The new chapter on social cognition focuses on children's understanding of social information. This is a broad area that includes knowledge about self and others; knowledge about the mind and the mental states that give rise to behavior, such as desire, intention, and belief; and knowledge about the social world, including understanding of social rules and social categories.

All of the remaining chapters have also been revised and updated. Some of the many additions are increased coverage of interrelations between perception and action, an expanded discussion of children's biological concepts, and additional information about the development of language comprehension.

As in previous editions, we have continued to emphasize the practical contributions of research on children's thinking. Some examples that are discussed are techniques for eliciting accurate recollections of events from children who need to testify in court cases, techniques for assessing children's knowledge, and instructional methods for improving reading, writing, and mathematical skills.

Each of us is fortunate to have had a rich and stimulating intellectual environment in which to work during the writing of the book. Many of our colleagues have given generously of their time to help us improve the book. Some read drafts of chapters or parts of chapters and offered feedback, including Jim Dannemiller, Chuck Kalish, Ken Koedinger, Brian MacWhinney, and Jenny Saffran. We are grateful for the opportunities to discuss children's thinking with these individuals and many others, including Karen Adolph, Zhe Chen, Judy DeLoache, Julia Evans, Susan Goldin-Meadow, David Klahr, Eric Knuth, Patrick Lemaire, Colleen Moore, Nicole McNeil, Mitchell Nathan, John Opfer, Seth Pollak, David Rakison, and Bethany Rittle-Johnson. We would also like to thank the anonymous reviewers who provided comments on the previous edition, and Maureen Kaschak and Karin Ockuly, who spent many hours tracking down references. Finally, we would like to thank Theresa Treasure, who in this edition as in the previous one, did whatever it took to get the work done in a timely fashion.

A different kind of thanks is due our friends and families, who have provided support as well as inspiration during the time we worked on this book. Robert Siegler would like to thank his children, Todd, Beth, and Aaron Siegler, who have progressed over the four editions of this book from unwittingly providing interesting examples of children's thinking to thoughtfully advancing interesting ideas about it. Martha Alibali would like to thank her husband, Peter, who offered unwavering support in myriad ways, and would also like to thank her many nieces and nephews, who provided compelling examples of children's thinking at various stages of development. These individuals make the research come alive for us, and they make our endeavors worthwhile.

We would like to dedicate this book to the new children who came into our lives during the writing of it, Robert Siegler's granddaughter Alexis, and Martha and Peter Alibali's daughter, Mariana. The opportunity to observe their thinking and to take part in their development has provided us with great joy, and we hope to learn from them for many years to come.

Robert S. Siegler
Martha Wagner Alibali

1

An Introduction to Children's Thinking

When did the sun begin? When people began living. *Who made it?* God. *How did God do this?* He put a real lot of lightbulbs in it. *Are these lightbulbs still in the sun?* No. *What happened to them?* They burnt out. No, they stay good a long time. *So are the lightbulbs still in it?* No. I think he made it out of gold. And he lit it with fire. *(Siegler, conversation with son, 1985)*

The child in the vignette above answered these questions one week before his fifth birthday. What do his answers tell us about how he viewed the world at that time? Do they reflect a simple lack of knowledge about astronomy and physics? Or do they indicate a fundamental difference between young children's reasoning and that of older children and adults? An adult who did not know the origins of the sun would never ascribe its origins to God putting lightbulbs in it. Nor would an adult link the origins of the sun to the fact that people began to be alive. Do these differences mean that children generally reason in more literal and self-centered ways than adults? Or do they just reflect a child's grasping at straws when faced with a question for which he cannot even generate a plausible answer?

For hundreds of years, people have wondered about these and related questions. Do infants see the world in the same way as adults? Why do societies throughout the world first send children to school between ages 5 and 7? Why are

TABLE 1.1 Chapter Outline

adolescents so much more likely than 10-year-olds to fervently believe in causes such as vegetarianism or environmentalism? A century ago, people could only speculate about these issues. Now, however, we have concepts and methods that magnify our ability to observe, describe, and explain the process of development. As a result, our understanding of children's thinking is growing rapidly.

The goal of this chapter is to introduce some basic issues and ideas regarding children's thinking. The first section focuses on what children's thinking involves. The next section introduces some of the enduring questions that motivate people to study cognitive development. Finally, the last section provides an overview of the book's organization. An outline of the chapter is provided in Table 1.1.

What Is Children's Thinking?

Children's thinking refers to the thinking that takes place from the moment of birth through the end of adolescence. Defining what thinking is turns out to be quite difficult, because no sharp boundary divides activities that involve thinking from ones that do not. Thinking obviously involves the higher mental processes: problem solving, reasoning, creating, conceptualizing, remembering, classifying, symbolizing, planning, and so on. Other examples of thinking involve more basic processes, processes at which even young children are skilled: using language, and perceiving objects and events in the external environment, to name two. Still other activities might or might not be viewed as types of thinking. These include being socially skillful, having a keen moral sense, feeling appropriate emotions, and so on. The capabilities in this last group involve thought processes, but they also involve many other, nonintellectual qualities. In this book, we give these boundary areas some attention, but the spotlight is on problem solving, conceptual understanding, reasoning, remembering, producing and comprehending language, and the other, more purely intellectual activities.

A particularly important characteristic of children's thinking is that it is constantly changing. How children think at particular points in development is interesting in and of itself, but even more central for understanding cognitive development are the questions of what changes occur and how the changes occur. Comparing an infant, a 2-year-old, a 6-year-old, and an adolescent, it is easy to appreciate the magnitude of these changes. But what processes could transform the mind of a newborn baby into the mind of an adolescent? This is the central mystery of cognitive development.

Consider an example of the dramatic changes that occur with development. DeVries (1969) was interested in 3- to 6-year-olds' understanding of the difference between appearance and reality. She presented children of these ages with an unusually sweet-tempered cat named Maynard and allowed them to pet him. When the experimenter asked what Maynard was, all of the children knew that he was a cat. Then, as the children watched, the experimenter put a mask of a fierce dog on Maynard's face. The experimenter asked, "Look, it has a face like a dog. What is this animal now?"

Many of the 3-year-olds thought that Maynard had become a dog. They refused to pet him and said that under his skin he had a dog's bones and a dog's stomach. In contrast, most 6-year-olds knew that a cat could not turn into a dog, and that the mask did not change the animal's identity.

How can a human being, even a very young one, believe that a cat can turn into a dog? And how does the 3-year-old who has this belief turn into the 6-year-old who scoffs at such a silly notion? We know that the change happens, the issue is how it happens.

Key Questions about Children's Thinking

What are the most important questions in the study of children's thinking? Many answers are possible, but there is widespread agreement that the following six questions are among the most important:

Are some capabilities innate?
Does children's thinking progress through qualitatively different stages?
How do changes in children's thinking occur?
Why do individual children differ so much from each other in their thinking?
How does development of the brain contribute to cognitive development?
How does the social world contribute to cognitive development?

Of course, these questions are interrelated in many ways. For example, understanding the roles of the brain and the social world in cognitive development is crucial to understanding how change occurs. Likewise, understanding mechanisms of change may shed light on why individual children differ from one another.

Researchers from different theoretical perspectives and different content areas have focused on different questions to varying degrees. For example, as described later, researchers who take an information-processing perspective on cognitive development tend to emphasize the issue of how change occurs, whereas researchers who take a sociocultural perspective focus on how the social world contributes to cognitive development. However, despite these differences in emphasis, each of the major theories of cognitive development has something to say about each of these main questions.

These key questions are introduced in the following sections. The emphases in this chapter are on fundamental concepts relevant to each question and on major themes that will recur repeatedly throughout the book.

Are Some Capabilities Innate?

When infants are born, how do they experience the world? When they see a chair, or people talking to each other, or a dog barking, what exactly do they see? What do they know, what don't they know, and what learning capabilities do they possess? If we assume that infants come into the world poorly endowed with knowledge and learning capabilities, the question becomes, "How can they develop as rapidly as they do?" If we assume that infants come into the world richly endowed, the question becomes, "Why does development take so long?"

The question of infants' initial endowment has elicited many speculations. Three of the most prominent come from the *associationist perspective,* the *constructivist perspective,* and the *competent-infant perspective.*

The associationist perspective was developed by English philosophers of the 1700s and 1800s, including John Locke, David Hume, and John Stuart Mill. They suggested that infants come into the world with only minimal capabilities, primarily the ability to associate experiences with each other. Therefore, infants must acquire virtually all capacities and concepts through learning.

The constructivist perspective, developed by Jean Piaget between the 1920s and the 1970s, suggests that infants are born possessing not only these associative capabilities but also several important perceptual and motor capabilities. Although few in number and limited in scope, these capabilities allow infants to explore their environment and to construct increasingly sophisticated concepts and understandings. For example, infants in their first 6 months are said not to be able to form mental representations of objects and events, but through actively manipulating and investigating objects, they are said to become capable of forming such representations later in their first year.

The competent-infant perspective, based on more recent research (e.g., Spelke & Newport, 1998), suggests that both of the other approaches seriously underestimate infants' capabilities. Within this view, even young infants have a much wider range of perceptual skills and conceptual understandings than had previously been suspected. These capacities allow infants, in a rudimentary way, to perceive the world and to classify their experiences along many of the same dimensions that older children and adults use.

The impressive capabilities that recent investigations have uncovered can be illustrated in the context of infants' perception of distance. Philosophers have long speculated about how people can judge the distances of objects from themselves. Some, such as George Berkeley, an associationist philosopher of the eighteenth century, concluded that the only way in which infants could come to accurately perceive distance was by moving around the world and associating how objects looked with how much movement was required to reach them. Yet, the day after infants are born, they can already perceive which objects are closer and which are farther away (Granrud, 1987; Slater, Mattock, & Brown, 1990). Clearly, some degree of distance perception is present even before infants have experience crawling and walking around the environment.

Infants also possess surprising knowledge of the properties of objects. For example, by age 3 months, the earliest age at which such knowledge has been successfully measured, infants show some understanding that objects continue to exist even when they move behind other objects and cannot be seen; that without support, objects will fall; that objects move along spatially continuous paths; and that solid objects cannot move through one another (Baillargeon, 1994; Spelke, 1994, 2000). Such knowledge is not identical to the knowledge of adults; for example, 3-month-olds seem to believe that any contact between an object and a support is sufficient to hold the object up, even when, for example, only the right edge of a block on the bottom is under the left edge of a block on top of it. By 6 months, infants show the more advanced understanding that for a support to be effective, the block on the bottom must be under a substantial proportion of the block on the top (Baillargeon, 1994).

In addition to possessing primitive versions of fundamental concepts, infants also possess general learning mechanisms that help them acquire a wide range of new knowledge. One such learning mechanism is *imitation.* When 2-day-olds see an adult move his head in a certain way, they tend to move theirs in a similar fashion; when 2-week-olds see an adult stick out his tongue, they tend to stick out their tongues in response (Meltzoff, 2002; Meltzoff & Moore, 1983). Such repetitions provide a way for infants to learn new behaviors and also to strengthen their bond with those they imitate, particularly their parents.

Another such learning mechanism is *statistical learning,* which involves extracting sequential patterns from input. In their first year of life, infants are capable of detecting such patterns both in auditory input, such as sequences of tones or linguistic sounds (Saffran, 2003b; Saffran, Aslin, & Newport, 1996), and in visual input, such as sequences of colored shapes (Kirkham, Slemmer, & Johnson, 2002). Statistical learning is a powerful mechanism by which infants can detect regularities in their environment.

Findings like these have given rise to the view that infants are quite cognitively competent. But like previous perspectives, the new view raises as many questions as it answers. If infants understand fundamental concepts, why do much older children experience such difficulty with the very same concepts? For example, if infants understand that a toy continues to exist even when a cover is placed on it, why do 3-year-olds still not understand that a cat cannot be turned into a dog simply by putting a mask on it? Reconciling the strengths that are present early in development with the weaknesses that are also present then and for years thereafter is one of the greatest challenges in understanding children's thinking.

Another challenge is specifying how innate or early-developing abilities interact with experience to yield developmental change. One approach to addressing this issue is to examine the effects of variations in experience on the nature and path of development. For example, does perceptual development differ in typically developing infants and infants who are blind or deaf from birth? Does language acquisition depend on the nature of the linguistic input that children receive? The solutions to these puzzles highlight the complex interplay between biologically specified abilities and experience in the physical and social world.

Does Development Progress through Stages?

When a girl misbehaves, her parents might console each other by saying, "It's just a stage she's going through." When a boy fails utterly to learn something, his parents might lament, "I guess he just hasn't reached the stage where he can understand this." The idea that development, including cognitive development, occurs in stages is common among psychologists as well as parents. But what exactly does it mean to say that a child is in a stage, and do children in fact progress through qualitatively distinct stages of thinking? And why might development be stagelike, rather than continuous?

The view of development as stagelike was in part inspired by the ideas of Charles Darwin (1877). Darwin is not usually thought of as a developmental psychologist, but in many ways he was one. In his book *The Descent of Man,* Darwin discussed the development of reason, curiosity, imitation, attention, imagination, language, and self-consciousness. Not surprisingly, he was most interested in the evolutionary course of these competencies, that is, in how they emerged in the course of the evolution from earlier-appearing animals to humans. However, many of his ideas could be, and were, translated into concepts about the development that occurs in an individual human lifetime.

Perhaps Darwin's most influential observation was his most basic: that over the vast period of time that living things have populated the earth, they have evolved through a series of qualitatively distinct forms. This observation suggested to some that development within a given lifetime also progresses through distinct forms or stages. Unlike Darwin himself, however, developmental theorists who adopted an evolutionary perspective further hypothesized that children would make the transition from one stage to the next quite suddenly. This stage approach directly contradicted speculations by associationist philosophers,

such as John Locke, that children's thinking develops through the gradual accretion of innumerable particular experiences. Associationists compared the developmental process to a building being constructed brick by brick. Stage theorists compared it to the metamorphosis from caterpillar to butterfly.

In the early part of the twentieth century, James Mark Baldwin hypothesized a set of plausible stages of intellectual development. He suggested that children progressed from a sensorimotor stage, in which sensory observations and motor interactions with the physical environment were the dominant form of thought, to a quasilogical, a logical, and finally a hyperlogical stage. The idea that children progress through these stages receives a certain amount of support in everyday observations of children. Infants' interactions with the world do seem, at least at first impression, to emphasize sensory input and motor actions. And not until adolescence do children spend much time thinking about purely logical issues, such as whether laws that apply to them, including those regarding driving, voting, and drinking, are logically consistent with each other. Baldwin's stage theory was ignored by most of his contemporaries, but it exerted a strong influence on at least one later thinker: Jean Piaget.

Piaget, without question, added more than any other individual to our understanding of children's thinking. He made a huge number of fascinating observations about the ways in which children think at different ages. For example, the reason that Siegler asked his son about the origins of the sun (the anecdote at the beginning of this chapter) was because he was fascinated by Piaget's descriptions of the answers given by children in the 1920s, and Siegler was curious whether children in the 1980s would respond similarly (they do). Among Piaget's other contributions were developing the stage notion to a much greater extent than Baldwin had, and popularizing the idea of viewing intellectual development in terms of stages.

What exactly *do* we mean when we say that children's thinking progresses through certain stages? Flavell (1971) noted four key implications of the stage concept. First, stages imply *qualitative changes.* We do not say that a boy is in a new stage of understanding of arithmetic when he progresses from knowing 50 percent of the multiplication facts to knowing all of them. Instead, we reserve the term for situations in which the child's thinking seems not only better but different in kind. For example, when a girl makes up her first genuinely amusing joke after several years of telling stories that she may call jokes, but that do not even make sense to adults, it seems like a qualitative change. Note the ambiguity of the term *seems like,* though. Perhaps the girl's efforts had been improving slowly for a long time but had not quite reached the threshold for what an adult recognizes as a joke. To some degree, what constitutes a qualitative change is in the eyes of the beholder.

A second implication of stage theories, which Flavell labeled the *concurrence assumption,* is that children make the transition from one stage to another on many concepts simultaneously. When they are in Stage 1, they show

Stage 1 reasoning on all of these concepts; when they are in Stage 2, they show Stage 2 reasoning on all of them. As a result of these concurrent changes, children's thinking shows abstract similarities across many domains. When the parent in the above example said, "He's just not in a stage where he can understand this," the implication was that a general deficiency would keep the child from understanding not just the particular concept but also other concepts of comparable complexity.

Viewing children's thinking as progressing through a series of stages also has two additional implications. One, which Flavell called the *abruptness assumption*, is that children move from one stage to the next suddenly rather than gradually. Children are in Stage 1 for a prolonged period of time, enter briefly into a transition period, then are in Stage 2 for a prolonged period, and so on. The fourth assumption of stage theories is *coherent organization*. The child's understanding is viewed as being organized into a sensible whole, rather than being composed of many independent pieces of knowledge.

Thus, stage theories depict development as involving qualitative change, occurring simultaneously for many concepts, occurring suddenly, and involving a transition from one coherent way of thinking to a different coherent way of thinking. Without question, this is an elegant and appealing description. But how well does it fit the realities of children's thinking? This issue will be considered in greater depth in Chapter 2.

How Does Change Occur?

To develop is to change. Several types of change that occur during the course of development are illustrated in Figure 1.1. The depiction originally was formulated to describe changes in perceptual development (Aslin & Dumais, 1980), but the categories apply to all types of changes in children's thinking.

The left side of the figure illustrates three patterns of change that can occur in the *prenatal period* (before birth): a particular capability can develop fully, partially, or not at all. The right-hand side depicts changes occurring after birth. An already-developed ability can either be maintained or decline; a partially developed ability can grow, stay the same, or decline; and an undeveloped ability can grow or stay undeveloped.

The variety of possible patterns expands further when we realize that any given ability involves many components that may follow quite different developmental courses. For example, regardless of where infants are born, they can produce all of the sounds that are used in any of the world's languages. Over the course of childhood, however, they lose the ability to produce many sounds that are not part of their native language. On the other hand, they gain increasing facility in producing at will the sounds that are part of their own language. Thus, after infancy, the ability to produce speech sounds both declines and grows, depending on which sounds we are talking about.

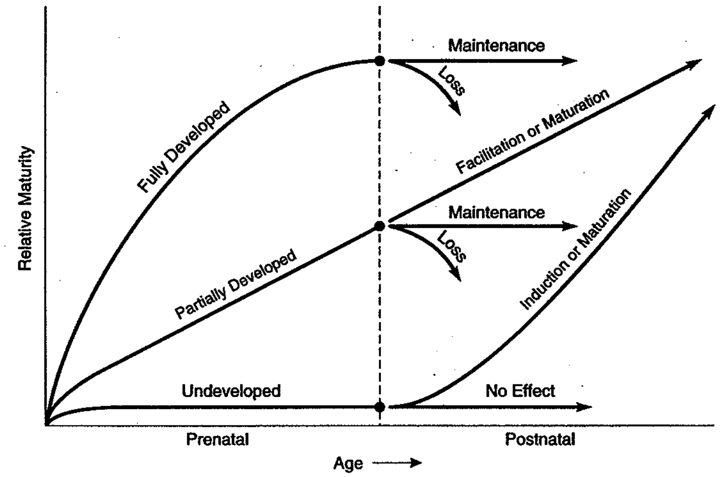

FIGURE 1.1 Illustration of several paths of developmental change (after Aslin & Dumais, 1980). Reprinted from Aslin, R.N. & Dumais, S.T., Binocular vision in human infants: A review and a theoretical framework, in L.P. Lipsitt & H.W. Reese (Eds.), Advances in Child Development and Behavior, Copyright 1980, with permission from Elsevier.

How can changes in children's thinking be explained? Two of the most influential efforts to answer this question are the Piagetian and the information-processing perspectives. Piaget suggested that the basic mechanisms that produce all cognitive changes are *assimilation* and *accommodation*. Assimilation is the process through which people represent experiences in terms of their existing understanding. A 1-year-old girl who saw a round candle might think of it as a ball if she knew about balls but not candles. Accommodation is the opposite process; in it, people's existing understanding is altered by new knowledge. The 1-year-old who saw the round candle might notice that this "ball" was different from others in having a thin object (the wick) protruding from it. This discovery might lay the groundwork for later learning that the world includes round candles.

Researchers who adopt the information-processing approach to children's thinking have been particularly interested in the process of change. They have focused on four change mechanisms that seem to play large roles in cognitive development: *automatization*, *encoding*, *generalization*, and *strategy construction*.

Automatization involves executing mental processes increasingly efficiently so that they require less and less attention. With age and experience, processing becomes increasingly automatic on a great many tasks, allowing children to see connections among ideas and events that they otherwise would miss. For example, in the first few weeks of walking home from school, a 5-year-old girl might need to completely focus her attention on the task of finding her way. Later, the activity would become automatized, and she would find her way home despite paying attention to what other people were saying and doing while she walked with them.

Encoding involves identifying the most informative features of objects and events and using those features to form internal representations of the objects and events. The importance of improved encoding in children's increasing understanding of the world is evident in the context of their learning to solve story problems in arithmetic and algebra. Often such stories include irrelevant as well as relevant information. The trick to solving the problems is to encode the relevant information and to ignore the irrelevant parts.

The third and the fourth change mechanisms are *generalization* and *strategy construction.* Generalization is the extension of knowledge acquired in one context to other contexts. Strategy construction is the generation or discovery of a new procedure for solving a problem. The workings of generalization and strategy construction can be illustrated through a single example. After repeated experience with suddenly nonfunctioning computers, lamps, toasters, and radios, a child might reach the generalization that when machines do not work, it often is due to their being unplugged. On drawing this generalization, the child might form a strategy of always checking the plug whenever pushing a machine's "on" button has no effect.

The child's construction of this strategy illustrates that change processes work together rather than in isolation. Constructing the check-the-plug strategy depended on automatizing the perception of the machines sufficiently to encode the plug as a separate part of each machine and on drawing the generalization that machines that have plugs usually do not work when the plug is disconnected. As will be evident throughout this book, these four change processes—automatization, encoding, generalization, and strategy construction—play crucial roles in improvements in children's thinking in everything from infants' statistical learning to adolescents' computer programming.

How Do Individuals Differ?

Just as children of different ages vary, so do children of any given age. Individual differences are present in all aspects of development, from height and weight to personality and creativity. However, they have received especially intense examination in the study of intelligence. This scrutiny began in earnest in the 1890s, when France initiated a program of universal public education. Recognizing that not all children would benefit from the same instruction, the French Minister of Education commissioned Alfred Binet and Theophile Simon to develop a test to identify children who would have difficulty learning from standard classroom procedures and who therefore would need special education.

The first Binet-Simon test was released in 1905. It included questions that were intuitively related to many aspects of intelligence: language, memory, reasoning, and problem solving. In 1916, Lewis Terman, a professor at Stanford University, revised the test for use in the United States and labeled it the Stanford-Binet. Updated versions remain in wide use today.

The Stanford-Binet and other intelligence tests are based on the assumption that not all children of a given age think and reason at the same level. Some 7-year-olds reason as well as the average 9-year-old; others reason no better than the average 5-year-old. To capture these individual differences among children, intelligence tests distinguish between a child's *chronological age* (CA) and the child's *mental age* (MA). Chronological age reflects the time since the child was born; if a girl was born 60 months ago, her chronological age is 5 years. Mental age is a more complex idea in that it reflects the child's performance on an intelligence test relative to that of other children. Specifically, a child's mental age is defined as the age at which 50 percent of children answer correctly as many items on the test as the particular child did. For example, if the average 5-year-old correctly answers 20 questions on a test, then a child who answered 20 items correctly would have a mental age of 5 years, regardless of whether the child is a 4-year-old, a 5-year-old, or a 6-year-old.

Terman saw that the implications of a 4-year-old, a 5-year-old, and a 6-year-old having a mental age of 5 years are quite different. For a 4-year-old, this level of performance is precocious; for a 5-year-old, it is average; for a 6-year-old, it is slow. To express these implications numerically, Terman borrowed an idea developed by Wilhelm Stern, a German psychologist, and combined the concepts of mental and chronological age to form an *Intelligence Quotient*, or IQ. A child's IQ is the ratio between the child's mental and chronological ages. This ratio is multiplied by 100, so that the IQ can be expressed as an integer, as shown below:

$$IQ = \frac{\text{Mental Age}}{\text{Chronological Age}} \times 100$$

Thus, in Terman's example, the 6-year-old who had a mental age of 5 years would have an IQ of 83 ($5/6 \times 100$), whereas the 4-year-old who had a mental age of 5 years would have an IQ of 125 ($5/4 \times 100$). When we consider all children of a given chronological age, their average IQ score is 100, since the average mental age for any age group is, by definition, the same as that group's chronological age. Whether the IQ score is above or below 100 (that is, whether the child's mental age exceeds or falls below his or her chronological age) indicates whether the child scored above or below average for the age group; the distance of the score from 100 indicates how far above or below average the score was.

One reason that IQ scores have been used so widely is that they predict performance in school quite well. Another reason is their stability over long periods of time. For example, a 6-year-old's IQ quite accurately predicts the child's IQ at age 16. The relation is not perfect; some children show large increases in IQ over time, and others show large decreases. There is also considerable controversy about what intelligence is and how well these or other tests measure it. Clearly, however, intelligence test scores tend to be quite stable from first grade to adulthood, and they allow quite accurate prediction of school achievement.

Until recently, no comparable predictive relation between early and later performance had been established for very young children. Scores on intelligence tests developed for children below 4 years were essentially unrelated to IQ scores of the same children when they were older. This suggested that individual differences in infant intelligence might be unrelated to individual differences in later intelligence.

Recently, however, a measure of infants' information processing has revealed some continuity between intelligence in infancy and intelligence in later childhood. The measure is surprisingly simple. When infants are repeatedly shown a stimulus, such as an object or a picture, they lose interest in it and look at it less and less. That is, they *habituate* to it. Individual infants habituate at varying rates; some reduce their looking quite quickly, whereas others take much longer to do so. The key finding is that the more rapidly that 7-month-olds habituate (stop looking), and the greater their preference for a new picture after they have habituated (often called "novelty preference"), the higher their IQ scores tend to be 4 to 10 years later (Colombo, 1993; Fagan & Singer, 1983; Rose & Feldman, 1995, 1997; Sigman, Cohen, & Beckwith, 1997). The habituation rates also are related to later achievement test scores in reading and mathematics and to general language proficiency. Further, children whose habituation rates are slowest at 7 months have higher rates of learning disabilities when they are 6-year-olds (Rose, Feldman, & Wallace, 1992).

Why should rate of habituation at 7 months predict IQ and achievement test scores years later? One explanation is that both the early and the later performance reflect the effectiveness of the child's encoding (Bornstein & Sigman, 1986; Colombo, 1993, 1995). In other words, more intelligent infants are quicker to encode everything of interest about the picture, leading them to be the first to lose interest in it. They perk up more when the new picture is shown because they more clearly encode the differences between it and the old one. Superior encoding has also been found to be related to the ability of gifted older children and adolescents to solve problems and learn quickly (Sternberg, 1999). Thus, quality of encoding may link early and later intellectual capabilities.

The large majority of research on intelligence and other areas of cognitive development focuses on individual children's behavior. However, in trying to gain additional insights, researchers have recently been extending the search both inward and outward. The inward-looking efforts examine how development of the brain is related to changes in children's thinking. The outward-looking efforts consider not only the individual child but also the formative influences of other people and of cultural institutions. Thus, the first approach builds on findings and insights from the neighboring disciplines of biology and neuroscience, and the second builds on findings and insights from sociology and anthropology. These approaches to understanding children's thinking are introduced in the next two sections.

How Do Changes in the Brain Contribute to Cognitive Development?

In general, the bigger the brain of a species, the more intelligent individuals of that species are likely to be. Without question, changes in the size, structure, and connection patterns of the brain during the course of a child's development profoundly contribute to changes in the child's thinking. These changes, which are both quantitative and qualitative, occur at three levels: (1) changes in the brain as a whole; (2) changes in particular structures within the brain; and (3) changes in the billions of cells that make up the brain (neurons).

Changes in the brain as a whole. The changes that occur in the brain as a whole are evident in large-scale increases in its weight from birth to adulthood. The brain weighs roughly 400 grams at birth; 850 grams at 11 months; 1100 grams by age 3 years; and 1450 grams by adulthood (Kolb & Whishaw, 2003). Thus, the brain of an adult weighs almost four times as much as the brain of a newborn. These changes in size make possible much more advanced thinking.

Changes in structures within the brain. The relative sizes and levels of activity of the main parts of the brain also change over the course of development. The brain can be divided into two main parts: subcortical structures and the cortex. The subcortical structures are areas atop the spinal cord, such as the thalamus, medulla, and pons (Figure 1.2). They are quite similar in the brains of humans and of other mammals, especially other primates such as apes and monkeys.

Like these subcortical areas, the cortex includes some structures that are similar in humans and other primates. Among them are the hypothalamus and the amygdala. In addition, however, the cortex includes a large structure that is far more highly developed in humans than in any other animal: the *cerebral cortex.* Sitting atop the rest of the brain, this large structure is what makes possible the high-level cognitive skills that are unique to human beings, such as language and complex problem solving.

At birth and for several years thereafter, the cerebral cortex is immature relative to other parts of the brain. This is evident both in its being a lower percentage of its adult weight and in its being less like its mature form in organization and patterns of electrical and chemical activity. The relative immaturity of the cerebral cortex has important consequences for cognitive functioning. It leads to some types of cognition being impossible early on and to others

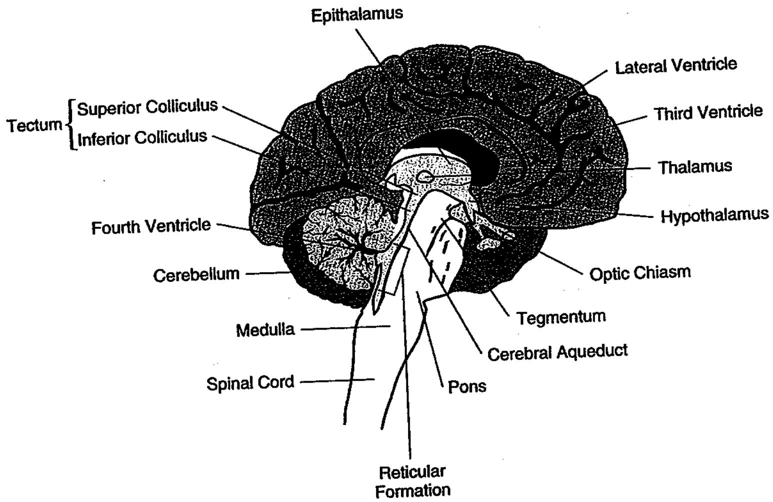

FIGURE 1.2 The structure of the brain. A number of subcortical areas are labeled; the convoluted area sitting atop them is the cortex.

being accomplished at first by more mature parts of the brain, even though the cortex will later play a dominant role in them.

As shown in Figure 1.3, the cerebral cortex includes four main lobes: the *frontal* lobe, at the front of the brain; the *parietal* lobe, at the top; the *occipital* lobe, at the back; and the *temporal* lobe, toward the bottom. Each area is particularly active in producing certain types of cognitive activity. For example, the occipital lobe is especially heavily involved in processing visual information, whereas the frontal lobe is especially involved in consciousness, planning, and the regulation of cognitive activity. As you might expect from the types of activities in which the frontal lobe is particularly active, it is especially immature at birth, relative to other parts of the brain and even other parts of the cerebral cortex. Its profound development during infancy and early childhood seems to be crucial to the rapid advances in cognitive capabilities that occur during that period. (For a good discussion of the different rates of maturation of different parts of the brain, see Chugani and Phelps, 1986.)

The cerebral cortex is divided into two halves, or *hemispheres*, connected by a dense tract of nerve fibers called the *corpus callosum*. For the most part, each hemisphere processes sensory information and motor responses from the opposite side of the body; thus, sensory inputs and motor responses on the left side of the body are processed largely by the right hemisphere, and vice versa. The two

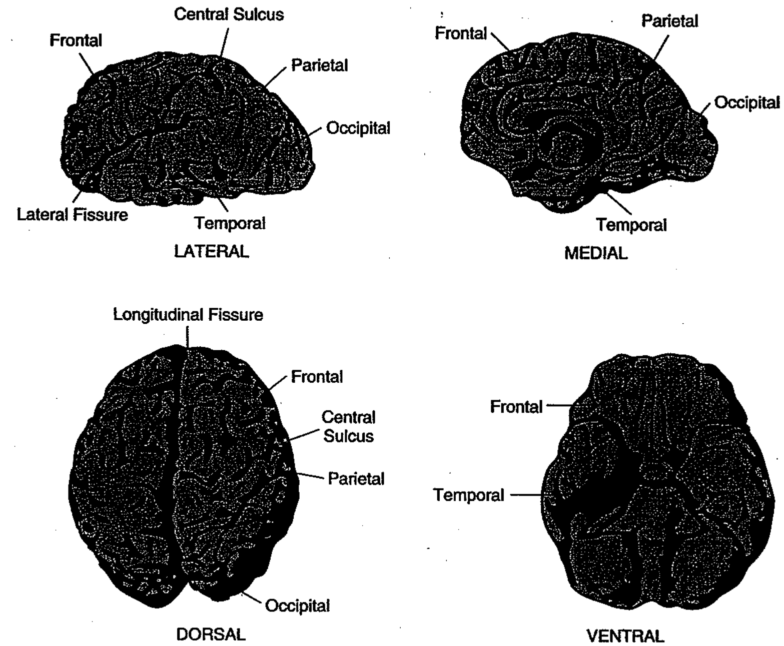

FIGURE 1.3 Four views of the cortex. The top-left view is from the left, the bottom-left view is from above, the top-right view is from the left looking at the inner surface of the right half of the brain, and the bottom-right view is from below.

hemispheres also appear to be specialized for processing information in different ways. For example, in most right-handed adults, the left hemisphere is specialized for processing information in a sequential, analytic fashion, whereas the right hemisphere is specialized for processing information in a more holistic, integrative manner. As a consequence, linguistic and logical information tends to be processed primarily in the left hemisphere, and emotional and spatial information tends to be processed primarily in the right hemisphere. Because one hemisphere plays a dominant role in carrying out these functions, they are said to be *lateralized*.

Recent studies suggest that cerebral lateralization is present even in infancy. For example, infants show hand preferences in motor tasks as early as 6 months of age, suggesting that these functions are lateralized by that time (Michel, 1998). As another example, one study compared patterns of mouth opening in 5- to 12-month-old infants as they produced babbling sounds, which are an early step in language acquisition, and non-babbling sounds. When the infants produced babbling sounds, they opened their mouths wider on the right side than on the left, suggesting left-hemisphere control, but when they produced non-babbling sounds, they opened the two sides of their mouths equally wide (Holowka & Petitto, 2002). These findings suggest that the left hemisphere is preferentially involved in language processing from early in the first year.

Changes in neurons. A third, yet more specific, level of change that occurs in the brain involves specific *neurons* (nerve cells). Neurons are present in vast numbers in all parts of the brain—a total of between 100 and 200 billion. Over development, the neurons become increasingly interconnected.

Each neuron includes three main parts: a cell *nucleus*, which is the core of the nerve cell; a number of *dendrites*, which are fibers that bring information from other neurons to the cell nucleus; and one (or occasionally more) *axons*, which are larger fibers that transmit information from the cell nucleus to other neurons (Figure 1.4).

Neurons transmit information both electrically and chemically. Within a given neuron, the transmission is electrical. Electrical signals travel from the dendrites to the cell nucleus to the axon(s). Between neurons, the transmission is chemical. Neurons are not directly connected to each other; instead, there are tiny gaps, called *synapses*, separating the axon of one neuron from the dendrite of another. The electrical impulse traveling along the axon leads to release of chemical *neurotransmitters*, which flow across the synapse from the end of the axon to the beginnings of dendrites of adjacent neurons. When the neurotransmitters arrive at the dendrites of the receiving neurons, the information is converted back into electrical impulses, which are then transmitted within that neuron. In an adult, a single neuron often has more than 1,000 synapses with other neurons. These multiple connections allow information to be simultaneously transmitted to diverse areas of the brain (Thompson, 2000).

Synaptogenesis. The formation of synapses between neurons (*synaptogenesis*) is far from complete at birth. Within many parts of the brain, it follows a distinctive developmental course of overproduction and pruning. Early in development, there is an explosive proliferation of synapses, causing the number of synapses in a toddler's brain to far exceed the number in an adult's. Then, over the course of childhood, the number of synapses decreases to adult levels. In one part of the frontal lobe, for example, the density of synaptic connections increases tenfold between birth and 12 months. By age 2, the density of connections there is almost twice as great as in adults. After this point, it gradually decreases, reaching adult levels by about age 7 (Huttenlocher, 1994).

In other parts of the brain, the overproduction and pruning follows the same general pattern, but with different timetables (Huttenlocher & Dabholkar, 1997). For example, in the visual cortex, the peak density of synapses is generally reached earlier than in the frontal lobe—around 1 year—and the pruning continues longer—until age 11 (Huttenlocher, 1990). However, the basic cycle of

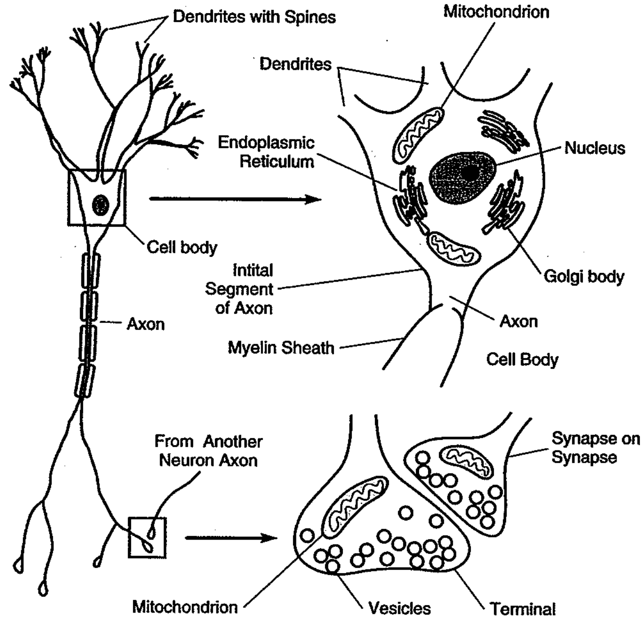

FIGURE 1.4 Structure of a typical neuron (left) including dendrites at top, cell body in the square, and axon below the square. Note that the initial segment of the axon where it leaves the cell body is uncovered; the ovals around the axon below that are myelin, an insulator that improves the rate of electrical transmission. As shown in the drawing at the bottom right, synapses are where the ends of an axon from one neuron are adjacent to the beginning of a dendrite from another neuron. Chemicals known as neurotransmitters flow across the synapse from the end of the axon to the beginning of the dendrite or to another axon, thus transmitting information from neuron to neuron.

rapid initial generation of synapses, followed by prolonged pruning of them, seems to generally hold true.

What determines the ultimate pattern of synaptic connections in the brain? The early phases of the process of synaptogenesis appear to be largely genetically controlled (Bourgeois, 2001). However, experience also plays a crucial role, especially in later phases. In particular, experience appears to be an important determinant of which synapses are maintained and which ones pruned. If experiences lead to synapses firing so that neurotransmitters are released, they tend to be maintained. If not, they tend to wither (Greenough & Black, 1992;

Greenough, Black, & Wallace, 1987). Thus, in the brain as in behavior, development involves a complex interplay of genetics and experience.

Some researchers have proposed that the early surplus of synapses is related to infants and toddlers acquiring certain kinds of capabilities more effectively than adults (e.g., Bjorklund, 1997). For example, toddlers and young children are especially good at picking up the sounds and grammar of their native languages. They are far more effective learners than those who immigrate to a new country as adults and try to learn its language then (Johnson & Newport, 1989). It is not just that the children are learning their first language and the adults their second; young children also learn phonology and syntax more effectively when they are learning it in a second language (as when a 5-year-old comes to a new country). The extra synapses in the young children's brains may be especially useful for learning the extremely complex systems of contingencies embodied in the phonology and grammar of languages such as English.

Because of the surplus of synapses available in early life, the immature brain displays an enormous capacity to adapt to variations in experience. This early *plasticity* is the reason why infants and children often show dramatic recovery from early brain damage, such as sometimes occurs as a result of injury or stroke (Stiles, Bates, Thal, Trauner, & Reilly, 2002). For example, infants or children who experience damage to portions of the brain that process language often recover fully, because other parts of the brain take over the processing of language. In effect, the brain becomes "rewired," and portions of the brain not initially specialized for language take over that function. Adults who experience damage to these same brain regions typically fare less well, because the remaining neurons in other parts of their brain are already dedicated to other functions.

Neural plasticity is not only important for recovery from injury—it also enables the brain to adapt to variations in experience due to patterns of use (Elbert, Heim, & Rockstroh, 2001). For example, compared to non-musicians, individuals who play stringed instruments display an enlarged cortical representation of the fingers of the left hand. Moreover, it appears that musical training has a greater effect on cortical organization when it begins at younger ages. Musicians who learned to play stringed instruments at an earlier age showed greater neural activation in response to stimulation of the little finger of the left hand than did musicians who learned to play at later ages (Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995). This finding suggests that the plasticity of the human brain decreases over the life span.

How Does the Social World Contribute to Cognitive Development?

Understanding cognitive development requires understanding not only the brain, but also the contributions of the social world. From the day children emerge from the womb, they live in a profoundly social environment. It is social not just in including other people who interact with children—parents, siblings, other adults and other children. It also is social in including many artifacts that exist only because of people's efforts and ingenuity (such as books, television sets, computers, automobiles), many skills that reflect our cultural heritage (including reading, writing, mathematics, computer programming, video-game playing), and many values that guide strategies and problem-solving efforts in certain directions (such as speed, accuracy, neatness, truthfulness). Clearly, all of these manifestations of the social world influence what children think about and how they think about it. Developmental theories that emphasize the role of the social world in children's development are called *sociocultural* theories. Such theories are the focus of Chapter 4; however, examples that illustrate the importance of other people in children's cognitive development can be found throughout the book.

The sociocultural perspective on development was initially articulated by Lev Semenovich Vygotsky, a Russian developmental psychologist, in the early part of the 20th century. Vygotsky's theory and its modern-day counterparts ascribe a central role to the social, cultural, and historical context in explaining the process of cognitive development. The context is viewed as an integral part of children's experience, such that it is not meaningful to consider cognition or behavior as separable or distinct from the context in which it occurs (Rogoff, 1998). Moreover, developmental change is conceptualized as occurring, not only in individual children's knowledge and cognitive processes, but also in children's roles in social interactions and in their ways of participating in culturally determined forms of behavior. Thus, according to the sociocultural perspective, it is essential to investigate and analyze behavior in context if we are to understand performance at any age or developmental change in that performance.

What does it mean to investigate behavior in context? In practice, different lines of scientific inquiry have focused on different dimensions of the social and cultural context. One particularly influential approach to delineating aspects of context is Urie Bronfenbrenner's (1979) conceptualization of context as a "set of nested structures, each inside the next, like a set of Russian dolls" (p. 3). Bronfenbrenner described several concentric layers of the social and cultural context, each of which influences psychological functioning both on its own and in interaction with other layers. This framework is depicted in Figure 1.5.

As shown in the figure, the innermost layer of context consists of the *microsystems* within which development occurs. Microsystems are social relationships in which the child plays a direct part, such as the mother-child relationship, sibling relationships, and relationships with teachers and classmates. Moving outward, the next layer consists of *mesosystems*, which are made up of multiple, interrelated microsystems. For example, the microsystems of family and school interact to form a mesosystem. Families hold expectations and provide opportunities for learning that influence how children perform in school. Likewise, schools sponsor activities that influence how families interact, such as social events and parent-teacher conferences. Next are *exosystems*, which are social systems in which the child does not play a direct part, but that nevertheless

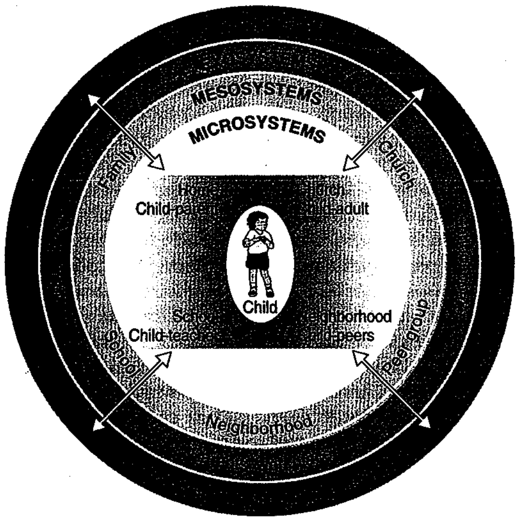

FIGURE 1.5 Schematic depiction of interacting layers of context (based on Bronfenbrenner, 1979).

influence children's development. A good example of an exosystem is the school board, which makes decisions about the organization of community schools, the length of the school year, and the nature of the required curriculum. Although children are not involved directly in this system, it clearly has an impact on their development. Finally, all of these systems are situated within the *macrosystem* of the broader cultural context. The macrosystem incorporates cultural expectations regarding how children should be cared for and what activities children should engage in at various points in development. More broadly, the macrosystem incorporates cultural practices about how families and communities are organized, cultural values about children's roles within these communities, and cultural institutions such as school and day care.

All of these systems, from the microsystems to the macrosystem, change over time. For example, children's relationships with their parents change as they grow, and societal expectations about children's behavior vary with the child's age and over the course of history. Recent formulations of Bronfenbrenner's framework have also incorporated the dimension of time at various levels of context (e.g., Bronfenbrenner, 1998).

All of these aspects of context are addressed within sociocultural theories of development. However, the bulk of research within the sociocultural tradition has focused on social interactions in which the child plays a direct role (the micro- and mesosystems), and on the opportunities for development that are afforded in various cultures and subcultures (the macrosystems).

Social interaction and cognitive development. Vygotsky's theory focused on what he termed the "higher" psychological processes—those processes that differentiate humans from animals, such as reasoning and concept formation. Vygotsky believed that all of the "higher" psychological processes had their origins in social interactions. Children initially perform cognitive tasks with support from social partners, and over time, these social interactions are gradually internalized, until children can perform tasks on their own. Thus, according to Vygotsky, the central mechanism of developmental change is the internalization of socially shared processes.

The notion of internalization highlights the integral role of other people in guiding and supporting children's development. One type of assistance that other people provide to children is *social scaffolding*, which includes helping children think about a task appropriately, modeling ways of solving problems, and giving hints that guide the child in useful directions. The idea of social scaffolding is based on an analogy to the physical scaffolds used to construct buildings. Physical scaffolds are metal frameworks that allow construction workers to work high above the ground while putting up the basic structures of buildings. Once the basic structure is built, it can support the workers, and the scaffolding can be removed. Similarly, in social scaffolding, the activities of more competent people provide a temporary framework that allows children to think in more advanced ways than they otherwise could. After working for a while at this higher level, children can work at the level without the external support. Parents tend to teach their children in a way that fits the scaffolding model, playing active roles when children are just beginning to learn a skill, and progressively withdrawing to the background as the children show increasing mastery (Pratt, Kerig, Cowan, & Cowan, 1988; Wood, 1986).

The cultural context of cognitive development. Vygotsky's theory also highlighted the importance of the culture in which children develop. In particular, he focused on the importance of *cultural tools* in shaping and constituting thought. Cultural tools include the entire range of culturally constructed objects and ideas that allow people to achieve their goals: machines such as calculators and computers; representational devices such as books and maps; ways of knowing about the world such as mathematics and science; notational systems such as numbers and letters; and ideas such as gravity and efficiency.

Interacting with even the most mundane cultural tools helps children better understand the social and physical world. Think about calendars and clocks, for example. Learning about them involves much more than just telling time. It also involves learning the belief of our culture that it is useful to break up time into discrete units of years, months, days, hours, minutes, and seconds. The ways in which people use these tools also is revealing. We tell children to be home by 6:00 or 6:15, and to be at school at 8:05, but never to be at home or at school by 8:07 and 30 seconds, much less at 8:07 and 30 and 7/10 seconds. We view it as useful to break up time to a certain level of precision, but not ordinarily beyond that. Countless such experiences shape the way in which children think about concepts even as basic as time.

Culture also plays a role in children's development by influencing the types of activities in which children engage. There is great variation across cultures in how children are cared for, and in the types of things that are typical for children to do. In some cultures, including the United States, children are typically segregated from adults' social and economic worlds for much of the day. In such cultures, many of children's opportunities for learning occur in the context of day care or formal schooling. In other cultures, children are routinely integrated into adult activities, including household activities such as cleaning and preparing meals, and economic activities such as farming and weaving textiles. In such cultures, most of children's opportunities for learning take place in the context of everyday situations. Such variations in children's opportunities for learning lead to variations in the nature and path of children's cognitive development. Thus, culture influences children's development by shaping how children participate in culturally valued activities.

The Book's Organization

The organization of this book can be viewed either on a chapter-by-chapter basis or in terms of the central themes that recur in many chapters. In the sections that follow, the book is described from each perspective.

THE CHAPTER-BY-CHAPTER ORGANIZATION

The book is divided into three sections. The first section, which includes Chapters 1–4, explores broad perspectives on children's thinking, including Piaget's theory, the information-processing approach to development, and the sociocultural approach to development. The second section, which includes Chapters 5–11, focuses on more specific aspects of children's thinking, such as how they perceive the world, how they use language to communicate, and how they learn reading, writing, and mathematics. The third section includes only a single chapter, Chapter 12. It is a summary of what has gone before and a look forward toward the issues that promise to be most important in the future.

The first chapter, which you are just finishing, is an attempt to define the field that is considered in this book and to introduce ideas that are important within it. Chapter 2 is devoted to the work of Piaget, whose investigations into children's thinking can fairly be said to have created the modern field of cognitive development. On topics ranging from how children infer the origins of the sun to how they order the weights of different objects, Piaget saw much that other people had missed. In addition, Piaget observed children of an extremely wide age range, stretching from the first days of infancy into late adolescence. Thus, his observations provide a feel for many aspects of development in infancy, childhood, and adolescence.

Chapter 3 examines another prominent approach to the study of children's thinking, the information-processing approach. In some ways, this approach represents a modern extension of Piaget's theory; in other ways, it represents an alternative. The basic assumptions of the information-processing approach are that children's mental activities can be characterized in terms of processes that manipulate information; that processing capacities are limited; and that the interaction between the individual's processing system and the environment leads to cognitive growth (Klahr & MacWhinney, 1998). The information-processing approach has proved especially useful for studying development, because it provides precise ideas about the mechanisms that produce cognitive change.

Chapter 4 addresses a third prominent approach to the study of children's thinking, the sociocultural approach. As discussed above, the social and cultural world has a profound effect on what children do, on what they think about, and on how they think. Research guided by sociocultural theories investigates how social and cultural factors influence cognition and development.

Chapter 5 begins the second main section of the book, which examines seven specific aspects of children's thinking: perception, language, memory, conceptual understanding, social cognition, problem solving, and academic skills. Chapter 5 focuses on perceptual development. The emphases are on the surprising number of visual and auditory skills that children possess from early in infancy, and on the relations between perception and action.

Chapter 6 examines language development. Here the discussion centers on what types of words children use first, when and how they learn grammar, how they acquire word meanings, and how they use language to communicate with others.

Chapter 7 is about the development of memory. It focuses on how the development of basic capacities, strategies, and content knowledge contribute to children's growing abilities to remember. The chapter also addresses the practical issue of whether in court cases, children's recall of what happened can be trusted, and how the accuracy of their testimony changes with age.

Chapter 8 concerns conceptual development. The early part of the chapter examines whether children internally represent concepts primarily in terms of dictionary-like definitions, in terms of loosely related characteristic features, or in terms of causally connected theories. The latter part of the chapter examines the development of several particularly important concepts: time, space, number, and living things.

Chapter 9 is about social cognition. The focus is on children's developing understanding of social information, including knowledge about the self and others, knowledge about the mind and the mental states that give rise to behavior, and knowledge about the social world.

Chapter 10 focuses on problem solving. All of us solve problems daily, but such activities play an especially large role in the lives of young children. The reason is that many tasks that older individuals find routine pose novel challenges for younger ones. Among the problem-solving processes examined in the chapter are planning, causal inference, analogy, tool use, and scientific and logical reasoning.

Chapter 11 concerns the development of reading, writing, and mathematics. Many of the skills for which development is described in the preceding chapters—perception, language, memory, conceptual understanding, and problem solving—are put to use in the classroom. Children's acquisition of academic skills illustrates how different types of thought processes work together to allow learning of complex concepts and skills.

The third main section of the book is Chapter 12. It summarizes the main conclusions that apply across the diverse areas of children's thinking and identifies key issues for future investigation.

The Central Themes

This chapter-by-chapter organization provides one way of thinking about the material the book covers. Another way is to consider the themes that arise in many chapters. The following are eight recurring themes.

1. The most basic issues about children's thinking are "What develops?" and "How does development occur?"
2. Four change processes that seem to be particularly large contributors to cognitive development are automatization, encoding, generalization, and strategy construction.
3. Infants and very young children are more cognitively competent than they appear. They possess a rich set of abilities that enable them to learn rapidly.
4. Differences between age groups tend to be ones of degree rather than kind. Not only are young children more cognitively competent than they appear, but older children and adults are less competent than we might think.
5. Changes in children's thinking do not occur in a vacuum. What children already know about material that they encounter influences not only how much they learn but also what they learn.
6. The development of intelligence reflects changes in brain structure and functioning as well as increasingly effective deployment of cognitive resources.
7. Children's thinking develops within a social context. Parents, peers, teachers, and the culture at large influence what children think about, as well as how and why they come to think in particular ways.
8. Increasing understanding of children's thinking is yielding practical benefits as well as theoretical insights.

A simple strategy for improving your understanding of the material in this book is to spend a few minutes now re-reading and thinking about these eight themes. Then, as you read subsequent chapters, try to notice how they unite different aspects of children's thinking.

Summary

For hundreds of years, people who have had contact with children have wondered about such questions as where the children's ideas came from and whether infants perceive the world in the same way as adults. Recent conceptual and methodological advances have greatly improved our ability to explore these and many other questions about children's thinking.

A number of the most important questions about children's thinking have long histories. Are some capabilities innate? Do children proceed through qualitatively different stages of thinking, or is development continuous? How do changes in children's thinking occur? How do individuals differ in qualities such as intelligence, and how much continuity is there between early and later abilities? How do the internal world of the maturing brain and the external world of other people shape development? These continue to be among the most basic questions about children's thinking.

A number of themes are identified that recur throughout the book. Among these are the surprising cognitive competence of infants and young children, the continuous growth of children's thinking beyond this initial competence, the challenge that children face of coping with complex tasks while having only limited processing resources, the ways in which existing knowledge influences learning, and the influence of brain development and of the social world on children's thinking.

Recommended Readings

Bronfenbrenner, U. (1979). ***The ecology of human development: Experiments by nature and design.*** Cambridge, MA: Harvard University Press. In this book, Bronfenbrenner presents his influential conceptualization of layers of social and cultural context.

Flavell, J.H. (1971). Stage-related properties of cognitive development. ***Cognitive Psychology,*** *2,* 421–453. A classic analysis of stage theories of development.

Johnson, M.H., Munakata, Y., & Gilmore, R.O. (Eds.). (2002). ***Brain development and cognition: A reader*** (2nd edition). Oxford, UK: Blackwell. A compilation of a large number of the most important articles about the relation between development of the brain and children's thinking.

Meltzoff, A. (2002). Imitation as a mechanism of social cognition: Origins of empathy, theory of mind, and the representation of action. In U. Goswami (Ed.), ***Blackwell handbook of childhood cognitive development.*** Malden, MA: Blackwell. Infants in their first month out of the womb show some ability to imitate the actions of other people; this chapter summarizes some of the evidence for this surprising capability and how it develops during infancy and beyond.