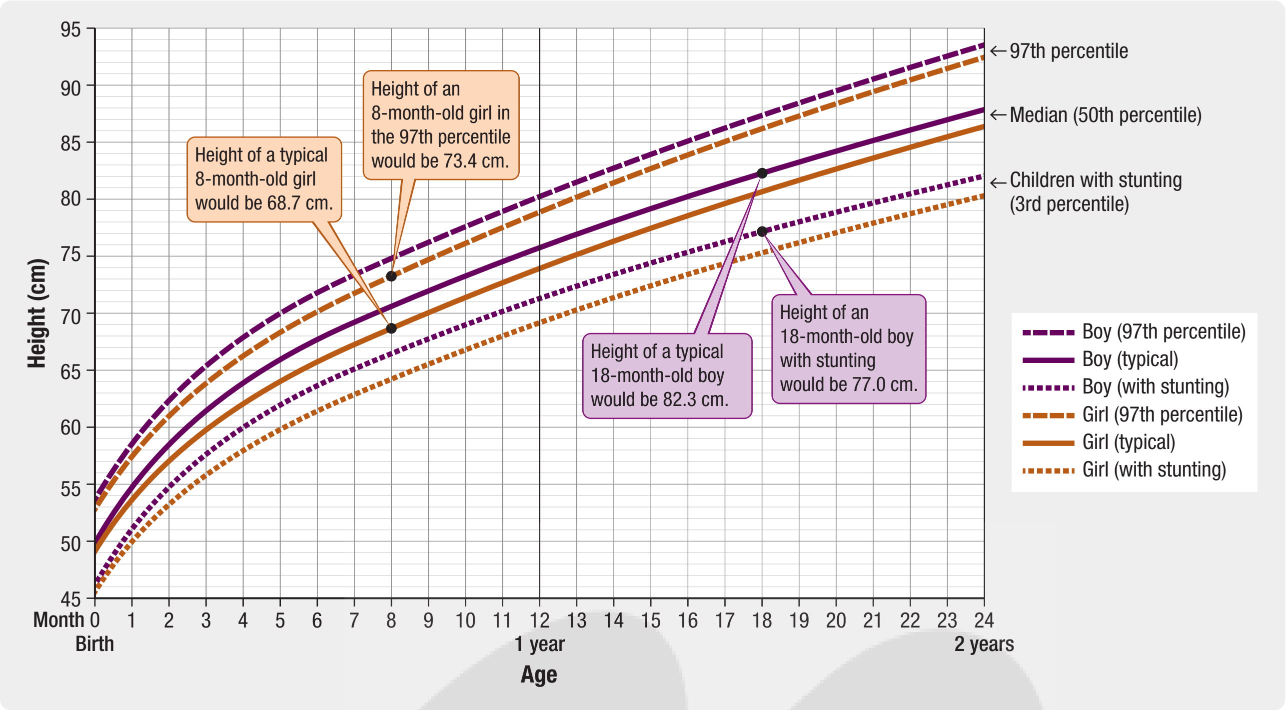
Children can experience growth wasting when they do not have enough food or develop a serious illness. For instance, Telele was a typical 23 pounds (10.5 kg) at 16 months. A child with growth wasting would weigh less than 18½ pounds (8.5kg). If babies are malnourished for a long period, they may also experience **stunting**, which means that their growth has slowed so much that they are significantly shorter

malnutrition When someone does not have adequate nutrients to support their growth.

wasting When a child is so seriously malnourished that they are below the 5th percentile in the ratio of weight to height, or lighter for their height than 95 percent of children their age and height.

percentile A way of statistically comparing an individual to a group.

stunting When a child's growth has slowed so much that they are significantly shorter than they should be for their age.



Data from World Health Organization, 2006.

FIGURE 4.1 **Understanding the Growth Curve** Growth charts help health professionals track individual growth. For instance, a child in 35th or 70th percentile would likely track around that same level at each checkup. Diverging from the percentile might indicate a problem, such as when an infant suddenly drops into the 25th percentile from the 70th percentile.

than they should be for their age, or smaller than 98 percent of all other children (de Onis et al., 2019). For instance, at age 2, Telele was 31 inches (79 cm) tall, but a toddler with stunting might be just 27 inches (69 cm) tall. Around the world, more than one in five children show signs of stunting (UNICEF/WHO/World Bank Group, 2020). In the United States, as in other affluent countries, very few children — fewer than 3 in every 100 — develop stunting (Fryar et al., 2020a).

Malnutrition affects the brain as well as the body and is likely to lead to learning challenges (McCormick et al., 2020). Prevention begins with improving nutrition during pregnancy and breastfeeding, as well as making sure babies are well-nourished and avoid chronic infections early in life (Bhutta et al., 2020). Public health **interventions** — evidence-based programs or services designed to improve health, psychological well-being, or behavior — have dramatically improved the rate of malnutrition and helped children recover. Interventions may happen at the population level, as when an entire community benefits from extra nutrients in milk, or at the individual level, as when one family is offered supplemental vitamins. A generation ago, twice as many children around the world had stunted growth. Today, more children are growing to their full potential (Vaivada et al., 2020).

In the United States and many other communities around the world, being too large is more common than being too light (Fryar et al., 2020b). Infants who are heavier for their age and height than most other children, or above the 85th percentile on

Benedicte Kurzen/NOOR /Redux

Checking the Garden In rural Senegal, access to fresh water for drinking and growing has made it easier for families to grow healthy food.

interventions Evidence-based programs or services designed to improve health, psychological well-being, or behavior.

overweight When a child is heavier for their age and height than most other children, or above the 85th percentile.

CONNECTIONS

We will look more in depth into controversies about measuring size and health, and the stigma against larger bodies, in Chapter 6.

growth charts, are said to have an unhealthy weight, which medical providers refer to as **overweight**. In the United States, about one in eight 2-year-olds has an unhealthy weight (Fryar et al., 2020b).

Babies with an unhealthy weight have an increased likelihood for poor health later in life, including a higher rate of asthma, cardiovascular disease, and diabetes (Deal et al., 2020). This is particularly true for babies who were born prematurely and for those who gain weight very quickly in the first six months (Ou-Yang et al., 2021). Experts believe that these early months program an infant's metabolism (Fall & Kumaran, 2019). Babies who gain weight too rapidly are less likely to stay at a healthy weight in adulthood (Zheng et al., 2018).

Even when it comes to infants, talking about weight is difficult (Pesch et al., 2021). Larger bodies are stigmatized in communities around the world (Puhl et al., 2021). Medical providers must explain that weight is one of many factors influencing children's health without shaming families. Conversations about weight often trigger feelings of parental guilt, which make it more difficult for families to build positive attitudes about eating (Hagerman et al., 2020).

Zhang Yuwei/Xinhua News Agency/eyevine/Redux

Nursing Can Be Hard for Parents... But it is fascinating for big brother. Song Dan helps make nursing easier on parents (and babies) as a professional lactation consultant near her home in Beijing, China.

Healthy Nutrition

One of the biggest questions parents have for health care providers is what they should be feeding their babies (Lavigne et al., 2017). Early foods vary. In some places, babies are not fed at all for the first days of life. In others, infants may be given special tea, honey, or formula (Chea & Asefa, 2018; O'Neil et al., 2017). Regardless of where they live, all infants must be fed frequently because their small bodies can handle only tiny servings, and they need extra nutrients to fuel their rapid growth.

Human Milk Experts agree that babies should ideally be fed only human milk from birth until they are about 6 months old. From about 6 months to 2 years, or longer, babies may continue to drink human milk but also begin to eat other foods (Meek et al., 2020).

Human milk is a complex and living concoction of stem cells, immune-boosting antibodies, immune cells, and disease-fighting proteins (Boquien, 2018). But producing milk is not always easy. More than 8 in 10 nursing parents in high-income countries report difficulties with expressing milk, including breast infections and intense nipple pain (Lucas et al., 2019). Difficulties are more common for adoptive or transgender parents, who *may* be able to express human milk and nurse but often lack the medical and social support to get started (Paynter, 2019; Trautner et al., 2020). You do not need to identify as a woman in order to create human milk: With hormonal support, early reports suggest that breast tissue in many people can support infant development. Some people feel uncomfortable with the gender labels for expressing milk, and may prefer the more neutral term *chestfeeding* to breastfeeding (MacDonald et al., 2019).

Share It!

For people who are used to getting milk from the refrigerator, human milk can be surprising. The yellowish paste that is first expressed, known as *colostrum*, is supercharged with nutrients and beneficial bacteria.

(Bardanzellu et al., 2017)

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CAN YOU BELIEVE IT?

Is Human Milk Magic?

You have probably heard many claims about the benefits of human milk—that it makes children smarter or reduces their risk of developing an unhealthy weight. For many caregivers, especially those who do not identify as women, those who work, and those who have certain physical conditions expressing milk can be challenging or impossible. Some families may feel judged for not feeding their infants human milk (Penniston et al., 2021). What is the evidence for the benefits of human milk in this sometimes sensationalized discussion (Jackson et al., 2021)?

Scientists have investigated the benefits of human milk through large observational studies of families, comparing babies who received human milk with those who did not. As you may remember from Chapter 2, these are *correlational studies*, because they look at the correlation, or the relationship, between babies' health and what and how they are fed (Azad et al., 2018).

Correlational studies have found that babies who receive human milk are less likely to die early in life or develop diarrheal and infectious diseases (Christensen et al., 2020; Victora et al., 2016). Some studies have found that benefits continue after infancy: Babies who received human milk are at lower risk for unhealthy weight, diabetes, and cardiovascular disease when they are older (Güngör et al., 2019; Rzehak et al., 2017). Some research even suggests that babies who receive human milk score slightly higher on intelligence tests later in life and may have an easier time regulating their emotions (Horta et al., 2018; Weaver et al., 2018). There are benefits for people who express milk, too, including lower risks for cardiovascular disease, cancer, and depression (Sattari et al., 2019).

Some of the associations between human milk and children's outcomes are very strong; others are weaker. For instance, babies in low-income countries are about 14 times more likely to survive to their first birthday if they receive human milk instead of formula, which is a strong association (Horta, 2019). However, babies who receive human milk have intelligence test scores that are only two-tenths of a percentage point higher than formula-fed babies, a much smaller association (Oster, 2019).

Stronger evidence also comes when there is a testable explanation for *why* the relationships occur. Some studies have found observable differences in the process of nursing and in human milk itself that make it beneficial. Human milk is lower in protein than formula, contains different fats, and conveys microbes that help develop intestinal bacteria: This may account for some of the health benefits (Deoni et al., 2018; Horta, 2019). Behaviors matter, too: Families tend to interact with babies differently when they are nursing than during bottle-feeding. There is more skin-to-skin contact and back-and-forth interaction, and infants have more control. These distinctions may contribute to later differences in babies' emotion regulation, appetite, and cognitive development (Hodges et al., 2020).

Remember from Chapter 2 that experiments are a gold standard for research because they seek to identify a *causal relationship* between variables. Experiments conducted in Belarus, an Eastern European country, compared the outcomes of babies who were randomly assigned to receive either human milk or formula (Singhal et al., 2004). The researchers established that babies who received human milk were healthier than those who did not receive human milk and scored slightly higher on intelligence tests, although these differences decreased over time (Yang et al., 2018).

As a result of decades of research, scientific consensus is that there are strong benefits for human milk, particularly when it is delivered through nursing and particularly for families who live in low-resource settings with limited health care (Azad et al., 2018; National Academy, 2020). However, in communities like the United States, human milk is not a cure-all. Nutrition is complex: Dramatic effects due to a single variable are rarely seen in developmental science. While human milk is certainly helpful, babies can thrive without it. Relationships are more central to how infants grow than micronutrients are, and relationships are not built on *what* babies drink but on *how* they are fed (Hairston et al., 2019).

Around the world, fewer than half of families are able to feed their babies human milk exclusively for the first six months of life (UNICEF, 2020). In affluent countries

Westend61/Getty Images

Sharing a Moment Bottle-feeding takes patience, attention, and time. Feeding a newborn gives parents and babies time to get to know each other.

like the United States, income and cultural differences influence how families feed their children (Beauregard et al., 2019). Parents who are female and have immigrated to the United States or identify as Latina are also more likely to nurse their babies than Black or White parents. This may be because they are more likely to have family support, particularly from mothers or grandmothers who also nursed their babies (Dennis et al., 2019). In addition, higher-income families with more years of education are more likely to provide human milk to their infants, perhaps because they can afford to stay home or have jobs that offer them more flexibility (Victora et al., 2016).

Around the world, parents who work often have difficulty sustaining nursing because they do not have adequate breaks or a place to pump. This is problematic whether they work as doctors or wait tables (Kavle et al., 2017; Melnitchouk et al., 2018). As one parent working in retail explained, "I couldn't just leave the register to pump when I needed. At first I was leaking everywhere, and then my milk supply dropped and I had to start formula" (Spencer et al., 2015, p. 979). Less than half of nursing parents report that their employer accommodates nursing (Johnson et al., 2015).

Alternatives to Human Milk Babies who are not fed human milk exclusively drink commercial formulas containing a mix of cow's milk, soy or corn proteins, and a mix of nutrients. In Canada, the European Union, and the United States, all infant formulas are regulated and include the same nutrients (Harris & Pomerantz, 2020). Infant formula provides complete nutrition for babies and is convenient for multiple caregivers and those without access to human milk. Like nursing, formula-feeding comes with logistical challenges. One of these is cost: Many families struggle to pay for it (Frank, 2020).

As with nursing, the mechanics of formula-feeding are not always intuitive (Kotowski et al., 2021). Pediatricians recommend holding babies while they are feeding and allowing babies to decide when they're done, practices that ensure bottle-fed babies experience social interaction and learn to regulate their appetite (Kotowski et al., 2020). Babies who are bottle-propped do not get that interaction and may be at risk for overeating or suffocation. Nevertheless, 40 percent of U.S. parents put their babies to bed with a bottle, and about a quarter use a pillow or stuffed animal to prop a bottle in an infant's mouth (Perrin et al., 2014).

Moving to Solid Food Marjorie and Dewey intended to start Telele out with a traditional food like blueberries, she has been known to taste French fries. As babies become more mobile, solid food becomes interesting. Between about 4 and 6 months, pediatricians recommend offering soft versions of a fully balanced diet, and letting babies take the lead in discovering the joys of eating (Ahluwalia, 2020; NAS, 2020).

Solid food sets the stage for a lifetime of eating habits, and learning to eat involves many of baby's new skills. It takes social awareness and close attention to watch what other people are eating. And it takes fine motor skills to pick up those peas. Eating offers toddlers an opportunity to build responsive relationships, letting caregivers know what they like and do not like, and to learn to regulate their own feelings of hunger (Nix et al., 2021).

Many families are not able to provide the fruits, vegetables, and proteins their infant needs. In the United States, more than one in five babies does not eat fruits or vegetables every day, and more than one in three regularly has sweetened drinks (Roess et al., 2018). Experts speculate that caregivers' food choices are often influenced by marketing and the convenience of packaged foods that do not provide ideal nutrition (Harrison et al., 2017; Spyreli et al., 2021). Biology is working against families, as well: Infants are born with a strong preference for sweet and salty foods (Mennella et al., 2018). If given the choice, babies will always prefer cookies to kale.

Share It!

Small children are vulnerable to exposure to environmental toxins. Recent studies have found that many U.S. commercial foods for infants and toddlers include potentially dangerous amounts of heavy metals, including cadmium, arsenic, and lead.

(Mousavi Khaneghah et al., 2020; Radwan, 2019)

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Babies' focus on other people also helps them develop a preference for French fries. If babies see other people enjoying a food, they are more likely to try it (Liberman et al., 2021). Simply being exposed to foods will help babies learn to enjoy them, and these preferences will stick: Whether it is mouthed, eaten, or rubbed into the hair, early food experiences will help determine baby's tastes for the rest of their life (Switkowski et al., 2020).

Staying Healthy

Despite the best efforts of caregivers and health care providers, babies and toddlers in the United States typically get sick 8 to 14 times a year (Vissing et al., 2018). During the recent pandemic, many came down with COVID-19, but their immune systems, primed to fight new diseases, often prevented them from developing the most severe physical responses to the virus (Suwanwongse & Shabarek, 2020).

Babies who are in child care tend to get sick twice as frequently as other infants, because they are exposed to a broader variety of viruses. However, by the time these toddlers reach school age, they will be ill less frequently (Ansari & Gottfried, 2020).

Disease and Mortality Around the world, nearly 4 out of every 100 babies die before their fifth birthday. Many of them die shortly after birth as a result of birth trauma, genetic disorders, prematurity, or low birthweight (UN IGME, 2020). Older babies tend to die from diseases such as malaria and pneumonia, which are often made worse by environmental pollution and malnutrition (Heft-Neal et al., 2020; WHO, 2020). While rates of infant and toddler mortality had been improving prior to the COVID-19 pandemic, experts expect that the global disruption to health services will lead to a sharp increase in deaths during those years (Roberton et al., 2020).

CONNECTIONS

Remember from Chapter 3 that there are striking disparities in birth outcomes by income and racial background. Babies from Black and Native American families are more than five times as likely as Asian or White infants to die before they are a month old.

Even in a technologically advanced nation like the United States, 2 out of every 1,000 children die before their third birthday. Many of those babies die accidentally (CDC, NCHS, 2021). Babies are particularly vulnerable to everyday hazards like falls and car accidents and are too small and fragile to recover if they experience violence or abuse. Others die of sleep-related injuries (Ely & Driscoll, 2020).

Babies at higher risk tend to be from low-income families and often live in rural areas (Ehrenthal et al., 2020; Mohamoud et al., 2021). This is not unique to the United States. In New Zealand, Indigenous Māori people, who tend to have lower incomes and experience discrimination, also have higher rates of unexplained infant death (Rutter & Walker, 2021). Many of these babies were at higher risk before they were born, perhaps because they were premature or had LBW. Inequitable access to health care and the pervasive effects of discrimination contribute to such disparities (Owens-Young & Bell, 2020).

One successful intervention for preventing early mortality is to provide families with home visits by nurses, social workers, or community health workers after a baby is born (le Roux et al., 2020; Supplee & Duggan, 2019). These visits give caregivers extra social support, including advice for soothing babies, encouragement for responsive feeding, and consultations about safe sleep. Decades of research on home visiting has demonstrated its significant success (Goodman et al., 2021). One randomized study in Memphis, Tennessee, had dramatic results: Home visits reduced the mortality rate for children and their mothers by half, with benefits that stuck with children through adolescence (Kitzman et al., 2019; Olds et al., 2014).

MediaNews Group/Reading Eagle via Getty Images

Extra Support Helps Families Thrive. Adjusting to life with a newborn can be easier with someone to talk to and an extra set of hands. Lorrie Arnt is a nurse with the Nurse–Family Partnership, who came to Shelby and Rafael's house in Reading, Massachusetts, to help them with their new baby, Jaden.

Immunizations Shots, vaccinations, jabs—no matter what you call them, routine vaccinations are one of the biggest scientific success stories of all time, saving the lives of millions every year (Okowo-Bele, 2015). **Immunizations** protect against diseases by introducing a tiny part of an infectious virus into the body to teach it to defend itself. If you encounter the virus later, you are much less likely to get sick because your body's immune system is prepared to protect you. More than 9 in 10 U.S. toddlers have received basic vaccines, but they often skip their annual flu shots (Hill et al., 2020).

Despite generations of research indicating that vaccines are safe, worries are common around the world (Puri et al., 2020). Families who are hesitant about vaccination are often distrustful of the scientific community and government institutions (Salmon et al., 2015). Others are concerned, despite evidence to the contrary, that vaccines may cause developmental disorders, or that they may be unnecessary (Kempe et al., 2020).

In many countries, families who chose not to vaccinate their children have contributed to outbreaks of preventable infectious diseases, such as whooping cough and measles (Dubé et al., 2021; Phadke et al., 2020). A recent outbreak in the Pacific nation of Samoa resulted in more than 80 measles deaths, most of them in children under 5 (Graig et al., 2020). Immunizations have been extensively tested for safety and are one of the most important ways of reducing infant mortality around the world.

Share It!

Cultural humility helps build empathy and understanding. Vaccine hesitancy may be a result of mistrust in institutions or a result of misinformation.

(Ferdinand, 2021)

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Sleep

Like all babies, Telele spent almost half of her first two years fast asleep. In infancy, sleep is essential to rebuilding energy, growing, and recovering from disease. Babies who do not get enough tend to be more irritable and have poorer health (Meltzer et al., 2021). Experts suggest that between 4 and 12 months, babies should be getting 12–16 hours of sleep per day, and from 12 months to 2 years, they should be getting between 11 and 14 hours (Paruthi et al., 2016).

While infants sleep, the brain is building networks that help them remember what they have learned (Konrad & Seehagen, 2020). Even a brief nap can help babies retain information. For instance, in one study, researchers taught 15-month-olds new words, and the ones who slept after they learned the words remembered them better when tested later than did babies who skipped the nap (Werchan et al., 2021).

At around 4 months, a baby's **circadian rhythm** matures (Barry, 2021). Circadian rhythm is your internal clock for the daily cycle of rest, wake, and sleep. It is highly influenced by the activity levels and light babies are exposed to; bright lights, movement, and noise help them learn when it is time to be awake (Yates, 2018).

Researchers who observe infants while they are sleeping have seen what most caregivers do not: Babies never "sleep through the night" (Adams et al., 2020; St James-Roberts et al., 2015). Neither do adults—we all have periods of wakefulness, even if we may not remember them in the morning. This short period of waking or drowsiness happens each time we transition from one cycle to another. The milestone caregivers are really hoping for is that babies will settle themselves back to sleep without needing help.

Many babies can go five hours without needing a caregiver's attention by about 4 months (Barry, 2021). To scientists, this means they have achieved the milestone of sleeping through the night. But there is tremendous variability in when babies go eight hours without needing care. While many do so by 6 months, what a baby does on one night may not happen the next (Pennestri et al., 2018, 2020). By age 2, however, babies typically can make it eight hours with only one awakening (Paavonen et al., 2020). Three factors lead to this milestone: (1) babies are big enough not to need to eat overnight; (2) experience with the outside world has led to the development of strong circadian rhythms; and (3) infants have learned how to settle themselves after waking.

immunization A means of protection against diseases that introduces a tiny amount of an infectious virus into the body to teach it to defend itself against that virus. If the immunized person encounters the virus later, they are less likely to get sick, because their immune system is prepared.

circadian rhythm Your internal clock for the daily cycle of rest, wake, and sleep.

Managing Sleep When caregivers do not get enough sleep or feel that their babies are not sleeping enough, they have difficulties functioning and are at increased risk for depression (Bai et al., 2020; Wilson et al., 2019). However, the ideal sleep schedule varies from family to family (Pennestri et al., 2018). In the United States, bedtime is typically around 8 P.M., but in Korea, Brazil, and Italy, infants regularly go to bed around 10 P.M. (Netsi et al., 2017). How often infants are expected to wake up during the night also varies. Babies in the United States are typically only expected to wake up once nightly after 6 months, whereas babies in China, India, Finland, and Vietnam are usually expected to wake up at least twice (Lin et al., 2019; Mindell et al., 2010).

Every year in the United States, about 3,500 babies die while they are sleeping (Bombard et al., 2018). When otherwise healthy infants pass away, their deaths are termed **sudden unexpected infant deaths (SUID)**. If investigators determine that sleep practices caused the death, as with being smothered, the death is called a *sleep-related suffocation*: These account for most of the SUID deaths in the United States (Parks et al., 2021).

Children who die while they are asleep often have three intersecting risk factors. First, the babies are very young, typically under 6 months. Second, even though they may appear healthy, they tend to have medical vulnerabilities, such as heart irregularities, brain abnormalities, or complications from being born prematurely (Cummings & Leiter, 2019; Kinney et al., 2018; Ostfeld et al., 2017). Third, they are often exposed to environmental risks, such as drugs or alcohol in their prenatal environment; exposure to nicotine, cigarette smoke, or other pollutants after they are born; an unsafe sleeping arrangement; or a minor illness like a cold (Anderson et al., 2019; Vivekanandarajah et al., 2021).

Managing sleep is often part of firmly held cultural practices. For instance, some caregivers in the Ivory Coast wake up their babies when they have visitors (Gottlieb, 2004). In other places, families prepare a separate room where their baby will sleep. Particularly in Asia and Africa, many caregivers *bed-share* or *cosleep* with their babies (Rudzik & Ball, 2021). This is also true for more than half of parents in the United States (Bombard et al., 2018; Ordway et al., 2020).

Compared to other affluent countries, pediatricians in the United States have the strictest policies about sleep safety and sternly admonish against co-sleeping (Doering et al., 2019). Some researchers suggest that these policies may communicate cultural insensitivity and even frighten families from getting advice about safe sleep (Mandlik & Kamat, 2020). Caregivers can reduce risk when they are co-sleeping (see **Table 4.1** for a list of ways to make sleep safer; Erck Lambert et al., 2019). Successful public health initiatives are often designed to bridge traditional practices with science, including the New Zealand program of providing traditional *wahakura*

Courtesy National SUDI Prevention Coordination Service, Hāpai Te Hauora Tapui

Sleeping Like a Baby Public health officials in New Zealand adopted traditional woven wahakura baskets to promote safe-sleep practice. Notice that New Zealand experts allow caregivers to tuck infants in with sheets and blankets. There is limited international consensus on this practice: U.S. experts advise keeping blankets out of babies' beds.

TABLE 4.1 Safe Sleep Recommendations

- Put babies to sleep on their backs, where they are less likely to suffocate, until age 1.
- Babies should sleep on a firm mattress in an approved surface, with no bottles, blankets, bedding, bumpers, pillows, or stuffed animals.
- Babies should not sleep on couches or recliners, or in car seats or playpens.
- Pacifiers help babies sleep and prevent sleep-related injuries.
- Families should not smoke during pregnancy and should avoid exposing babies to secondhand smoke.
- Babies should share a room (but not a bed) with their caregiver until 6 months.
- Falling asleep while feeding or soothing a baby in the middle of the night is common. It is safer to feed a baby in bed than on a recliner or a couch if the caregiver is concerned about falling asleep.
- Parents who have been drinking, using drugs or sedatives, or are extremely tired should have someone else watch the baby.
- Be extra cautious when there is a change of caregivers, sleep patterns, or sleep situations.
- Monitor babies closely at night when they are sick or have an underlying medical problem, as they may be more prone to suffocation.

Information from Mölloborg et al., 2015; Moon et al., 2016.

sudden unexpected infant deaths (SUID) When an otherwise healthy infant dies. SUIDs can include *sleep-related suffocation.*

bassinets that can be used in the bed to protect babies from suffocation (Tipene-Leach & Abel, 2019).

APPLY IT! **4.1** Dewey and Marjorie encourage 18-month-old Telele to eat with them and feed herself. What might Telele be learning from these experiences?
4.2 All families want to keep their babies safe in the first years when their health is fragile. How would you use principles of cultural humility to communicate the benefits of safe sleep, vaccination, and responsive feeding to new families?

The Changing Brain

Learning Objective

4.2 Explain the role of neurons and synapses in brain function during the first two years.

The first two years are a time of major milestones: first steps, first words, first teeth. Telele is learning to scribble, negotiate for more ice cream, and navigate the playground. Her growing brain powers all these capabilities. The experiences Telele encounters, including the hundreds of words she hears each day and the thousands of times she wiggles her fingers, shape how her brain grows.

Scientists use brain imaging to see exactly what is changing in a baby's brain in the first two years, but you can guess what is happening without an MRI machine. As you will see in **Infographic 4.1**, the brain grows dramatically in the first year. Skull size in adulthood is predictive of nothing but hat size, but an infant's expanding skull actually is important. (This is why health providers measure it at every visit.) By 2 years, the brain has doubled in volume (Thompson et al., 2020).

Remember from Chapter 3 that babies are born with just about all the *neurons*, or brain cells, that they will have in their life. Explosive growth is not caused by new neurons, but by new, faster connections between them (Gilmore et al., 2018). These connections help Telele learn how to control her body and also how to talk and connect with other people.

During infancy, the brain becomes customized to what babies' experience, an individualization that can also have a downside. If growing infants don't have certain experiences in the first few years, like hearing language or seeing through both eyes, it may be more difficult for them to recover their skills. The young brain is particularly vulnerable, and early injuries and deprivation can have lifetime consequences (Gabard-Durnam & McLaughlin, 2020).

More Connections Make a Larger Brain

Brain growth is so critical in infancy that infants expend more calories growing the brain than growing the body (Kuzawa et al., 2014; Vasung et al., 2019). In newborns, the brain grows by 1 percent every day (Holland et al., 2014).

The fastest growing area of the infant brain? The area devoted to movement and language. As Telele learned to control her body, sit without toppling over, and pull herself up, the part of her brain known as the *cerebellum* grew and expanded most quickly (Sathyanesan et al., 2019). Also fast-growing are the *subcortical structures*, which are involved in emotional processing and relationships and will help Telele learn to connect with her parents and manage her feelings (Gilmore et al., 2018). The regions of the brain that drive her communication skills grow quickly as well: The *cortex*, the outer, wrinkled part of the brain, gets thicker as Telele grasps more words and grammar (Gilmore et al., 2020).

More Connections The expansion of the brain is caused by changes you could only see with a high-powered microscope. Individual neurons are connecting and sending information to one another, which accounts for the extra pounds of brain Telele is carrying around (Thompson et al., 2020).

INFOGRAPHIC 4.1 Brain Development in Infancy and Toddlerhood

THE BRAIN INCREASES DRAMATICALLY IN SIZE

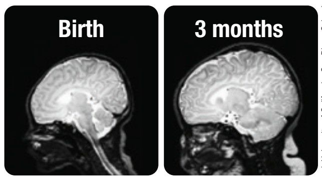
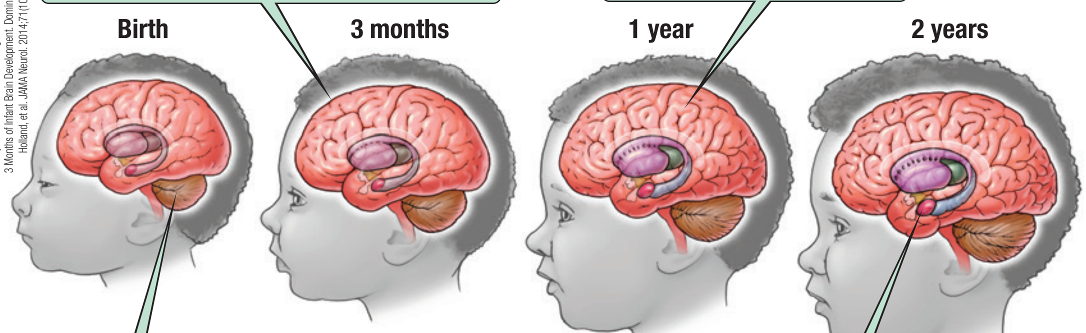


Photo courtesy of Dominic Holland, University of California, San Diego School of Medicine. Structural Growth Trajectories and Rates of Change in the First 3 Months of Infant Brain Development. Dominic Holland, et al. JAMA Neurol. 2014;71(10).

The brain doubles in size between birth and age two. Most of this explosive growth happens in the first months of life. These brain scans were taken just 90 days apart.

Growth is particularly intense in the areas of the brain devoted to movement and emotional regulation, like the cortex, the cerebellum, and the subcortical structures.

The wrinkled outside of the brain is the ***cortex***. This region of the brain expands dramatically during infancy.



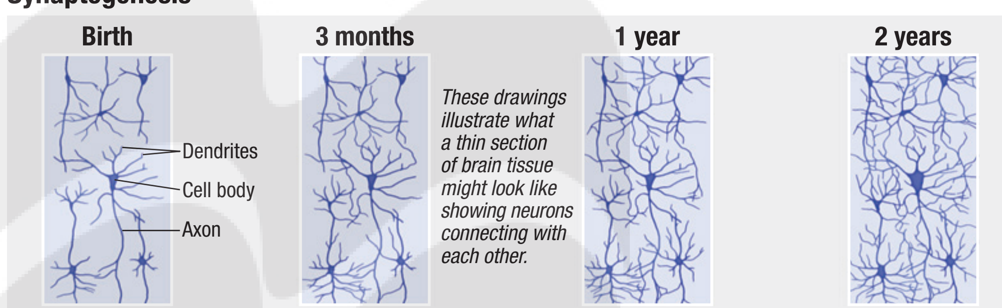
The ***cerebellum*** is the small structure in the lower part of the brain, that looks like a miniature version of the brain. This structure plays an important role in motor development and grows quickly during infancy, as infants develop the ability to control their bodies.

The ***subcortical structures***, part of the limbic system, are often activated when we process emotional experiences or memories.

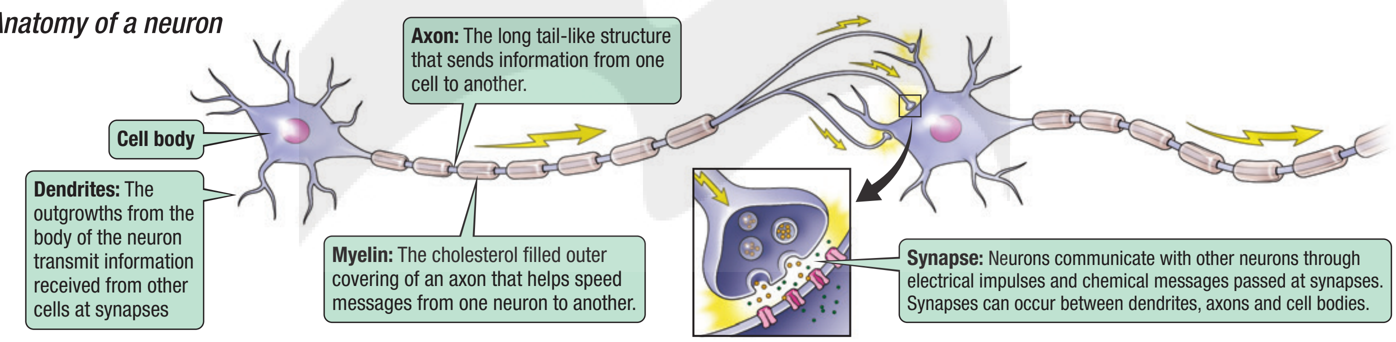
NEURONS AND CONNECTIONS GROW VIBRANTLY

Experiences shape the creation of new synapses and neural connections. The brain creates millions of new connections every second, and the network of neurons in the brain becomes denser over time.

Synaptogenesis



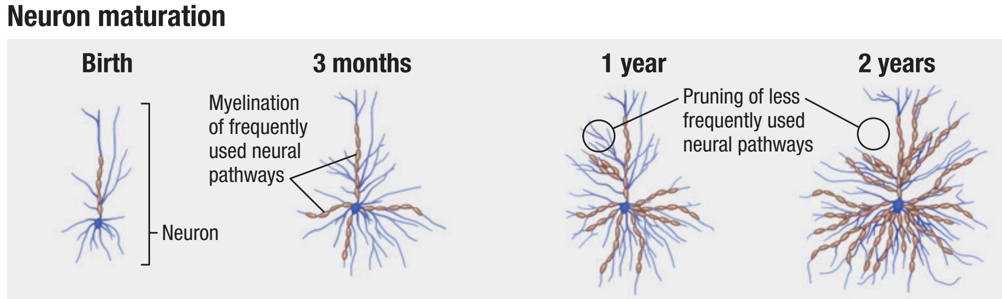
Anatomy of a neuron



EXPERIENCE SHAPES THE BRAIN THROUGH MYELINATION AND PRUNING

Neural connections that are used frequently are more likely to be myelinated. These connections become stronger and faster. They are known as white matter. Connections that are used less frequently are likely to be pruned away.

Neuron maturation



axon The long, tail-like structure attached to the cell body that transmits a chemical signal to other neurons.

dendrite A branch-like appendage that grows out of the cell body and receives communication from other neurons.

synaptogenesis The process of creating new synapses between neurons, which begins before birth and continues throughout the lifespan.

synaptic pruning The process in which the brain cuts back on underused synapses.

myelination The lifelong process of adding myelin to axons.

myelin Layers of cholesterol-rich fat that insulate the axon, helping to speed up communication.

experience-expectant brain development Brain maturation that relies on nearly universal environmental inputs.

Neurons make connections through their **axon**, the long, tail-like structure attached to the cell body that transmits a chemical signal to other neurons (see Infographic 4.1). This communication is received by other neurons' **dendrites**, branch-like appendages that grow out of the cell body. Sometimes the message is transmitted directly to the cell body itself. Communication occurs in the *synapse*, the gap between the sending neuron's axon and the receiving neuron's dendrite, where chemical packets carry information from one neuron to another.

Each neuron's axon may connect to multiple dendrites from many different neurons (Han et al., 2018). Neurons connect to as many as 7,000 other neurons, with some including as many as 30,000 synapses (Mohan et al., 2015). Each axon may be very long: The longest axons stretch from the brain way down to the bottom of the spinal cord.

Synaptogenesis, or the process of creating new synapses between neurons, begins before birth and continues throughout the lifespan. Experiences shape the creation of new synapses and neural connections. Because the brain creates millions of new connections every second, by age 2, Telele will have more synaptic connections than there are grains of sand on a beach (Stiles & Jernigan, 2015). She will have 80 percent more synapses than she did at birth and far more than she will have as an adult (Sakai, 2020).

Creating Efficient Connections As babies grow, their neural connections change. The strength and density of synapses correspond to experience: The more a synapse is used, the stronger it gets. For instance, if an infant hears a lot of language, the part of the brain devoted to language will be larger as a result of increasing synaptic connections, compared to babies who don't hear as much language (Merz et al., 2019).

New connections are created every second and get stronger with experience, and the brain manages this complexity and creates efficiency by cutting back on underused synapses. This process is called **synaptic pruning**, named for the practice of pruning branches of a plant to make it stronger. Synaptic connections operate on a "use it or lose it" idea: Connections that are used are strengthened, and those that aren't die off (Cheadle et al., 2020). This increases speed in the brain, because neural signals travel more quickly along thicker, more robust connections.

Synaptic pruning, as with the process of creating new synapses, begins before birth and continues throughout the lifespan. It peaks between about 18 months and 2 years (Huttenlocher & Dabholkar, 1997).

Making Faster Connections The process of **myelination** also helps Telele's brain process information more quickly. Some axons in the brain are covered with **myelin**, layers of cholesterol-rich fat that insulate the axon. Just like the plastic covering an electrical line, myelin speeds communication by up to 100 times (Kanda, 2019).

Myelination is controlled by both genes and experience. Axons that are used more frequently are more likely to be myelinated than those used less frequently (Rosenke et al., 2021). Individual experiences matter, as well. For instance, as a toddler learns to ride a tricycle, areas of the brain that control movement of the pedals will myelinate. A toddler who has never ridden a tricycle, however, will not show myelination in the same regions. Myelination begins prenatally, peaks during infancy, and continues through the lifespan until myelin itself begins to degrade in later life (Chapman & Hill, 2020; Dai et al., 2019).

How Does Experience Change the Brain? Neuroscientists distinguish between two ways that experience triggers changes in the brain: *experience-expectant development* and *experience-dependent development*. **Experience-expectant brain development** is brain maturation that relies on nearly universal environmental inputs (Greenough et al., 1987). These processes affect a broad range of functions, from the senses to emotional,

real444/Getty Images

Nice-to-Have Development Experience-dependent brain development is not universal and relies on input from the environment. Not all babies get to push around on the grass on a toy lion, but if this infant practices every day, their brain will respond to this experience by myelinating the connections that respond to the movement.

language, and cognitive development. Experience-expectant brain development is triggered by typical, basic inputs in the environment, including nutrition, sensory stimulation, and caregiving, that are required in order for the neural circuits in the brain to develop.

Remember from Chapter 1 that *sensitive periods* are times in development when the body or brain is particularly sensitive to the environment. Infancy is a sensitive period for a few forms of experience-expectant development (Frankenhuis & Walasek, 2020). If necessary experiences do not happen at all, or at the expected time, a baby may never develop typical functioning. For instance, since brain development requires adequate nutrition, even short periods of deprivation in infancy can have lifelong effects. This was demonstrated in Israel, where, for a few weeks, some babies drank formula that lacked *thiamine*, a B vitamin, due to a manufacturing error. Since the brain requires thiamine to trigger language development, these babies' language abilities were permanently altered. Despite intensive interventions, they never caught up with their peers who received healthy formula (Harel et al., 2017).

CONNECTIONS

As explained in Chapter 3, critical periods are a special type of sensitive period. Maturation that happens during a critical period operates on a "now or never" principle: If it does not happen at that time, there is no workaround. Scientists believe that critical periods happen only during prenatal development: After birth, most maturation is more flexible.

Unlike experience-expectant brain development, **experience-dependent brain development** is not universal; it includes features that are "nice to have" but not required. These processes rely on the quantity or quality of environmental input and, like all learning, continue throughout the lifespan (Fandakova & Hartley, 2020; Rosenzweig & Bennett, 1996). For instance, the ability to produce and understand language is an experience-expectant process, but the *quality* of a baby's language skills and which languages they speak are experience-dependent. Experience-dependent processes may make life richer, as with learning to play patty-cake or fasten Velcro, but these experiences don't necessarily need to happen at a specific time or during a sensitive period.

Principles of Early Brain Development

Over the past 30 years, scientists have observed some principles that explain the significance of changes in the brain (Nelson et al., 2019).

1. *Brain development is a long process that allows personalization.* Brain development begins in the embryo, but the brain isn't mature until early adulthood. It continues to change until the end of life (Walhovd & Lovden, 2020). Slow brain development allows the brain to be shaped to experience. As a result, each baby's brain is as unique as their fingerprints.
2. *Brain development is affected by genes* and *the environment.* Instructions in the genome direct brain development, but genes need to be epigenetically triggered by the environment (Frith, 2019). For instance, monozygotic twins share similar genetic instructions and may even share some of the same prenatal conditions, but their experiences vary, and as a result, their brains are never the same (McEwen & Bulloch, 2019).
3. *There are limits to the brain's* plasticity, *or ability to adjust to the environment.* The brain is always changing, as new synapses are being created and myelinated, but development requires some experience-expectant experiences to happen at particular times. As the foundational structures of the brain are being built, trauma and deprivation can cause damage that will be challenging, and perhaps impossible, to overcome (Wade et al., 2020).

APPLY IT! **4.3** How does myelination and the creation of new synapses support Telele's ability to learn new skills, like how to draw with a crayon?
4.4 Why do scientists think the first years of life are so important to brain development?

experience-dependent brain development Brain maturation that relies on the quantity or the quality of environmental input and, like all learning, continues throughout the lifespan.

Sensing and Moving

Learning Objectives

4.3 Describe vision and hearing development in infancy.

4.4 Explain how the typical maturation of movement changes a baby's experience of the world.

CONNECTIONS

Remember from Chapter 3 that a baby's senses begin to develop while they are still in the uterus. At birth, newborns have remarkable abilities to see, hear, smell, taste, and feel the world around them. These early senses are shaped by prenatal experiences and help them make connections with the people in their world.

When you are picking out mangos at the grocery store, you might take for granted your ability to smell, see, and feel the mango and to hear the phone buzzing in your pocket. But you weren't born with all these skills working the way they do today and there are many individual differences in how our senses work and develop. As infants develop, real-world experience builds the connection between body and brain that helps their senses change and mature (see **Figure 4.2**). Here we focus on the typical development of two critical senses that help infants learn and connect to the world: vision and hearing.

Seeing

Dewey remembers how intensely newborn Telele looked into his face. Young babies are drawn to faces, people, and animals moving around them, and their preference for people helps propel their impressive learning abilities (Grossman, 2017; Kelly et al., 2019). In the first two years, babies' vision typically improves quickly, along with their ability to move their focus from one object to another. By 3 or 4 months, infants can see a full spectrum of colors and may even have a favorite (researchers have found that

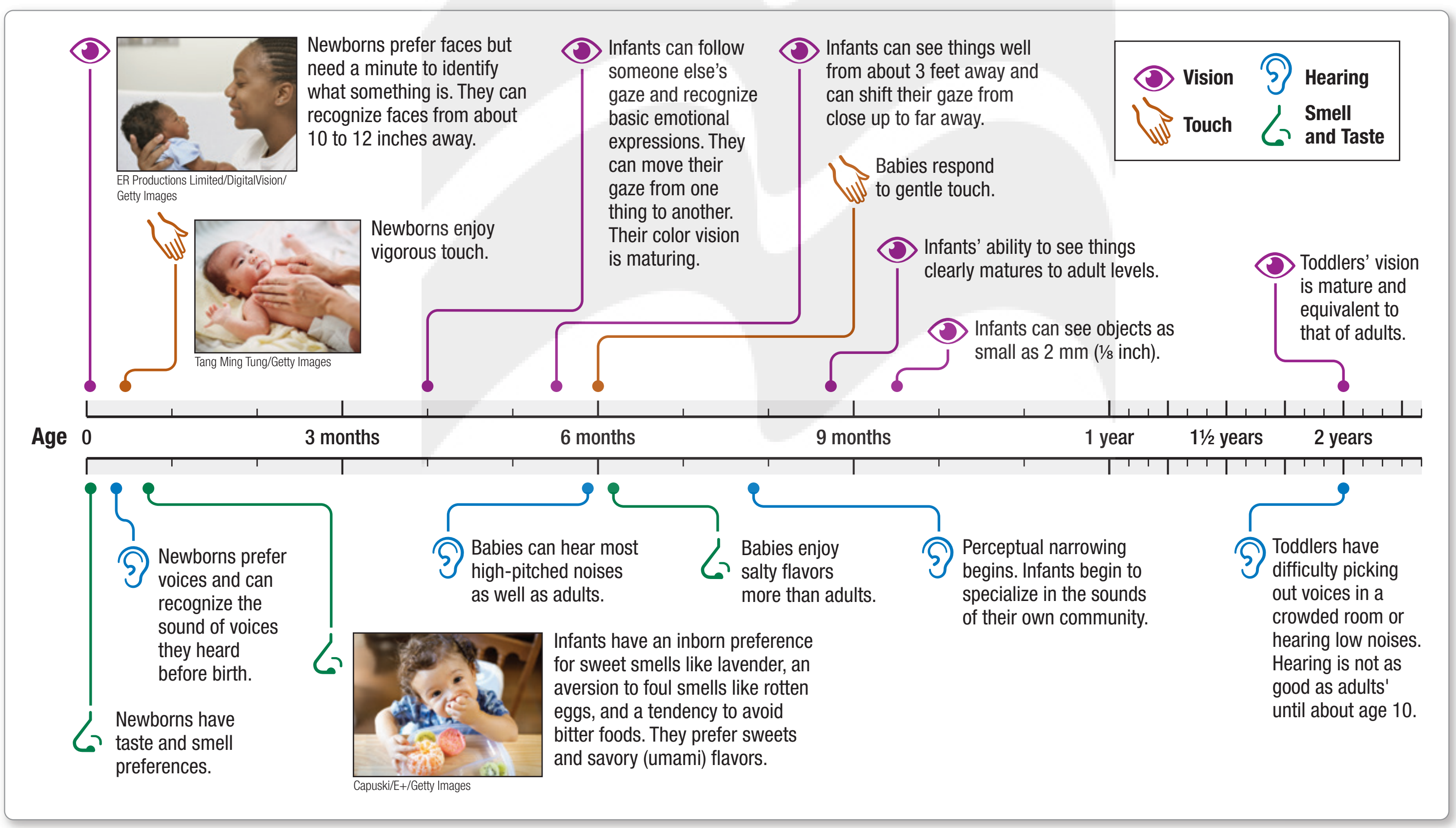


FIGURE 4.2 Highlights of Sensory Development Typically, infants are born with some sensory abilities, like the ability to recognize their caregivers close up, and some of the sounds and tastes they may have experienced before birth. But their senses are not fully developed until they are much older. Many senses show evidence of *perceptual narrowing* before a baby's first birthday, as an infant's perception begins to specialize in the sights and sounds they experience most frequently.

most babies prefer yellow to blue) (Skelton & Franklin, 2020). Their ability to see details improves rapidly between 6 and 9 months (Goldstein & Brockmole, 2017). When Telele saw the candle on her first birthday cupcake, she could see as well as her parents, including all the colors of the decorations.

Scientists use the **preferential looking technique** to measure what babies perceive and to identify their favorite color. In this procedure, researchers harness babies' intrinsic interest in new things. Babies turn their heads to look at what they are interested in and naturally look longer at an object they haven't seen before. They also look longer at an image that interests them, such as a picture of a face as opposed to an abstract image.

Todd Heisler/The New York Times/Redux

What Do Babies Look At? Babies move from looking at faces to looking at hands as they develop the ability to move their own hands and get around the house. Miles is 14 months old and wears a camera over his eye to track what he is looking at. Researchers use eye-tracking to better understand exactly how children see the world.

Hearing

When Telele was a newborn, Marjorie and Dewey tried not to speak too loudly, even if she was in the other room. However, this may have been unnecessary (Werner, 2017). In the first few months, typically-developing babies can hear normal conversations but not whispers (Litovsky, 2015). Infants (and other young children) also have a hard time ignoring background noises or distinguishing speech from background noise (Leibold & Buss, 2019). Despite these limitations, babies are particularly attuned to speech, especially the voices of people they know (McDonald et al., 2019; Newman et al., 2013). What do they hear best? The sound of their caregivers calling their name.

Hearing improves quickly due to maturation in the ear canal, the tube that runs from the eardrum to the outside of the ear. As it grows, it works like an amplifier to make sounds louder (Werner, 2017). Hearing doesn't just happen in the ears: Sound is processed in the brain as you make sense of what you hear. In infancy, neural circuits are building between the ear, the brainstem, and the cortex, which helps the brain process sensory information. As these circuits mature and change over the lifespan, people can continue to develop their hearing, including the ability to perceive musical notes, rhythms, or new languages (Reetzke et al., 2018). About 2 in every 1,000 babies has some type of hearing impairment: early identification helps these infants get the support they need (Bussé et al., 2020).

The Specialization of the Senses

Could you tell the difference between two monkeys? Unlike most adults, a 6-month-old can. However, by 9 months, babies have lost the ability (Pascalis et al., 2002; Simion & Di Giorgio, 2015). Similar changes happen in babies' hearing. In the first months of life, babies can perceive a wide variety of tones and language sounds. A few months later, they lose this skill. For instance, English-speaking adults have difficulty perceiving sounds that only appear in other languages, like consonants unique to in Czech or Kikuyu, or tones that appear in Thai. Infants do not: They can perceive the sounds of all the languages of the world (Maurer & Werker, 2014). However, by age 1, their ability to hear sounds is more limited, and they no longer respond to sounds that do not occur in their own languages (Kuhl et al., 2014).

Researchers call this phenomenon **perceptual narrowing**. At birth, infants are sensitive to a wide variety of sensory input whether that is monkey faces or the sounds of languages, but they become *less* sensitive during their first year: Babies' brains have begun to specialize. Developmental processes including neural pruning and myelination make this possible; frequently used connections become faster and more efficient, and unused connections fade. As a result, babies who grow up hearing Mandarin will be good at hearing tonal differences in Mandarin. Babies who are raised among people will learn to distinguish between different people's faces and lose the ability tell the differences between monkeys (Barry-Anwar et al., 2018).

preferential looking technique A procedure that measures what babies perceive in which researchers harness babies' intrinsic interest in new things.

perceptual narrowing The process by which infants become less sensitive to sensory input as they grow and begin to specialize in the sights and sounds to which they are exposed more often.

motor development The development of body coordination.

gross motor development The development of bigger movements like walking, jumping, or skipping.

fine motor development The development of small movements requiring precise coordination, like picking up little objects, swallowing, or pointing.

Moving

For many families, one of the highlights of early development is movement. Babies, too, seem enthralled by their ability to control their environment, whether that means dropping a spoon from the highchair or running to catch up to an older friend. Learning to control the body not only changes how babies see the world and relate to other people, but it also changes their brains (Adolph & Hoch, 2020). Although babies can move in the uterus, learning to move independently after they are born takes a long time.

The development of body coordination is called **motor development**. Scientists analyze the development of bigger movements like walking, jumping, or skipping, called **gross motor development** (*gross* here means "large"). They also study the development of small movements requiring precise coordination, like picking up little objects, swallowing, or pointing, called **fine motor development** (*fine* here means "tiny"). (See **Figure 4.3**.)

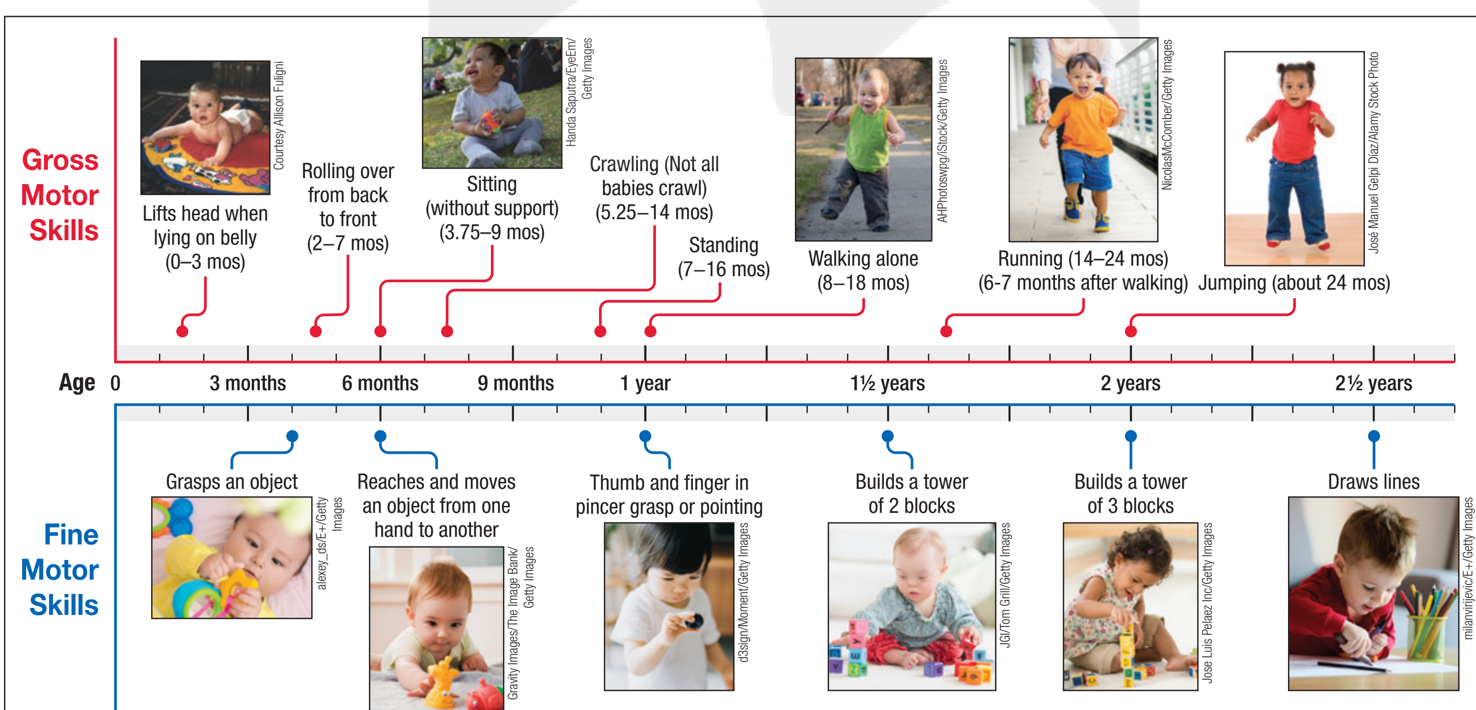
Large Movements

At 5 months, Telele dropped a ball, and it tumbled out of her reach. She leaned forward gingerly to avoid toppling over while grabbing it, but she could not make it quite far enough. She had a face of complete frustration as she cried out for help.

We should be sympathetic. Almost a quarter of babies' weight is in their large head, and they need tremendous muscle strength to manage the 2-pound weight (Bayley, 1956; Salzmann, 1943). Stabilizing the head is just the first step in the ability to move. As Telele found, controlling the body begins in the core. Without enough control to keep from tipping or swaying, babies cannot move much else (Rachwani et al., 2019).

As Telele gets older, her body proportions will change and her growth will slow down, making movement easier. A 2-year-old's head is still about one-fifth the size of their body, but they aren't growing as quickly as they were as an infant (Huelke, 1998). Their bodies are also narrower, with less fat and more muscle. These new proportions make it easier to control movement.

FIGURE 4.3 What Can Babies Do with Their Bodies? No baby's development matches the precise order on a chart, but researchers have observed a common sequence for many infants and toddlers. The timing of development depends on individual and cultural factors. You will see some average ranges for typically developing children indicated in parentheses. Learning to move will change infants' thinking, relationships, and ways of responding to the world.



Babies learn to control their bodies in a **cephalocaudal**, or head-downward, pattern, beginning with the ability to support their heavy heads. By about 6 weeks, babies can hold their heads up consistently, allowing them to look at what they are interested in (Adolph & Franchak, 2017). At around 4 months, being able to roll from their back to their front or vice versa means they can now tumble off couches and are no longer safe even lying in the middle of a bed (Shoaibi et al., 2019). Sitting, which typically happens around 6 months, is another critical development. Now infants can keep themselves from toppling over and also see their hands to pick up toys and explore more of their world (Franchak, 2019).

Babies typically walk on their own at about 1 year because of practice, faster neural connections, and stronger muscles, which give them more power (Adolph, 2019). As the brain develops, connections are myelinated between the muscles, the spine, and the brain, and within areas of the cortex, making walking easier (Marrus et al., 2018). But faster neural connections don't make it effortless: A typical 1-year-old baby might take more than 2,400 steps an hour and fall more than 12 times (Adolph, 2019; Han & Adolph, 2020).

The development of gross motor skills does not end with walking. By age 2, babies can typically jump and even begin to climb steps and scramble up ladders or into boats, depending on where they live. As with walking and crawling, the development of more coordinated skills like jumping or hopping takes practice (Veldman et al., 2018).

cephalocaudal Development that occurs in a head-downward pattern, beginning with a baby's ability to support their heavy head.

proximodistal principle A pattern of physical development in which control of movement begins in the core and expands outward.

Controlling the Hands

While caregivers may focus on their infants' walking ability, babies are also learning how to make smaller movements. Fine motor skills require infants to coordinate many abilities: perceiving what is around them (where the Cheerio is on the table); making a plan (I want to pick up that last Cheerio); and manipulating their bodies to do their bidding (thumb and forefinger at the ready) (Adolph & Franchak, 2017).

It is difficult to reach for and grab an object if your torso is swaying back and forth. Thus, babies must be able to balance their core and torso before they can control their arms and hands. This pattern of physical development, where control of movement begins in the core and expands outward, is called the **proximodistal principle**.

Babies also need to learn how to manage their strength. At birth, newborns have a powerful whole-hand grasp, called the *palmar grasp*, that would crush a blueberry. They learn to be gentler: At around 10 months, they develop their *pincer grasp*, coordinating the thumb and fingers to hold small objects (Gonzalez et al., 2018). This makes it easier to eat blueberries, and also to grab little, potentially dangerous objects such as pills or batteries. By age 1, as a result of practice and brain maturation, babies are able to point, reach, and grasp small objects (Karl et al., 2019).

Fine motor dexterity also means that by age 1, babies can use basic tools such as such as spoons or markers, buttons or chopsticks (Rachwani et al., 2020). In many families, these tools also include tablets and other electronic devices, despite pediatricians' cautions against media use (Souto et al., 2020).

Culture and Motor Development

Across time and place, there are significant variations in how and when typical babies learn to move. *Ethnotheories*, or caregivers' beliefs about how children should be raised, are critical. For instance, some caregivers believe that children shouldn't be pushed to walk before they are "ready," but others may encourage babies to walk so that they can be more independent (Harkness et al., 2013; Mendonça et al., 2016).

Many communities around the world encourage children's mobility, beginning with infant massages and practice (Adolph & Hoch, 2020). Babies who get this exercise

Share It!

Can babies learn when parents text? Researchers watched as parents tried to teach infants a new skill while being interrupted by a text on their phones. Their babies tended to fuss while their parents were distracted but were still able to learn the new skill. Texting may not be ideal, but it does not make learning impossible.

(Konrad et al., 2021)

Scientific American: Lifespan Development

affordance The term for what people can learn from objects in the world around them.

learn to control their bodies earlier than others. For instance, babies in Cameroon typically sit on their own at 4 months, two months earlier than babies in the United States. On the other extreme, infants in Norway, where parents are often reluctant to "push children to perform," cannot walk with assistance until about 10½ months (Karasik et al., 2018; WHO, 2006). There are many ways that babies may learn to walk, and *when* babies learn to walk depends on their experience. But whether they spend a lot of time sitting still or get lots of practice, most typical babies develop all the motor skills necessary for their culture (Adolph & Hoch, 2019).

Learning from Moving

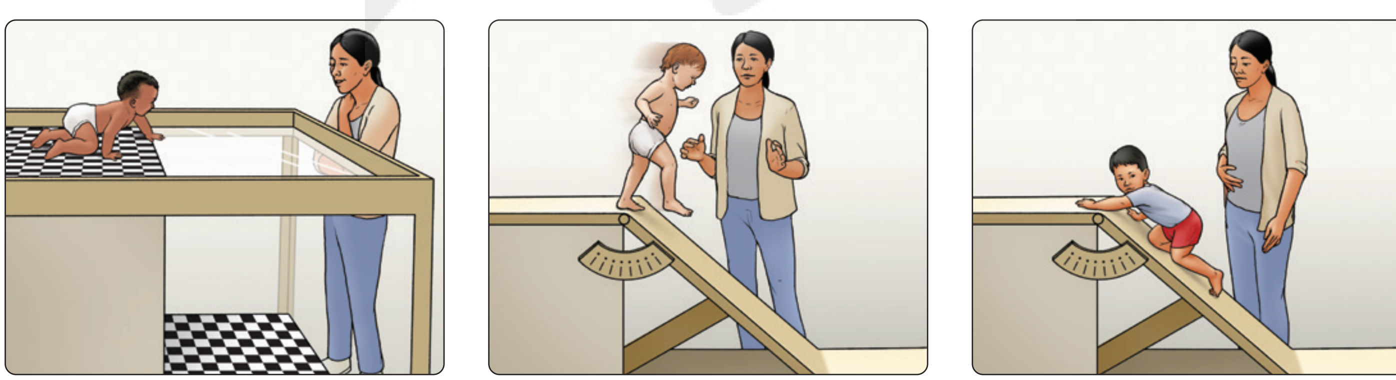
Telele's face lights up when she scoots across the room for the first (and second, and third, and eighteenth) time. Learning to move independently, whether crawling, walking, or pushing a toy, changes how infants experience the world (Franchak, 2020; Gibson, 1988). Moving also changes how other people relate to babies. A walking and running child is treated much differently from an immobile infant. Movement launches a cascade of development across different parts of a baby's life.

Hugh Scott, Sooner Magazine

How Does Movement Change the Brain? Professor Thubi Kolobe studies how infants learn to wriggle, crawl, and walk. She has also invented devices to help give extra support to babies who cannot move easily on their own, reinforcing their inborn drive to move.

Movement helps babies learn more about the many possibilities in the physical world. For instance, a phone may be good for sucking, for tapping on, or even for throwing off a highchair. Researchers have a term for what people can make from objects in the world around them: **affordance** (Gibson, 1979, 1988). One of the basic affordances infants make about the environment is whether it is safe. For instance, what will happen if they head down the stairs?

Over the years, researchers have put babies into dozens of situations to learn how they understand what is safe. They have thrown things toward babies' heads to see if they would duck (the flying objects would never actually hit them) and found that even very small children can accurately gauge how fast a ball is moving and when to move away. They have observed how babies walk or crawl on a jiggly waterbed or over a gap in the floor. Researchers famously tested babies' willingness to take risks by watching to see if they would crawl right



A B C

FIGURE 4.4 Learning from Experience Researchers study how infants think about decisions in the laboratory by watching how they move. In panel A, you can see how a baby investigates the visual cliff, a piece of plexiglass that appears transparent. This baby seems to be an inexperienced crawler and is making a risky choice, which might result in a tumble in real life. In panel B, a new walker is taking a chance by going headfirst down a sleep slope. Without practice, they are likely to fall. In panel C, a more experienced walker takes the safer route and goes down the steep slope on their belly.

off a ledge, using a device called a **visual cliff** (Anderson et al., 2013; Gibson, 1988; LoBue & Adolph, 2019). Originally designed to test babies' visual depth perception (Gibson & Walk, 1960), the visual cliff is a 2½-foot gap covered with plexiglass that, if properly lit, appears to be an empty gap.

This research demonstrated that it takes weeks of experience before babies learn what is safe. Experienced walkers or crawlers will stop before the edge of a dangerous situation, whether that is a big gap or a steep slope, but babies who have just learned to crawl or walk tend to make mistakes (Han & Adolph, 2020). The practical note is that babies are in more danger of making mistakes right after they have learned a new skill. They will fall off beds and tumble down stairs or slopes. Babies need time to integrate the new movements with the sensory information they receive from the environment (Adolph, 2019).

APPLY IT! **4.5** Health providers often check infants' hearing as part of their developmental screening. Why is hearing so important to babies' development?
4.6 Practice and experience change what we can perceive. How does this support Marjorie and Dewey's decision to expose Telele to multiple languages early in development?
4.7 Babies are at risk for accidents as they learn new skills. What should families be careful of as their babies learn to move independently?
4.8 How do infants' new motor skills change how people respond to them?

Cognitive Development and Learning

The first two years of life involve huge amounts of learning. Telele came into the world with eyes blinking, hardly able to see her surroundings. By her second birthday, she was confident enough in her understanding of the world that she could count both of her birthday candles and gently put her stuffed moose to sleep by singing an Iñupiaq lullaby. There is certainly a lot of development in Telele's ability to reason and understand the world, in her memory, and in her ability to pay attention and learn.

Learning Objectives

4.5 Explain maturation in sensorimotor thinking, attention, and memory during infancy and toddlerhood.

4.6 Describe the factors influencing learning during the first two years.

Piaget's Theory of Cognitive Development

Remember from Chapter 2 that Jean Piaget changed attitudes about infant's minds, helping researchers realize that even infants are curious and inventive in their approach to understanding the world. Piaget saw young infants' early cognitive activity as a combination of their senses and their motor activities (Piaget, 1952). Piaget described the first 18 months of a baby's life as the **sensorimotor** period because of the focus on learning through sensation and movement. He divided this stage into six substages (see **Table 4.2**).

In stage 1, called *reflexes*, from birth to about 1 month, newborns are a bundle of reflexes, as you read in Chapter 3 (Piaget, 1968). Newborns are not limited to reflexes for very long. They may begin by indiscriminately sucking anything that comes close to their mouths, like a finger or even a button, but this teaches them that they can't suck everything as they do with a breast or a bottle. Infants begin to recognize and develop *schemas* about what can be sucked. This is a major accomplishment: They are remembering and developing concepts about how the world works.

In stage 2, called **primary circular reactions**, from about 1 to 4 months, babies begin to adapt their reflexes to new uses and show more creative behaviors (Piaget, 1952). The term "primary circular reaction" refers to an experience the baby repeats with their own body (primary), and that is repeated on purpose again and again (circular). Piaget believed babies' first adaptation to the world is to apply their basic reflexes, like sucking and grasping, to new purposes. Piaget observed

visual cliff A means of assessing what risks babies will take while crawling, in which a 2½-foot gap is covered with plexiglass that, if properly lit, appears to be an empty gap.

sensorimotor Piaget's term for the cognitive stage that spans the first 18 months of a baby's life and focuses on learning through sensation and movement.

primary circular reactions The second stage of the sensorimotor period, from about 1 to 4 months, in which babies begin to adapt their reflexes to new uses and show more creative behavior.

TABLE 4.2 Piaget's Sensorimotor Stage of Cognitive Development

Stage	Key Events	
Stage 1 **Reflexes** (birth to 4–6 weeks)	Babies cannot consciously control much of their bodies, but they can move nonetheless. Their hands reflexively grasp and suck whatever approaches their mouths. In this stage, they begin to assimilate new behaviors, like sucking their thumb, onto existing reflexes.	 Thirawatana Phaisalratana/Getty Images
Stage 2 **Primary Circular Reactions: Adaptation of Reflexes** (1–4 months)	Infants can now adapt their movements and newborn reflexes to the world around them. They can suck a pacifier differently than a stuffed animal. They can grasp a finger differently than a rattle. In primary circular reactions, they can repeat adapted reflexes again and again.	 LiuSol/iStock/Getty Images
Stage 3 **Secondary Circular Reactions: Making Fun Last** (4–8 months)	Infants can manipulate their bodies as well as other people or things. They enjoy not only their own movement but also the effect of this movement on something in the world. They can watch as a toy on a mobile jiggles again and again as they shake it.	 Dorling Kindersley ltd/Alamy Stock Photo
Stage 4 **Coordination of Secondary Reactions: Making a Plan for Action** (8 months–1 year)	Babies can begin to make a plan and carry it out. They can anticipate what is going to happen next, like giggling with happiness as they try to put on a hat to go out into the snow.	 Seth Hill/Getty Images
Stage 5 **Tertiary Circular Reactions: Little Scientists Running Experiments** (1 year–18 months)	Toddlers can manipulate their world to explore through trial-and-error: "What happens if I drop this toy off of my highchair?" or "What happens if I squeeze all the diaper cream out of the tube into a pile?"	 Dorling Kindersley ltd/Alamy Stock Photo
Stage 6 **Mental Combinations: Thinking before Doing** (about 1 ½–2 years)	Toddlers can make a plan in their mind without taking action. They can also use symbols, like language, to get what they want. They can call for their father for help or indicate that they have lost their sock.	 Cavan Images/Getty Images

this stage in his own children as they learned to suck their fingers for the joy of it (Piaget, 1952).

In stage 3, called **secondary circular reactions**, from about 4 to 8 months, babies learn to extend their activities to manipulate the world around them. Infants discover that they can use their bodies to act on an external object, which could be a toy, a person, or a pet, to get a reaction. Babies in this stage are happily interactive. Piaget described his daughter, Jacqueline, gently shaking a doll hanging from her bassinet. She clearly enjoyed her new power and, in Piaget's words, the glory of "making interesting sights last" (Piaget, 1952). She understood what the shaking would do, and when she was later lying in her bassinet for a nap, she remembered the action that led to the shaking doll and did it again.

In stage 4, *coordination of secondary circular reactions*, from about 8 to 12 months, babies can make a plan and combine separate schemas to accomplish their goals. At this age, Piaget observed that babies have discovered **object permanence**, the understanding that objects continue to exist even when they are out of sight (Piaget, 1954). Rather than appearing to ignore a hidden object, a baby who has achieved object permanence will search for it, looking around and lifting items to look underneath. This ability to keep the idea of an object in mind after it disappears from sight is an important milestone in infants' thinking. This means that Dewey could no longer trick Telele by hiding his keys out of her sight in the diaper bag.

In stage 5, *tertiary circular reactions*, between 12 and 18 months, Telele was even more clever. Sometimes, as when she discovered the joy of smearing shaving cream on a bathroom floor, this is a messy stage. Piaget called children this age *active experimenters* and *little scientists*. They demonstrate **tertiary circular reactions**, or the ability to deliberately vary their actions to see the results. Like scientists, babies are trying to learn more about the world and the results of their actions (Piaget, 1952).

In stage 6, *mental combinations*, from about 18 to 24 months, babies can think through their plans and experiments *before* they take action. For instance, right before she turned 2, Telele revealed just how highly motivated she was to eat cookies. She moved quietly into the kitchen, pushed a chair toward the counter, and began "mixing" ingredients into a bowl. She remembered what she had done before and had a plan for getting her cookies. Even though she made a mess, she was showing evidence of **mental representation**—the ability to think things through using internal images rather than needing to act on the environment and the first sign of true intelligence.

Piaget's theory is nearly 100 years old, and research over the decades has refined some of his ideas. Researchers now believe that babies are much more capable than Piaget gave them credit for: that they understand object permanence, for instance, much earlier than he thought (Carey et al., 2015; Rochat, 2018). In addition, Piaget did not write much about the influence of culture and the social world on babies' development (Davis et al., 2021). Now, through observation of babies in different contexts, researchers know that emotional and social cues are critically important for babies' cognitive development. A baby raised in a structured environment and carried much of the time, for instance, will be less of a "little scientist" than one allowed ample unstructured time and the space to practice dropping Cheerios on the floor.

Information Processing

In the decades since Piaget first wrote about children's thinking, many modern researchers have taken an *information-processing approach* to understand how children and adults think. Remember from Chapter 2 that this approach focuses on the

secondary circular reactions The third stage of the sensorimotor period, from about 4 to 8 months, in which babies learn to extend their activities to manipulate the world around them.

object permanence Piaget's term for the understanding that objects continue to exist even when they are out of sight.

tertiary circular reactions Babies' ability to deliberately vary their actions to see the results.

mental representation The ability to think things through using internal images rather than needing to act on the environment.

Jose Luis Pelaez Inc/Getty Images

Building Mental Representation with Grandpa This little girl is learning to love reading and building her mental representations for what books mean with her grandfather at home in New Jersey.

individual components of thought and intelligence as they develop over time. These include *attention*, the process of focusing on the information we take in through our senses; *memory*, how we save this information for later use; and *processing speed*, how quickly we are able to retrieve and use this information.

Paying Attention If you watch a newborn for a few minutes, you might wonder if they ever really pay attention. Over the course of a few minutes, a newborn might look out into space, yawn, cry, and then nurse. Researchers watching how infants suck and where they look have discovered that although newborns' attention may look haphazard, they actually can focus (Hendry et al., 2019). Over their first year, babies get better at paying attention, whether on a toy they are playing with or on the face of someone singing them a lullaby (Abney et al., 2020).

When babies are first born, they struggle to move from looking at one thing to another. Researchers call this *sticky fixation*. Once they start looking at one thing—say, the gently swaying mobile above their crib—it is hard for them to move their attention to something else (Rosander, 2020). By 4 months, as their sight improves, so does their ability to shift their attention. They become able to scan what is in front of them—which makes it easier to, say, pick out a particular toy from a pile. By 9 months, they start to look at things that are interesting, rather than just fixating on whatever is in front of them (Papageorgiou et al., 2014).

One way that babies learn to focus is through coordinated or *joint attention*, the process of focusing on something with someone else (Amso & Lynn, 2017; McQuillan et al., 2020). Joint attention is at work when Dewey shares a book with Telele and they look at the pictures together: Caregivers model and motivate babies to focus by telling a story, pointing to and explaining a new toy, or singing a silly song. This early attention training later helps children focus in school (Blankenship et al., 2019).

Scientific American Profile

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How Caregiving Builds Cognitive Skills

MAKING A DIFFERENCE

Early Screening and Intervention

Just a generation ago, health care professionals often took a "wait and see" approach when families were concerned about differences in their babies' early cognitive development. They suggested that children would "grow out of" any developmental delays and that early interventions would not help (Raspa et al., 2015). But developmental scientists changed that. In the past decade, researchers have shown that dramatic growth happens in infants' thinking and learning in the first years. Health care providers and scientists are now able to identify differences in cognitive development—and intervene early to help when the brain is highly sensitive to environmental input (Zwaigenbaum et al., 2015). Screening for cognitive milestones is now part of standard well-child visits in the United States (Lipkin et al., 2020).

Intervention and screening have particularly benefited children with an increased likelihood of having **autism spectrum disorder (ASD)**, a cognitive and communication disorder that is diagnosed in about 1 in every 54 U.S. children (Maenner et al., 2020; White et al., 2020). Some of the early signs of ASD include lack of eye contact, joint attention, and difficulties engaging in responsive back-and-forth communication, including pointing or talking (APA, 2013; Hyman et al., 2020). Young children with increased likelihood of developing ASD also may be especially reactive to sounds, lights, taste, or touch and may have passionate interests in one type of activity or toy (Smith et al., 2020). Early screening has helped reliably identify children as young as 12 months who may need support (Zwaigenbaum et al., 2021).

autism spectrum disorder (ASD) A cognitive and communication disorder characterized by difficulties with communication and social interaction.

Experts believe ASD is linked to genetic and brain anomalies. It is a *spectrum* disorder, which means that children with ASD have variable levels of skills and challenges. Some may require significant support: About 3 in 10 children diagnosed with ASD cannot talk, and about half have intellectual disabilities (Hyman et al., 2020). Others may have more subtle symptoms but also benefit from support, particularly in building relationships and resilience to stigma (Kapp, 2018).

Children and adults with ASD often face challenges in a world that is not open to people who are different and must grapple with inaccurate stereotypes about the disorder (White et al., 2020). Early identification enables children with ASD to receive intervention earlier, boosting their communication skills (Rogers et al., 2019). Interventions also encourage responsive caregiving, acceptance of children's distinctive abilities, and an understanding of the benefits of a neurodiverse world. The goal is not to eliminate the differences between children diagnosed with ASD and their peers, but to help children develop the skills—particularly communication—that will allow them to advocate for themselves and live meaningful lives (Bottema-Beutel et al., 2021; Kapp, 2018).

habituation A basic form of learning in which you become bored with something if you experience it repeatedly.

implicit memory Memory of new skills and processes and ability to habituate.

explicit memory Memory of names, dates, and details.

Memory Babies may not be able to explain what happened to them last week, but they remember more than you might think. Marjorie tells us that at just 6 months, Telele remembered the pediatrician's office (she cried as soon as she recognized the mobile hanging from the ceiling). It is very likely that she was right.

How do we know what babies remember? First, we react differently to things we remember. Recall from Chapter 3 that **habituation** is a basic form of learning in which you become bored with something if you experience it repeatedly. Researchers use it to observe whether babies notice differences between experiences or objects, called *stimuli*. If babies habituate to one object, they will ignore it and look away. Given a choice of two objects, one they have seen many times and one that is new, they prefer the new one. In this way, researchers can tell whether babies notice the difference between the two. Researchers also examine how long it takes babies to become habituated. Whereas newborns typically need to look at a new stimulus, like the dots in **Figure 4.5**, a few times before they can remember it, 1-year-olds only need to look for 10 seconds before they remember it (Hayne et al., 2015).

Changes in Memory Infants are born with some unique memory strengths: They are very good at remembering people, which helps them learn new skills and processes from their caregivers, from picking up a cup to taking off their diaper. The memory for these skills and processes and the ability to habituate are referred to as **implicit memory**, which is nearly mature by 3 months (Rovee-Collier & Giles, 2010; Vohringer et al., 2018). At the same time, they are lacking in **explicit memory**, which is the memory for names, dates, or details (Amso & Kirkham, 2021).

Some ground-breaking studies have helped researchers understand the strength of babies' early implicit memory and the fragility of their long-term memory (Cuevas & Sheya, 2019; Schneider & Ornstein, 2019). Babies as young as 2 months were introduced to a crib mobile with a ribbon hanging down from it (see **Figure 4.6**). Then researchers tied one of the baby's legs to the mobile so that the baby could move the mobile by moving their leg. After the baby realized the association between the movement of their leg and the movement of the mobile, the researchers untied the ribbon. If the baby continued to try to move the mobile by kicking their leg, the researchers concluded

FIGURE 4.5 **Which Dots Speak to You?** A researcher in Grenoble, France, watches to see where this newborn is looking. Will they recognize the difference between the shapes shown on the right and the left? This experimental design can help scientists understand how long it will take babies to habituate to a stimuli and what they prefer to look at.

Thierry Berrod, Mona Lisa Production/Science Source

FIGURE 4.6 **Scientific Experiments Can Be Fun.** Researcher Carolyn Rovee-Collier noticed that her son was happy when he could jiggle the mobile above his crib (as seems to be the case with this baby), allowing her some time to work. She turned this observation into groundbreaking research, demonstrating that babies, like this little girl, have strong procedural memory very early in their lives.

that the baby remembered the procedure. If the baby didn't move their leg at all, researchers concluded that they had forgotten.

The babies studied in this experiment, even those just a few months old, had a tremendous memory for this experience. However, infants' memories were fragile. If something changed in the environment, for example, if the crib was decorated differently or if the room had an unusual smell, babies were likely to forget to kick altogether (Rovee-Collier & Cuevas, 2009).

What Do Babies Know Already?

You might not think that Telele knew very much as a newborn, but some researchers argue that babies are born with a wide range of innate knowledge about how the world works. This **nativist** (or *core knowledge*) **approach** represents the "nature" side of the nature/nurture continuum. For instance, Telele knows that three objects cannot magically become two and that there is a difference between a living being, such as an animal, and an inanimate object, such as a coffee cup (Smith et al., 2020; Tardiff et al., 2020). Using habituation methodologies to observe how babies respond to different possible and "impossible" scenarios, scientists have demonstrated that even newborns understand some basic processes, including:

- *Basic physics.* Not only do babies understand the principle of gravity, that unsupported objects should fall, but they also understand that two objects can't take up the same physical space (Lin et al., 2021).
- *Basic math.* Even newborns seem to have an innate sense that counting can refer to the number of things in a row, and they know when one item disappears from that row (Spelke, 2017).
- *Basic biology.* Babies have some simple ideas about what makes an animal different from an inanimate object; for example, it can move on its own and it is not hollow inside (Tardiff et al., 2020).
- *Basic psychology.* Even infants have a sense that people are more likely to help other people they know or who are part of their same group (Ting et al., 2020). They also assume that in a conflict, bigger players will win over smaller players (Thomsen, 2020).

Does this mean that core knowledge researchers think that babies are ready for college? Not at all. Instead, these scientists ask us to appreciate the tremendous capabilities that infants are born with. Awareness of what babies are born knowing can be used to design interventions that help young children learn (Dillon et al., 2017).

Born to Imitate

Nativist or core knowledge theorists aren't the only developmental scientists who recognize newborn babies' innate genius. More than 40 years ago, when one researcher sat in front of a newborn and stuck out his tongue, he found that, with enough time and patience, the newborn will often respond with a similar facial expression in return (Meltzoff, 2020; Meltzoff & Moore, 1977).

Imitation is another tool that helps infants learn and adjust to the world. Learning how to talk, for example, is much easier if a baby can watch a caregiver's mouth and mimic the same shapes with their own mouth. Understanding that someone else's body is similar to one's own is an essential part of early imitation (Nagy et al., 2020). Although babies may continue to imitate and learn (think about

nativist approach A theoretical perspective that maintains that babies are born knowing a great deal about how the world works. (Also called the *core knowledge approach*.)

how easily a toddler can pick up a "bad" gesture they have seen just once), automatic imitation tends to fade in favor of more active imitation games later in life (Yu & Kushnir, 2020). How strong and robust early imitation is remains controversial, but scientists agree that copying is a crucial part of how children learn (Davis et al., 2021; Slaughter, 2021).

Lisa5201/E+/Getty Images

Do As I Do. Newborn babies sometimes imitate caregivers' facial expressions. The drive to copy helps propel infants' early learning.

Culture, Context, and Early Cognition

Developmental scientists who study the impact of culture address how much early development is determined by culture and context, rather than by a universal genetic blueprint. They are interested in the "nurture" part of the nature/nurture continuum: Does how a baby is cared for impact how their thinking develops? Many cognitive abilities, like the abilities to learn, talk, imitate, and remember, are experience-expectant: They develop in all children who are given care, nutrition, and stimulation. However, context is also critical. Many early cognitive skills, from how children learn to their attention and memory, are experience-dependent, contingent on the cultural context around them (Arauz et al., 2019; Legare, 2019).

Even as young as 1 month, babies in some cultures have longer memories and greater attention spans than those in others (Clearfield & Jedd, 2012; Werchan et al., 2019). All babies will learn to pretend and to find hidden objects, but some will do so as much as 18 months earlier than others (Callaghan, 2020; Callaghan et al., 2011). Many of these skills seem to be experience-dependent: Babies receive a lot of early practice in skills valued by their communities and, as a result, perform better at these skills. For instance, toddlers who spend a lot of time talking about the past tend to remember their early experiences longer than other children. This enriched experience builds memory (Hayne et al., 2015).

CONNECTIONS

Remember from Chapter 1 that many theorists, including Lev Vygotsky, emphasize the critical role of culture in how children learn.

How babies learn also depends on what families expect from children. Inspired by Vygotsky, researchers have observed that in many cultures, adults don't spend much time explicitly teaching babies one-on-one (Shneidman et al., 2016a, 2016b). Babies in these cultures learn primarily from watching, overhearing, and even helping with what is going on, called *learning through observation and pitching in* (Rosado-May et al., 2020). Developmentalists have found that babies who live in communities where observational learning is encouraged are better at learning from this teaching style than other children are. Thus, babies learn how to learn in a way that fits their culture (see **Infographic 4.2**.) (Shneidman et al., 2016a).

Adriana Zehbrauskas

Learning Through Observation and Pitching In Alondra is helping out her family and learning how to safely peel a mango. Her sister, Susy, is close by, as they prepare a snack at their home in Valladolid, Mexico. Watching what bigger people do is an important way small children learn about the world around them.

Early Learning

At age 2, Telele has already learned a great deal. Like many babies, she benefits from lots of enrichment: Telele has been read to and sung to, and is learning four languages. She has doting parents and an extended family who are thrilled to be helping to raise the next generation.

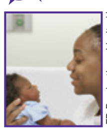
It is challenging for researchers to measure early cognitive skills in babies. A missed nap or a growth spurt can make it difficult to know whether a baby has fallen behind or is just having a bad day (LoBue et al., 2020). However, researchers who have tracked babies' development over time begin to see strengths and challenges in

INFOGRAPHIC 4.2 Timeline of Cognitive Development

Piaget's Stages of Cognitive Development

Reflexes | *Primary Circular Reactions* | *Secondary Circular Reactions* | *Coordination of Secondary Circular Reactions* | *Tertiary Circular Reactions* | *Mental Combinations*

Age 0 | 3 months | 6 months | 9 months | 1 year | 1½ years | 2 years



ER Productions Limited/ DigitalVision/Getty Images

Pays attention to people and faces

Habituation: Infants are interested in new things but show signs of boredom as they habituate to an experience. This is a sign that they remember.

Implicit memory, processes for learning how to do things, is mature.

Social smile: Encourages back-and-forth interaction.

Shows interest in exploring and tries to reach new objects

Searches for a hidden object

Joint attention: Babies learn to pay attention and focus through sharing attention with a partner.

Deferred imitation

Symbolic play: Using toys to represent real objects and ideas

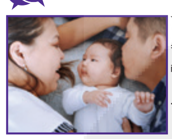
Can use language for social interaction

Can sort things by color or shape

Travel_Master/Shutterstock

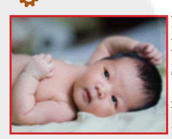
Babies are born with basic understanding of how the world works: the ideas of gravity, that animals are different from objects, and that people help each other.

Imitation: Babies seem born to copy what they see.



Arman Zhenikeyev/ Getty Images

Recognizes and remembers familiar people



artworkbyme/iStockphoto/ Getty Images Plus

Attention: From “sticky fixation” at 2 months, babies become able to shift visual attention from one thing to another around 6 months.

Object permanence: Infants understand how to find hidden objects.

minchen liang/Alamy Stock Photo

The age of little scientists or experimenters

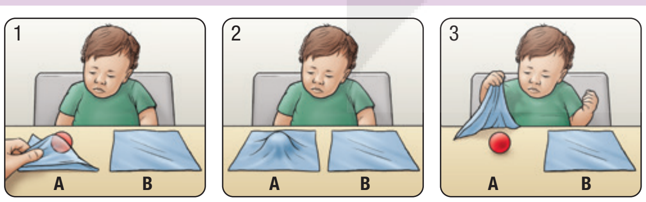
Maskot/DigitalVision/ Getty Images

Pointing: Encourages shared interaction

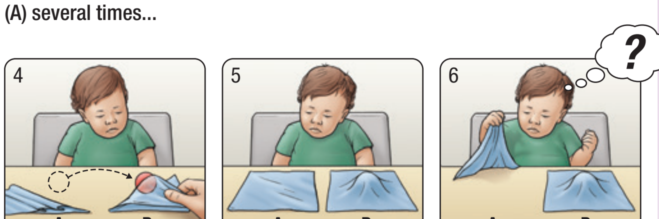
Achievements of Piaget's Stages
Information-Processing Milestones
Social Cognition Milestones

How Do the Major Theories Explain Object Permanence?

Researchers developed a way of assessing infants' development of *object permanence*, called the *A-not-B task*. They found that when a caregiver hides an object, a young infant will act as if the object has vanished. The baby will not hunt for it. After they are about 8 months old, babies will try to find the object, staring at its last location or moving a barrier to look for it. Not until 10–12 months do they begin to systematically and accurately locate hidden objects.



In the A-not-B task, a baby is shown a toy which is then hidden in one place (A) several times...



The toy is then moved, in full view, to another hiding place (B). The baby is distracted for a minute and then allowed to search for it. Babies younger than about 10 months will typically reach toward the first location (A) to find the missing toy, rather than where they saw the toy most recently hidden (B).

I'm still not sure...
Piaget believed that children's errors in their search for hidden objects indicate that they do not understand that objects continue to exist when out of sight. Although babies can successfully find the object in a simple task at about 8 months, Piaget felt the full understanding takes longer to develop and isn't fully mature until they succeed at the A-not-B task, at 18–24 months.

Where was it again...?
According to information-processing scientists, this error reflects immature memory and inhibition skills. The longer babies are forced to wait before searching, the more mistakes they make, suggesting difficulty holding the correct location in mind. Also, the practice of finding the toy at place A forms a habit that is difficult to break. Babies must *inhibit* this habit, stopping themselves from reaching toward place A.

Things don't just disappear...
Core knowledge researcher Renee Baillargeon demonstrated that even very young babies have some sense of object permanence and show surprise in lab experiments when objects seem to violate this expectation. Core knowledge theorists suggest that A-not-B errors do not indicate lack of understanding of object permanence, but rather immature memory and search skills.

This is a strange activity...
Cultural theorists note that there may be cultural differences in familiarity with this type of hide-and-seek activity. Babies who have had more practice paying attention and managing distractions, or even more practice playing with toys, tend to make fewer mistakes in this task.

Information from Baillargeon, 1987; Brace et al., 2006; Diamond, 1985; Lipina et al., 2005; Marcovitch et al., 2016; Marcovitch & Zelazo, 1999; Piaget, 1954.

infants' cognitive skills even before they turn 2 (Betancourt et al., 2016; Johnson et al., 2016). What builds a baby's cognitive skills?

- *Good health.* As already explained, adequate nutrition before and after birth is essential for early brain development. Lack of iron or exposure to toxins, even in babies with good health, can cause delays and challenges in cognitive development (Georgieff et al., 2018; Valentine, 2020).
- *Attention.* Babies benefit from shared, joint attention from caregivers. Whether Telele is pointing at a bird on the feeder, watching her mother unpeel a banana, or drawing with her parents, eye contact and shared attention help babies learn to focus (Brandes-Aitken et al., 2019; Suarez-Rivera et al., 2019).
- *Responsive caregiving.* Caregivers who respond to vocalizations, movements, and gazes are encouraging their babies to explore, communicate, and learn from them. Back-and-forth, or *contingent*, interactions, where babies and caregivers share a toy, a conversation, or a clapping game, are critical to early cognitive development (King et al., 2019; McCormick et al., 2020; Rosen et al., 2020).

Around the world, nearly one in three children is at risk for cognitive delays or disabilities that begin in infancy (McCann et al., 2020). The major cause is poor health, often due to malnutrition or chronic diseases like malaria (Black et al., 2020; French et al., 2020). In affluent countries like the United States, cognitive challenges are more frequently caused by neglect and adversity. Researchers have various measures for the number of *adverse experiences* a family faces during infancy, like the loss of a primary caregiver, violence, living with a family member with a serious mental health or substance use disorder, discrimination, or food or housing insecurity (Felitti et al., 1998; Hodel, 2018). The more adverse experiences an infant's family faces without enough support, the more likely the baby is to have cognitive consequences (Luby et al., 2020).

In the United States, about one in three young children has experienced at least one adverse experience, and one in five lives in a family with low income (ACS, 2020; Crouch et al., 2019). Caregivers who are stressed may have less time to give infants the attention they need. Exposure to too many stress hormones can disrupt brain development, and neglect, leading to a lack of early stimulation, can cause critical neural pathways to be pruned instead of grown (Amso & Lynn, 2017). Early difficulties often stem from systemic issues in the community, rather than problems in an individual family (Shonkoff et al., 2021). Adversity is a risk factor, not a prediction: Millions of babies whose families experience poverty, trauma, or stress do not have cognitive delays (Noble & Giebler, 2020).

Approaches to Boost Cognitive Development

Around the world, many early interventions to promote children's development focus on taking care of families' basic needs and well-being, such as making sure adults have access to parental leave, health care, and basic financial resources (Clark et al., 2020; Richter et al., 2017). Programs also focus on enhancing caregiving, so that parents, grandparents, and even older siblings can have responsive interactions with babies (Cuartas et al., 2020). Home-visiting programs, such as the Nurse–Family Partnership and ChildFirst, have shown to be effective in fostering children's early cognitive development and caregivers' well-being (Heckman et al., 2017; Molloy et al., 2021).

Adam Robison/The Northeast Mississippi Daily Journal via AP

How Does It Work? Exploring a toy in this child care center in Tupelo, Mississippi, involves trial-and-error and engaging conversation. A caregiver's responsive, back-and-forth interactions with these toddlers will help them grow.

Another way of supporting and advancing cognitive development in young children is to make sure that they receive high-quality care outside of the home (Burchinal & Farran, 2020). High-quality child care typically has a lower ratio of children to caregivers, who have an academic background in child development and provide responsive, developmentally appropriate care. Early Head Start and Educare, a public-private partnership program, have both been shown to provide high-quality, center-based child care (Yazejian et al., 2017).

Unfortunately, these programs are not accessible to all families: For example, Early Head Start serves fewer than half of all eligible children due to inadequate funding (NASEM, 2018). During the COVID-19 pandemic, even fewer toddlers were able to access quality out-of-home care, as many programs shut down around the world (Gilliam et al., 2021). One sign of poor-quality early child care is if babies and toddlers spend time in front of a screen or if caregivers are particularly stressed (Blasberg et al., 2019; Hewitt et al., 2018; Reid et al., 2021).

SCIENCE IN PRACTICE

Shoneice Sconyers, BSW, MS, Family Resource Partner

Shoneice describes herself as a "connector," someone who brings people together. She uses these skills and her graduate degree in social work to get help for children and families in need. One of the things that hurts young children's developing cognitive skills is trauma, which can result from homelessness, having a caregiver with a mental illness, or having a serious illness of their own. Trauma can keep families from back-and-forth communication with children, and young children's language and cognitive development may suffer as a result.

Shoneice has years of training and coursework but she describes her job is to be a "fairy godmother" who keeps connections strong. If parents, grandparents, or community have let a child down, her job is to help them pick themselves back up. Filling in the gaps was often difficult in the middle of a global pandemic that turned home visits into video calls, but she knows what she does is important. It is more difficult for caregivers to function if they are under strain, and programs like Shoneice's have been shown to encourage more back-and-forth between toddlers and their caregivers, which continues even after the intervention services are over (LoRe et al., 2018). Shoneice says she loves the work which "lights her up on the inside."

Keeping Screens Out of Strollers

Screens are popular with families of small children, but pediatricians and developmental scientists have found that babies do not benefit from and may even be harmed by too much exposure to screen media (AAP, 2016; WHO, 2019). For instance, the American Academy of Pediatrics (AAP) advises that babies not watch any video or screens at all until 18 months of age, and that older babies be limited to an hour a day viewed with an adult.

Developmental scientists suggest that time spent in front of a screen is time when babies are not doing things that are proven to help them develop. Infants and toddlers on screens are not engaging in responsive interaction, playing, or sleeping—activities that spur their social, cognitive, and emotional development (Madigan et al., 2020; Willumsen & Bull, 2020).

Despite these recommendations, many babies are exposed to more than six hours of background television and are actively watching screens for more than three hours a day (Barr et al., 2020; Chen & Adler, 2019; NSCH, 2021). The amount of screen time for babies increased dramatically during the recent pandemic (Monteiro et al., 2021). Caregivers often use media to keep children occupied, allowing them to play a smartphone game or watch a video while a parent is on a Zoom call or washing dishes (Chen & Adler, 2019;

Rideout, 2013). Babies are quieter and less disruptive when they are in front of a screen, but that helps the caregivers, not the infant.

Many caregivers, perhaps influenced by claims of the educational value of videos or apps, believe that media can accelerate cognitive development. Researchers have come to the opposite conclusion: Screens do not offer the critical back-and-forth, contingent interaction that babies need in order to learn (Li et al., 2017). However, babies interacting with real people through real-time video, such as a Zoom or FaceTime call, *do* pick up new words and information. As a result, developmentalists and pediatricians conclude that there is some benefit to infants who engage in video chats because they involve a responsive give-and-take (Strouse et al., 2018).

APPLY IT! **4.9** How would Piaget explain why Telele methodically drops pieces of pear from her highchair and watches them fall?

4.10 How does Telele's memory help her learn how to pet a dog, beat a drum, and eat with a spoon, but make it difficult to memorize the alphabet?

4.11 How does the development of object permanence explain why Telele got better at searching for lost toys when she entered toddlerhood?

4.12 Telele's parents are planning to send her to early child care. What qualities would you suggest they look for in a caregiver or child-care center?

4.13 What would you tell Dewey and Marjorie about the relationship between screen media and toddlers' cognitive development?

Language Development

Learning Objective

4.7 Describe the typical pattern of language development in the first two years.

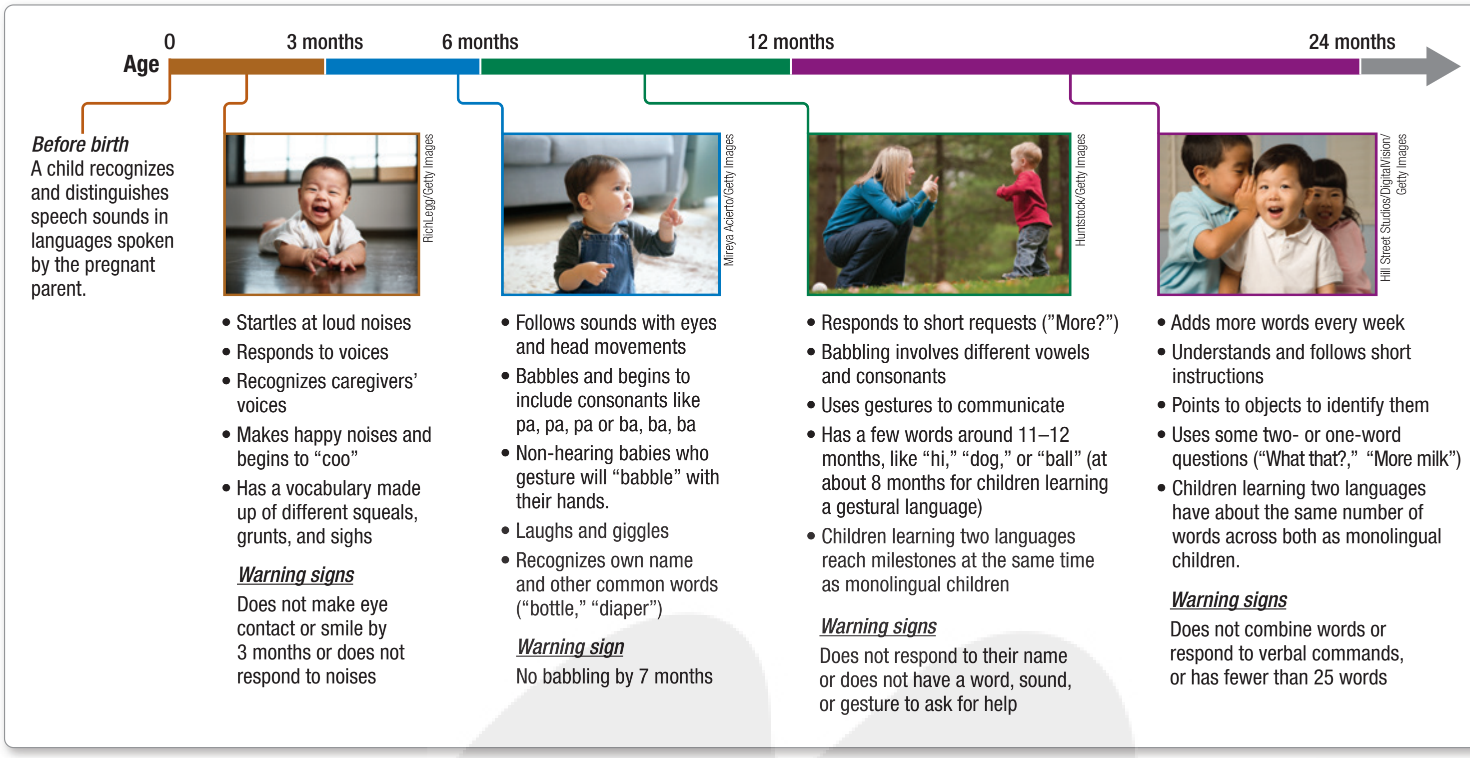
At age 2, Telele can now point, talk, and complain. She can ask for pears instead of cheese with dinner at 13 months and tattle on her cousin at 24 months. By age 2, babies are able to understand language at about 150 words per minute and respond in a conversation in about 200 milliseconds (Chater et al., 2016). Language is not only the words you say or read; it is a complex, rule-based system for using symbols to communicate. These symbols include spoken words, gestures, shrugs, facial expressions, finger signs, and even emojis.

Steps to Talking and Understanding

Babies communicate from the moment they are born, beginning with the cry that reassures everyone in the room that they survived childbirth. They soon begin to make other noises, such as grunts, growls, and squeals. These noises begin to get happier over the first few months, with laughter appearing at about 3 months, and become easier to interpret as contented or fussy expressions (Oller et al., 2019).

At the same time, babies are listening. Infants can understand language long before they are able to produce it, perhaps because they get more practice listening than they do speaking (Chater et al., 2016). By 5 months, they can recognize a few words, such as their name (Holzen & Nazzi, 2020). At about 6 months, they can associate words with a wide variety of things (see **Figure 4.7**).

One challenge from a baby's perspective is that there are so many words and so many things they could refer to. Researchers tracking babies' eyes have observed that they use cues such as gesture, shared attention, eye gaze, and even intonation to learn what people are talking about (Smith et al., 2018). Babies even use statistics: They notice combinations of sounds that are common. Statistics also help them figure out which parts of words are frequently repeated, like endings (*-ed*, *-ing*, or *-s* in English) and function words (*of*, *to*, and *that* in English) (Saffran, 2020).



Information from from ASHA, 2017; Wankoff, 2011; Hanen, 2017; Ferjan Ramírez & Kuhl, 2016; Rinaldi et al., 2014; Jhang & Oller, 2017; Özçalışkan & Goldin-Meadow, 2005; Petitto et al., 2016.

FIGURE 4.7 **Highlights of Language Development** Language skills help infants learn and build relationships. There are many variations in how children learn to understand and produce language, but most children follow a predicable sequence. Children whose development is not quite typical may need some extra support.

The World from a Baby's Perspective How does this baby know that his caregiver is talking about the oatmeal in the bowl? Researchers believe that babies use social cues, shared attention, and statistics. Frequently used words are more likely to be associated with frequently used objects. For instance, in this photo, "spoon" more likely refers to what the baby is grabbing.

babbling Short, repetitive, syllable sounds, like ba-ba-ba or pa-pa-pa (in English), that begin at about 4 months and become more speechlike by 7 months.

fast-mapping A child's ability to quickly learn new words.

At about 5 months, infants can predictably produce sounds. In the next few months, they begin to experiment with short sounds that sound more like language (Cychosz et al., 2020). These short, repetitive, syllable sounds, like ba-ba-ba or pa-pa-pa (in English), are called **babbling**. Babbling begins at about 4 months and becomes more and more speechlike by 7 months, as combinations of consonants and vowels are produced and reproduced. Babies around the world typically babble regardless of whether they are raised by talkative families or in quieter homes, whether they are babbling in speech or in gestural languages, like American Sign Language (Flaherty et al., 2021; Petitto & Marentette, 1991).

No matter where they are born, babies usually begin to produce their first words around the time of their first birthdays (MacWhinney, 2017). Babies who use gestural languages sign their first words a few months earlier (Ozcaliskan & Goldin-Meadow, 2005). Around the world, caregivers report that babies' first words are about them: words like *Mama* (in English and Spanish) or *Baba* (*father* in Arabic and Marathi) (Ferguson, 1964). *Mama* and *Dada* are usually followed by other early words like *hi*, *bye*, *more*, and *no*, reminding us that toddlers use words socially (Frank et al., 2021). Telele's first word was *bath*.

While babies' vocabularies are building, their language acquisition varies dramatically (Dick et al., 2016). Some babies will show a vocabulary "burst," but others may show a slow-and-steady rise with many typical variations (Werker, 2018). By age 2, children typically produce between 75 and 225 words but understand many more (Rescorla, 2019).

By 18 months, they can learn new words almost instantaneously. For instance, if you offer a toddler a kumquat, saying: "Here, try a kumquat," they will immediately understand that the word "kumquat" refers to the tiny orange fruit in your hand (Weatherhead et al., 2021). This ability to quickly learn new words is called **fast-mapping**

(Byers-Heinlein et al., 2018; Carey, 1978, 2010). Fast-mapping increases babies' vocabularies exponentially, which is why people who spend a lot of time with small children must watch what words they are using. Babies can just as easily fast-map that word you used to describe a bad driver as the name for a zoo animal.

This rapid vocabulary development can mean being overly rigid about what words refer to, in errors of **overextension** or **underextension**. A toddler who is overextending might assume that a specific term relates to a larger category, such as insisting that all birds are called pigeons. A toddler who is underextending might insist that the word *cat* only applies to their pet and never to the neighbors' cat. These errors will generally be corrected naturally as children use them in give-and-take conversations with others.

overextension An error in which a child assumes that a specific term relates to a larger category.

underextension An error in which a child insists that a word only applies to a specific member of the group, rather than the whole group itself.

infant-directed speech (IDS) Adults' use of high-pitched, sing-songy tones and simple sentences when they talk to infants.

What Helps Babies Learn to Talk?

Babies all over the world learn to communicate in one or more of 6,000 languages. How many words they learn and how fluently they use them depends on how much early language they practice. Just like learning to walk or ride a bike, learning to talk takes work. Babies who hear and use a lot of language develop larger vocabularies, which seems to help children do well later in school (Ramírez et al., 2020).

Many adults use high-pitched, sing-songy tones and simple sentences when they talk to infants, which scholars call **infant-directed speech (IDS)**. Infant-directed speech helps babies pick out a single word in a mass of sounds and helps them focus (Byers-Heinlein et al., 2021). IDS does not have to be high-pitched baby talk; its key characteristic is a responsive give-and-take, even if the child may not respond in full sentences or can only coo (Masek et al., 2021).

In many communities, adults don't speak directly to babies and toddlers very often. For instance, adults in Polynesia and Samoa believe that small children shouldn't be spoken to until they begin to speak. The idea, as one scientist explains, is that the "child has to adapt . . . rather than the other way around" (Stoll & Lieven, 2014, p. 26). Rather than talking, families may rock, touch, or bounce their infants to entertain them. Despite this lack of early language exposure, babies in these cultures learn to talk at about the same age as babies in other places (Shneidman & Goldin-Meadow, 2012). However, the more babies are directly spoken to, the larger their vocabularies (Lopez et al., 2020; Madigan et al., 2019). The more responsive caregivers are to their babies' attempts to communicate, often called "bids" for attention, the more verbal their babies will become (Anderson et al., 2021).

Share It!

Did masks affect language development? Some researchers found that babies were able to learn new words from people who wore traditional, opaque masks but had trouble learning from people who wore clear masks. Researchers suspected that the relatively unusual clear masks made it hard for babies to focus.

(Singh et al., 2021)

Scientific American: Lifespan Development

Within the United States, the amount of talk babies hear—and how verbally responsive their caregivers are—varies dramatically. Research that uses voice-activated recorders has shown that some families speak to their children as much as 20 times more than others (Bergelson et al., 2019; Hart & Risley, 1995). The more language a baby hears, the larger their vocabulary, language understanding, and even their scores on cognitive development tests (Madigan et al., 2019). Does this mean that caregivers are to blame if their children do not meet the expectations for language development? Some have suggested that identifying the differences in language exposure may stigmatize toddlers who have limited vocabulary (Adair et al., 2017; Williams, 2020). Others point out that families' interactions with their babies may reflect systemic marginalization and stress rather than cultural choices (Golinkoff et al., 2019).

Masksim/DigitalVision/Getty Images

Do They Mean to Be Rude? Babies learn about the world by pointing, interacting, and playing peek-a-boo with Dad.

Theories of Language Development

For many researchers, understanding how language develops comes down to a question of the environment, or nurture, versus genes, or nature (Chomsky, 1957; Friederici et al., 2017). On one side of the debate are scholars who believe that all humans are genetically programmed to develop language (Berwick & Chomsky, 2017). In particular, these researchers point to babies' unique ability to recognize grammatical rules without being taught them (Pinker, 1984). These *nativist* scholars, who follow the theoretical approach we discussed earlier in this chapter, call this inborn ability **universal grammar** (MacWhinney, 2017). They note that all world languages have grammar and argue that the infant brain is programmed to pay attention to grammar in the language they hear.

In the other camp are those who suggest that language is not a unique cognitive process but rather is another skill that emerged as the human brain developed to allow us to think and relate to others (Bohn et al., 2019). These **emergentist**, or *constructivist*, scholars argue that human abilities to recognize patterns and the drive to communicate and imitate, rather than brain processes specifically devoted to language, created the uniquely human ability to use language. Similarly, learning theories like *behaviorism* and *social learning theory* apply their basic concepts of conditioning and imitation to language development. These theorists would argue that infants' early vocalizations are rewarded with praise and attention, and that children observe and imitate the language models around them.

As brain and behavioral research has expanded, most developmental scientists today adopt something close to the emergentist position. They recognize that language has both genetic *and* environmental influences. Most focus on the connections between language and other types of learning and communication. Although the complexity of language is different from other cognitive skills, it builds on many other forms of communication and thinking that toddlers demonstrate, such as their ability to imitate, think symbolically, and remember.

The Multilingual Advantage

Growing up speaking more than one language is the norm for most people around the world (Ramírez & Kuhl, 2016). In the United States, about one in five children speaks a second language (ACS, 2018).

Children raised in multilingual homes have a host of benefits. Switching from one language to another can improve attention and communication skills and builds executive function (Antoniou, 2019). For instance, babies exposed to two languages have to remember whether Grandma says "cat" or "gato" like Mom, so they must use their attention and perspective-taking skills a little more every day. These benefits can last a lifetime (Bialystok, 2020).

Multilingual infants reach their early language development milestones, like babbling and first words, at about the same time as children exposed to only one language (Petitto et al., 2001). However, they tend to lag behind monolingual children in developing vocabularies and more sophisticated grammar in each individual language (Höhle et al., 2020). Children who are learning two or more languages are typically exposed to fewer words in each language, so although their combined vocabulary in both languages may be the same as that of monolingual children, their vocabulary in each separate language tends to be smaller (Lauro et al., 2020). Multilingual children may not catch up to monolingual children until they are about 10 (Hoff & Core, 2015).

What does this mean for Telele? Being fluent in multiple languages is not her only advantage. Like all multilingual children, she will likely demonstrate more advanced executive function than monolingual children her age. In addition, it will create a sense of identity and belonging to her community (Lynch, 2018). Language helps connect Telele and her parents to their ancestors, their land, and the sacred knowledge of their community. As Dewey and Marjorie explain, every word they teach Telele reminds them that language is "a connection to culture and a guidebook to survival," a way to "give Telele strength and a sense of who she is."

CONNECTIONS

Remember from Chapter 2 that behaviorism focuses on measuring what we do. Behaviorist researchers like B. F. Skinner explained that language development was shaped through operant conditioning. Social learning theorists suggest learning comes from observing and imitation.

Scientific American Profile

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How Multilingualism Boosts Cognition

Learn It Together

Reflect on Multilingual Development

Plan Analyze the benefits of multilingual language development.

Engage Divide into groups and share personal experiences or reflections from Telele's story about the cultural and cognitive benefits and potential challenges of multilingual development.

Practice Connect personal experience with research on multilingual development. Practice your skills in scientific communication.

Reflect How does your personal experience help support or challenge what you've learned about the research on multilingual development?

universal grammar A child's inborn ability to recognize and use grammar.

emergentist Scholars who argue that humans' drive to communicate and imitate and ability to recognize patterns, rather than brain processes specifically devoted to language, created the uniquely human ability to use language. (Also called *constructivist*.)

APPLY IT! **4.14** A friend of Marjorie's is worried that her 18-month-old makes mistakes when she speaks. For instance, she sometimes calls cats in their neighborhood "Twinkles" — the name of her pet cat. What should Marjorie say to reassure her about her daughter's development?

4.15 Telele already speaks four languages at home with her family. What would you tell her parents about the strengths and possible challenges for multilingual toddlers?

Wrapping It Up

LO 4.1 Explain factors promoting healthy patterns of growth and development during the first two years. (p. 102)

Infants grow more rapidly than at any other point in the lifespan, and their health is more fragile. Infant mortality remains high around the world and is distributed inequitably. Healthy nutrition, ideally including human milk, helps set the stage for a lifetime of health. Adequate sleep, access to health care, and vaccination also help babies thrive.

LO 4.2 Explain the role of neurons and synapses in brain function during the first two years. (p. 110)

The brain doubles in volume and adds *synapses*, or connections between neurons, during the first two years. Communication in the brain is faster as a result of myelination. Pruning of underused neural connections helps make brain circuits more efficient. The brain develops in response to experience, adding synapses and myelin to regions of the brain that are frequently activated. The brain is *plastic*, or flexible, in responding to the environment, but there are limits to its ability to bounce back from traumas.

LO 4.3 Describe vision and hearing development in infancy. (p. 114)

Infants are born with a preference for faces, and their vision develops rapidly in the first years, allowing them to shift their focus and perceive details. Babies' hearing is also improving but is attuned to voices and speech. Perceptual narrowing describes how babies' senses gradually specialize in the sights and sounds they are exposed to most frequently.

LO 4.4 Explain how the typical maturation of movement changes a baby's experience of the world. (p. 114)

Babies develop independent control of their gross and fine motor systems. They tend to learn to move their bodies in a *cephalocaudal*, or head-downward pattern, as they develop the ability to move their heads. They also learn to control their core first, in what is called *proximodistal development*. It takes practice for babies to learn how to move, and it often requires readjustment of how they see the world.

LO 4.5 Explain maturation in sensorimotor thinking, attention, and memory during infancy and toddlerhood. (p. 119)

Piaget called infancy and toddlerhood the sensorimotor period, which is divided into six stages: reflexes, primary circular reactions, secondary circular reactions, coordination of secondary circular reactions, tertiary circular reactions, and mental combinations. Infants develop object permanence and can mentally represent the results of their actions. Information-processing researchers look at the components of cognition, such as attention and memory. Babies learn from others through joint attention. Babies have strong implicit memory (memory for how to do something), but weaker explicit memory (memory for facts). Core knowledge, or nativist, theorists focus on the knowledge babies are born with. Cultural theorists study how cultural expectations and caregiving change how babies think and learn.

LO 4.6 Describe the factors influencing learning during the first two years. (p. 119)

The first two years are a time of rapidly building skills. Learning depends on good health, attention from caregivers, and responsive back-and-forth stimulation. Interventions can help families build stronger, responsive relationships. Experts agree that screens and apps do not help babies learn in the first few years and take time away from more important interactions.

LO 4.7 Describe the typical pattern of language development in the first two years. (p. 129)

Babies are born attuned to language, which can include spoken words, gestures, and facial expressions. Communication typically develops through stages, from babbling, to telegraphic speech, to complex speech. Toddlers typically learn words quickly through fast-mapping and usually speak 200 words by age 2, but they understand many more. Nativist theorists suggest that language development is a unique human ability distinguished by a universal grammar. Emergentist scholars suggest that language development is more closely connected to other cognitive skills. Responsive caregiving and infant-directed speech (IDS), help build language skills. Multilingual and bilingual children tend to have stronger executive function and self-control but take longer to build their vocabularies.

KEY TERMS

malnutrition (p. 102)
wasting (p. 102)
percentile (p. 102)
stunting (p. 102)
intervention (p. 103)
overweight (p. 104)
immunization (p. 108)
circadian rhythm (p. 108)
sudden unexpected infant deaths (SUID) (p. 109)
axon (p. 112)
dendrite (p. 112)
synaptogenesis (p. 112)
synaptic pruning (p. 112)
myelination (p. 112)
myelin (p. 112)
experience-expectant brain development (p. 112)
experience-dependent brain development (p. 113)
preferential looking technique (p. 115)
perceptual narrowing, (p. 115)
motor development (p. 116)
gross motor development (p. 116)
fine motor development (p. 116)
cephalocaudal (p. 117)
proximodistal principle (p. 117)
affordance (p. 118)
visual cliff (p. 119)
sensorimotor (p. 119)
primary circular reactions (p. 119)
secondary circular reactions (p. 121)
object permanence (p. 121)
tertiary circular reactions (p. 121)
mental representation (p. 121)
autism spectrum disorder (ASD) (p. 122)
habituation (p. 123)
implicit memory (p. 123)
explicit memory (p. 123)
nativist approach (p. 124)
babbling (p. 130)
fast-mapping (p. 130)
overextension (p. 131)
underextension (p. 131)
infant-directed speech (IDS) (p. 131)
universal grammar (p. 132)
emergentist (p. 132)

CHECK YOUR LEARNING

1. Why is it important to identify which babies may be at risk for malnutrition in early life?
   a) To check for early evidence of eating disorders
   b) To make sure their bodies are getting the nutrition they need to build their brain
   c) To see if they are eating too much
   d) To evaluate their appetite
2. What is the major cause of infant mortality in the United States and around the globe?
   a) Complications from birth and prenatal development
   b) HIV/AIDS
   c) Malnutrition
   d) Sleep injury
3. How is infant sleep different from adult sleep?
   a) Infants' brain development and memory consolidation happen at night.
   b) Infants require assistance to get back to sleep.
   c) Infants often wake up between sleep cycles.
   d) Missing sleep affects infants' mood.
4. Which of these processes is unique to infancy?
   a) The volume of the brain increases dramatically.
   b) Myelin helps to speed neural communication.
   c) Synapses that are unused are pruned away.
   d) New synaptic connections are created.
5. How does practice change babies' progress with motor development?
   a) More practice usually helps infants learn more quickly.
   b) The timing of motor milestones is entirely genetic, so practice does not matter.
   c) Practice is overwhelming to infants and is not safe.
   d) Practice destroys babies' motivation to move.
6. How does responding to infants or interacting with them influence their cognitive development?
   a) Infants do best without too much outside stimulation.
   b) Infants benefit from regular stimulation in most contexts.
   c) Infants' cognitive development is entirely genetic.
   d) Infants are easily stressed by extra attention.
7. When do infants begin to respond to language and communication?
   a) At 12 months
   b) At 3 months
   c) At birth
   d) At 6 months
8. Piaget developed his theories based on close observation of his three children. This is the case study method. How did this method help Piaget develop his breakthrough ideas? Can you explain some of the limitations of this method?
9. How might culture impact toddlers' thinking? Use examples from language development and information processing.
10. Some isolated children with profound hearing impairment in Nicaragua developed their own sign language when they were grouped together in a school with no other way to communicate. Scholars rushed to Nicaragua to study the children, communicate with them, and learn their language. Can you explain what nativist or universal grammar theorists would expect to find in these children?

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