CHAPTER 1

Introduction to Child Development and Education

This is a book about human development, an interdisciplinary field of study. Human development involves biological transformation: from a single cell to a fetus to an infant and then to a toddler. A child matures into an adolescent, who matures into an adult, who ages and eventually dies. Human development also includes psychological changes—from a newborn who exhibits more reflexes than intentional behaviors to a child whose thinking is more concrete than abstract. In turn, the child becomes an adolescent whose thinking gradually becomes more abstract and hypothetical. Teenagers soon become adults, whose intellectual powers increase across the lifespan in some ways and decline in others. Development also involves social changes—for example, from a newborn experiencing people as sensations to an infant who is attached to his or her caregivers to a preschooler with an expanding social world. The world of peers becomes increasingly important as the child grows older and enters adolescence.

Some basic themes have shaped the study of development and over decades have provided a framework for how to think about developmental theory and research. So, we begin this book with an overview of some of the concepts and movements that have defined developmental science and some of the controversies and uncertainties that surround these ideas.

The Evolution of Developmental Science

How educators and social scientists think about development has evolved over the past several decades. One way to think about the changes in the study of development is to consider to what extent children are dynamic participants in their development and to what extent our environment is actively engaged in forming a person's development (see Figure 1.1).

		Environment	
		Passive	*Active*
Person	*Passive*	"Static" theories	"Linear" theories
	Active	"Transformational" theories	"Transactional" theories

FIGURE 1.1. Thinking about developmental science in terms of person × environment interaction.

Suppose neither the person nor the environment is particularly active in determining the outcome of a person's development. This "static" theory was similar to how some people thought about children and development prior to the advent of developmental studies. Children were simply thought of as "miniature adults" and were not accorded any unique status or thought to be a whole lot different than adults. Fortunately, these kinds of ideas were replaced when educators and social scientists started to study children and how they developed. One type of theory that was fairly dominant in the history of psychology was "linear" theory, which assumed that our environment had a tremendous influence on how we behaved and who we became. Such theories were primarily behavioral or learning theories that assumed that contingencies (i.e., rewards and punishments) that rise from our environment determine how we behave and develop.

As psychology and developmental science matured, new theories emerged that emphasized the active role that children play in their development. These "transformational" theories postulated that development proceeds in an orderly fashion, that people go through stages of increasing complexity in their development, and that the capacities children acquire early in development will affect their later stages of development. More contemporary theories of development tend to be "transactional." They presume that both the environment and the person are active agents in a person's development. These theories of development emphasize that children are a product of their environment but that they also alter their environment. From this perspective, both environment and the person engage in a continuous dynamic interaction in which they reciprocally determine one another. Several such "Big Ideas" have been pervasive influences in both developmental science and education as these disciplines have matured. We will outline the more prominent Big Ideas here and refer to them throughout the book.

Active and Passive Child Influences

As already mentioned, one theme that has garnered a lot of attention is the question of how much a child is an active agent in his or her development. Some theories portray children, including infants, as continually active in their own development (Gopnik, Meltzoff, & Kuhl, 1999; Lerner & Fisher, 2013; Piaget, 1970; von Glaserfeld, 1995). They decide what they will attend to and process, seeking out things that are particularly interesting to them. Educators who subscribe to such theories

tend to favor arranging learning environments to stimulate children's curiosity and exploration; they believe that the learning resulting from interactions stimulated by the child's own interests will be especially enduring. Other theories depict children as more passive, learning from stimulation that is presented to them (Rosenshine, 1979). The educator's role according to these theories is to select to-be-learned information, present it to children, and provide feedback and reinforcement.

Our perspective is that children learn in a variety of ways. Some learning results from the active efforts of the child, that is, as a consequence of the child's natural curiosity and interests. Even so, humans have a tremendous capacity to learn without effort or even interest, acquiring much information incidentally. Children learn from observation, and they learn when they are reinforced to learn (Bandura, 1986). The skilled educator knows both how to stimulate children's natural activities and how to devise presentations and provide reinforcements in order to promote learning of important material. The skilled teacher also understands just how much can be learned incidentally from rich experiences and does everything possible to make certain that children experience informative worlds. Children learn through what they read, through what they are encouraged to watch on television, and through interactions with classmates and classroom visitors representing diverse perspectives.

Continuity and Discontinuity in Development

One way to think about human development suggests that people go through gradual changes. One example in nature is a blade of grass growing gradually with no remarkable change in its basic characteristics. Theories like social learning theory (see Chapter 5; Bandura, 1977, 1986) and information-processing theory (see Chapter 4) posit that maturation in behavior and intellect evolve gradually over time; that children's and adults' repertoire of behaviors and their intellect increase as their exposure to and knowledge of the world expand. The result is that with increasing age during childhood and continuing into adolescence a person's behavior becomes more complex and his or her thinking skills increase.

In contrast, there are theories of development that specify particular stages of psychological growth and maturation. One example in nature of development occurring in discrete stages is that of the metamorphosis of a caterpillar into a cocooned pupa and its final emergence as a butterfly. According to theories that emphasize discontinuities and stages in growth, children are fundamentally different depending on their stage, and movement from one stage to another stage is rather abrupt. For example, G. Stanley Hall (1904, 1905) conceived of adolescence as a period of great "storm and stress," brought on by the sudden physical changes that accompany adolescence, whereas Erik Erikson (1968) posited that adolescence brings with it concerns about identity that are not important at all earlier in life (see Chapter 5). Another example is Piaget's (1970) theory of intellectual development, which asserts that children during the grade school years are very concrete in their thinking, with the transition into adolescence accompanied by a dramatic increase in abstract thinking skills (see Chapter 3). So, according to the stage perspective, development proceeds in discrete steps that may seem dramatic or sudden. The developmental change is *abrupt*.

As we work our way through the various types of psychological developments that children and adolescents undergo, we will find elements of both continuity and discontinuity. On the one hand, development is often quite discontinuous. Children

and adolescents make progress toward more complex and sophisticated psychological functioning and then quite frequently regress and revert to behaviors and ways of thinking characteristic of previous stages of development. Also, sometimes developmental competencies are specific to particular situations, and children and adolescents might demonstrate a developmental competency in one venue or format but not in another. For example, children often recite the polite and considerate way to act with peers; they know in their minds how they are supposed to behave, but they don't always adopt those behaviors in social situations. Or they may be able to do calculations regarding sports or video gaming, while at the same time not be able to perform well in math class.

On the other hand, while there are discontinuities in development, often they are not as pronounced or as rapid in onset as some stage theories suggest. Educators should be realistic about what to expect from children of particular ages, but they should not be so tied to stage thinking as to ignore inconsistencies with it. For example, although elementary-age children often do have difficulty thinking hypothetically, they can be quite hypothetical when thinking about very familiar topics. If you need convincing, ask a 10-year-old chess expert some hypothetical questions about moves in chess!

Nature and Nurture

Today, most developmental psychologists do not believe that development is primarily due to either *nature* (determined by biology) or *nurture* (determined by experience). Instead, there is clear understanding that development is due to both nature and nurture, both biology and experience (Collins, Maccoby, Steinberg, Hetherington, & Bornstein, 2000; Institute of Medicine and National Resource Council, 2012; Rutter, 2002a, 2002b; Sameroff, 2010; Shonkoff & Phillips, 2000). Biology provides a range of possibilities. Which of those possibilities is realized depends greatly on the experiences available in the environment. Consider what may seem a simple example. A child inherits genes that provide him or her with a biological predisposition for being taller than average. Whether this child achieves this biological potential depends on environmental factors, such as the nutrition available and exposure to severe illness or disease.

Human intelligence provides a good example of how environmental influences act upon the range of biological possibilities. Humans do not inherit genes that result in a specific level of intelligence. Rather, they inherit the potential for a range of possibilities. Whether or not a child's level of intelligence reaches the top end of the range depends on the quality of the environment provided. Researchers debate, however, about how much **plasticity,** or sensitivity to environmental experiences, there is for intelligence (Garlick, 2002; Gottesman & Hanson, 2005; Lewontin, 1974). With considerable controversy, some contend the range is very narrow—that parental intelligence largely determines the intelligence of their children (Herrnstein & Murray, 1994; see also Chapter 8 and Hunt & Carlson, 2007). Others argue that the **reaction range** for intelligence, the range of all possible levels of intelligence given the biological predisposition, is substantially broader (Jacoby & Glauberman, 1995; Martinez, 2000), with some researchers emphasizing human autonomy and the role of individual choice in their analyses (Flynn, 2016). There is no doubt that there is some range and that where a child ends up in his or her particular reaction range is a function of the environment he or she experiences.

Virtually all of the theories of development presented in this book have both biological and environmental components. Some theories are more biological than environmental, and others emphasize environment much more than biology, but all are *both* biological and environmental. The goal of educators should be to make the most of the child's biological potential. That means providing children with consistent high-quality experiences. Biological perspectives can provide insights about when particular types of experiences are crucial as well as insights about the risks of environmental deprivations at particular points in development (see Chapter 2).

Social-Ecological Influences

The environment can affect development in many ways. Sometimes we encounter what we refer to as cohort effects. One kind of cohort effect is the time period we live in, and it can often be an important determinant of our development. Children born in the last few years are growing up in a world surrounded by sophisticated technology, a world that those born in earlier eras never could have dreamed of. As a consequence, they have far more information available to them to guide their development.

Family and extrafamilial relationships also can make an enormous difference in children's development (see Chapter 10). For example, how families communicate and interact with their children has a large effect on children's cognitive and social development. Preschoolers who are in families that verbally interact a great deal arrive at kindergarten with better developed language skills and make faster progress learning to read during the elementary years. Similarly, as children age, their range of social contacts increases, and by the time they become adolescents, peer interactions become more influential, interacting with family influences (Bornstein, Jager, & Steinberg, 2013; Hartup, 1989; Csikszentmihalyi & Larson, 1984). In addition to peer relationships, children have contact with a variety of adults besides their parents, such as neighbors, teachers, and physicians.

A variety of institutions, such as governments, media, religions, and schools, affect the life of the developing child. Federal and state *governments* have a variety of policies that can touch the life of an individual child. Government funds can provide money for prenatal care, children's health care, housing, and day care, all of which impact many children. Governments can pass laws that protect children from abuse or environmental contaminants, such as lead paint, and can enforce those laws. Governments can also fail to provide for the needs of children. Either way, children and their development are affected.

Knowledge that affects children comes from other institutions as well. *Media* outlets like the Internet or television have significant influence on youth (Singer & Singer, 2001). *Religion* is a knowledge-building force in children's lives, with the religious exposure children receive affecting their understanding of the world (Kerestes & Youniss, 2003). The institution most often associated with children's development is *school*.

The theory that integrates the various types of environmental influences on child and adolescent development is Urie Bronfenbrenner's (1979, 1989, 1992) *ecological systems theory* (see Figure 1.2). Bronfenbrenner divides the environment into the following elements: the microsystem, the mesosystem, the exosystem, and the macrosystem. The **microsystem** refers to the child's direct experiences in different

contexts such as home or school. The **mesosystem** represents the linkages of two or more microsystems—for example, parent and school interactions or interactions of the family with community or church resources. The **exosystem** includes governments and institutions that regulate mesosystems and can have a significant effect on the child, even though they are removed from the child's direct experiences. For example, the policies of the local school may have an indirect effect on the child. Finally, the **macrosystem** embodies the cultural forces, values, and beliefs acting upon the child and the rest of the ecological system surrounding the child.

An important theme in Bronfenbrenner's ideas is that people are embedded in their ecological contexts and are interdependent of and inseparable from their social ecology. Similarly, Bronfenbrenner emphasizes the reciprocity that exists between different levels of ecological systems: the environment affects the child, and the child also affects the environment. Moreover, even though exosystems and macrosystems are rather remote from the day-to-day activities of individual children and adolescents, they still have a profound effect on them, probably much more than vice versa. Because of these principles, Bronfenbreener asserted that studying human beings and their development required understanding their social contexts and that the only legitimate way to understand human nature was to study humans within their social environments.

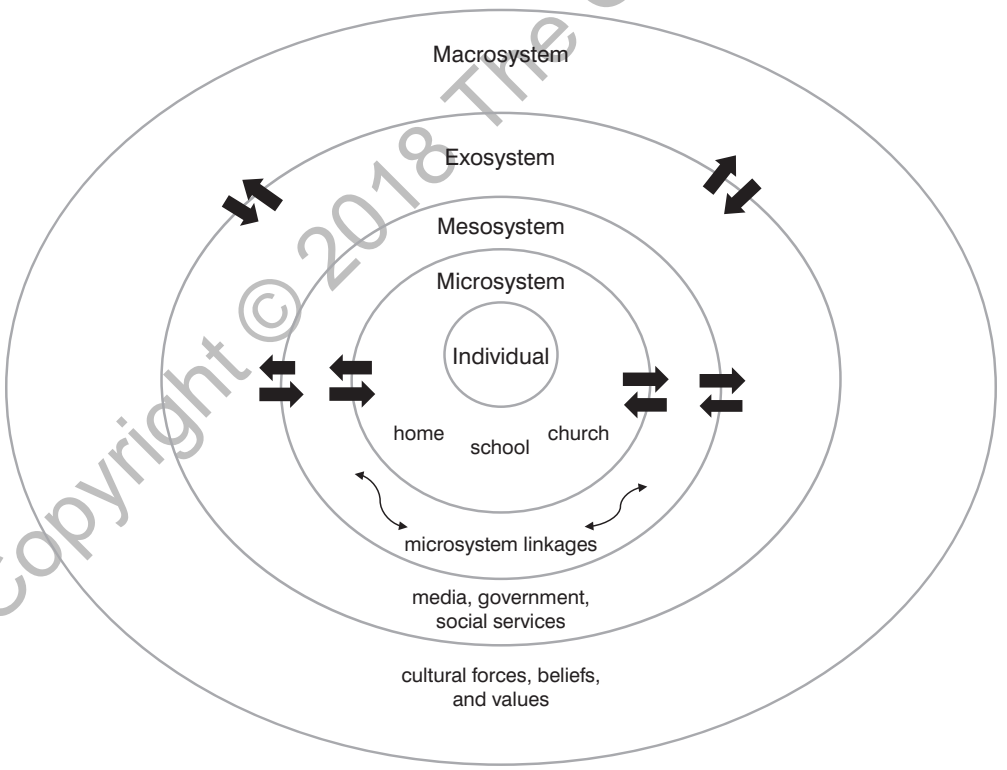

FIGURE 1.2. Bronfenbrenner's ecological systems theory divides the environment into the microsystem, the mesosystem, the exosystem, and the macrosystem, as portrayed in this figure.

Universal and Culture-Specific Development

Many developmental theorists assert that there are universals in development, stages and psychological events that all children everywhere experience (Flavell, 1971). This idea is most strongly evident in developmental theories that emphasize biological influences. At a biological level, the similarities between people from different cultures and races are much more pronounced than the differences. Indeed, from a biological perspective, the similarities between human males and females are much greater than the differences (see Chapter 11). Because of these biological similarities, similarities in physical and behavioral development are inevitable.

Conversely, some developmental theorists emphasize the role of culture in determining development and how development proceeds differently in different cultures (see Chapter 6; Cole & Scribner, 1977; Gauvain & Perez, 2015; Mistry, Contreras, & Dutta, 2013). To the extent that environment makes a difference in development, culture should make an impact on development. The environments children experience in one part of the world can be very different from the environments children experience in another part of the world.

Because development is both biologically determined and a function of environment, there are both universals in development and culture-specific developments. Indeed, evidence of this exists in any school district in the United States. Children in a given classroom may be very diverse both economically and culturally. Nonetheless, these same children are much more similar to one another in their behaviors and competencies than they are to older children or adults.

Summary of the Big Ideas

Development is very complicated, and it is essential that educators appreciate and understand its complexities. Even so, in order to remain manageable, the study of development often requires simplification since individual research studies are always limited in scope (as we will see in the next section on research methods). To emphasize the complexity of human development, we will briefly return to a consideration of the Big Ideas of development outlined earlier in each chapter summary.

Research Methods in Child Development and Education

Since the study of child development is a scientific enterprise, every student of development must have at least a rudimentary understanding of basic research methods. It is also important for educators to be informed consumers of research. Advocates for school reform have emphasized the need for educators to employ evidence-based best practices. To do so, educators need to have at least a rudimentary understanding of how research evidence is gathered. Researchers interested in human development use diverse research methods. One reason for the diversity of methods is that not all problems can be addressed with any one method. A second reason is that some researchers personally prefer some methods over others, perhaps because of their education or their philosophical assumptions. One way to conceptualize research methods is to distinguish between quantitative and qualitative methods.

Quantitative Methods

Quantitative approaches begin with a **hypothesis,** which is a proposed relationship between two or more variables. For example, a researcher may hypothesize that "cooperative learning is more likely to promote achievement in same-sex than mixed-sex cooperative groups." This hypothesis is then tested. Researchers often derive hypotheses from a larger theoretical orientation and/or generate them from previous studies on the topic. The investigations of the hypotheses may in turn lead to revisions and refinements of the theory or, on occasion, the discarding of a theory in favor of a new one inspired by the research results.

After researchers formulate a testable hypothesis, it is operationalized in a study. **Operationalization** refers to the process of defining variables by specifying how they will be measured or manipulated in a study. Thus, for the cooperative learning hypothesis, a cooperative learning situation is specified, perhaps mathematics classes in six fourth-grade, six fifth-grade, and six sixth-grade classrooms, each containing about 30 students. Same-sex cooperative groups are defined as four boys or four girls working together (one each per classroom). Mixed-sex groups are defined as having three boys and a girl (one per classroom), three girls and a boy (one per classroom), or two girls and two boys to a group (one per classroom). Cooperative learning could be operationalized with the teacher urging children in each small group to help one another answer the week's study problems, explaining to each other their rationales for solving problems. Cooperative learning defined in this manner might be studied for 5 weeks, comparing the learning in same-sex and mixed-sex groups with learning defined as the mean performance of each group on end-of-week quizzes over the week's mathematics assignments.

In quantitative investigations, observations are translated into numbers that are then statistically analyzed. There are two main classes of quantitative studies. In **manipulative investigations,** usually called "experiments," researchers control variation by randomly assigning people to one educational treatment or another. **Random assignment** means that before the experiment begins, each student has an equal chance of being assigned to any treatment condition. One way to ensure random assignment of all the students in a class is to pick the names, one at a time, out of a hat. The first name is assigned to condition A, the second to condition B, the third to C, the fourth to D, the fifth to E, and so on.

In **nonmanipulative investigations,** researchers systematically analyze naturally occurring differences between people or settings. Comparisons of different age groups in a developmental study are necessarily nonmanipulative comparisons. We discuss nonmanipulative studies in more detail later in the chapter.

Manipulative Investigations

Often educational researchers compare a new educational intervention to conventional instruction or some other alternative instruction (Campbell & Stanley, 1966). For example, an investigator may compare typical mathematics instruction with mathematics instruction enriched by information about when and where to use the math being learned. A researcher interested in memory strategies may compare the recall performance of students taught to rehearse to learn vocabulary words to those who learned vocabulary words using their own methods. In investigations of reading strategies, the typical comparison would be between reading performances by

students taught a strategy (e.g., predicting what will happen next) and those not instructed to use the strategy.

The design for a simple study in which one experimental group is contrasted with a control group contains two conditions. The factors manipulated in an experiment are the **independent variables.** In a simple two-condition experiment, there is only one independent variable: the experimental versus control manipulation.

Independent variables are hypothesized to have effects on particular **dependent variables,** which are the performances measured in the study. Many different types of dependent variables are collected in quantitative studies. These include behavioral observations (e.g., prosocial or aggressive actions), learning measures (e.g., amount of information recalled), performances on standardized tests (e.g., achievement or intelligence tests), and responses to surveys and interviews. Sometimes dependent measures are obtained from secondary sources, such as parents or teachers. For example, parents can provide reports to researchers about the amount of homework done by their children, or teachers can rate the sociability of each of the children in their classrooms.

Research studies are often much more complex than merely contrasting one experimental condition with one control condition. Researchers may be interested in studying several different variables, each of which can be manipulated. For example, if researchers believe that both nutritional supplements and instructional enrichment promote the learning and thinking of young children, they could conduct a factorial study. This study can be set up as a 2 (levels of nutrition) by 2 (levels of instruction) factorial design (see Figure 1.3). In one condition, children receive only the nutritional supplement; in a second condition, children receive the nutritional supplement and instructional enrichment; in a third condition, participants are given only the instructional enrichment; and in the fourth (control) condition, children receive neither the nutritional nor the instructional enrichment. This design permits evaluation of whether nutrition, instruction, or nutrition and instruction combined produce differences in children's performances measured by the researchers—perhaps on learning tasks or on an intelligence test.

How are differences determined in manipulative investigations? For each condition in an experiment, two statistics are particularly important for each of the dependent variables that are collected. One is the **mean** value, which is the arithmetic average of all scores. The second is the **standard deviation,** which is an index of how much, on average, each individual score differs from the mean for the condition. The larger the standard deviation, the more spread out the scores are from the mean. The smaller the standard deviation, the more the scores are clustered around the mean. Thus, the standard deviation is an index of the variation between scores in a condition.

FIGURE 1.3. Design of a 2 (levels of nutrition) by 2 (levels of instruction) study.

How do researchers determine whether or not the differences between means are due to chance? They use the means and standard deviations in statistical tests that produce estimates of the likelihood that the experimental and control means differ at greater than a chance level. These tests determine whether there is a *statistically significant difference*—one that is unlikely to occur by chance—between the means. If there is a statistically significant difference between the experimental and the control group performances, researchers can draw the conclusion that there is a good chance the experimental treatment *caused* the difference in performance. In general, unless there is a 95% chance that the difference is not random (therefore, the chance of an error is 5%—an error rate of $p < .05$), social scientists are reluctant to conclude the difference is real. Often, researchers require even a more stringent standard, such as 99% certainty (an error rate of $p < .01$).

In addition to significance testing as just described, researchers sometimes also calculate the **effect size** that is observed in a study. Why compute effect size if the difference is statistically significant? If a study has a very large number of participants, it is possible for even small effects to be statistically significant. Effect size, however, is not determined by the number of participants in a study. One way to determine effect size is by comparing the size of the difference between the experimental and control means with the size of the standard deviation for the control condition. For example, if the experimental students average 65% on a posttest, with a standard deviation of 15, and the controls averaged 50%, with a standard deviation of 20, the effect size would be 0.75—that is (65% – 50%) / 20. If effect size exceeds 0.8, the difference between the means is usually considered to be large; if effect size is between 0.4 and 0.8, the difference is often described as moderate; and if effect size is 0.2 or less, the difference is considered small (Cohen, 1977). In reading reports of research studies, the informed consumer considers the effect size as well as the statistical significance.

Nonmanipulative Investigations

Some significant developmental questions must be studied using nonmanipulative techniques since random assignment to the variables of interest is not possible. For example, if a researcher is interested in the effects of social class, race, age, or gender on educational achievement, it is impossible to randomly assign students to these socioeconomic or biologically determined categories. People can differ in still other ways, leading to other interesting variables that can predict important outcomes. For example, psychologists have devised tests to classify people as more and less intelligent (see Chapter 8). Intelligence testing remains important to educators because it predicts success in school. Sometimes researchers conduct studies to classify people based on differences in how they process information. For instance, people differ in their use of memorization strategies, reading comprehension processes, and problem-solving tactics. People can be classified as rehearsers, elaborative rehearsers, and imagery users (see Chapter 4). These differences in how students process information also predict memory performance: rehearsers do not remember lists as well as people who integrate list items into memorable mental images.

Researchers also use individual differences in information processing to test theories. For example, suppose a researcher hypothesizes that construction of mental images during reading improves understanding of ideas in the text. If that is true, children who naturally construct mental images while they read should have a better

comprehension of what they read. In fact, they do (Sadoski, 1983, 1985). There is a relationship, called a **correlation,** between the two variables, use of imagery and text comprehension. In Sadoski (1983), the correlation between fifth graders' reported imagery and their comprehension and recall of text was +.37. What does this mean?

A **correlation coefficient** is used to summarize relationships between two variables and can range from –1.00 to +1.00. The greater the absolute value of the correlation coefficient, the greater the relationship between the two variables. A correlation coefficient of 0 implies no relationship between the two variables, but the closer the value is to either a –1.00 or a +1.00, the stronger the relationship. For instance, a correlation of .80 (or –.80) is high, .40 (or –.40) is moderate, and .10 (or –.10) is low. When a correlation is positive, it means that high values on one variable are associated with high values on the other variable. For instance, time spent studying is positively correlated with test performance in that more time spent studying for a test is associated with higher test scores. When a correlation is negative, it means that high values on one variable are associated with low values on the other variable. For instance, test anxiety is negatively correlated with test performance in that more test anxiety is associated with lower test performance. So, in the case of the reported correlation coefficient of +.37 reported by Sadoski (1983), the relationship between mental imaging and text comprehension and recall was moderate in size and positive. The fifth graders who reported creating more images while they read comprehended and recalled more text. The presence of a correlation, however, does not prove a causal relationship. For example, in the case of the correlation between construction of mental images and text recall that it is possible that children who naturally use imagery are more intelligent or deeper thinkers. If so, their greater comprehension could be due to greater intelligence or deeper thinking rather than their use of imagery. Still, many sophisticated statistical analyses use correlational techniques to create complex models showing how variables relate to each. These models increase our understanding of how developmental change takes place.

Summarizing across Quantitative Studies

When a number of individual studies have been conducted on a given topic by different researchers in diverse settings under varied conditions, it can be difficult to summarize what is known about the topic. Researchers who wish to draw conclusions from data generated by multiple studies may employ a technique called **meta-analysis.** Meta-analysis is a statistical technique used to analyze and summarize patterns of results across quantitative studies. Quantitative results across multiple studies are combined to generate an average effect size or to produce a weighted average correlation. Throughout this book, references will be made to a meta-analysis on a given topic (if available), and the magnitude of the effect or the size and direction of the correlations across studies will be discussed. Typically, meta-analyses will yield a *d*-index, a standardized difference across studies, the difference between the means of groups or experimental conditions on some construct divided by the average standard deviation. A *d*-index below 0.20 would be considered trivial, between 0.20 and 0.49 small, 0.50 to 0.79 moderate, and 0.80 or higher large (Cohen, 1977). Similarly, weighted correlations less than 0.10 would be considered small, 0.10 to 0.25 small to medium, 0.25 to 0.40 medium to large, and greater than 0.40 large (Roorda, Koomen, Split, & Oort, 2011). How large an effect is important when considering an educational intervention? That depends, and as suggested by Lipsey et

al. (2012), the cost (e.g., time, effort, expense) of an educational intervention should always be considered in light of the potential benefits.

Evaluating Quality of Quantitative Investigations

How can the quality of quantitative research be evaluated? A number of characteristics define a good study, described as follows:

- Objectivity of variables: **Objectivity** is the use of measures that are publicly observable and clearly measurable. The number of times teachers assist students is objective data; if researchers ask the teachers why they intervened, the data are more subjective and open to interpretation.

- Reliability of dependent variables: Dependent measures need to be reliable. **Reliability** of a measurement means that if the measurement were to be taken again, about the same score would be obtained. One reason why behavioral measures, objective performance, and standardized tests are more embraced by researchers is that they often are more reliable than other kinds of dependent measures such as surveys, interviews, and adult ratings of children. One way to increase reliability is to combine observations rather than rely on just one observation. Thus, if the dependent variable of interest is learning of text, instead of studying how students learn on text, collect data on three or four texts and combine the performances into a single score. This combined measure will be more reliable than any of the single-text scores.

- "Blind" testing: One way to enhance the quality of a study is to ensure that those collecting the dependent variables are "blind," meaning uninformed, as to key features of the research study. For example, in an experiment, the data collectors should be blind to the participants' assignment to a condition. It helps if participants in the study also are blind to both the hypotheses of the study and to the condition to which they have been assigned. Results can be very different when such precautions are taken. For example, Harrell, Capp, Davis, Peerless, and Ravitz (1981) reported large gains in the intelligence test scores of children with intellectual disability when they were administered large doses of vitamins. Unfortunately, these researchers did not employ blind testing techniques. When others attempted to replicate the outcome using appropriate blinding (i.e., of the researchers testing the children and of the children's families), no effect of vitamin therapy manipulation on the intellectual functioning of children with intellectual disability was found (Smith, Spiker, Peterson, Cicchetti, & Justice, 1984; Zigler & Hodapp, 1986).

Internal validity: When a study has high **internal validity,** there are no other plausible competing interpretations of the results. A study with internal validity does not have confounding variables (Campbell & Stanley, 1966). **Confounding variables** are variables unrelated to the treatment of interest that may be influencing the outcome. For example, if students taught to use an imagery strategy are led to believe they are being taught this strategy because they are smart, it is impossible to know whether any improvement in performance is due to the imagery instructions. The difference could simply reflect enhanced self-esteem due to the comments about intelligence made to the imagery students. In this case, self-esteem is the confounding variable.

- Discriminant validity: Sometimes general motivational factors are confounding variables. An improvement attributed to an educational intervention may simply

be a reaction to novel teaching, owing to increases in student motivation or interest (Smith & Glass, 1987). Perhaps the improvement is due to changes in teachers' expectations that affect student motivation (Rosenthal & Jacobson, 1968). Or maybe the improvement is due to students' awareness that their performance is being used to evaluate the effectiveness of the new instruction (Campbell & Stanley, 1966). To eliminate such explanations, researchers can include variables that should not be affected by the independent variable or be correlated with the nonmanipulated variables of interest. Why? Independent variables are typically hypothesized to affect particular outcomes rather than all outcomes; nonmanipulated variables are typically hypothesized to be correlated with some other variables but not all other variables. If researchers can predict in advance which outcomes measured are affected by an independent variable (and which are not), or which measures are correlated with a nonmanipulated variable (and which are not), the study can produce powerful evidence to support a hypothesis. In that case, the study has **discriminant validity** (Campbell & Fiske, 1959).

- Convergent validity: When researchers use more than one dependent variable and the pattern of outcomes is consistent across the dependent variables, there is said to be **convergent validity** (Campbell & Fiske, 1959) or **triangulation** (Mathison, 1988). For example, suppose that a researcher is studying a method for increasing the amount children read. If the researcher observes the classrooms in the study and records more reading by children receiving the intervention than children not receiving the intervention, the researcher's hypothesis that the factor being studied can increase the amount of children's reading is supported. If the teachers (who are "blind" to which students are receiving the intervention) also rate the amount of student reading and the teacher ratings indicate that the children who are receiving the treatment are reading more, convergent support exists for the researcher's hypothesis. If parents' ratings of the amount of reading occurring at home are also consistent with this pattern, there is additional convergent support of the hypothesis. Three different measures consistent with the hypothesis are better than one measure consistent with it.

- Replicability: **Replicability** is the likelihood of obtaining the same results consistently. Replicability is high when the same results are found on different occasions and low when results differ from occasion to occasion.

- External validity: Studies that have **external validity** resemble the real-life issue the researcher is trying to investigate (Bracht & Glass, 1968). For instance, a study of reading in college students is externally valid to the extent typical college students are reading actual college texts. If the study participants were not representative of college students (e.g., students enrolled in a remedial English class) or if the readings were contrived (e.g., passages written by the researcher rather than from textbooks), external reliability would be reduced.

Qualitative Methods

What are the key differences between quantitative and qualitative approaches to research (Denzin & Lincoln, 2000; Guba, 1990; Hitchcock & Hughes, 1989; Howe, 1988)? Quantitative approaches emphasize hypothesis testing, whereas qualitative researchers are more interested in constructing theories, often based on the perceptions and interpretations of participants in a setting. Whereas quantitative

researchers do all that is possible to obtain *objectivity*, qualitative researchers are more comfortable with *subjectivity*. Qualitative researchers often are attempting to develop what is called a **grounded theory,** a theory grounded in data and interpretations of data collected in natural situations (Glaser & Strauss, 1967).

The distinction between quantitative and qualitative methods can be fuzzy in that an increasing number of studies have both quantitative and qualitative aspects (Tashakkori & Teddlie, 2003). One example is an experiment comparing traditional elementary science instruction with science instruction that includes reading of literary pieces related to the science unit (Morrow, Pressley, Smith, & Smith, 1997). In this study, the researchers used both quantitative measures of reading and science achievement (test scores) and qualitative analysis of the differences in the interactions in the two conditions. Mixing of quantitative and qualitative approaches is becoming more common in educational research.

Development of a Grounded Theory

Strauss and Corbin (1998) summarized how to construct grounded theories. Construction of a grounded theory begins with the *collection of data*. Qualitative researchers use a number of approaches to data collection. For instance, the researcher may observe behaviors in a setting of interest. In the case of a researcher interested in constructing a theory of first-grade reading groups, this may mean many visits to first grades to observe reading groups. Alternatively, the researcher may interview many first-grade teachers about what goes on in their reading groups. In some cases, the observations may be made by the participants themselves, perhaps in the form of diaries or daily journals. Of course, the methods of data collection can be combined. Many qualitative studies combine observational and interview data.

Then, the researcher goes through the data, systematically *looking for meaningful clusters and patterns*—behaviors that seem to go together logically. For example, if the teacher pairs off students to read to each other, encourages students to ask one another about difficult words, and suggests that several students read and discuss a library book, these observations suggest a meaningful cluster of activities. The researcher then names the cluster. In this case, "cooperative reading" would be a reasonable category name for this cluster of behaviors.

Analysis of extensive observations and interviews is likely to result in a number of categories. The next objective is to *identify support for the categories* by reviewing the data. The qualitative researcher is always open to—and actually looking for—data inconsistent with an emerging category. Qualitative researchers begin their data analyses early in the data collection. As tentative categories emerge, they look for support or nonsupport of categories. The researchers often take the emerging categories back to those being observed and interviewed and ask them to evaluate the credibility of the emerging categories. This is called **member checking** (Lincoln & Gduba, 1985). Often the subjects of the investigation can provide important refinements and extensions of the categories. As a result of member checking, the researcher may change categories or their names.

Eventually, the researcher has established a stable set of categories based on data collected to date. The task now is to begin to *organize these categories in relation to one another*. For example, the category of "teacher modeling" seems to subsume some of the other categories of behaviors such as teachers' "thinking aloud about how to decode a word," "acting out reading processes," and "acting out deciding to

read for fun." Thus, the category "teacher modeling" is higher on an organizational chart than the three categories it subsumes (see Figure 1.4).

Once the researcher has identified categories and placed them in a hierarchical arrangement, more data are collected and old data are reviewed again. For the first-grade reading group example, it could be time to observe some more groups, adjusting the categories and their arrangements in light of new observations, interviews, and so on. The researcher continues to collect and analyze data until no new categories emerge from new observations, no new properties of categories are identified, and no additional adjustments are made to the hierarchical arrangement of the categories.

Once enough data are collected, the researcher begins hypothesizing about causal relationships between the categories of information that have emerged as related to one another. For instance, some reflection on the teacher interviews may indicate that teacher modeling is caused by contemporary teacher education practices. That is, the teachers indicated they were running reading groups as they had learned to run them in their methods classes in college. Alternatively, reflection on the interviews may suggest that teacher modeling is due to tradition. That is, the teachers claimed they were running reading groups consistent with what they had experienced as children. Or perhaps the interviews indicate that teacher modeling is due to in-service resources, since the teachers reported that there had been many in-services on teacher modeling. Teacher modeling is not only caused but also in turn causes reactions. Thus, perhaps students begin to model reading processes to one another. The qualitative researcher evaluates all the various causal possibilities, actions, and reactions, against all of the available data as completely as possible. Those that are supported by the data are retained; those that are not are discarded. This continues until the point of **theoretical saturation,** when all the data are explained adequately.

Eventually, the qualitative researcher must report the data in a way that can be easily understood. The researcher must identify a key category or categories around which to tell the story. These must be in sufficient detail to reflect the richness of the data analysis. This emerging story should be member-checked as well, until there is eventually a tale that seems reasonable to researchers and participants. See the Applying Developmental Theory to Educational Contexts special feature (Box 1.1) for an example of qualitative research.

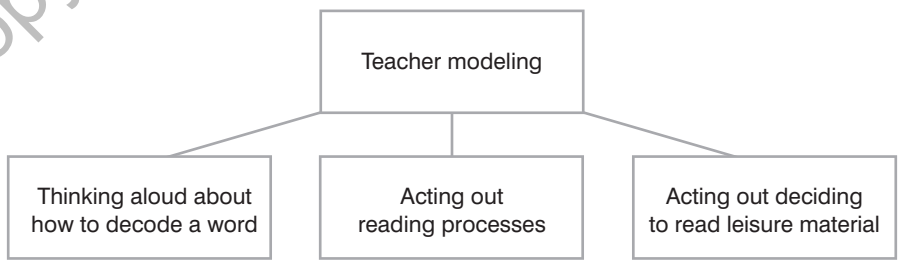

FIGURE 1.4. An organizational chart where the category of teacher modeling subsumes three categories of observations. From McCormick and Pressley (1997). Copyright © 1997 by Christine B. McCormick and Michael Pressley. Adapted by permission.

Applying Developmental Theory to Educational Contexts

BOX 1.1. Difficulties in Communications between Schools and Minority-Group Parents: An Example of a Qualitative Approach

Beth Harry (1992) used a qualitative approach to study potential miscommunications between schools and minority parents, miscommunications that reduce the likelihood of positive relationships between schools and families. Harry focused on the interactions between schools and 12 Spanish-speaking, Puerto Rican American families whose children were enrolled in special education. Such intensive study of a relatively few families is consistent with the qualitative approach to research. She conducted interviews with these families, made observations, and studied the children's school records as part of a large-scale effort to understand how these families interacted with the schools and understood those interactions. Harry alternated between data collection and analyses, changing tactics to take advantage of opportunities that might be revealing. Such flexibility in method is characteristic of qualitative studies. Her findings were quite striking:

1. The U.S. schools seemed impersonal and uncaring to the parents compared to schools they remembered in Puerto Rico. The U.S. schools often made errors in classification of the students in these families, and these errors undermined parental trust. For example, children were "promoted" by mistake and subsequently returned to their previous grade level. Because these parents tended to defer to authority figures, their concerns were not aired. Ironically, the respect of these parents for the professionals they encountered in the school, respect that resulted in the parents not challenging the professionals, increased the lack of trust felt by parents.

2. The written communications from the schools were offputting to these parents, in part because the letters were in English, which required finding someone to interpret them. The letters were also filled with educational jargon embedded in text that was above the readability level of many parents.

3. Parents often felt that they had not received critical information about their children. Sometimes the information had in fact been provided but was not understood. Other times it was provided incompletely. Sometimes the messages were mixed.

4. Many of the parents withdrew from interactions with the school and increasingly felt alienated.

The results of this qualitative study were shocking and led to many changes in how schools communicate with parents since schools recognized that education is more effective when coordinated efforts are made between schools and families. The qualitative research approach can reveal important factors in child development and education.

Evaluating Quality of Qualitative Investigations

Just as it is possible to evaluate the quality of quantitative studies, it is also possible to evaluate qualitative studies and on similar dimensions. The language is different, however (Guba & Lincoln, 1982; Lincoln & Guba, 1985). Thus, rather than worrying about internal validity, qualitative researchers are concerned with **credibility.** The stronger the case that the grounded theory captures the reality of the situation studied, the greater the credibility of the study. Rather than external validity, the qualitative researcher values **transferability,** which is a measure of how representative

the setting is. Evaluating transferability means deciding whether the analysis would apply somewhere else, which may require data collection in another setting. **Dependability** is the qualitative researchers' term for replicability. The qualitative researcher must convince others that most people would come to the same conclusions based on the data. **Confirmability** is the term used instead of objectivity. Confirmability is generally high when triangulation occurs in the study—that is, when multiple indicators are used to buttress conclusions.

Specific Approaches to Developmental Research

Without a doubt, the variable most frequently studied by researchers interested in development is age. Since age cannot be manipulated, causal conclusions about effects due to age are not possible. This makes conceptual sense, for age itself cannot cause anything (Wohlwill, 1973). Age can only index potential causal mechanisms, most obviously biological maturation. Thus, walking is not caused by being 9 months of age (or 10 months, or 11 months, or whenever the particular child begins to walk), but, in part, because of motor maturation, which can be indexed by age.

Cross-Sectional Approach

Age differences are sometimes examined at one point in time between different people who differ in age, for example, a study of 5-year-olds, 10-year-olds, and 15-year-olds in which all data was collected in 2018. This is an example of the **cross-sectional approach** to the study of development. One strength of this approach is that data across the entire age range of interest can be collected immediately. This contrasts with the most popular alternative approach to the study of development, the longitudinal approach (Baltes, Reese, & Nesselroade, 1988; Miller, 1987).

Longitudinal Approach

In the **longitudinal approach,** the same people are followed for an extended period of time, for example, from when they are 5 years of age until they are 15. The strength of this approach is that it permits study of *developmental change* rather than only age differences (Wohlwill, 1973). Thus, longitudinal studies provide information about changes within people that cross-sectional studies cannot provide.

Given such an advantage, it might seem that all developmental research should be conducted using longitudinal methods. In fact, there are many more cross-sectional than longitudinal studies. The most important reason is that *it takes much longer to produce information* about relationships between age and behavior using the longitudinal approach. The greater the developmental span of interest to the researcher, the greater the problem. Thus, for researchers interested in cognitive development from middle childhood to old age, a single longitudinal study over this interval would consume more than an entire career!

Besides the longevity of the researcher, the *longevity of the participants* must be considered. In mobile societies, maintaining a sample of participants for any period of time can be a real problem. Even when people do not move, sometimes they choose to discontinue their participation in a study. However, those who are willing to remain in a longitudinal study *may not be representative of the original population sampled*. That is, people willing to undergo repeated testing may be different from

people who have a lower tolerance for long-term testing or simply cannot be bothered with continuing in a study. When a large proportion of a sample is lost to a study because they have moved, it is likely that those who did not move were different from those who did. Another concern is that developmental changes in a longitudinal study may be due to *practice effects* with the tests or becoming accustomed to observation by researchers.

Even if there are no practice effects, the measures collected in a longitudinal study may become progressively more problematic as the study continues. For many issues in human development, new (and often better) measures are being developed. Moreover, the hypothesis being studied may be less exciting as a study continues. Hypotheses that seem interesting today may not be so important in the years and decades ahead. Because *a longitudinal study is tied to the measures and hypotheses that were in vogue when the study began*, it is possible that years of effort will produce results viewed as uninteresting or unimportant by the scientific community when the longitudinal study is finally completed.

Longitudinal studies are also *financially expensive* relative to cross-sectional studies. A longitudinal study must be funded for many years before there are definitive outcomes. Typically, research grants are provided for periods of 1–5 years, far shorter than the time needed for longitudinal studies of long-term development. In an environment in which research funds are generally scarce, only the most important longitudinal research questions compete favorably for continuous funding. We stress, however, that some important developmental issues can be addressed only by longitudinal study. Thus, some developmental researchers investigate how certain variables are related to later developmental outcomes in longitudinal studies. See the Applying Developmental Theory to Educational Contexts special feature (Box 1.2) for an example.

Because of the disadvantages of the longitudinal approach described above, many researchers choose to conduct cross-sectional investigations of development. Researchers are aware, however, that the outcomes obtained in a cross-sectional study can be very different from the outcomes obtained in a longitudinal investigation. See the Considering Interesting Questions special feature (Box 1.3) for an example.

Combined Longitudinal and Cross-Sectional Approach

A methodology favored by researchers interested in development across the adult lifespan is to combine cross-sectional and longitudinal methodologies (Schaie & Parham, 1977). For example, if we begin studying samples of 5-year-olds, 10-year-olds, and 15-year-olds today, the result is cross-sectional data (see Figure 1.5). Gather follow-up data on the 5-year-olds and the 10-year-olds in 5 years, who would then be 10- and 15-year-olds, respectively. Add a new group of 5-year-olds at that point. What you will then have in 5 years is longitudinal data on two samples (on the original 5- and 10-year-olds) and a new set of cross-sectional data on 5-, 10-, and 15-year-olds. Then, 5 years later, follow up again, this time seeing the original 5-year-old sample for a third time, revisiting the new 5-year-old sample who would then be age 10, and adding still another sample of 5-year-olds. At that point, you would have 10 years of longitudinal data on the original 5-year-olds, providing longitudinal information on that group for the entire span of development of interest in the study; you would also have 5 years of longitudinal data on the original 10-year-olds (between 10 and 15

Applying Developmental Theory to Educational Contexts

BOX 1.2. What Does High School Underachievement Predict?: An Example of a Longitudinal Study

McCall, Evahn, and Kratzer (1992) analyzed data from a study begun in 1965–1966 in the state of Washington. They obtained achievement and ability data on more than 6,000 high school juniors and seniors who spanned the entire range of achievement. The sample included three broad categories of students: (1) overachievers who had better grades relative to their expected ability, (2) ability-consistent achievers whose grades and abilities were consistent, and (3) underachievers whose grades were worse than would be expected on the basis of their ability. Thirteen years later, the researchers located and collected information from many of the original participants—a huge undertaking!

What happened to the underachievers? They continued to underachieve. For example, they made less money as adults than their former classmates who were ability-consistent achievers. Their jobs had less status than the jobs of ability-consistent achievers. They had obtained less postsecondary education than ability-consistent achievers. Underachievers were about 50% more likely than ability-consistent achievers to divorce in the 13 years following high school. Yes, there were exceptions to this general pattern. Underachievers who valued education, came from families that valued education, participated in high school activities, and were confident that they could go on to complete college did seem to catch up after high school, with their incomes, job status, and marital stabilities resembling those of the ability-consistent achievers more than those of the other underachievers. Still, this was a small proportion of underachievers. In general, underachievement in high school predicts future economic and personal difficulties. This type of finding was only possible through longitudinal study. Of course, an immediate question is whether these outcomes might not be cohort-specific. That is, would the same pattern of consistent underachievement be obtained if high school graduates from the early 2000s were evaluated today? We cannot know from the McCall and colleagues (1992) data because they were collected on only one cohort of young adults.

years of age) and from the 5-year-olds added at the second testing (between 5 and 10 years of age). You would have a total of three cross-sectional comparisons between 5-, 10-, and 15-year-olds!

But you have something else: a way to determine whether there are cohort effects. **Cohort effects** refer to children who are born in the same time being influenced by a particular set of historical or cultural conditions. Thus, research results based on one cohort may not apply to others growing up in different times. If there are no cohort effects, then 5-year-old performances should have been about equal at each testing, as should 10-year-old and 15-year-old performances. If there are cohort effects, then there would be differences between the 5-year-old means as a function of time of testing, between the 10-year-old means as a function of time of testing, and between the 15-year-old means as a function of time of testing. To the extent that there are cohort effects, the case strengthens the notion that environmental factors play an important role in determining the behavior being studied. To the extent that cohort effects exist there is an important additional limitation of simple longitudinal studies: outcomes obtained with any particular cohort might not generalize to another cohort. If a single longitudinal sample is studied, the results could reflect development per se or development only at that historical moment. Recall the

Considering Interesting Questions

BOX 1.3. Does Intelligence Decline during Adulthood?: Different Answers as a Function of Methodology

Do you expect to be smarter as you grow older, or do you expect that your intelligence will decline with increasing age during adulthood? Perhaps you believe it will stay the same? For many, the intuitive answer to this question is that intelligence should either stay the same (if intelligence is determined by genetic mechanisms that are insulated from other factors) or perhaps even increase (if experience really is a determinant of intelligence). Data from cross-sectional studies where intelligence tests were administered to groups of adults varying in age across the lifespan, however, indicated that with increasing age after the age of 20, the number of intelligence test items answered correctly declines (Salthouse, 2009; Schaie, 1959).

When intelligence is studied longitudinally, however, the results are very different. In that case, collapsing across all types of items on an intelligence test, intelligence appears not to decline until late in life (Botwinick, 1977; Schaie, 1990, 2013). Yes, a 45-year-old person answers fewer intelligence test items correctly than does a 25-year-old, but there is a cohort effect in that intelligence test items are better matched to the experiences of current young adults than to older adults. That is, differences in educational and cultural experiences found in older and younger adults influence their performance on intelligence tests (Baltes, 1968; Baltes et al., 1988; Kaufman, 1990; Schaie & Labouvie-Vief, 1974). Remember that in cross-sectional studies different people provided the intelligence data at each age level, and thus cross-sectional studies confound age level and the cohort of people providing the data.

In summary, the perspective on the development of intelligence across the lifespan changed entirely once longitudinal data were contrasted with cross-sectional data. The methodology used to study a phenomenon can make a huge difference in the conclusions that are drawn. More nuanced changes in intelligence across the lifespan are discussed in Chapter 8.

	Time of testing				
Subjects born	Now (2018)		5 years from now (2023)		10 years from now (2028)
2003	15-year-olds		Exited study		Exited study
2008	10-year-olds	→	15-year-olds		Exited study
2013	5-year-olds	→	10-year-olds	→	15-year-olds
2018	Not yet in study		5-year-olds	→	10-year-olds
2023	Not yet born		Not yet in study		5-year-olds

FIGURE 1.5. In this combined cross-sectional longitudinal design, can you find the cross-sectional comparisons? (*Hint:* Look in the columns for three separate cross-sectional comparisons of 5-, 10-, and 15-year-olds.) Can you find the longitudinal comparisons? Can you find the data that allow you to conclude whether a cohort effect is apparent at the 5-year-old level? (*Hint:* Look at each place in the study when 5-year-old data are collected.)

importance of historical moment in determining development, as described earlier in this chapter.

Much more information about development is generated using the combined cross-sectional and longitudinal approach than by either simple cross-sectional or longitudinal methods. Because of the expense and problems associated with the combined approach—basically all the same problems associated with the longitudinal approach plus the additional expense of continuously adding samples with each new wave of data collection—the combined method is rarely used in the study of child development despite its analytical power.

Summary of Research Methods in Development and Education

The two major classifications of quantitative studies are manipulative and nonmanipulative. Random assignment is the key characteristic of a manipulative study. Manipulation of variables, however, is sometimes not possible. The best quantitative studies are simultaneously high on internal and external validity, report outcomes proven to be reliable, and use a variety of objective measures so that triangulation is possible. Sometimes in quantitative studies a relationship between two variables is indicated in a correlation coefficient.

Quantitative research focuses on testing theories using objective techniques. In contrast, qualitative researchers use subjective interpretation to construct a grounded theory that is verified through member checking. The best qualitative studies are credible and produce outcomes that are transferable, dependable, and confirmable. Consult Table 1.1 for a list of questions to consider when reading reports of research.

Longitudinal and cross-sectional approaches to research are specific to the study of development. In the cross-sectional approach, people of different ages are studied at the same point of time. In the longitudinal approach, the same people are studied for an extended period. Although the longitudinal approach allows the researcher to directly study developmental change (and the cross-sectional approach

TABLE 1.1. Questions to Ask Yourself as You Read a Description of a Research Study

What research approach was used?
- Quantitative, qualitative, or both?

Depending on your answer to the first question, select questions from the following:
- Is the study manipulative or nonmanipulative?
- Was random assignment used?
- Were any statistical tests significant?
- How large was the effect size?
- Are there any confounding variables?
- Is there evidence of blind testing?
- Are the measures and procedures reliable, valid, and objective?
- Is there evidence of triangulation?
- Can the results be generalized to real-life situations?
- If different age groups are used, is the study longitudinal or cross-sectional?
- Do the data fit the story told?
- Is there evidence of member checking?
- Are the results credible, transferable, dependable, and confirmable?

does not), the longitudinal approach requires a longer investment of time, has a greater likelihood of losing research participants, and is more expensive than the cross-sectional approach. Developmental researchers must always be alert to potential cohort effects, differences due to belonging to a particular *cohort* (a group of people born at the same time) rather than to other factors.

REVIEW OF KEY TERMS

cohort effects Effects due to children born in the same time being influenced by a particular set of historical or cultural conditions.

confirmability In a qualitative study, the point at which multiple indicators all support the same conclusion.

confounding variables Variables unrelated to the experimental treatment that may be influencing its outcome.

convergent validity Consistency of patterns of outcomes across more than one dependent variable.

correlation A relationship between two variables.

correlation coefficient A number, ranging between –1.00 and +1.00, that indicates the size and direction of a relationship between two variables.

credibility The degree to which the grounded theory generated by qualitative research captures the reality of the situation studied.

cross-sectional approach The study of developmental differences carried out by examining age differences among different people at different age levels at one point in time.

dependability In qualitative research, the strength of the argument that most people would come to the same conclusion based on the data.

dependent variables Variables measured to determine the effects of the independent variable.

discriminant validity Pattern of outcome in which variables that should not be affected by the independent variable are not affected.

effect size A measure of the size of a mean difference between experimental and control conditions that allows for comparisons across studies.

exosystem In Bronfenbrenner's ecological systems theory, environmental influences such as media that affect the child but that are removed from the direct experiences of the child.

external validity In a research study, the criterion standard of resembling closely the real-life issue the researcher is trying to investigate.

grounded theory A theory constructed from interpretations of data.

hypothesis A proposed relationship between two or more variables.

independent variables The factors that are manipulated in an experiment.

internal validity In a research study, the criterion of there being no other plausible interpretations of the results.

longitudinal approach The study of developmental differences carried out by following the same people for a period of time.

macrosystem In Bronfenbrenner's ecological systems theory, the cultural influences affecting a child.

manipulative investigations Studies in which researchers control variation by randomly assigning people to one educational treatment or another.

mean An arithmetic average of all scores.

member checking In qualitative research, the practice of taking emerging categories back to those being studied and asking them to evaluate the credibility of the categories.

mesosystem In Bronfenbrenner's ecological systems theory, environmental influences such as school and church that relate microsystems to each other.

meta-analysis A statistical technique to analyze patterns by aggregating data across multiple quantitative studies.

microsystem In Bronfenbrenner's ecological systems theory, the direct experiences of the child in various settings such as home and school.

nonmanipulative investigations Studies in which researchers systematically analyze naturally occurring differences between people or settings.

objectivity The use of measures that are publicly observable and clearly measurable.

operationalization The process of defining variables by specifying how they will be measured or manipulated in a research study.

plasticity Sensitivity to environmental experiences. As used in describing the brain, having fundamental physical properties, such as the size and number of synaptic connections, vary with environmental stimulation.

random assignment A method of ensuring that before an experiment begins, each participant has an equal chance of being assigned to any treatment.

reaction range The range of all possible manifestations of a biological predisposition; the range of possible phenotypes based on a given genotype.

reliability Consistency, as in a test or measure that obtains the same results consistently.

replicability The likelihood of obtaining the same results consistently, as when studies are repeated using the same measures.

standard deviation An index of how much individual scores on a test differ from the mean.

theoretical saturation The point in qualitative research when all data are explained adequately.

transferability In qualitative research, an indication of the representativeness of the setting.

triangulation In research studies, multiple indications of a phenomenon.

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