part 4
MIDDLE CHILDHOOD

chapter 9

Physical and Cognitive Development in Middle Childhood

outline

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learning objectives

Describe physical changes and health in school-age children.

Describe cognitive development in school-age children.

Explain how language abilities continue developing in school-age children.

Summarize children's adjustment to school and influences on school achievement.

Describe how schools educate children with special needs.

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did you know?

- The COVID-19 pandemic led to declines in physical activity in children.
- Children who believe they can master schoolwork are more likely to do so.
- Studies support the value of bilingual education.

In this chapter, we look at strength, endurance, motor proficiency, and other physical developments among 6- to 11-year-olds. Cognitively, we examine concrete operations, memory, problem solving, intelligence testing, and literacy. We discuss school achievement, methods of teaching reading, and second-language education. Finally, we look at special-needs education.

It is easier to build strong children than to repair broken men.

—Frederick Douglass (1818–1895)

PHYSICAL DEVELOPMENT

Aspects of Physical Development

Growth during middle childhood slows considerably. Still, although day-by-day changes may not be obvious, they add up to a startling difference between 6-year-olds, who are still small children, and 11-year-olds, many of whom are now beginning to resemble adults.

HEIGHT AND WEIGHT

Children grow about 2 to 3 inches each year between ages 6 and 11 and approximately double their weight during that period (Table 1). Girls retain somewhat more fatty tissue than boys, a characteristic that will persist through adulthood. The average 10-year-old weighs about 18 pounds more than 40 years ago (Fryar et al., 2016).

DENTAL HEALTH

Globally, about 560 million children have untreated tooth decay in their permanent teeth (World Health Organization, 2017). In the United States, approximately 20 percent of 5- to 11-year-old children, who hail disproportionately from lower-income families, have untreated dental decay (Centers for Disease Control and Prevention, 2021). There are disparities by racial and ethnic group in the United States as well: 12.1 percent of non-Hispanic White children, 22.6 percent of African American children, and 18.4 percent

TABLE 1 Physical Growth, Ages 6 to 11 (50th percentile*)

Age	HEIGHT (INCHES)		WEIGHT (POUNDS)	
	Girls	Boys	Girls	Boys
6	46.8	46.8	52.3	52.6
7	48.9	49.7	60.2	61.0
8	51.1	52.0	69.1	69.8
9	53.9	53.5	76.9	78.1
10	56.3	55.8	90.6	89.8
11	59.2	58.8	106.1	102.6

*Fifty percent of children in each category are above this height or weight level, and 50 percent are below it.

Source: Fryar et al. (2021).

of Hispanic children have untreated cavities (US Department of Health and Human Services, 2020).

Although tooth decay is still a common untreated condition, children's oral health has improved dramatically from previous decades. The improvements can be attributed to a variety of factors, including parental education, access to dental care, fluoridated water supplies or the use of fluoride supplements (discussed in Chapter 7), as well as the increased use of adhesive sealants on rough chewing surfaces. Slightly over one-third of children aged 6 to 8 have a dental sealant on at least one tooth, and slightly over half of children aged 9 to 11 have a sealant. Sealants reduce tooth decay for at least 4 years after they are applied and can prevent up to 80 percent of dental caries.

Access to proper dental care is important for young children. Untreated dental caries can result in pain, difficulties chewing food, missed school, problems with concentration, and discomfort with appearance. Parents can help prevent dental caries with regular dental care, fluoridated water supplies or fluoride supplements, and the use of adhesive sealants on rough chewing surfaces (Centers for Disease Control and Prevention, 2021). Programs in which mobile dental equipment is brought to schools serving low-income families and treatment is offered to children there during the school day have been shown to be effective at reducing cavities as well as being cost-effective (Forss et al., 2013; Centers for Disease Control and Prevention, 2021).

NUTRITION

How did the COVID-19 pandemic influence nutrition? Research shows parents and their children were more likely to engage in non-nutritive snacking during lockdown; however, they were also more likely to eat dinner together as a family (Jansen et al., 2021).

The recommended calories per day for schoolchildren 9 to 13 years of age range from 1,400 to 2,600, depending on gender and activity level. Nutritionists recommend a varied diet, including plenty of grains, fruits, and vegetables, and high levels of complex carbohydrates such as whole grains. Children, like adults, should get only about 25 to 30 percent of their total calories from fat and less than 10 percent of the total from saturated fat. They should consume less than 10 percent of their calories from added sugars (DeSalvo et al., 2016) as added sugar consumption has been linked to unhealthy weight gain (Luger et al., 2017).

Unfortunately, American children aged 6 to 11 years score a 53.9 percent average on the Healthy Eating Index, a scoring system designed to measure how well children meet dietary guidelines. Generally, scores tend to be higher in younger children, and there are no differences between boys and girls and between children of different socioeconomic level (Thompson et al., 2019). Poor nutrition is not a problem limited to the United States: Children across the world eat too few fruits and vegetables and regularly consume fast food and processed snacks low in nutritive value (UNICEF, 2021).

Research across 33 different countries has shown that skipping breakfast, which occurs in 10 to 30 percent of children and rises with age, is associated with an increased risk of overweight, obesity, and cardiometabolic risk factors (Monzani et al., 2019). Snacks, too, are problematic. Most children get almost a third of their daily calories through snacks (Shriver et al., 2018) and are eating almost three snacks a day in addition to the typical breakfast, lunch, and dinner (Piernas & Popkin, 2010). In schools in which vending machines are available, 18 percent of children report buying snacks or drinks from vending machines two or more days a week rather than lunch (Park et al., 2010).

Approximately one-third of children eat at fast-food restaurants on any given day. While socioeconomic status does not seem to impact fast-food consumption, race and ethnicity do. African American (9.8 percent) and White (9.1 percent) children are more likely than Hispanic (8.4 percent) and Asian (5.0 percent) children to eat fast food (Vikraman et al., 2015). The media strongly influence children's food choices and not for the better. For example, commercials that focus on fast-food restaurants and the enticing toys they often offer are common during children's programming hours. Exposure to fast-food and soft drink advertising is associated with increased consumption of both types of products, especially in overweight or obese children (Cairns et al., 2013; Andreyeva et al., 2011). Moreover, as children move to use increasingly diverse media platforms, so do advertisers. Food marketing on social media and content delivery plat-

forms such as YouTube has increased sharply in recent years and is likewise associated with less healthy eating habits (Bragg et al., 2020).

Nutrition education in schools can be helpful when combined with parental education and changes in school lunch menus, although they have been more successful in improving fruit intake than vegetable intake (Evans et al., 2012). Additionally, efforts to combat obesity benefit from an additional focus on energy expenditure through increased activity (Kelley et al., 2015). Proposed legislative responses include changes in food labeling, taxes on unhealthy foods, restrictions on foods in government-supported school lunch programs, regulation of food advertising directed toward children, and requiring restaurants to list nutrition information on their menus.

SLEEP

Sleep needs decline from 10 to 13 hours a day for 3- to 5-year-olds to 9 to 11 hours a day for ages 6 to 13 (Sleep Foundation, 2020). However, many children do not get enough sleep. A variety of correlates seem to be at play, including exposure to media screens, physical inactivity, secondhand smoke, poor housing, vandalism, and a lack of parks and playgrounds (Singh & Kenney, 2013). The presence of a television in the bedroom can also be highly disruptive. At the age of 7, 23 percent of children have a television in their bedroom, and increased television viewing is associated with fewer hours of sleep (Cespedes et al., 2014).

Snoring can be a marker of poor sleep. Estimates of how many children habitually snore vary widely and range from 7 to 21 percent. Whether or not a child snores can be affected by a variety of factors, including age, gender, race, family susceptibility, chronic health problems, and overweight (Goldstein et al., 2011; Bonuck et al., 2011; Li et al., 2010). Although children who snore sleep as long as do children who don't snore, their sleep is more fragmented, and fragmented sleep is associated with deficits in language and cognitive skills, fine motor skills, and activities of daily living skills, and lower scores on developmental tests (Yorbik et al., 2014). Obstructive sleep apnea, a severe form of sleep disordered breathing, is common in children and, because of the plastic nature of the brain in childhood, can result in permanent deficits in learning and behavior, as well as contribute to cardiovascular and metabolic morbidities (Bue et al., 2020). Children may be treated with surgery or may benefit from continuous positive airway pressure therapy in which an electronic device keeps airways open via air pressure delivered through a nasal mask (Gozal et al., 2020).

Failure to get adequate sleep is also associated with a variety of adjustment problems, and this effect is particularly marked when children are African American or come from homes of low socioeconomic status (El-Sheikh et al., 2010; Beebe, 2011). Sleep quality, sleep duration, and daytime sleepiness have all been found to affect academic performance and seem to affect younger children, particularly boys, to a greater degree (Dewald et al., 2010). Moreover, short sleep duration in children is associated with later risk of obesity (Deng et al., 2021).

BRAIN DEVELOPMENT

A number of cognitive advances occur in middle childhood that can be traced back to changes in the brain's structure and functioning. In general, these changes can be characterized as resulting in faster, more efficient information processing and an increased ability to ignore distracting information.

Although global brain volume increases at the rate of approximately 1 percent per year from childhood to adolescence (Mills et al., 2016), grey matter and white matter follow distinct developmental trajectories. Grey matter includes the neurons themselves, along with glial cells, dendrites, blood vessels and axons, whereas white matter is composed almost exclusively of myelinated axons.

Magnetic resonance imaging shows that the amount of gray matter in the frontal cortex, which is strongly influenced by genetics, is likely linked with differences in IQ

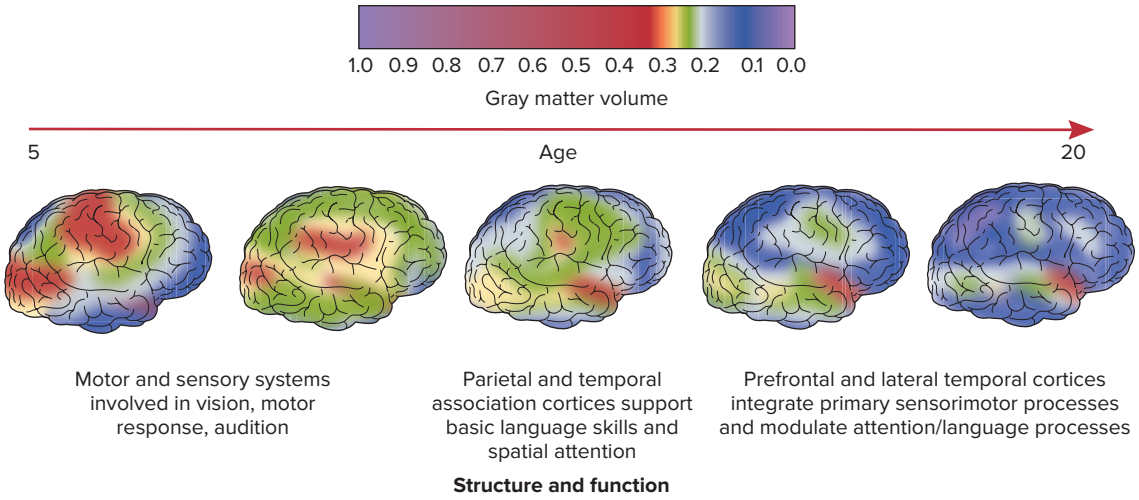

FIGURE 1

Gray-Matter Maturation in the Cerebral Cortex, Ages 5 to 20

Losses in gray matter density reflect maturation of various regions of the cortex, permitting more efficient functioning. Blue areas correspond to specific parts of the cortex undergoing loss of gray matter at a given age. These structures and their functional significance are described.

Source: Amso & Casey (2006); adapted from Gogtay et al. (2004).

(Toga & Thompson, 2005; Deary et al., 2010). Gray matter volume shows a U-shaped trajectory. The overall volume increases rapidly after birth, peaking in childhood. Then, in late childhood, it begins to decline and stabilizes at some point in the third decade (Tamnes et al., 2017). The decline in overall volume is driven primarily by a loss in the density of gray matter. Although "less" gray matter may sound negative, the result is actually the opposite. The "loss" reflects pruning of unused dendrites. In other words, those connections that are used remain active; the unused connections eventually disappear. The result is that the brain becomes "tuned" or calibrated to the experiences of the child.

Changes in the volume of gray matter peak at different times in the different lobes (Figure 1). The decline in gray matter volume is linearly associated with age, particularly in the occipital and parietal lobes. In the temporal and frontal lobes, gray matter volume peaks earlier (Aubert-Broche et al., 2013). Beneath the cortex, gray matter volume in the caudate—a part of the basal ganglia involved in control of movement and muscle tone and in mediating higher cognitive functions, attention, and emotional states—peaks at age 7 in girls and age 10 in boys (Lenroot & Giedd, 2006). The amount of gray matter present is associated with cognitive performance, and the strength of this association increases with age as the brain reaches a more mature state (Moore et al., 2017).

Beneath the cortex, gray matter volume in the caudate—a part of the basal ganglia involved in control of movement and muscle tone and in mediating higher cognitive functions, attention, and emotional states—peaks at age 7 in girls and age 10 in boys (Lenroot & Giedd, 2006). Gray matter volume in the parietal lobes, which deal with spatial understanding, and in the frontal lobes, which handle higher-order functions, peaks at age 11. Gray matter in the temporal lobes, which deal with language, peaks at age 14, while that in the cerebellum, which regulates motor movements, takes longer. Children's brains also show changes in the thickness of the cortex. Overall, the volume of the cortex peaks in late childhood to early adolescence (Raznahan et al., 2011). Generally, gray matter volume peaks 1 to 2 years earlier in girls than in boys (Gogtay & Thompson, 2010).

The loss in density of gray matter with age is balanced by another change: a steady increase in white matter. The connections between neurons thicken and myelinate,

beginning with the frontal lobes and moving toward the rear of the brain. This process can be accelerated by learning or intense activity, illustrating the plastic and environmentally responsive nature of the developing brain (Fields, 2015). Between ages 6 and 13, striking growth occurs in connections between the temporal and parietal lobes and continues into adulthood (Giedd & Rapoport, 2010; Lenroot & Giedd, 2006). In addition, changes in the density of the white matter in the corpus callosum may also underlie the advances seen in fine motor control in late childhood (Muetzel et al., 2008), such as the ability to write legibly, tie shoelaces, or play musical instruments.

checkpoint can you . . .

- Summarize typical growth patterns of boys and girls in middle childhood, including ethnic variations?
- Summarize the nutritional and sleep needs of school-age children?
- Discuss changes in the brain at this age and their effects?

MOTOR DEVELOPMENT AND PHYSICAL ACTIVITY

In the United States, school-age children now spend less time on sports and other outdoor activities than in the early 1980s and more hours on schooling, homework, and media activities (Juster et al., 2004; Basterfield et al., 2011). Fewer than 24 percent of US children ages 6 to 17 participate in the recommended 60 minutes of physical activity daily (Centers for Disease Control and Prevention, 2020), and children become increasingly less active and more sedentary with age (Nader et al., 2008).

Cross-Cultural Research on Physical Activity The physical activity trends found in the United States are not unique. In a meta-analysis including almost 100,000 children across 17 mostly high-income countries, children's cardiorespiratory fitness declined sharply beginning in the late 1980s but stabilized around 2015 (Fühner et al., 2021). Other research surveying over 25 million 6- to 19-year-olds in 27 countries across Africa, the Middle East, Asia, Australasia, Europe, and North America estimated aerobic fitness declined in all countries at the rate of about 0.46 percent a year (Tomkinson & Olds, 2007). Not surprisingly, other research shows that in much of the world, few children attain the recommended physical activity guidelines. In Australia, Canada, England, South Korea, Spain, Thailand, and Wales, only about a third of children are sufficiently active. In Belgium, Chile, China, Estonia, Qatar, Scotland, and the United Arab Emirates, fewer than 20 percent are (Tremblay et al., 2016).

In poorer countries with less infrastructure, children are more likely to get sufficient exercise. For example, in low- and middle-income countries lacking transportation options, active transportation (such as riding a bike or walking) is often used (Manyanga et al., 2018). Although data are sparse, indications are that the adoption of a modern lifestyle results in decreased physical activity for children. In one study, Australian aboriginal and Torres Straight Islander children were more active than their nonindigenous counterparts (Gwynn et al., 2010). Similarly, Inuit children in Canada, when living their traditional lifestyle in the high Arctic, were more physically fit than urban Canadian children. However, as they acculturated, they became increasingly sedentary, and their fitness levels approached that of the urban Canadian children (Shepherd et al., 2007).

Recess Cross-cultural research conducted across Europe, North America, and Asia shows that recess periods in primary school range from 15 to 150 minutes per day (Grao-Cruces et al., 2020). In the United States, most primary schools include a daily 30-minute recess period and two physical education classes a week. However, on average, primary school students spend only 15 minutes per school day engaged in vigorous- or moderate-intensity physical activity, a number that falls to 5 minutes per school day by high school (Kohl & Cook, 2013).

The games children play at recess tend to be informal. Most of recess activity involves socializing with peers, with younger children spending more time running and chasing each other (Holmes, 2012). Boys play more physically active games (Rose & Rudolf, 2006), whereas girls favor games that include verbal expression or counting aloud, such as hopscotch and jump rope (Pellegrini et al., 2002). About 10 percent of schoolchildren's free play in the early grades consists of **rough-and-tumble play**: wrestling, kicking, tumbling, grappling, and chasing, often accompanied by laughing and

rough-and-tumble play
Vigorous play involving wrestling, hitting, and chasing, often accompanied by laughing and screaming.

Games at recess, such as jump rope, tend to be informal. They promote both agility and social competence.
Lane Oatey/Blue Jean Images/Getty Images

checkpoint can you . . .

- Contrast boys' and girls' recess-time activities?
- Explain the significance of rough-and-tumble play?
- Tell what types of physical play children engage in as they grow older?

screaming. This kind of play may look like fighting but is done playfully among friends (Jarvis, 2010).

When given the choice, most children opt to play in natural or green areas rather than on concrete (Lucas & Dyment, 2010). However, when provided with more playground equipment, children tend to be more active during recess. Not surprisingly, more space to play in also leads to higher levels of activity, and children tend to decrease their activity levels as the temperature rises (Ridgers et al., 2010).

Contrary to the perception that recess takes time away from learning, recess is associated with improvements in academic performance (Murray et al., 2013). The improvements may stem from the changes in behavior that occur after children are allowed free time. A meta-analysis showed that after recess, children were better able to focus on class material; they were less fidgety, less listless, more focused and on task, and this was true whether or not recess involved physical interaction or social activity (Rasberry et al., 2011).

Organized Sports Estimates are that approximately 38 percent of 6- to 12-year-old children played team sports on a regular basis in 2018, a slow but steady decline from 44.5 percent in 2008. Household income was a major factor impacting the ability of children to participate. In 2018, slightly under 22 percent of children from families that made less than $25,000 a year participated in organized sports on at least one day that year, whereas over 42 percent of children from families that made more than $100,000 did (The Aspen Institute, 2020). Participation in unorganized physical activity, such as bicycling and shooting baskets, was higher at 77.4 percent (Duke et al., 2003). As discussed below, the COVID-19 pandemic altered patterns of physical activity in children.

Developmental changes determine what types of organized sports are most effective. Six- to 9-year-olds need more flexible rules, shorter instruction time, and more free time for practice than older children. At this age, girls and boys are about equal in weight, height, endurance, and motor skill development. Older children are better able to process instruction and learn team strategies.

The Impact of COVID-19 on Physical Activity Early in 2020, the COVID-19 virus reached pandemic status. To curb the spread of the disease, many schools closed; most organized sports were canceled; parks, playgrounds, trails and beaches were closed; and social distancing guidelines were recommended. These measures were necessary; however, they limited the degree to which most children could engage in physical activity.

The number of children involved in organized sports dropped sharply in the early months of the pandemic, although White children (41 percent) were more likely to remain active in sports than Black (35 percent), Hispanic (34 percent), and Asian (33 percent) children. Participation in sports that could be played outdoors or individually, such as basketball, fared better than in sports played indoors, such as gymnastics (The Aspen Institute, 2021). The most common activities children engaged in during lockdown were free play/unstructured activities or walks, and they were most likely to exercise in their homes or neighborhood. Approximately one-third of children engaged in some form of physical activity via a remote class or streaming service (Dunton et al., 2020). However, research conducted in the wake of the virus showed children became less physically active and more sedentary, and showed disrupted sleep schedules (Bates et al., 2020). Moreover, some data suggested the tendency of families to stock up on shelf-stable foods during the pandemic resulted in increased consumption of high-calorie, processed foods (Rundle et al., 2020).

The decreases in physical activity are likely to result in weight gain and declines in health, and are likely to more severely impact urban children without access to safe outdoor spaces (Rundle et al., 2020). Children with access to outdoor spaces such as a yard were more likely to engage in physical activity and less likely to show signs of depression or anxiety or fight with their family members (Francisco et al., 2020). There

are concerns that these changes in physical activity levels and sedentary activity will, with the continuing influence of the virus, become ingrained in children and lead to increased risk of disease.

Physical Health

The development of vaccines for major childhood illnesses has made middle childhood a relatively safe time of life in most of the world. Still, too many children are overweight, and some suffer from chronic medical conditions, accidental injuries, or lack of access to health care.

OVERWEIGHT

Overweight, a body mass index between the 85th and 95th percentile, and obesity, a body mass index over the 95th percentile, have become a major health issue for children worldwide. The prevalence rate has risen sharply: In 1975, just over 4 percent of children and teens ages 5 to 19 were overweight or obese. In 2016, 18 percent—or more than 340 million children and adolescents—were overweight or obese. Worldwide, the obesity rate has tripled since 1975. While overweight and obesity were once considered to be problems of high-income and urban countries, they are now found in low- and middle-income countries as well. In fact, many of these countries now carry a double burden and must manage the twin issues of undernutrition and obesity and overweight at the same time (World Health Organization, 2021).

In the United States, about 19.3 percent of children between the ages of 2 and 19 are obese, and another 16 percent are overweight. Boys are slightly more likely to be overweight than girls. Although overweight has increased in all ethnic groups, it is most prevalent among Mexican American boys (29.2 percent) and African American girls (29.1 percent). While Asian Americans show lower rates of overweight and obesity, there are indications they may have more body fat than Caucasian (White) children, and thus their health risks may begin at a lower weight compared to other ethnic groups (Fryar et al., 2020).

What's in children's lunch boxes? The typical composition is one sandwich, one piece of fruit, and one and a half "extras." The number of extras, which are more likely to be processed and low in nutritional value, peaks on Wednesdays (Brennan et al., 2010).

Causes of Overweight and Obesity Obesity can result from an inherited tendency aggravated by too little exercise and too much or the wrong kinds of food (Sahoo et al., 2015). Children are more likely to be overweight if they have overweight parents or other relatives, or are inactive. Television viewing appears to be an important variable and has been associated with an increased risk of obesity in both developing and developed nations (Katzmarzyk et al., 2015). Poor nutrition, encouraged by media advertising and the wide availability of snack foods and beverages, also contributes (Braithwaite et al., 2014; Bradley et al., 2011). Eating out is another culprit; children who eat outside the home consume an estimated 200 more calories a day than when they eat at home (French et al., 2001). Eating fast food has been associated with overweight and obesity (Braithwaite et al., 2014), and on a typical day, approximately one-third of children and adolescents report eating fast foods high in fat, carbohydrates, and sugar (Vikraman et al., 2015).

Where children live also matters. Children who live in rural areas have a 26 percent higher risk of obesity than children who live in urban areas, although the reasons for this are unclear (Johnson & Johnson, 2015). Additionally, children who live in public housing or unsafe neighborhoods with no facilities for outdoor exercise are most likely to be sedentary (Council on Sports Medicine and Fitness & Council on School Health, 2006). Additionally, physical inactivity and sedentary behaviors differ among children in various ethnic groups. For example, immigrant children are significantly more likely to be physically inactive and less likely to participate in sports than native children (Singh et al., 2013).

Overweight and Obesity Outcomes The adverse health effects of obesity for children are similar to those faced by adults. These children commonly have medical problems,

Barbie acts as a model for young girls, transmitting cultural ideals of beauty. However, the doll's body proportions present an unattainable female image. If she were real, Barbie would have a 39-inch bust, an impossibly small 18-inch waist, and 33-inch hips (Dittmar et al., 2006; Lind & Brzuzy, 2008).

Cookie Monster's favorite cookie is chocolate chip, followed by oatmeal. However, since 2006, Cookie Monster admits that cookies are best used as "sometimes snacks."

checkpoint can **you** . . .

- Discuss the extent of childhood obesity, how it can affect health, and how it can be treated?

including high blood pressure, high cholesterol, and high insulin levels, or they may develop such diseases at a younger age (Sahoo et al., 2015). Some data show that obese boys have higher levels of cardiometabolic risk factors than obese girls, suggesting they may be at even greater risk for developing disease (Skinner et al., 2015). Childhood diabetes is one of the prime results of rising obesity rates (Malik et al., 2010).

There are also socioemotional consequences to obesity. Overweight and obese children are often bullied, they report having fewer friends, and they must contend with negative stereotypes and social marginalization. Not surprisingly, obesity increases the likelihood of children developing emotional problems, and, in boys, it increases problems with peers (Black & Kassenboehmer, 2021). Moreover, obese children are at elevated risk for depression and anxiety disorders, low self-esteem, and body dissatisfaction. Additionally, there are often academic consequences. Some of the academic consequences can be attributed to a higher likelihood of school problems. However, obese children are also more likely to miss school due to health issues that co-occur with obesity, such as diabetes and asthma (Sahoo et al., 2015).

Overweight children are 5 times more likely to be obese in adulthood than children who are not obese (Simmonds et al., 2016), and they are at risk for problems in adulthood with hypertension (high blood pressure), heart disease, orthopedic problems, diabetes, and more (Sahoo et al., 2015). Indeed, childhood obesity may be a stronger predictor of some diseases than adult obesity (Baker et al., 2007) and may put children at risk of premature death (Franks et al., 2010).

Prevention and Treatment Childhood obesity rates continue to rise at alarming rates, particularly in African American and Hispanic children, and children from urban areas (Skinner et al., 2018; Ogden et al., 2018). The US Preventive Services Task Force (USPSTF, 2010) recommends screening children for overweight and obesity starting at the age of 6 years.

A typical weight in childhood does not guarantee a healthy weight in adulthood. Seventy percent of obese adults were not obese in childhood (Simmonds et al., 2016). Thus, prevention and intervention programs should target health in all children, not just overweight children.

Research supports efforts focused on overall lifestyle changes rather than narrowly defined diets or exercise programs. Recommendations include spending less time in front of television and computers, changes in food labeling and advertising, healthier school meals, education to help children make better food choices, and spending more time in physical education and informal exercise with family and friends, such as walking and unorganized sports (Evans et al., 2012; De Bourdeauhuij et al., 2011). The most effective interventions are those in which parents are helped to change their own behaviors as well as those of their children (Kitzmann et al., 2010).

Promoting an active lifestyle through both informal and organized sports is an important way to combat the problem of childhood obesity.
Ingram Publishing/SuperStock

CHRONIC MEDICAL CONDITIONS

Most US children are healthy: More than 85 percent report very good or excellent health (National Center for Health Statistics, 2021). When illness does occur in middle childhood, it tends to be brief. **Acute medical conditions**—occasional, short-term conditions, such as infections and warts—are common. Six or seven bouts a year with colds, flu, or viruses are typical as germs pass among children at school or at play (Behrman, 1992).

Fortunately, most children without underlying medical conditions appear to be at low risk

of complications or death as a result of contracting the novel coronavirus COVID-19 (Stokes et al., 2020). However, children with preexisting conditions, especially when those conditions are medically complex, are at significantly elevated risk of complications (Shekerdemian et al., 2020). Additionally, a minority of children, especially Black and Hispanic children, are at risk of developing multisystem inflammatory disorder 4 to 6 weeks after infection. This disorder can result in a range of symptoms, from fever and inflammation to shock and the failure of multiple organ systems (Yasuhara et al., 2021).

According to a nationally representative survey of more than 200,000 households, an estimated 12.8 percent of US children have or are at risk for **chronic medical conditions:** physical, developmental, behavioral, or emotional conditions that persist for 3 months or more (Kogan et al., 2005). These rates have been rising, as have the rates of hospital admissions for children with more than one medically complex condition (Burns et al., 2010). Two chronic conditions that have become increasingly common are asthma and diabetes.

Although generally not an issue in the United States and most industrialized nations, diseases that cause lethargy and problems with attention threaten children in tropical countries. The cause? Tropical parasites such as hookworm or schistosomiasis (World Health Organization, 2021).

acute medical conditions
Illnesses that last a short time.

chronic medical conditions
Illnesses or impairments that persist for at least 3 months.

asthma
A chronic respiratory disease characterized by sudden attacks of coughing, wheezing, and difficulty in breathing.

Asthma **Asthma** is a chronic, allergy-based respiratory disease characterized by sudden attacks of coughing, wheezing, and difficulty breathing. Asthma affects 262 million people a year (World Health Organization, 2021). Global prevalence has been increasing, especially in low- and middle-income countries (Ferrante & Grutta, 2018). Its prevalence in the United States is also on the rise (Akinbami, 2006). Approximately 11 percent of children are diagnosed with asthma at some point. It is more likely to be diagnosed in Black (14 percent) than in White (6 percent), Hispanic (7 percent), and Asian (4 percent) children, and is more common in children living below the poverty line (Federal Interagency Forum on Child and Family Statistics, 2021).

The causes of the asthma increases are uncertain, but a genetic predisposition is likely. For example, researchers have identified a gene variant that increases the risk of developing asthma, an effect that is exacerbated in homes where children are exposed to smoke (Calişkan et al., 2013). Smoke exposure is a major environmental risk factor by itself, as is pollution from car emissions (Burke et al., 2012; Gasana et al., 2012). Approximately 51 percent of US children live in counties where the pollutant concentrations exceed air quality standards at least once a year (Federal Interagency Forum on Child and Family Statistics, 2021). Increasing evidence points to an association between obesity and asthma (Lang et al., 2018). There is also an association between low levels of vitamin D and increased incidence of asthma in children (Bener et al., 2012). Moreover, vitamin D enhances the anti-inflammatory effects of the inhaled steroids often used to treat asthma attacks in children (Searing et al., 2010).

diabetes
(1) One of the most common diseases of childhood. It is characterized by high levels of glucose in the blood as a result of defective insulin production, ineffective insulin action, or both. (2) Disease in which the body does not produce or properly use insulin, a hormone that converts sugar, starches, and other foods into energy needed for daily life

Diabetes **Diabetes** is characterized by high levels of glucose in the blood. Worldwide, approximately 463 million people are diabetic (Saeedi et al., 2019). Incidence rates vary widely across countries, with almost 100,000 new cases diagnosed across the globe every year in children under the age of 15 (Patterson et al., 2019).

Type 1 diabetes is the result of an insulin deficiency that occurs when insulin-producing cells in the pancreas are destroyed. Type 1 diabetes accounts for 5 to 10 percent of all diabetes cases and the majority of diabetes in children under 10 years of age. Symptoms include increased thirst and urination, hunger, weight loss, blurred vision, and fatigue. Treatment includes insulin administration, nutrition management, and physical activity (American Diabetes Association, 2021). Although the majority of type 1 diabetes cases in children are diagnosed in high- and middle-income countries, the bulk of deaths resulting from type 1 diabetes occur in lower-income countries (Patterson et al., 2019). In the United States, approximately 210,000 children and adolescents have been diagnosed with diabetes (Centers for Disease Control and Prevention, 2020).

Type 2 diabetes is characterized by insulin resistance and used to be found mainly in overweight and older adults. As childhood obesity has increased, so has type 2

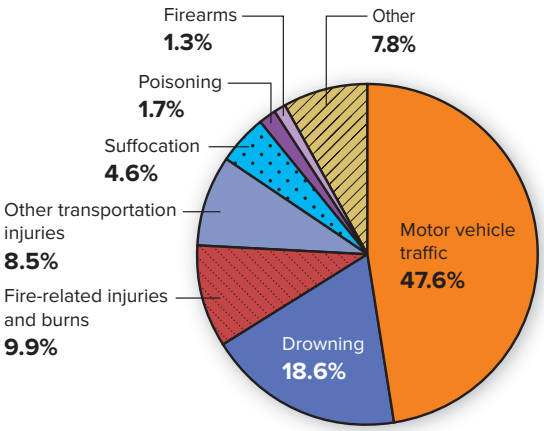

FIGURE 2

Accidental Deaths for Children Ages 5-9

Traffic accidents, drowning, and burns are the most common causes of accidental deaths among children under 18 years of age.

Source: Centers for Disease Control and Prevention (2021).

hypertension
Chronically high blood pressure.

Children with ADHD or attentional difficulties are more accident prone (Lange, 2016).

About half of kids who drown do so within 25 yards of an adult. This happens partly because drowning doesn't look like it does in movies. A drowning child does not yell for help or splash. Signs to look for? Head low in the water, perhaps tilted back with hair covering the eyes, silence, glassy or closed eyes, mouth at or slightly below the water line, and ineffective attempts to roll over to the back or swim (Vittone, 2010).

diabetes. Because type 2 diabetes is associated with lifestyle factors, especially obesity, there is great variability in risk across countries. This factor, in conjunction with differential access to medical care and varied screening and research methodologies, makes accurate estimates challenging. However, some trends have emerged. Across different countries, ethnic minority children have higher rates of type 2 diabetes than White children, girls are at higher risk than boys, and the incidence risk rises over the course of childhood with age (Farsani et al., 2013).

Each year about 3,700 US children are diagnosed with type 2 diabetes, with higher incidence among White, Hispanic, and African American children (Dabelea et al., 2014). Symptoms are similar to those of type 1 diabetes. Nutrition management and increased physical activity can be effective treatments, although glucose-lowering medication or insulin may be needed.

Childhood Hypertension **Hypertension,** or high blood pressure, was once rare in childhood, but it has become increasingly common, especially among ethnic minorities. Globally, estimates are that approximately 3.28 percent of 6-year-old children have hypertension, a number that rises to almost 8 percent at 14 years of age (Song et al., 2019). Risk factors include obesity or overweight, salt intake, sedentary lifestyle, poor sleep quality, and race (Bucher et al., 2013; Rosner et al., 2013).

Although high blood pressure in childhood is not generally associated with mortality as it is in adulthood, it does put children at risk for later disease and is associated with damage to organs. For example, it can lead to left ventricular hypertrophy (thickening and hardening of the left wall of the heart), damage to the retina of the eyes, or damage to arteries (Falkner, 2010). Additionally, there are indications that high blood pressure may negatively affect the developing brain. Children with hypertension have lower neurocognitive test performance than their unaffected peers (Lande & Kupferman, 2019).

Weight reduction through dietary modification and regular physical activity is the primary treatment for overweight-related hypertension. Recommendations also include stress reduction, possibly via the use of meditation. If blood pressure does not come down, drug treatment can be considered. (Flynn et al., 2017). However, care must be taken in prescribing such drugs, as their long-term effects on children are uncertain.

ACCIDENTAL INJURIES

As in early childhood, accidental injuries are the leading cause of accidental death among school-age US children (Centers for Disease Control and Prevention, 2021; Figure 2). In 2019, 673 US children between the ages of 5 and 9 years died in accidents, the majority—340—in car accidents (Centers for Disease Control and Prevention, 2020).

An estimated 70 percent of children in the United States ride bicycles (Mattei et al., 2012). Unfortunately, despite laws requiring the wearing of bicycle helmets, their use is still low (Kaushik et al., 2015). An estimated 23,000 children each year suffer serious brain injuries from bicycle accidents, and as many as 88 percent of these injuries could be prevented by using helmets (AAP Council on Injury and Poison Prevention, 2001). Protective headgear also is vital for baseball, softball, football, roller-skating, in-line skating, skateboarding, scooter riding, horseback riding, hockey, speed sledding, snowmobiling, skiing, snowboarding, and tobogganing. In soccer,

"heading" the ball should be minimized because of the danger of brain injury (Briskin et al., 2012).

checkpoint can you . . .

- Distinguish between acute and chronic medical conditions?
- Discuss the incidence and causes of asthma and diabetes?
- Identify factors that increase the risks of accidental injury?

COGNITIVE DEVELOPMENT

Piagetian Approach: Cognition

At about age 7, according to Piaget, children enter the stage of **concrete operations** when they can use mental operations, such as reasoning, to solve concrete problems. Children can think logically because they can take multiple aspects of a situation into account. However, their thinking is still limited to real situations in the here and now.

concrete operations
Third stage of Piagetian cognitive development (approximately ages 7 to 12), during which children develop logical but not abstract thinking.

COGNITIVE ADVANCES

In the stage of concrete operations, children have a better understanding than preoperational children of spatial concepts, causality, categorization, inductive and deductive reasoning, conservation, and number (Table 2).

Piaget maintained that the shift from the rigid, illogical thinking of younger children to the flexible, logical thinking of older children depends in part on neurological development, a belief that has been bolstered by research in brain imaging. Broadly, during the preoperational stage, there is rapid development of the prefrontal cortex, an increase in the volume of grey and white matter in the brain, extensive synaptic pruning, and continuing myelination of axons. These brain changes are believed to underlie the advances in shifting attention, inhibiting incorrect responses, and manipulating items in working memory–all abilities used in correctly solving Piagetian tasks (Bolton & Hattie, 2017).

TABLE 2 Advances in Selected Cognitive Abilities during Middle Childhood

Ability	Example
Spatial thinking	Keisha can use a map or model to help her search for a hidden object. She can find her way to and from school, estimate distances, and judge how long it will take her to get somewhere.
Cause and effect	Douglas knows which physical attributes of objects on each side of a scale will affect the result (i.e., the number of objects matters but color does not). He does not know which spatial factors make a difference.
Categorization	Elena can sort objects into categories, such as shape, color, or both. She knows that a subclass (roses) has fewer members than the class of which it is a part (flowers).
Seriation	Catherine can arrange a group of sticks in order from the shortest to the longest and can insert an intermediate-size stick into the proper place. She knows that if one stick is longer than a second stick and the second stick is longer than a third, then the first stick is longer than the third.
Inductive and deductive reasoning	Dominic can solve both inductive and deductive problems and knows that inductive conclusions (based on particular premises) are less certain than deductive conclusions (based on general premises).
Conservation	Sol, at age 7, knows that if a clay ball is rolled into a sausage, it still contains the same amount of clay (conservation of substance). At age 9, he knows that the ball and the sausage weigh the same. Not until early adolescence will he understand that the objects will displace the same amount of liquid if dropped in water.
Number and mathematics	Kevin can count in his head, can add by counting up from the smaller number, and can do simple story problems.

Spatial Relationships Eight-year-old Ella stares intently at the map. "The star means we are here," she points, "so that must mean the store is there!" Ella turns to her mother with a smile, and they both begin walking.

Ella is now in the stage of concrete operations. She is better able to understand spatial relationships. This allows her to interpret a map, estimate the time to get from one place to another, and remember routes and landmarks. Children are more easily able to navigate a physical environment with which they have experience, and training can help improve spatial skills as well (Uttal et al., 2013). This is important, as the ability to engage in numerical reasoning is associated with spatial visualization (Hawes & Anzari, 2020).

Causality Another key development during middle childhood involves the ability to make judgments about cause and effect. For example, when 5- to 12-year-old children are asked to predict how balance scales work, older children give more correct answers. In addition, earlier in middle childhood, they understood the number of objects on each side of a scale matters, but it is not until later they understood that the distance of objects from the center of a scale is also important (Amsel et al., 1996).

As children learn more about the world, their growing knowledge informs the quality of their reasoning. For example, in one study, children ages 3 to 11 years were given information about oral health that was either consistent (e.g., going to the dentist is good for teeth) or inconsistent (e.g., drinking cola is good for teeth) with reality and scenarios in which the outcome was either good or bad oral health. Children were then asked how the causal association provided in the scenarios might be tested. When the information was consistent with reality and had a good outcome, or inconsistent and had a bad outcome, children were more likely to use appropriate hypothesis testing (i.e., manipulate only one variable at a time). In other conditions, they used scientifically invalid procedures (e.g., changing all variables at a time) (Croker & Buchanan, 2011). Thus, the quality of their reasoning was better when they were able to use their understanding of the world to inform their thinking. Moreover, children are better at causal reasoning when they have the opportunity to explain and collaborate with others. For instance, they may seek knowledge about causality by asking "why" questions of their parents or exploring their environments jointly with another person (Legare et al., 2017).

Categorization John sits at the table, working on his class project. He is making a timeline of his life. His mother has given him six photographs of himself from infancy to the current time, and John carefully lays them in order from earliest to latest.

seriation
Ability to order items along a dimension.

Part of the reason John is now able to complete tasks such as this class project is because he is better able to categorize objects. One such ability is **seriation,** arranging objects in a series according to one or more dimensions. Children become increasingly better at seriation for dimensions such as time (earliest to latest), length (shortest to longest), or color (lightest to darkest) (Piaget, 1952). This is important as children's later mathematical achievement is dependent on early numeracy (Raghubar & Barnes, 2017) and difficulties in seriation predict later learning disabilities in mathematics (Desoete, 2015).

transitive inference
Understanding the relationship between two objects by knowing the relationship of each to a third object.

Another development during this age involves **transitive inferences** (if a < b and b < c, then a < c). For example, Mateo is shown three sticks. He is shown that the yellow stick is shorter than the green stick and is then shown that the green stick is shorter than the blue stick. However, he is not shown all three sticks in order of their length. If Mateo is able to understand transitive inferences, he should be able to quickly and easily infer that the yellow stick is shorter than the blue stick without physically comparing them (Piaget & Inhelder, 1967). While Piaget believed that children did not develop this ability until middle childhood, more recent research on visual preferences has shown that children as young as 15 months have some limited ability to reason in this fashion, at least for social stimuli (Gazes et al., 2017; Mou et al., 2014). As with seriation, difficulties with transitive inferences predict later difficulties with math (Schwartz et al., 2018).

Class inclusion also becomes easier. **Class inclusion** is the ability to see the relationship between a whole and its parts, and to understand the categories within a whole. For example, Piaget (1964) showed preoperational children 10 flowers—seven roses and three carnations—and asked them whether there were more roses or more flowers. Children in the preoperational stage of development tended to say there were more roses because they were comparing the roses with the carnations rather than the whole bunch of flowers. Not until age 7 or 8 do children consistently report that roses are a subclass of flowers (Flavell et al., 2002). More recent research indicates that children actually do have the ability to understand the logic of class inclusion but usually fail to inhibit the incorrect response in favor of the misleading perceptual comparison (Borst et al., 2013).

class inclusion
Understanding of the relationship between a whole and its parts.

Inductive and Deductive Reasoning **Inductive reasoning** involves making observations about particular members of a class of people, animals, objects, or events, and then drawing conclusions about the class as a whole. For example, if one neighbor's dog barks and another neighbor's dog barks, then the conclusion might be that all dogs bark.

Deductive reasoning, by contrast, starts with a general statement—a premise—about a class and applies it to particular members of the class. If a premise is true of the whole class and the reasoning is sound, then the conclusion must be true. So, for example, if the belief is that all dogs bark and a new dog comes along, it would be reasonable to conclude that the new dog will also bark.

inductive reasoning
Type of logical reasoning that moves from particular observations about members of a class to a general conclusion about that class.

deductive reasoning
Type of logical reasoning that moves from a general premise about a class to a conclusion about a particular member or members of the class.

Piaget believed that children in the concrete operations stage of cognitive development only used inductive reasoning. Deductive reasoning, according to Piaget, did not develop until adolescence. However, research suggests Piaget underestimated the abilities of children. In one study, researchers gave inductive and deductive reasoning problems to kindergarteners, second graders, fourth graders, and sixth graders. Because they did not want the children to use real-world knowledge, they used imaginary terms and words to create both inductive and deductive reasoning problems. For example, one of the inductive problems was "Tombor is a popgop. Tombor wears blue boots. Do all popgops wear blue boots?" The corresponding deductive reasoning problem was "All popgops wear blue boots. Tombor is a popgop. Does Tombor wear blue boots?" Contrary to Piagetian theory, second graders (but not kindergartners) were able to answer both kinds of problems correctly (Pillow, 2002). Moreover, children can be encouraged to reason at higher levels via training or intervention programs (Molnar, 2011; Barkl et al., 2012). Overall, when faced with inconclusive evidence, older children are more likely than younger children to realize more information is needed and ask for it to help them draw a logical conclusion, and they are also then more accurate in their problem-solving (Busch & Legare, 2019).

How can parents and teachers help children improve their reasoning ability?

Conservation In the preoperational stage of development, children are focused on appearances and have difficulty with abstract concepts. For example, Camilla, who is at the preoperational stage of development, is likely to think that if one of two identical clay balls is rolled into a long, thin snake, it will now contain more clay because it is longer. She is deceived by appearances and thus fails this conservation task. However, Aarush, who is in the stage of concrete operations, will say that the ball and the snake still contain the same amount of clay. What accounts for his ability to understand that the amount of clay remains unchanged regardless of the form it takes?

In solving various types of conservation problems, children in the stage of concrete operations can work out the answers in their heads. Three primary achievements allow them to do this. First, they understand the principle of identity. For instance, Aarush understands that the clay is still the same clay even though it has a different shape because nothing was added or taken away from it. Second, children in the concrete operations stage understand the principle of reversibility. Aarush can picture what would happen if he went backward in time and rolled the snake

A child who has achieved conservation of liquid knows that pouring water from a wide, short glass into a tall, thin glass does not change the volume of water, even though the shape is different.
Marmaduke St. John/Alamy Stock Photo

back into a ball. Third, children at this stage can decenter. When Camilla looked at the snake, she focused only on its length, ignoring that it was thinner and flatter than the ball of clay. She centered on one dimension (length) while excluding the other (thickness). Aarush, however, is able to decenter and look at more than one aspect of the two objects at once. Thus, although the ball is shorter than the snake, it is also thicker.

Typically, children can solve problems involving conservation of matter, such as the clay task, at about age 7 or 8. However, it is not until age 8 or 9 that children correctly solve conservation of weight tasks in which they are asked, for instance, whether the ball and the snake weigh the same. In tasks involving conservation of volume—in which children must judge whether the snake and ball displace the same amount of liquid when placed in a glass of water—children rarely answer correctly before age 12. Piaget's term for this inconsistency in the development of different types of conservation is **horizontal décalage.** Children's thinking at this stage is so concrete, so closely tied to a particular situation, that they cannot readily transfer what they have learned about one type of conservation to another type, even though the underlying principles are the same.

horizontal décalage
Piaget's term for an inability to transfer learning about one type of problem to other types of problems sharing the same conceptual underpinnings.

Number and Mathematics When 4- to 5-year-old children deal a deck of cards or distribute portions of pizza, they demonstrate that they have some intuitive understanding of fractions. However, children have more difficulty when dealing with numbers, which are more abstract. They tend not to think about the quantity a fraction represents; instead, they focus on the numerals that make it up. Thus, they may say that ½ plus ⅓ equals ⅖. It is also difficult for children to grasp that ½ is bigger than ¼—that the smaller fraction (¼) has the larger denominator (Geary, 2006).

By age 6 or 7, many children can count in their heads. They also learn to count on: to add 5 and 3, they start counting at 5 and then go on to 6, 7, and 8. It may take 2 or 3 more years for them to count down for subtraction, but by age 9, most children can count up and down (Geary, 2006). Children also become more adept at solving simple story problems, such as "Pedro went to the store with $5 and spent $2 on candy. How much did he have left?" When the original amount is unknown—"Pedro went to the store, spent $2, and had $3 left. How much did he start out with?"—the problem is harder because the operation needed to solve it (addition) is not as clearly indicated. Few children can solve this kind of problem before age 8 or 9 (Resnick, 1989).

The ability to estimate progresses with age. When asked to place 24 numbers along a line from 0 to 100, kindergartners exaggerate the distances between low numbers and minimize the distances between high numbers. Most second graders produce number lines that are more evenly spaced (Siegler & Booth, 2004). Second, fourth, and sixth graders show a similar progression in producing number lines from 0 to 1,000 (Siegler & Opfer, 2003), most likely reflecting the experience older children gain in dealing with larger numbers (Berteletti et al., 2010). Practice matters; children who play board games that include linear sequences show an advantage in their number line estimation, number estimation, and counting-on skills (Whyte & Bull, 2008; Laski & Siegler, 2014). In addition to improving in number line estimation with age, school-age children also improve in computational estimation, such as estimating the sum in an addition problem; numerosity estimation, such as estimating the number of candies in a jar; and measurement estimation, such as estimating the length of a line (Booth & Siegler, 2006).

Cultural Influences on Piagetian Task Performance Although the structure underlying performance on Piagetian tasks appears to be universal across cultures, the pace at which performance develops is strongly influenced by culture (Mishra, 2001). In many cultures, children reach proficiency at tasks at a later age, and in some cultures, never at all (Dasen, 1975). However, this is affected by the nature of the task. Children can think more logically about things they know something about.

For example, a series of studies compared formally schooled children in Geneva with Australian hunter-gatherer indigenous children. The progression of conservation abilities in indigenous children was similar to that of the children from Geneva but occurred several years later. However, on tasks assessing the understanding of spatial relationships,

the indigenous children showed an advantage. The progression of these skills in each domain mapped onto important cultural values and tasks. The apportionment of resources in the indigenous culture did not depend on accurately segmenting items into equal amounts but rather on kinship relationships. Items were rarely counted, and there were no number words past *five*. Accurately judging amounts was not an important task in that culture. By contrast, remembering where resources, such as water, were located was an important cultural task, and thus, indigenous children were advanced in that area (Dasen, 1994).

Similarly, West African children who produced, stored, and exchanged food in markets attained proficiency at conservation of liquid tasks at an earlier age than Inuit children, who traditionally lived a hunter-gatherer lifestyle (Dasen, 1984). Likewise, Mexican children whose families made pottery and who thus had early and extensive experience with clay, showed an advantage for conservation of matter over similar children whose families did not make pottery (Price-Williams et al., 1969). In Western countries, cultural change over time can affect the timing of abilities. When 10,000 British 11- and 12-year-olds were tested on conservation of volume and weight, their performance was 2 to 3 years behind that of their counterparts 30 years earlier, presumably because teachers were focusing on the three Rs rather than hands-on experience with the way materials behaved (Shayer et al., 2007).

There are also cultural influences on mathematical abilities. Research suggests the ability to add develops through concrete experience in a cultural context (Guberman, 1996; Resnick, 1989). In a study of Brazilian street vendors ages 9 to 15, a researcher said, "I'll take two coconuts." Each coconut cost 40 cruzeiros; she paid with a 500-cruzeiros bill and asked, "What do I get back?" The child counted up from 80: "Eighty, 90, 100 . . ." and gave the customer 420 cruzeiros. However, when this same child was given a similar problem in the classroom to answer on paper ("What is 500 minus 80?"), he arrived at the wrong answer (Carraher et al., 1988).

Findings such as these illustrate different routes for cultural learning. Understanding emerges from culturally defined experiences, and children are more likely to learn about skills that are valued and required in their culture.

checkpoint can you . . .

- Identify six cognitive advances during middle childhood?
- Name three principles that help children understand conservation, and discuss influences on its mastery?

Information-Processing Approach: Planning, Attention, and Memory

As children move through the school years, they make steady progress in the abilities to regulate and sustain attention, process and retain information, and plan and monitor their behavior and strategies. All of these interrelated developments contribute to **executive function,** the conscious control of thoughts, emotions, and actions to accomplish goals or solve problems.

executive function
Conscious control of thoughts, emotions, and actions to accomplish goals or solve problems.

EXECUTIVE FUNCTIONING

The gradual development of executive function from infancy through adolescence is the result of developmental changes in brain structure. The prefrontal cortex, the region that enables planning, judgment, and decision making, shows significant development during this period (Lamm et al., 2006). As unneeded synapses are pruned away and pathways become myelinated, processing speed improves dramatically (Williamson & Lyons, 2018; Mah & Ford-Jones, 2012). This increases the amount of information children can keep in working memory (McAuley & White, 2011). As children develop the ability to mentally juggle more concepts at the same time, they are also able to develop more complex thinking and goal-directed planning.

Another aspect of executive function involves the development of self-regulatory capacity, including the ability to regulate attention, inhibit responses, and monitor errors. Advances in these areas, as well as in working memory, occur in concert with increases in activity of frontoparietal and frontostraital circuits (Hughes, 2011; Tau & Peterson, 2010). Language, too, matters. Children with robust language skills do well with executive function; those with language delays have difficulty (Gooch et al., 2016).

Environmental influences are also important and, given the slow rate of development of the frontal cortex, exert a relatively large effect. For example, parenting quality and family environment—including such factors as cognitive stimulation, parental scaffolding, and parental sensitivity—have been found to positively predict later executive control. Moreover, just as high-quality family environments can promote the development of executive functioning, less ideal circumstances can undermine its development. Children with parents who are high in control, intrusive, or detached tend to show less advanced executive functioning abilities (Valcan et al., 2018). Environmental circumstances may interact with individual characteristics as well. For example, although poverty is associated with poor executive control (St. John et al., 2018), children low in temperament reactivity do not show impaired functioning, whereas temperamentally reactive children do (Raver et al., 2013).

Illustrating the plasticity of the brain, children—particularly those with poor executive control—benefit from training. A wide variety of techniques have been successfully used, including computerized training, physical activity such as martial arts or yoga, and mindfulness (meditation) training (Diamond & Lee, 2011).

SELECTIVE ATTENTION

School-age children can concentrate longer than younger children and can focus on the information they need and want while screening out irrelevant information. For example, in school, it may be necessary for a child to focus on a teacher's less-than-exciting lesson while simultaneously ignoring the antics of the class clown. This growth in selective attention—the ability to deliberately direct one's attention and shut out distractions—may hinge on the executive skill of inhibitory control, the voluntary suppression of unwanted responses (Luna et al., 2004).

The increasing capacity for selective attention is believed to be due to neurological maturation and is one of the reasons memory improves during middle childhood (Sanders et al., 2006). Older children make fewer mistakes in recall than younger children because they are better able to expect and predict what might be important to remember, to then select and attend to the appropriate stimulus when presented with it, and, when asked, to recall the relevant information from memory while ignoring irrelevant information (Gazzaley & Nobre, 2012).

WORKING MEMORY

Working memory involves the short-term storage of information that is being actively processed, like a mental workspace. For example, if you are asked to compute what 42 × 60 is, you would use your working memory to hold part of the answer while you solved the rest of it.

The efficiency of working memory increases greatly in middle childhood, laying the foundation for a wide range of cognitive skills. For example, between the ages of 6 and 10, there are improvements in processing speed (how quickly information is processed) and storage capacity (how many things can be simultaneously held in working memory) (Bayliss et al., 2005). The changes are reflected in brain development. As children become more proficient in working memory tasks, they shift from the use of generalized networks recruited with a heavy reliance on the corpus callosum to an increasingly adultlike specialized recruitment of devoted memory circuits (Bathelt et al., 2018). Part of this is due, as with executive control, to development of frontoparietal and frontostriatal circuits (Darki & Klingberg, 2015).

The capacity of a child's working memory is associated with academic achievement in a bidirectional fashion (Peng & Kievit, 2020). Working memory allows children to call up and mentally manipulate required information from long-term memory systems when solving a problem, such as when a child might recall the correct order of operations while completing a math problem. A child with a more efficient and effective working memory is able to do this more easily. At the same time, as children learn more, they have more information to use within working memory. So, for example, a child with a rich vocabulary might be better able to puzzle through the meaning of a complex sentence with multiple dependent clauses because less cognitive effort would be needed to think about vocabulary meaning and more could be spent on holding the unfinished clauses in memory until the end of the sentence.

Research has indicated that as many as 10 percent of school-age children suffer from poor working memory (Alloway et al., 2009). Training programs can improve working memory capacity, and indeed training programs have been shown to be associated with changes in brain activity in frontal and parietal cortices and basal ganglia, and increased dopamine receptor density (Klingberg, 2010). Thus far, such training effects tend to be absent or short-lived or do not transfer to areas other than the specific form of working memory addressed (Melby-Lervåg & Hulme, 2013; Rowe et al., 2019). Some researchers have even suggested results are poor enough such that future working memory interventions should be halted (Sala & Gobet, 2020). However, more research is needed in this area.

mnemonic device
Strategy to aid memory.

external memory aids
Mnemonic strategies using something outside the person.

rehearsal
Mnemonic strategy to keep an item in working memory through conscious repetition.

organization
(1) Piaget's term for the creation of categories or systems of knowledge. (2) Mnemonic strategy of categorizing material to be remembered.

elaboration
Mnemonic strategy of making mental associations involving items to be remembered.

metamemory
Understanding of processes of memory.

MNEMONICS

Were you ever taught the saying "please excuse my dear Aunt Sally" as a technique to help you remember the order of operations in solving an equation? This is an example of a **mnemonic device,** a strategy to aid memory.

Common memory strategies are rehearsal, organization, and elaboration. Writing down a telephone number, making a list, setting a timer, and putting a library book by the front door are examples of **external memory aids**: prompts by something outside the person. Saying a telephone number over and over after looking it up, so as not to forget it before dialing, is a form of **rehearsal,** or conscious repetition. **Organization** is mentally placing information into categories (such as animals, furniture, vehicles, and clothing) to make it easier to recall. In **elaboration,** children associate items with something else, such as an imagined scene or story. To remember to buy lemons, ketchup, and napkins, for example, a child might visualize a ketchup bottle balanced on a lemon, with a pile of napkins handy to wipe up any spills.

There are developmental changes in children's ability to use these memory strategies. For example, many children say words out loud when they are trying to remember them, and this simple rehearsal strategy does appear to help them remember material more effectively (Icht & Mama, 2015). However, they do not often spontaneously use other mnemonic aids. As children grow older, they develop better strategies, use them more effectively (Bjorklund, 1997; Karably & Zabrucky, 2017), and are better at assessing if they are reaching their memory goals (Schneider, 2008). Older children also often use more than one strategy for a task and choose different kinds of strategies for different problems (Bjorklund et al., 1997).

Contestants in a spelling bee make good use of mnemonic strategies—devices to aid memory—such as rehearsal (repetition), organization, and elaboration.
Chuck Myers/MCT/Alamy Stock Photo

METAMEMORY

Metamemory can be described as the knowledge of and reflection about memory processes. From kindergarten through the elementary school years, children advance steadily in understanding memory (Schnieder, 2008).

Kindergarteners and first graders know that people remember better if they study longer, that people forget things with time, and that relearning something

checkpoint can you . . .

- Identify four ways in which information processing improves during middle childhood?
- Explain the importance of executive function, selective attention, working memory, and metamemory?
- Name four common mnemonic aids and discuss developmental differences in their use?
- Give examples of how improved information processing explains cognitive advances Piaget described?

is easier than learning it for the first time (Flavell et al., 2002). However, younger children tend to overestimate their memory capacity (Karably & Zabrucky, 2017). It is not until third grade that children realize that some people remember better than others and that some things are easier to remember than others (Flavell et al., 2002), and they become more proficient in their use of memory strategies (Karably & Zabrucky, 2017). Children's metamemory abilities continue to progress through adolescence and quite possibly longer (van der Stel & Veenman, 2014).

Metacognition (thinking about thinking) is related to academic performance because it allows learners to reflect upon the strategies they are using and select those that are most effective (Vrugt & Oort, 2008). Metamemory may allow learners to calibrate whether or not the subjective assessment of the accuracy of responses (does it "feel right") aligns with reality by monitoring failures. This ability is supported by cortical thinning in the anterior insula and an increase in the thickness of the ventromedial prefrontal cortex from childhood through adolescence (Fandakova et al., 2017).

Psychometric Approach: Intelligence

In this section, we discuss how intelligence (IQ) has been measured, its relationship to IQ, and some of the important influences on intelligence.

MEASURING INTELLIGENCE

Wechsler Preschool and Primary Scale of Intelligence, Revised (WPPSI-IV)
Individual intelligence test for children, which yields verbal and performance scores as well as a combined score.

Stanford-Binet Intelligence Scales
Individual intelligence tests for ages 2 and up used to measure fluid reasoning, knowledge, quantitative reasoning, visual-spatial processing, and working memory.

Otis-Lennon School Ability Test (OLSAT8)
Group intelligence test for kindergarten through 12th grade.

The most widely used individual test is the **Wechsler Intelligence Scale for Children (WISC-IV).** The test for ages 6 through 16 measures verbal and performance abilities, yielding separate scores for each as well as a total score. The separate subtest scores pinpoint a child's strengths and help diagnose specific problems. For example, if a child does well on verbal tests (such as general information) but poorly on performance tests (such as drawing the missing part of a picture), the child may be slow in perceptual or motor development.

Another commonly used individual test is the **Stanford-Binet Intelligence Scale**. The Stanford-Binet measures both verbal and nonverbal abilities and consists of five subtests: fluid reasoning, knowledge, quantitative reasoning, visual-spatial processing, and working memory (Becker, 2003).

A popular group test, the **Otis-Lennon School Ability Test (OLSAT8),** has levels for kindergarten through 12th grade. Children are asked to classify items, show an understanding of verbal and numerical concepts, display general information, and follow directions. Separate scores for verbal comprehension, verbal reasoning, pictorial reasoning, figural reasoning, and quantitative reasoning can identify specific strengths and weaknesses.

The Kaufman Assessment Battery for Children (K-ABC-II) is designed to evaluate cognitive abilities in children with diverse needs, such as hearing impairments and language disorders.
Juan Silva/The Image Bank/Getty Images

Some other diagnostic and predictive tools are based on neurological research and information-processing theory. The second edition of the **Kaufman Assessment Battery for Children (K-ABC-II)** (Singer et al., 2012). an individual test for ages 3 to 18, is designed to evaluate cognitive abilities in children with diverse needs (such as autism, hearing impairments, and language disorders) and from varying cultural and linguistic backgrounds.

Dynamic tests based on Vygotsky's theories focus on the child's zone of proximal development (ZPD): the difference between the items a child can answer alone and the items the child can answer with help. Thus, dynamic tests contain items up to 2 years above a child's current level of competence. Examiners help the child when necessary by asking leading questions, giving examples or demonstrations, and offering feedback (Resing, 2013).

THE IQ CONTROVERSY

The use of psychometric intelligence tests such as those just described is controversial. On the positive side, because IQ tests have been standardized and widely used, there is extensive information about their norms, validity, and reliability. Cross-culturally, scores on IQ tests are good predictors of school achievement (Lynn et al., 2007). Childhood IQ is also predictive of a host of health outcomes, including general health, the risk of late-onset dementia, and chronic health conditions such as diabetes and cardiovascular disease (Deary et al., 2010; Wraw et al., 2015; Dobson et al., 2017).

On the other hand, critics claim that the tests underestimate the intelligence of children who are in ill health or, for one reason or another, do not do well on tests (Sternberg, 2004). Because the tests are timed, they equate intelligence with speed and penalize a child who works slowly and deliberately. Their appropriateness for diagnosing learning disabilities also has been questioned (Benson, 2003). Moreover, such variables as working memory (Alloway & Alloway, 2010), self-control (Duckworth et al., 2012), and even overall happiness (Bücker et al., 2018) have been found to be important in predicting academic achievement.

A more fundamental criticism is that IQ tests do not directly measure native ability; instead, they infer intelligence from what children already know. Further, the tests are validated against measures of achievement, such as school performance, which are affected by such factors as schooling and culture. There is also controversy over whether intelligence is a single, general ability or whether there are types of intelligence not captured by IQ tests. For these and other reasons, strong disagreement exists over how accurately these tests assess children's intelligence.

Kaufman Assessment Battery for Children (K-ABC-II)
Nontraditional individual intelligence test designed to provide fair assessments of minority children and children with disabilities.

dynamic tests
Tests based on Vygotsky's theory that emphasize potential rather than past learning.

checkpoint can you . . .

- Name and describe two traditional intelligence tests for schoolchildren?
- Give arguments for and against IQ tests?

INFLUENCES ON INTELLIGENCE

Both heredity and environment influence intelligence. Keeping in mind the controversy over whether IQ tests actually measure intelligence, let's look more closely at these influences.

Brain Development Intelligence is highly heritable (Polderman et al., 2015). There are likely thousands of genes that, additively, help determine the parameters of intelligence for an individual. These genetic influences interact with the environment over the course of a lifetime in complex ways, exerting their effects more strongly with age (Plomin & Von Stumm, 2018).

Research has found a relationship between intelligence and genes that regulate brain development (Sniekers et al., 2017). Overall brain volume is heritable as well as being associated with intelligence (Jansen et al., 2020). Myelination and neurogenesis (the formation of new neurons) (Hill et al., 2018), cortical thickness (Schmitt et al., 2019), and the development of neurons in the somatosensory cortex, hippocampus, and midbrain (Coleman et al., 2019) have also been shown to be influenced by genes associated with intelligence.

The developmental changes found in cortical thickness are also strongly influenced by genes (Fjell et al., 2015). Intelligence is highest in those children whose cortex thins most quickly (Schnack et al., 2014) or whose white matter develops most rapidly (Tamnes et al., 2010). Moreover, while IQ is generally a stable trait, there are sometimes fluctuations. Research has shown that children and adolescents who show declines in IQ over time also show reductions in cortical thickness, suggesting a neural substrate for their declines in intellectual performance (Burgaleta et al., 2014).

Although reasoning, problem solving, and executive function are linked to the prefrontal cortex, other brain regions under strong genetic influence also contribute to intelligent behavior (Davis et al., 2009), as does the speed and reliability of transmission of messages in the brain. The efficiency and integration of brain processes, both at the global and specific level, are associated with intellectual functioning (Kim et al., 2016).

Asian American children often do well in school. As with other academic differences found across racial and ethnic groups, the reasons seem to be cultural, not genetic.
ucchie79/Shutterstock

Influence of Schooling on IQ Schooling increases tested intelligence (Adey et al., 2007). IQ scores drop during summer vacation and rise again during the academic year (Ceci & Williams, 1997; Huttenlocher et al., 1998). Additionally, scores attained on various educational assessment tests—which test knowledge, such as math and science, unlikely to be learned outside of an educational environment—are strongly correlated with IQ, and this relationship exists in all countries for which data are available (Lynn & Meisenberg, 2010; Lynn & Vanhanen, 2012). A recent meta-analysis suggests the effect of education on intelligence ranges from 1 to 5 IQ points per year of schooling (Ritchie & Tucker-Drob, 2018).

However, the cognitive gains associated with schooling do not appear to be general in nature and instead consist of direct gains in specific cognitive skills that are then tapped by IQ tests (Ritchie et al., 2015). Not surprisingly, the type of schooling also matters. Children who are enrolled in schools with an academic focus tend to show greater gains in intellectual performance than children in schools with a vocational focus (Becker et al., 2012). Last, there are differential effects on children. Children with the lowest intelligence derive the greatest benefits from schooling (Hegelund et al., 2020).

Influences of Race/Ethnicity on IQ Historically, Black children scored about 15 points lower than White children and showed a comparable lag on school achievement tests (Neisser et al., 1996). However, these gaps have narrowed by as much as 4 to 7 points (Dickens & Flynn, 2006). Average IQ scores of Hispanic American children fall between those of Black and White children (Ang et al., 2010). Projections for both African Americans and Hispanics are that the IQ gaps will fall even further in the coming decades (Rindermann & Pichelmann, 2015).

What accounts for racial/ethnic differences in IQ? Some researchers have argued for a substantial genetic factor (Herrnstein & Murray, 1994; Jensen, 1969). Although there is strong evidence of a genetic influence on individual differences in intelligence, there is no direct evidence that IQ differences among ethnic, cultural, or racial groups are hereditary (Gray & Thompson, 2004; Neisser et al., 1996; Sternberg et al., 2005). Instead, many studies attribute ethnic differences in IQ to inequalities in environment (Nisbett et al., 2012; Colman, 2016)—in income, nutrition, living conditions, health, parenting practices, early child care, intellectual stimulation, schooling, culture, or other circumstances such as the effects of oppression and discrimination that can affect self-esteem, motivation, and academic performance.

What about Asian Americans, whose scholastic achievements consistently top those of other ethnic groups? Asian American children's strong scholastic achievement seems to be best explained by their culture's emphasis on obedience and respect for elders, the importance Asian American parents place on education as a route to upward mobility, and the devotion of Asian American students to homework and study (Nisbett et al., 2012).

checkpoint can you . . .

- Assess the effects of brain development on intellectual functioning?
- Assess the effects of schooling, race/ethnicity, and culture on IQ?

IS THERE MORE THAN ONE INTELLIGENCE?

A serious criticism of IQ tests is that they focus almost entirely on abilities that are useful in school. Most IQ tests do not cover other important aspects of intelligent behavior, such as common sense, social skills, creative insight, and self-knowledge.

Gardner's Theory of Multiple Intelligences Is a child who is good at analyzing paragraphs and making analogies more intelligent than one who can play a challenging violin solo or pitch a curve ball at the right time? The answer is no, according to Gardner's (1993, 1998) **theory of multiple intelligences.**

theory of multiple intelligences
Gardner's theory that each person has several distinct forms of intelligence.

window on the world

CULTURAL CONCEPTIONS OF INTELLIGENCE

In most Western cultures, conceptions of intelligence tend to focus on being able to reason logically and analyze problems, and having a wide base of knowledge. However, this view is not held everywhere.

A variety of cultures consider intelligence to include not just intellectual capabilities but also the ability to get along with other people. For example, the Luo of rural Kenya believe part of being intelligent involves social-emotional competence (Grigorenko et al., 2001). Similarly, in many Asian cultures, intelligence is associated with being educated but also with being able to successfully maintain harmonious social relationships (Cocodia, 2014).

Many cultures also include a sense of social responsibility as a component of intelligence. The Mexican concept of *educado* includes respect for others and a strong sense of morality. Similarly, rural Zambians and the Baole of the Ivory Coast consider intelligence to include a sense of citizenship and cooperation. Behavior that is performed for selfish reasons is not viewed as intelligent (Rogoff, 2003).

Most intelligence tests in Western countries are timed. The implication drawn from this is that intelligence therefore must include the ability to complete tasks rapidly. However, this view is not shared by all cultures. Ugandan villagers associate words such as *slow* and *careful* with intelligence (Wober, 1971). Similarly, among the Navajo, completing a task in a deliberate and unhurried manner is valued by adults (Ellis & Siegler, 1997).

Test developers have tried to design **culture-free tests**—tests with no culture-linked content by posing tasks that do not require language, such as tracing mazes, putting the right shapes in the right holes, and completing pictures—but they have been unable to eliminate all cultural influences. Test designers also have found it virtually impossible to produce **culture-fair tests** consisting only of experiences common to people in various cultures. Psychologists continue to work on constructing suitable tests and on interpreting the meanings of findings on intelligence.

what's your view

Do you think intelligence will be defined the same way 100 years in the future? Is there anything about intelligence that is always the same across time and place?

According to Gardner, conventional intelligence tests tap only three "intelligences": linguistic, logical-mathematical, and, to some extent, spatial. The other five, which are not reflected in IQ scores, are musical, bodily-kinesthetic, interpersonal, intrapersonal, and naturalist (Table 3 gives definitions of each intelligence and examples of fields in which it is most useful). In addition, while its inclusion has elicited some criticism, Gardner later proposed a ninth intelligence, that of existential intelligence, akin to spiritual or religious intelligence.

Gardner argued that these intelligences are distinct from each other and that high intelligence in one area does not necessarily accompany high intelligence in any of the others. A person may be extremely gifted in art (a spatial ability), precision of movement (bodily-kinesthetic), social relations (interpersonal), or self-understanding (intrapersonal), but not have a high IQ. Thus an athlete, an artist, and a musician could be equally intelligent, each in a different area.

Gardner (1995) would assess each intelligence directly by observing its products—how well a child can tell a story, remember a melody, or get around in a strange area—and not with typical standardized tests. The type of intelligence being assessed would determine the type of test required.

Critics of Gardner argue that his multiple intelligences are actually more accurately labeled as talents or abilities and assert that intelligence is more closely associated with skills that lead to academic achievement. They further question his criteria for defining separate intelligences that largely overlap, such as mathematical and spatial intelligence (Willingham, 2004).

culture-free tests
Intelligence tests that, if they were possible to design, would have no culturally linked content.

culture-fair tests
Intelligence tests that deal with experiences common to various cultures, in an attempt to avoid cultural bias.

Approximately 65 percent of Americans believe themselves to be smarter than the average person—a mathematical impossibility. Moreover, the least intelligent people are the ones most confident in their intelligence (Heck et al., 2018).

TABLE 3 Eight Intelligences, According to Gardner

Intelligence	Definition	Fields or Occupations Where Used
Linguistic	Ability to use and understand words and nuances of meaning	Writing, editing, translating
Logical-mathematical	Ability to manipulate numbers and solve logical problems	Science, business, medicine
Spatial	Ability to find one's way around in an environment and judge relationships between objects in space	Architecture, carpentry, city planning
Musical	Ability to perceive and create patterns of pitch and rhythm	Musical composition, conducting
Bodily-kinesthetic	Ability to move with precision	Dancing, athletics, surgery
Interpersonal	Ability to understand and communicate with others	Teaching, acting, politics
Intrapersonal	Ability to understand the self	Counseling, psychiatry, spiritual leadership
Naturalist	Ability to distinguish species and their characteristics	Hunting, fishing, farming, gardening, cooking

Source: Based on Gardner (1993, 1998).

triarchic theory of intelligence
Sternberg's theory describing three elements of intelligence: componential, experiential, and contextual.

componential element
Sternberg's term for the analytic aspect of intelligence.

experiential element
Sternberg's term for the insightful or creative aspect of intelligence.

contextual element
Sternberg's term for the practical aspect of intelligence.

tacit knowledge
Sternberg's term for information that is not formally taught but is necessary to get ahead.

Sternberg's Triarchic Theory of Intelligence

Sternberg's (1985, 2004) **triarchic theory of intelligence** identifies three elements, or aspects, of intelligence: componential, experiential, and contextual

- The **componential element** is the analytic aspect of intelligence; it determines how efficiently people process information. It helps people solve problems, monitor solutions, and evaluate the results. Some people are more effective information processors than others.
- The **experiential element** is insightful or creative; it determines how people approach novel or familiar tasks. It enables people to compare new information with what they already know and to come up with new ways of putting facts together—in other words, to think originally.
- The **contextual element** is practical; it helps people deal with their environment. It is the ability to size up a situation and decide what to do. What actions are most appropriate for a given situation depend on the context; a person might decide to adapt to a situation, change it, or get out of it.

The Sternberg Triarchic Abilities Test (STAT) (Sternberg, 1993) seeks to measure each of the three aspects of intelligence through multiple-choice and essay questions. Because Sternberg focused on processes rather than content and those processes should predict intelligent behavior across domains of knowledge, three domains of intelligence are assessed: verbal, quantitative, and figural (or spatial). For example, an item to test practical quantitative intelligence might be to solve an everyday math problem having to do with buying tickets to a ball game or following a recipe for making cookies. A creative verbal item might ask children to solve deductive reasoning problems that start with factually false premises (such as "Money falls off trees"). An analytical figural item might ask children to identify the missing piece of a figure. As predicted, the three kinds of abilities are only weakly correlated with each other (Sternberg, 1997; Sternberg & Clinkenbeard, 1995). However, validation studies have found a positive correlation between the STAT and several other tests of critical thinking, creativity, and practical problem solving. Additionally, total STAT scores predict academic achievement (Sternberg et al., 2001; Ekinci, 2014).

In the real world, book knowledge may not always be helpful. For example, children in many cultures have to learn practical skills, known as **tacit knowledge,** in order to

succeed. In studies in Usenge, Kenya, and among Yup'ik Eskimo children in southwestern Alaska, children's tacit knowledge of medicinal herbs, hunting, fishing, and preserving plants showed no correlation with conventional measures of intelligence but were necessary for survival (Grigorenko et al., 2004; Sternberg, 2004).

checkpoint can you . . .

- Compare Sternberg's and Gardner's theories of intelligence?

Language and Literacy

Language abilities continue to grow during middle childhood. Areas of particular importance during this age stage are vocabulary, grammar, syntax, pragmatics, and literacy.

VOCABULARY, GRAMMAR, AND SYNTAX

As vocabulary grows during the school years, children use increasingly precise verbs. They learn that a word such as *run* can have more than one meaning, and they can tell from the context which meaning is intended. Simile and metaphor, figures of speech in which a word or phrase that usually designates one thing is compared or applied to another, become increasingly common. Although grammar is quite complex by age 6, children during the early school years rarely use the passive voice (as in "The sidewalk is being shoveled") (Owens, 1996).

Children's understanding of rules of syntax (the deep underlying structure of language that organizes words into understandable phrases and sentences) becomes more sophisticated with age (Chomsky, 1969). For example, most children under age 5 or 6 think the sentences "John promised Bill to go shopping" and "John told Bill to go shopping" both mean that Bill is the one to go to the store. By age 8, most children can interpret the first sentence correctly, and by age 9, virtually all children can. They now look at the meaning of a sentence as a whole instead of focusing on word order alone.

Sentence structure continues to become more elaborate. Older children use more subordinate clauses ("The boy *who delivers the newspapers* rang the doorbell."). Still, some constructions, such as clauses beginning with *however* and *although,* do not become common until early adolescence (Owens, 1996).

Learning a language requires approximately 1.5 megabytes of data (Mollica & Piantadosi, 2019).

PRAGMATICS

The major area of linguistic growth during the school years is in **pragmatics:** the social context of language. Pragmatics includes both conversational and narrative skills.

pragmatics
(1) The practical knowledge needed to use language for communicative purposes. (2) The social context of language.

There are wide individual differences in such skills; some 7-year-olds are better conversationalists than some adults (Anderson et al., 1994). Children who have a larger vocabulary and produce more sophisticated grammar are more likely to be better at pragmatics. Theory of mind development is likewise associated with pragmatic skills, although to a lesser extent (Matthews et al., 2018). There are also gender differences. Boys tend to use more controlling statements, negative interruptions, and competitive statements, whereas girls phrase their remarks in a more tentative, conciliatory way and are more polite and cooperative (Leman et al., 2005; Cook-Gumperz & Syzmanski, 2001).

If you want children to tell you the truth, ask them to promise to do so before asking your question. Researchers have found that children are less likely to lie after promising to tell the truth (Evans & Lee, 2010).

Children also improve at telling stories. Most 6-year-olds can retell the plot of a short book, movie, or television show. They are beginning to describe motives and causal links. By second grade, children's stories become longer and more complex. Fictional tales often have conventional beginnings and endings ("Once upon a time . . ." and "They lived happily ever after"). Word use is more varied than before, but characters do not show growth or change, and plots are not fully developed.

Older children usually set the stage with introductory information about the setting and characters, and they clearly indicate changes of time and place during the story. They construct more complex episodes than younger children do but with less unnecessary detail. They focus more on the characters' motives and thoughts, and they think through how to resolve problems in the plot.

checkpoint can you . . .

- Summarize improvements in language skills during middle childhood?

SECOND-LANGUAGE LEARNING

In 2019, 23 percent of US children ages 5 to 17 spoke a language other than English at home. The primary language most of these children spoke was Spanish, and 4 percent had difficulty speaking English (Federal Interagency Forum on Child and Family Statistics, 2021). About 9.4 percent of the public school population are defined as English-language learners (ELLs) (NCES, 2017).

Some schools use an **English-immersion approach** (sometimes called ESL, or English as a second language) in which language-minority children are immersed in English from the beginning in special classes. Other schools have adopted programs of **bilingual education,** in which children are taught in two languages, first learning in their native language and then switching to regular classes in English when they become more proficient. These programs can encourage children to become **bilingual** (fluent in two languages) and to feel pride in their cultural identity.

Advocates of early English immersion claim that the sooner children are exposed to English, the better they learn it. Proponents of bilingual programs claim that children progress faster academically in their native language and later make a smoother transition to all-English classrooms (Padilla et al., 1991). Statistical analyses of multiple studies conclude that children in bilingual programs typically outperform those in all-English programs on tests of English proficiency (Crawford, 2007; Krashen & McField, 2005).

Another, less common approach is **two-way (dual-language) learning,** in which English-speaking and foreign-speaking children learn together in their own and each other's languages. By valuing both languages equally, it reinforces self-esteem and improves school performance. However, less than 2 percent of English-language learners nationwide are enrolled in two-way programs (Crawford, 2007).

English-immersion approach
Approach to teaching English as a second language in which instruction is presented only in English.

bilingual education
System of teaching non-English-speaking children in their native language while they learn English and later switching to all-English instruction.

bilingual
Fluent in two languages.

two-way (dual-language) learning
Approach to second-language education in which English speakers and non-English-speakers learn together in their own and each other's languages.

checkpoint can you . . .

- Describe and evaluate three types of second-language education?

LITERACY

Today, the global literacy rate is approximately 86 percent, and 750 million people worldwide are illiterate. Two-thirds of the illiterate population are women. Almost half (49 percent) of the illiterate population is in southern Asia, followed by sub-Saharan Africa (27 percent). Age makes a difference too. Children and adolescents are less likely to be illiterate than adults (UNESCO Institute for Statistics, 2017).

Learning to Read and Write

Think of what happens in order for a child to learn to read words. First, a child must remember the distinctive features of letters; for example, that, a "c" consists of a curved half-circle and an "o" is a closed circle. Then a child must be able to recognize the different phonemes by breaking down words into their constituent parts. For example, a child must be able to understand that the word *dog* is composed of three different sounds, the "d," the "o," and the "g." Finally, the child must be able to match the visual features of letters and the phonemes and remember which ones go together. This process is known as **decoding.**

In the traditional approach to literacy, called the **phonetic (code-emphasis) approach,** the child sounds out the word, translating it from print to speech before retrieving it from long-term memory. To do this, the child must master the phonetic code that matches the printed alphabet to spoken sounds (as described in the previous paragraph). Instruction generally involves rigorous, teacher-directed tasks focused on memorizing sound-letter correspondences.

The **whole-language approach** emphasizes visual retrieval and the use of contextual cues. This approach is based on the belief that children can learn to read and write naturally, much as they learn to understand and use speech. By using **visually based retrieval,** the child simply looks at the word and then retrieves it. Whole-language proponents assert that children learn to read with better comprehension and more enjoyment if they experience written language from the outset as a way to gain information and express ideas and feelings, not as a system of isolated sounds and syllables to be learned by memorization and drill.

decoding
Process of phonetic analysis by which a printed word is converted to spoken form before retrieval from long-term memory.

phonetic (code-emphasis) approach
Approach to teaching reading that emphasizes decoding of unfamiliar words.

whole-language approach
Approach to teaching reading that emphasizes visual retrieval and use of contextual clues.

visually based retrieval
Process of retrieving the sound of a printed word when seeing the word as a whole.

Despite the popularity of the whole-language approach, research has found little support for its claims. Although humans have brains wired for spoken language, there is no theoretical reason to assume that written language, a relatively new invention in human history, has similar evolutionary roots and thus should be learned as naturally as spoken language. A long line of research supports the view that phonemic awareness and early phonetics training are keys to reading proficiency for most children (Brady, 2011).

Many experts recommend a blend of the best features of both approaches (National Reading Panel, 2000). Children can learn phonetic skills along with strategies to help them understand what they read. For example, they might be drilled in sound-letter correspondences but also be asked to memorize certain common words such as *the* and *one* that are more difficult to decode. Children who can summon both visually based and phonetic strategies become better, more versatile, readers (Siegler, 1998, 2000).

Writing is difficult for young children. Unlike conversation, which offers constant feedback, writing requires the child to judge independently whether the communicative goal has been met. The child also must keep in mind a variety of other constraints: spelling, punctuation, grammar, and capitalization, as well as the basic physical task of forming letters (Siegler, 1998).

Older preschoolers begin using letters, numbers, and letterlike shapes as symbols to represent words or parts of words (syllables or phonemes). Often their spelling is quite inventive—so much so that they may not be able to read it themselves (Ouellette & Sénéchal, 2008). Typically, children's spelling improves as they become better readers, and this is associated with phonological awareness (Ritchey, 2008).

checkpoint can you . . .

- Compare the phonetic and whole-language methods of teaching reading, and discuss how comprehension improves?
- Identify factors that affect reading improvement in poor beginning readers?
- Explain why writing is hard for young children?

The Child in School

First grade marks entry into "real school." It is a milestone in academic development and sets the stage for future success or failure.

Did you take psychology because you thought it would be easy? You're not alone. By the age of 7, children believe that psychology is easier than the natural sciences (Keil et al., 2010).

INFLUENCES ON SCHOOL ACHIEVEMENT

In the following sections, we address influences on school achievement. We also address wider systemic issues related to educational reform, class size, alternative educational models, the use of computers in the classroom, and the effects of the COVID-19 pandemic.

Self-Efficacy Beliefs Think of how you felt the last time you studied for a big exam. Did you feel you could do well as long as you studied, and were you confident in your ability to master the material? Or did you feel that nothing you could do would matter and that the material was just too hard? Your attitude can be described as involving a construct called self-efficacy. Those students high in self-efficacy believe they can master schoolwork and regulate their own learning (Komarraju & Nadler, 2013). They are more likely to succeed than students who do not believe in their abilities (Caprara et al., 2008), in part because high self-efficacy has a positive effect on motivation (Skaalvik et al., 2015). Self-regulated learners try hard, persist despite difficulties, and seek help when necessary. Moreover, doing well in school then results in increases in self-efficacy, which once again results in attitudes and behaviors likely to lead to academic success (Schöber et al., 2018). Unfortunately, the converse is also true. Students who do not believe in their ability to succeed tend to become frustrated and depressed—feelings that make success increasingly elusive over time.

Interest, attention, and active participation all contribute to a child's academic success in school.
Andersen Ross/Blend Images/Getty Images

Gender Girls tend to do better in school than boys. They receive higher marks, on average, in every subject (Voyer & Voyer, 2014; Halpern et al., 2007), are less likely to repeat grades, have fewer school problems (Freeman, 2004), outperform boys in reading and writing assessments

Children who have a social network and who are liked and accepted by peers tend to do better in school.
Stockbyte/Digital Vision/Getty Images

(Scheiber et al., 2015), and tend to do better than boys on timed tests (Camarata & Woodcock, 2006). Some research has suggested that boys outperform girls on science and math (Reilly et al., 2015), but other research has not found a gender gap (Lindberg et al., 2010) or has found it varies by culture (Else-Quest et al., 2010).

Gender differences tend to become more prominent in high school. A combination of several factors, including early experience, biological differences, and cultural expectations, may help explain these differences (Nisbett et al., 2012; Halpern et al., 2007).

Peer Acceptance Children who are disliked by their peers tend to do poorly in school, a finding that exists for both boys and girls (Nakamoto & Schwartz, 2010; van Lier et al., 2012). This association is strongest earlier in childhood and exerts a stronger influence in Asian countries (Wentzel et al., 2021). It may be that the characteristics of some children, including aggression and oppositional behavior, lead to doing poorly in school and not being liked by peers. Then their academic underachievement and peer victimization lead to anxiety, depression, and further declines in academic performance (van Lier at al., 2012). For example, children low in emotional knowledge tend to be less liked than their peers and are also less likely to be successful academically (Voltmer & von Salisch, 2017). There is also some evidence that this effect is bidirectional; students who do poorly in school also seem to later show social difficulties (Caemmerer & Keith, 2015).

Early teacher identification of children who exhibit social problems could lead to interventions that would improve such children's academic as well as emotional and social outcomes (Flook et al., 2005). Additionally, teachers can serve as buffers against some of the effects of negative peer interactions, either by establishing a warm relationship with a rejected child or by promoting a classroom climate in which victimization of disliked children is discouraged and positive social identities are encouraged (Elledge et al., 2016; Serdiouk et al., 2015).

Parenting Practices Generally, regardless of how it is defined, parental involvement has a positive effect on academic achievement (Wilder, 2014; LaRocque et al., 2011). However, some forms of involvement appear to be more effective than others. For example, homework assistance has not been consistently related to academic achievement (Hill & Tyson, 2009; McNeal, 2012), perhaps because homework itself is minimally related to academic achievement (Bas et al., 2017). School involvement, including parental participation in school events and activities and good communication with teachers, is more strongly associated with strong academic performance (Overstreet et al., 2005; Topor et al., 2010). The strongest effects for parent involvement, however, center on parental expectations. Those parents who expect that their children will do well in school have children who live up to those beliefs (Boonk et al., 2018), perhaps because children also adopt the same attitude about their abilities (Topor et al., 2010).

Another influence: When teachers are enthusiastic about class material, children remember it better (Moe et al., 2021).

Socioeconomic Status Socioeconomic status (SES) can be a powerful factor in educational achievement—not in and of itself but through its influence on family atmosphere, choice of neighborhood, parenting practices, and parents' expectations for children. Generally, achievement gaps between advantaged and disadvantaged students widen from kindergarten to third grade (Kena et al., 2014). Summer vacation contributes to these gaps because of differences in the typical home environment and in the summer learning experiences the children have, particularly with respect to reading (Johnston et al., 2015). Moreover, as the income gap between wealthy and poor families has gotten larger, the achievement gap between wealthy and poor children has also grown (Reardon, 2011). Race, too, matters. In the last few decades, the achievement gap between poor White students and poor Black and Hispanic students has increased. However, the achievement gap between wealthier White and wealthier Black and Hispanic students has declined (Paschall et al., 2018).

In addition to these factors, socioeconomic status may influence brain development itself. For example, children who live in poverty are more likely to be exposed to environmental toxins such as lead, which can negatively impact brain development. Poor children are also less likely to have access to healthy foods and more likely to suffer from nutrient deficiencies. Moreover, poverty is associated with higher stress, and high levels of chronic stress can have a direct negative effect on development as well as indirect effects on development via its impact on relational processes (Hackman et al., 2010; Blair & Raver, 2016). Research has demonstrated that children living in poverty have 3 to 4 percent less gray matter volume in their frontal lobe, temporal lobe, and hippocampus, a finding that has implications for academic functioning (Hair et al., 2015).

Educational Reform The No Child Left Behind (NCLB) Act of 2001 was a sweeping educational reform designed to funnel federal funding to research-based programs and practices. Students in grades three through eight were tested annually to determine if they were meeting statewide progress objectives. NCLB was replaced in 2015 by the Every Student Succeeds Act (ESSA) with bipartisan support. ESSA retained the standardized testing requirements of NCLB but shifted the responsibility and accountability of oversight to the state governments.

What has been the influence of these regulatory systems? The pattern of improvements in achievement scores has been highly variable across states, grades, and subjects (Lee & Reeves, 2012). However, test scores do show improvement. In 2007, for example, math scores for fourth and eighth graders on the National Assessment of Educational Progress (NAEP) rose to their highest levels since the test began in 1990. Black, White, and Hispanic students all improved (NCES, 2007), but ethnic group gaps remain (Hernandez & Macartney, 2008). The gaps between high and low achievers have increased over time. For example, although the average math and science scores increased between 2009 and 2019, the increase was due to higher scores of already high-achieving students. The scores of low-achieving students either declined or did not change. This performance gap suggests increasing inequity across educational systems (National Center for Education Statistics, 2021).

Class Size The average class size varies widely across different countries. Average class sizes are larger in Chile (30.8 students), Japan (27.2 students), and the United Kingdom (26 students) and smaller in Costa Rica (15.7 students), Luxembourg (15.9 students), and Latvia (16.5). The average class size in the United States is 20.9 students (Organisation for Economic Co-Development and Learning, 2021).

The evidence on the importance of class size in educational achievement is mixed. Some researchers have not found evidence that reducing class size benefits academic performance (Chingos, 2012; Hoxby, 2000). Other research has shown that reducing class size has a beneficial effect on academic performance and results in improved test scores in reading, mathematics, and word recognition (Shin & Raudenbush, 2011). However, it has been argued that the effects are small and not likely to lead to sizable increases in student learning (Cho et al., 2012). Moreover, the effect of class size varies depending on cultural context. In some Asian countries, including China and Japan, classes are larger, yet students perform at a high level (Organisation for Economic Co-Operation and Learning, 2013).

However, many educators argue that smaller classes do benefit students. In smaller classes, students spend more time interacting with the teacher, are more likely to be the focus of a teacher's attention, and spend more time on-task and less time off-task (Blatchford et al., 2011; Folmer-Annevelink et al., 2010). Smaller class size has at times been associated with improved test scores on reading, mathematics, and word recognition (Shin & Raudenbush, 2011). Some data suggest that the students most at risk, including students of lower socioeconomic status or from marginalized or disenfranchised groups, benefit the most from small classrooms. Additionally, small class size seems to be most useful for younger children (Nandrup, 2016; Zyngier, 2014; Watson et al., 2013).

checkpoint can you . . .

- Evaluate how efficacy beliefs, gender, parenting practices, SES, and peer acceptance affect school achievement?

Charter Schools and Homeschooling More than 3.3 million children, or about 6.5 percent of public schools students, attend charter schools (White et al., 2021). Charter schools tend to be smaller than regular public schools and have a unique philosophy, curriculum, structure, or organizational style. Some studies have found achievement gains, especially in mathematics, for students enrolled in charter schools (Betts & Tang, 2016), some studies have found mixed results (Berends, 2015), and some studies have found negative results (Clark et al., 2015). Currently, not enough data are available for general recommendations to be made.

Homeschooling is legal in all 50 states. National homeschooling rates rose in the early 2000s and plateaued in 2012 at approximately 3.3 percent of the school-age population. However, during the COVID-19 pandemic, homeschooling rates expanded sharply. For example, in fall 2020, approximately 11.1 percent of households with children reported homeschooling (Eggleston & Fields, 2021). The main reasons parents give for choosing to homeschool their children is a poor or unsafe learning environment in the schools and the desire to provide religious or moral instruction (NCES, 2008). Most homeschooled students are White (89 percent), and most (about 90 percent) live above the poverty level (Redford et al., 2016).

checkpoint can you . . .

- Discuss changes and innovations in educational philosophy and practice?

Although advocates of homeschooling argue that homeschooling is associated with good academic outcomes (Christian Home Educators Association of California, 2013; Ray, 2010), the studies that have been conducted have serious methodological flaws and tend to come from a limited pool of researchers and organizations with potential biases (Kunzman & Gaither, 2020; Lubienski et al., 2013). Thus, the efficacy of homeschooling remains in question. Given the variety of methods and materials used (Redford et al., 2016), it is likely the quality of instruction varies widely.

The Influence of COVID-19 on Education In 2020, many countries instituted physical distancing protocols, including school closures, to slow the spread of COVID-19, resulting in the largest education disruption in history. As of March 2022, over 43 million children still faced continuing school disruptions, and in six countries, schools remained fully closed (UNESCO, 2022). In February 2021, the Centers for Disease Control and Prevention released revised guidelines and advised schools could be reopened safely (Centers for Disease Control and Prevention, 2021). However, many schools remained fully or partly closed through fall 2021. Although the long-term effects of these educational interruptions remain to be seen, school closures and distance learning are likely to exacerbate existing social and economic inequalities (Research in Action).

Computer and Internet Use In 1994, only 4 percent of classrooms had Internet access, compared with 97 percent in 2008 (Snyder et al., 2018). Moreover, 87 percent of teachers report using digital learning in their classroom several times a week (Education Superhighway, 2020).

The COVID-19 pandemic resulted in an unprecedented need for distance learning solutions. However, there are vast disparities in how many children have access to technology. For example, although over 97 percent of children in the Netherlands and Iceland have a computer at home, in other countries such as Mexico (44.3 percent), Colombia (41.6 percent), and Brazil (39.4 percent), access is constrained, especially for poor children (OECD, 2021).

checkpoint can you . . .

- Discuss how the COVID-19 pandemic affected children's education?

In the United States, there is a 22-point gap in home computer access for children from higher- (95 percent) and lower-income (63 percent) households, although 97 percent of households overall have a mobile device in the home (Common Sense Media, 2020). This is troubling, given the importance of reliable internet access to remote schooling. Moreover, only 68 percent of teachers reported receiving training on how to use computers for instruction in the previous year (Garcia & Weiss, 2020). Overall, the pandemic is expected to exacerbate existing inequities in academic achievement for children of lower socioeconomic status.

COMPOUNDING DISADVANTAGE: EDUCATIONAL ACCESS IN THE AGE OF COVID-19

Historically disadvantaged students are those who have difficulty excelling in school due to circumstances beyond their control. Children from low-income, rural, or racial/ethnic minority backgrounds tend to have more difficulties in educational attainment due to economic, geographic, and social barriers (Legal Information Institute, 2021; National Institutes of Health, 2021). The COVID-19 pandemic resulted in an unheard of shutdown of US schools and a massive shift to online learning within a few weeks. The move to teaching online has had far-reaching effects that have widened the long-standing educational disparity between advantaged and disadvantaged students. How exactly has COVID-19 added to the burden disadvantaged students already face in society?

For starters, low-income students have less available spaces to do homework and less suitable electronic devices for online learning (Poletti & Raballo, 2021), making doing schoolwork from home difficult. Low-income students have also faced more food insecurity as a result of losing school-based free or reduced-price meals during school hours (Dunn et al., 2020).

Rural students also tend to lack broadband internet access (Graves et al., 2021) and are likelier to live farther away from public spaces with reliable internet service. Only 25 percent of rural students have access to reliable internet service, compared to 41 percent of urban students (UNICEF & International Telecommunications Union, 2020), which makes connecting to online learning platforms difficult.

Race plays a large role as well. Black and Hispanic children were among the least likely to have adequate computer access despite being enrolled in online school (Friedman et al., 2021). Black parents were also found to be overrepresented in "frontline" worker positions that required them to continue to work during pandemic lockdowns (Allen et al., 2020), making it harder to supervise their children's online learning even if devices were available. COVID-19 school closures in 2020 seemed to have a collective effect on Black, indigenous, and/or students of color, who were about 3 to 5 months behind in their learning as a result, compared to White students, who were only 1 to 3 months behind (McKinsey & Company, 2021).

What effects will these disparities have on disadvantaged students moving forward? As educational attainment is an important predictor of long-term health, COVID-19 may lead to the accumulation of physical and mental health risk for disadvantaged students over time (Fraiman et al., 2021). Controlling COVID-19 is not only a public health issue, but clearly an issue of social equality as well (Kahambing, 2021).

What strategies would you use to increase learning among disadvantaged students? How will the shift to online learning change schooling once COVID-19 is more controlled?

Educating Children with Special Needs

Public schools have a tremendous job educating children of varying abilities from all sorts of families and cultural backgrounds. They must also educate children with special needs: for example, those who have learning problems and those who are gifted, talented, or creative.

CHILDREN WITH LEARNING PROBLEMS

Just as educators have become more sensitive to teaching children from varied cultural backgrounds, they also have sought to meet the needs of children with special educational needs.

intellectual disability
Significantly subnormal cognitive functioning. Also referred to as cognitive disability.

Intellectual Disability

Intellectual disability is significantly subnormal cognitive functioning. It is indicated by an IQ of about 70 or less, coupled with a deficiency in age-appropriate adaptive behavior (such as communication, social skills, and self-care), appearing before age 18 (American Psychiatric Association, 2013). Intellectual disability is sometimes referred to as cognitive disability. Slightly over 1 percent of US children are intellectually disabled (Zablotsky et al., 2015). Worldwide, about 3.2 percent of children are intellectually disabled (Olusanya et al., 2020).

In 30 to 50 percent of cases, the cause of intellectual disability is unknown. Known causes include genetic disorders, traumatic accidents, prenatal exposure to infection or alcohol, and environmental exposure to lead or high levels of mercury (Woodruff et al., 2004). Many cases may be preventable through genetic counseling, prenatal care, amniocentesis, routine screening and health care for newborns, and nutritional services for pregnant women and infants.

Most children with intellectual disabilities can benefit from schooling. Intervention programs have helped many of those mildly or moderately disabled and those considered borderline (with IQs ranging from 70 up to about 85) to hold jobs, live in the community, and function in society. The profoundly disabled need constant care and supervision, usually in institutions. For some, day care centers, hostels for intellectually disabled adults, and homemaking services for caregivers can be less costly and more humane alternatives.

learning disabilities (LDs)
Disorders that interfere with specific aspects of learning and school achievement.

dyslexia
Developmental disorder in which reading achievement is substantially lower than predicted by IQ or age.

Learning Disabilities

Learning disabilities (LDs) interfere with specific aspects of school achievement, such as listening, speaking, reading, writing, or mathematics, resulting in performance substantially lower than would be expected given a child's age, intelligence, and amount of schooling. Estimates are that approximately 1 in 5 children has some form or learning or attentional issues impacting academic performance. In recent years, rather than waiting for children to fail and then providing services, it is more typical to provide early—and more effective—assistance to these children (National Center for Learning Disabilities, 2020).

Children with LDs often have near-average to higher-than-average intelligence and normal vision and hearing, but they have trouble processing sensory information. Causal influences include both genetic and environmental factors. Environmental factors include complications of pregnancy or birth, injuries after birth, trauma, and exposure to lead (National Center for Learning Disabilities, 2020).

Children's patterns of brain activation change as they become better readers (Kearns et al., 2019), illustrating the flexible nature and plasticity of our brains.

Dyslexia is the most commonly diagnosed of the learning disabilities. Dyslexia is a chronic, persistent medical condition and tends to run in families. It hinders the development of oral as well as written language skills and may cause problems with writing, spelling, grammar, and understanding speech as well as with reading (National Center for Learning Disabilities, 2020). Reading disability is more frequent in boys than in girls (Arnett et al., 2017). Although reading and intelligence are related to each other in children without dyslexia, they are not coupled in this fashion for children with dyslexia. In other words, dyslexia is not an issue of intelligence (Ferrer et al., 2010).

Brain imaging studies have found that dyslexia is due to a neurological defect that disrupts recognition of speech sounds (Peterson & Pennington, 2012). Many children—and even adults—with dyslexia can be taught to read through systematic phonological training, but the process does not become automatic, as it does with most readers (Eden et al., 2004; Shaywitz, 2003).

attention-deficit/hyperactivity disorder (ADHD)
Syndrome characterized by persistent inattention and distractibility, impulsivity, low tolerance for frustration, and inappropriate overactivity.

Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder (ADHD) is a chronic condition usually marked by persistent inattention, distractibility, impulsivity, and low tolerance for frustration. ADHD affects an estimated 5 to 7.2 percent of school-age children worldwide (Smith, 2017). In 2016, about 6.1 million children in the United States had at some point been diagnosed with ADHD, a rate of about 9.4 percent (see Figure 3). Approximately 60 percent of children diagnosed with ADHD have at least one other mental, emotional, or behavioral disorder (Centers for Disease Control and Prevention, 2020).

Similar to LDs, ADHD diagnosis rates vary greatly by gender, ethnicity, geographic area, and other contextual factors. Boys (12.9 percent) are more likely than girls (5.6 percent) to have ADHD (Centers for Disease Control and Prevention, 2020). Prevalence rates are higher in non-Hispanic White (12 percent) and Black (12.8 percent) children than Hispanic (6.1 percent) children (Xu et al., 2018).

Imaging studies reveal that certain regions in the brains of children with ADHD—most notably areas in the frontal cortex—show delays in development. The motor cortex is the only area that matures faster than normal, and this mismatch may account for the restlessness and fidgeting characteristic of the disorder. During tasks that require the deployment of attentional processes, children with ADHD show reduced activation in frontoparietal and ventral attention networks areas (Cortese et al., 2012). These frontal regions enable a person to set goals, focus attention, monitor progress, and inhibit negative impulses—all functions disturbed in children with ADHD.

Ritalin is a commonly prescribed drug that is generally very effective for the management of ADHD. However, it is related to slower growth in height and weight (Powell et al., 2015). Interventions with children with ADHD are most useful if they include behavioral interventions, modification of teaching instructions and student tasks, good communication with parents, and collaboration among school professionals such as teachers and psychologists (DuPaul & Stoner, 2014).

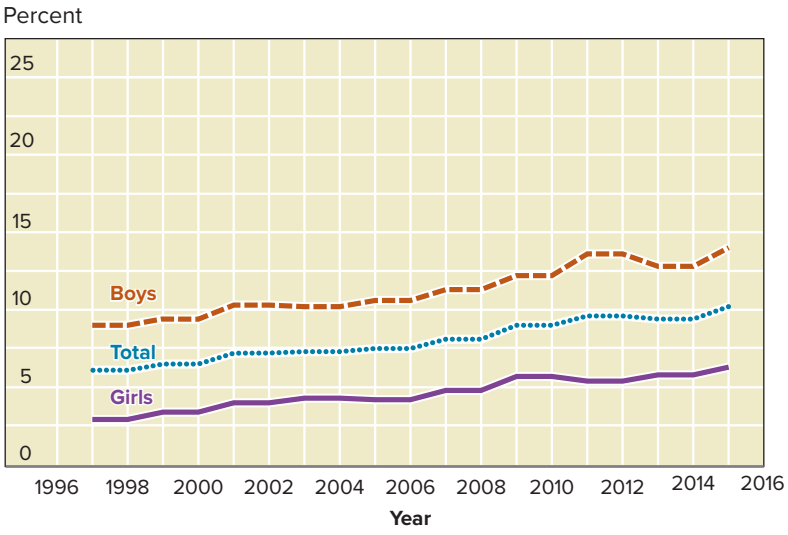

FIGURE 3
US Diagnosis of Attention-Deficit/Hyperactivity Disorder by Year

Diagnosis of learning disabilities has remained constant, but diagnosis of ADHD rose from 1997 to 2015.

Source: Xu et al. (2018).

Long-term effects of drug treatment for ADHD are unknown, but leaving the condition untreated also carries risks. If you had a child with ADHD, what would you do?

checkpoint can you . . .

- **Discuss the causes, treatments, and prognoses for three conditions that interfere with learning?**

GIFTED CHILDREN

The traditional criterion of giftedness is high general intelligence as shown by an IQ score of 130 or higher. This definition tends to exclude highly creative children (whose unusual answers often lower their test scores), children from minority groups (whose abilities may not be well developed, though the potential is there), and children with specific aptitudes (who may be only average or even show learning problems in other areas). Thus, all 50 states have moved beyond a single-score definition of giftedness (McClain & Pfeiffer, 2012).

Most states and school districts have adopted a broader definition of giftedness. Generally, multiple criteria are used for admission to programs for the gifted, including achievement test scores, grades, classroom performance, creative production, parent and teacher nominations, and student interviews. An estimated 6 percent of the student population is considered gifted (National Association for Gifted Children, n.d.).

Although most people think of special education programs as designed to benefit children with learning problems, gifted children also have needs different from the general student population.
FatCamera/E+/Getty Images

enrichment programs
Programs for educating the gifted that broaden and deepen knowledge and skills through extra activities, projects, field trips, or mentoring.

acceleration programs
Programs for educating the gifted that move them through the curriculum at an unusually rapid pace.

Programs for gifted children generally stress either enrichment or acceleration. **Enrichment programs** may deepen students' knowledge and skills through extra classroom activities, research projects, field trips, or expert coaching. **Acceleration programs** speed up their education through early school entrance, grade skipping, placement in fast-paced classes, or advanced courses. Other options include ability grouping within the classroom, which has been found to help children academically and not harm them socially (Vogl & Preckel, 2014), dual enrollment (for example, an eighth grader taking algebra at a nearby high school), magnet schools, and specialized schools for the gifted.

Gifted children tend to grow up in enriched family environments with intellectual or artistic stimulation. Their parents recognize and often devote themselves to nurturing the children's gifts and curiosity, and tend to give their children an unusual degree of independence and expose them to new experiences. Parents of gifted children typically have high expectations and are hard workers and high achievers themselves (Al-Dhamit & Kreishan, 2016; Garn et al., 2010; Gottfried et al., 2016).

Defining and Measuring Creativity

creativity
Ability to see situations in a new way, to produce innovations, or to discern previously unidentified problems and find novel solutions.

One definition of **creativity** is the ability to see things in a new light—to produce something never seen before or to discern problems others fail to recognize and find new and unusual solutions. High creativity and high academic intelligence (IQ) do not necessarily go hand in hand (Anastasi & Schaefer, 1971; Getzels & Jackson, 1963).

The reason creativity is not highly correlated with traditional IQ tests is because traditional tests are measuring a different kind of thinking than is characteristic of creativity. **Convergent thinking**—the kind IQ tests measure—seeks a single correct answer. For example, when solving an arithmetic problem, there is one correct answer upon which everyone is expected to converge. **Divergent thinking**, by contrast, involves coming up with a wide array of fresh possibilities, such as when children are asked to list how many different uses there might be for a paper clip or to write down what a sound brings to mind (Guilford, 1956). There is no one right answer.

convergent thinking
Thinking aimed at finding the one right answer to a problem.

divergent thinking
Thinking that produces a variety of fresh, diverse possibilities.

One possible reason creativity and academic achievement don't always relate is that personality characteristics related to creativity—such as being nonconformist or emotional—are generally viewed negatively by teachers (Westby & Dawson, 1995).

Tests of creativity call for divergent thinking. This ability can be assessed via the Torrance Tests of Creative Thinking (TTCT) (Torrance & Ball, 1984), one of the most widely known tests of creativity. While there has been controversy about the measurement qualities of the test, a 50-year follow-up showed that scores on the TTCT were related to personal achievement, and when IQ was also taken into account, scores were related to public achievement as well (Runco et al., 2010).

checkpoint can you . . .

- Tell how gifted children are identified?
- Explain why creativity is hard to measure?
- Compare two approaches to the education of gifted children?