SIXTH EDITION

THEORIES *of* DEVELOPMENTAL PSYCHOLOGY

Patricia H. Miller

THEORIES *of* DEVELOPMENTAL PSYCHOLOGY

This page intentionally left blank

SIXTH EDITION

THEORIES *of* DEVELOPMENTAL PSYCHOLOGY

Patricia H. Miller
San Francisco State University

worth publishers
Macmillan Learning
New York

Publisher, Psychology and Sociology: Rachel Losh
Associate Publisher, Psychology and Sociology: Jessica Bayne
Senior Associate Editor: Sarah Berger
Development Editor: Thomas Finn
Editorial Assistant: Kimberly Morgan-Smith
Executive Marking Manager: Katherine Nurre
Director, Content Management Enhancement: Tracey Kuehn
Managing Editor, Sciences and Social Sciences: Lisa Kinne
Senior Production Supervisor: Stacey B. Alexander
Project Editor: Kevin Bradley, Jouve North America
Photo Editor: Robin Fadool
Director of Design, Content Management: Diana Blume
Senior Design Manager: Vicki Tomaselli
Cover and Interior Design: Kevin Kall
Composition: Jouve India
Printing and Binding: RR Donnelley
Cover Image: Sergey Nivens/Shutterstock

Library of Congress Control Number: 2015960099

ISBN-13: 978-1-4292-7898-0
ISBN-10: 1-4292-7898-6

Printed in the United States of America

First Printing

Worth Publishers
One New York Plaza
Suite 4500
New York, NY 10004-1562
www.macmillanhighered.com

CONTENTS

Preface xi

CHAPTER 1

Introduction 1

What Is a Theory? 3

What Is a Developmental Theory? 7

Of What Value Is a Developmental Theory? 11

Organizing Information • Guiding Research

What Main Issues of Developmental Psychology Do Theories Address? 14

What Is the Basic Nature of Humans? • Is Development Qualitative or Quantitative? • How Do Nature and Nurture Contribute to Development? • What Is It That Develops?

SUMMARY 23

CHRONOLOGY OF DEVELOPMENTAL THEORIES 23

ORGANIZATION OF THIS BOOK 23

SUGGESTED READINGS 24

CHAPTER 2

Piaget's Cognitive-Stage Theory and the Neo-Piagetians 25

Biographical Sketch 26

General Orientation to the Theory 29

Genetic Epistemology • Biological Approach • Structuralism • Stage Approach • Methodology

Description of the Stages 36

Sensorimotor Period (Roughly Birth to 2 Years) • Preoperational Period (Roughly 2 to 7 Years) • Concrete Operational Period (Roughly 7 to 11 Years) • Formal Operational Period (Roughly 11 to 15 Years) • An Overview

Memory 55

Mechanisms of Development 57

Cognitive Organization • Cognitive Adaptation • Cognitive Equilibration • Section Overview

Sergey Nivens/Shutterstock

Position on Developmental Issues 62

Human Nature • Qualitative Versus Quantitative Development • Nature Versus Nurture • What Develops

Applications 65

Evaluation of the Theory 66

Strengths • Weaknesses

Piaget's Own Modifications of His Theory 80

The Neo-Piagetians 82

Robbie Case • Kurt Fischer • Neo-Piagetian Themes

Contemporary Research 89

Infants' Advanced Competencies • Domain-Specific Concepts • Mechanisms of Development

SUMMARY 93

SUGGESTED READINGS 94

CHAPTER 3

Freud's and Erikson's Psychoanalytic Theories 95

FREUD 96

Biographical Sketch 96

General Orientation to the Theory 99

Dynamic Approach • Structural Approach • Topographic Approach • Stage Approach • Normal–Abnormal Continuum • Methodology

Description of the Stages 113

Oral Stage (Roughly Birth to 1 Year) • Anal Stage (Roughly 1 to 3 Years) • Phallic Stage (Roughly 3 to 5 Years) • Period of Latency (Roughly 5 Years to the Beginning of Puberty) • Genital Stage (Adolescence) • Case Study of "Little Hans"

Mechanisms of Development 120

Position on Developmental Issues 122

Human Nature • Qualitative Versus Quantitative Development • Nature Versus Nurture • What Develops

Applications 123

Evaluation of the Theory 124

Strengths • Weaknesses

Contemporary Research 129

ERIKSON 132

Biographical Sketch 133

General Orientation to the Theory 133

Psychosocial Stages • Emphasis on Identity • Expansion of Psychoanalytic Methodology

Description of the Stages 139

Stage 1: Basic Trust Versus Basic Mistrust (Roughly Birth to 1 Year) • Stage 2: Autonomy Versus Shame and Doubt (Roughly 2 to 3 Years) • Stage 3: Initiative Versus Guilt (Roughly 4 to 5 Years) • Stage 4: Industry Versus Inferiority (Roughly 6 Years to Puberty) • Stage 5: Identity and Repudiation Versus Identity Diffusion (Adolescence) • Stage 6: Intimacy and Solidarity Versus Isolation (Young Adulthood) • Stage 7: Generativity Versus Stagnation and Self-Absorption (Middle Adulthood) • Stage 8: Integrity Versus Despair (Late Adulthood)

Mechanisms of Development 144

Position on Developmental Issues 145

Applications 146

Evaluation of the Theory 146

Strengths • Weaknesses

Contemporary Research 148

SUMMARY 150

SUGGESTED READINGS 152

CHAPTER 4

Vygotsky and the Sociocultural Approach 153

Biographical Sketch 155

General Orientation to the Theory 158

Child-in-Activity-in-Cultural-Context as the Unit of Study • Zone of Proximal Development • The Sociocultural Origins of Individual Mental Functioning: The Intermental Constructs the Intramental • Tools Provided by a Culture Mediate Intellectual Functioning • Methodology

Mechanisms of Development 176

Position on Developmental Issues 177

Human Nature • Qualitative Versus Quantitative Development • Nature Versus Nurture • What Develops

Applications 179

Evaluation of the Theory 182

Strengths • Weaknesses

A Related Approach: Developing-Person-In-Context 188

Contemporary Research 192

Collaborative Problem Solving • Research Across Cultures • Social Change • Immigrant Families • Development Through Narratives and Conversations • Concluding Comments About Contemporary Vygotskian–Sociocultural Research

SUMMARY 207

SUGGESTED READINGS 209

CHAPTER 5

Biological Approaches: Ethology, Developmental Neuroscience, Genetics 211

Ethology 212

History of the Theory • General Orientation to the Theory • Contributions to Human Developmental Psychology • Mechanisms of Development • Position on Developmental Issues • Applications • Evaluation of the Theory • Contemporary Research

Developmental Neuroscience 248

Brain Development • Theoretical Issues • Applications • Summary

Genetics 257

Models of Gene X Environment Interactions • Epigenetic Models • Theoretical Issues • Applications • Summary

Integrated, Multilevel Biological Theoretical Perspectives 268

SUMMARY 271

SUGGESTED READINGS 274

CHAPTER 6

Social Learning Theory 277

History of the Theory 279

Learning Theory • Social Learning Theory

General Orientation to the Theory 289

Observational Learning • Causal Model Includes Environment–Person–Behavior System • Cognitive Contributions to Learning • Self-Efficacy and Agency

Examples of Developmental Research: Moral Judgments and Gender Roles 300

Moral Judgments and Behavior • Gender-Role Development

Mechanisms of Development 303

Position on Developmental Issues 304

Human Nature • Qualitative Versus Quantitative Development • Nature Versus Nurture • What Develops

Applications 306

Evaluation of the Theory 308

Strengths • Weaknesses

Contemporary Research 311

Cognitive Approaches to Learning • Imitation • Selective Social Learning from Others

SUMMARY 314

SUGGESTED READINGS 316

CHAPTER 7
Information-Processing Theory 317

History of the Theory 320

General Orientation to the Theory 322
Humans as Information-Processing Systems • Development as Self-Modification • Task Analysis • Methodology

Major Developmental Approaches 330
Memory • Metamemory • Mathematical Understanding • Rules for Problem Solving • Computational Modeling

Mechanisms of Development 353

Position on Developmental Issues 355
Human Nature • Qualitative Versus Quantitative Development • Nature Versus Nurture • What Develops

Applications 357

Evaluation of the Theory 360
Strengths • Weaknesses

Contemporary Research 365
Executive Function • Developmental Cognitive Neuroscience • Embodied Cognition • Bayesian Computational Models • Developmental Robotics

SUMMARY 374

SUGGESTED READINGS 375

CHAPTER 8
Gibson's Ecological Theory of Perceptual Development 377

Biographical Sketch 378

General Orientation to the Theory 379
Ecological Approach: Affordances • Information Is Specified in Stimulation • Humans as Active Perceivers • Methodology

What Infants Learn About 387
Communication • Interaction with Objects • Locomotion in the Spatial Layout

Mechanisms of Development 392

Position on Developmental Issues 393
Human Nature • Qualitative Versus Quantitative Development • Nature Versus Nurture • What Develops

Applications 394
Evaluation of the Theory 394
Strengths • Weaknesses
Contemporary Research 397

SUMMARY 399
SUGGESTED READINGS 400

CHAPTER 9
Theories Today: Themes and Perspectives 401

Generally Accepted Theoretical Principles 402
Overview of Theorizing Today 403
Themes Driving Theorizing and Research Today 403
1. How general are developmental changes?
2. How can complex, dynamic change be captured theoretically?
3. How can theories best depict long-term development?
4. How can theories best depict universal and diverse aspects of development?
Position on Developmental Issues 419

SUMMARY 420
SUGGESTED READINGS 420

CHAPTER 10
Reflections 421

Developmental Issues Revisited 422
Human Nature • Qualitative Versus Quantitative Development • Nature Versus Nurture • What Develops
Moving Toward Mechanisms of Development 426
Historical Progress of Developmental Theories 428
Critical Psychology: Are Theories of Development Gendered? 431
Conclusions 434

References 435
Name Index 467
Subject Index 477

PREFACE

"What is your theory of psychological development?" As an undergraduate, I faced that very essay question on my final exam in an introductory child psychology class. Drawing on all the theories I had ever heard of, I modestly generated a 6 (age) × 20 (developmental tasks) matrix that covered all of development. My interest in theories was launched. Perhaps if I had been given a multiple-choice test this book would not have been written.

In all six editions of this book, I have tried to show the "big picture" of psychological development. Sometimes students are frustrated by fact-laden textbooks that do not provide frameworks in which to fit the facts. It is often not clear, for example, why a Swiss philosopher would be interested in children's numerical judgments after a row of objects is spread out or why it is noteworthy that infants cry when their mothers leave the room. This book provides frameworks for understanding and perceiving the significance of the research findings in developmental psychology.

Theories of Developmental Psychology can be used as a primary or supplementary text in undergraduate or graduate courses or as a resource book for instructors. In addition, it can provide perspectives on children's behavior for those who interact with children in any capacity. I hope that both developmental psychologists and readers from other disciplines will find something of interest in these pages.

I have used a parallel structure in the various chapters in order to help the reader compare the theories. Each chapter includes sections on four central issues of development, mechanisms of development, applications (e.g., to education or atypical development), strengths and weaknesses, and contemporary research. The section on contemporary research in each chapter shows how the theory is active today and how changes in the field of developmental psychology have changed what it draws from each theory. Where relevant, I provide biographies of major theorists, to show the connection between a theorist's culture, family background, and interests, and that person's theory. I have tried to convey what is exciting about each of the theories. The theories included are those that in my view are of most interest to developmental psychologists and professionals in related disciplines. Many important theories were necessarily excluded because of length restrictions. And some of the "theories"

Sergey Nivens/Shutterstock

included are not formal theories, but are perspectives that function as theories by identifying what to study, what questions to ask, and how to answer these questions.

Much has happened in the discipline of developmental psychology since the first edition in 1983. Each revision reflects these changes. In this sixth edition, I have continued to show how each theory has changed in its emphasis, its data base, and its influence on developmental psychology since the previous edition. A major change in this newest edition is a greatly expanded chapter on biological approaches, growing out of what originally was a chapter on ethology. This change reflects a major trend in the field toward biological perspectives. Exciting recent research in developmental neuroscience and genetics (Gene X Environment interactions and epigenetics) has had a major impact on both developmental psychology and psychology more generally. Evolutionary approaches, which continue to capture developmentalists' attention, are included as well. These biological perspectives also appear briefly in the sections on contemporary research in some of the other chapters. The biological chapter now appears earlier in the book; this chapter and the Vygotsky/culture chapter just before it together provide two major foundations of development.

Chapter 9 also is reorganized. That chapter, formerly titled "Contemporary Minitheories and Emerging Approaches," is now titled "Theories Today: Themes and Perspectives." The chapter is now organized around current themes in developmental psychology and how several theoretical approaches are addressing them. The chapter also now serves as a description of the "state-of-the-art" in developmental theorizing today.

The theories and empirical findings were updated throughout. Some particularly notable changes are the following: Reflecting a changing world, with its more diverse population, significant immigration, and increased globalization, several chapters address topics such as immigrant families, ethnic identity, social change and cultural evolution after modernization, and cultural differences in family processes. In the information processing chapter, sections on connectionist models, Bayesian models, statistical learning, and embodied cognition are expanded, to reflect the considerable interest in these approaches today. Throughout, when relevant, chapters include theoretical perspectives on atypical development, such as autism spectrum disorders, psychopathology, bullying, and altered stress regulation systems.

I want to thank a number of people who used the fifth edition and generously agreed to make suggestions for the current edition. The new sections on genetics and neuroscience greatly benefitted from Luke Hyde's feedback on an earlier draft. I also want to thank Sarah Berger, Thomas Finn, and Kimberly Morgan-Smith at Worth Publishers, who expertly guided the sixth edition. Finally, I am grateful to John Flavell, who guided my meanderings into theories when I was a graduate student and continued to be a source of inspiration throughout his career.

Patricia H. Miller
2015

This page intentionally left blank

THEORIES *of* DEVELOPMENTAL PSYCHOLOGY

This page intentionally left blank

CHAPTER 1

Introduction

Never trust an experimental result until it has been confirmed by theory.
—SIR ARTHUR EDDINGTON

Give us theories, theories, always theories.
—JAMES MARK BALDWIN

Sergey Nivens/Shutterstock

We have theories of development because observers of human behavior have been intrigued by what they saw children and adults do. A 3-year-old predicts that a crayon box holds crayons; then, after it is opened to reveal candles, he asserts that he always believed that it held candles. A 5-year-old claims that spreading out a row of buttons increases the number of buttons. A school-age child uses a good strategy to successfully solve an addition problem, but shortly thereafter, she uses a less reliable strategy on the same problem. An adolescent selects an identity without seriously exploring other possible identities. An adult reports a dream that seems to be a thinly disguised attempt to deal with childhood anxieties.

Developmental theorists try to make sense out of observations such as these and, by doing so, construct a story of the human journey from infancy through childhood or adulthood. Some of the theories we will explore are grand, encompassing theories, often associated with a particular person, for example, Piaget's, Freud's, Erikson's, and Vygotsky's theories. Other theories are minitheories that often can be traced back to a grand theory but are limited to a particular territory within development. An example is the "theory theory," which is connected historically to Piaget's theory but examines children's concepts about a particular domain, for example, the mind. Still other theories are families of approaches under a general theory or framework, such as social learning theory, information processing, dynamic systems, and ethology and other biological approaches, and are not identified with a single person.

Some developmental theories have been borrowed from areas outside of development and applied to developmental psychology, such as evolutionary theory, information processing, dynamic systems theory, and cultural psychology. Typically, a few key developmentalists see the potential of the theory for posing new questions about development or providing a new explanation of development and then translate the theory into a developmental framework. Thus, theory building in developmental psychology is a very rich, dynamic, and exciting enterprise that has come from many directions. The theories' stories are varied, but all give us insights into human behavior and change the way we look at the world.

This book attempts to convey not only the content of the theories but also the excitement and passion that developmentalists have felt as they constructed theories to solve the mysteries of development. The chapters also show how theories have expanded our vision of the nature of development. For example, Piaget's idea that the mental operations of adults have their origins in babies' sensory-motor behaviors opened up a whole host of new ways to think about cognitive development.

To understand the contribution of each theory, we must first look at the general nature of theories. In this Introduction, we ask the following questions about theories:

1. What is a theory?
2. What is a developmental theory?
3. Of what value is a developmental theory?
4. What main issues of developmental psychology do theories address?

What Is a Theory?

This is a deceptively simple question. In fact, a philosopher of science might "answer" our question by asking two more:

1. Are we asking what theories should be or what they typically are?
2. Are we asking about theories as they are stated formally or as they actually operate in a scientific community?

The philosopher's first question concerns the distinction between ideal and real theories and expresses the sad fact of scientific life that our theories fall short of their goal. Theories usually do not reach a complete, formal state. An ideal, complete, formal *scientific theory* is a set of interconnected statements—definitions, axioms, postulates, hypothetical constructs, intervening variables, laws, and hypotheses. Some of these statements, which are usually expressed in verbal or mathematical form, are deduced logically from certain other statements. The function of this set of interconnected statements is to describe unobservable structures, mechanisms, or processes and to relate them to each other and to observable events. Perhaps the best way to contrast these types of statements is to show that they occupy different levels within a theory. That is, they vary in their distance from observable behavior. The farther a statement is from observable behavior, the less likely it is to be supported or refuted by empirical data.

At a point farthest from observable behavior are certain *assumptions* (axioms, postulates) that are accepted without being tested. (For example, in Piaget's cognitive developmental theory, an assumption is that thinking is organized.) These assumptions may be so self-evident to the theorists that they are not even aware of them. As we move to a less general level, we find *hypothetical constructs*—concepts that posit relations among events, objects, properties, or variables. These constructs (such as "mental scheme" and "mental reversibility" in Piaget's theory) are unobservable themselves but refer to behavior that can be observed. Coming even closer to behavior, theorists translate hypothetical constructs into testable *hypotheses*—tentative statements about relations among events, objects, properties, or variables. (One Piagetian hypothesis is that infants tend to repeat interesting actions, such as shaking a rattle.) A hypothesis becomes a *fact* when it is sufficiently supported by research. As facts accumulate, they are tied together by a *law:* a relatively well-established general statement about the relationship among a set of facts.

A theorist builds a theory by going back and forth between *data* (repeatable empirical observations) and theory. New facts change the theory, and changes in the theory generate new experiments and thus new facts. The new facts again change the theory, and so the cyclical process continues. Empirical observations can provide strong support for a theory but can never completely prove that a theory is true because future observations could provide disconfirming evidence. Some theories do little more than summarize the facts (data). Particularly in Skinnerian learning theory, one finds statements such as "If a response is followed by reinforcement for several trials, the frequency of that response increases." Such theories that stay close to the data are easy to test because they are easy to disconfirm. At the other extreme, Freud's "unconscious" or Piaget's "equilibration" process is distantly related to observable behavior. Because a large distance between theoretical notions and data makes it more difficult to test the theory, several such theories may be equally good at explaining the same set of data and thus may be retained for years, regardless of their accuracy.

Traditionally, psychologists have judged theories by certain criteria. A theory should be logically sound, that is, internally consistent, with no statements that contradict each other. A theory should also be empirically sound, that is, not contradicted by scientific observations. Furthermore, it should be clear, testable, and parsimonious, relying on as few constructs, propositions, and the like as possible. Finally, a theory should cover a reasonably large area of a science and should integrate previous research.

Psychology has had few formal theories in its history, and probably no current theory of development falls into this category. However, the above requirements give us a context for judging whether each theory or model of development is headed in the right direction. We can ask whether each theory could eventually reach the status of a formal, testable theory. In their present form, developmental "theories" serve as frameworks for examining changes in behavior over time. For example, Piaget's theory directs our attention to the organization of thought rather than to specific pieces of knowledge, to stagelike changes during development rather than to a gradual accumulation of knowledge, and to children's active construction of knowledge rather than to their passive processing of information.

Today, theorists often use the term *model*—an informal theory of limited scope. Models sometimes are presented visually, for example, in a drawing of boxes and arrows to indicate the flow of information during thinking. Models also can be like analogies, as when the mind is likened to a computer.

The philosopher's second question distinguishes between theories as they are stated and how they actually operate in a scientific community. A theory, in its tidy and polished form in a textbook, only faintly resembles the way the theory guides the behavior of real people doing real research. The traditional view of theory building as an orderly, objective, logical process presents a picture of scientists in their "dress clothes." Although science sometimes does proceed in this way, more often it proceeds in a much messier, more irrational fashion, with a dose of luck, to produce a polished final product.

More specifically, in the conventional view of theory building, empirical observations provide objective bits of information that we can use to make more general statements or to test statements derived from a theory. In reality, facts do not simply present themselves to eager scientists. When people develop or adopt a particular theory, they take on a whole set of beliefs concerning what questions about development are worth asking, what methods for studying these questions are legitimate, and what the nature of development is. A Freudian is not likely to study how rats learn to press bars in tightly controlled experiments, and a learning theorist is not likely to ask people to describe their dreams or memories of childhood. There are unwritten rules of the game that are very much a part of the theory as it is practiced. Scientists' assumptions lead them to see certain facts more easily than others. If theorists assume that humans are basically rational, they are more likely to study thought than emotions, more likely to become a Piaget than a Freud. In fact, it can be difficult for theorists to see what they are *not* looking for. As an illustration, radio signals from Jupiter had been heard, but ignored, for many years because astronomers assumed that radio signals came only from Earth. Then one night in 1955, two young American astronomers heard these signals from Jupiter, but attributed them to a farmhand on his way home after a date (Weintraub, 2005). For some reason, they decided to look further. They then realized what the signals actually were, and recognized their significance—providing information about magnetic fields of planets and rates of planetary rotation.

Scientists make decisions about how to divide up the "stream of behavior" and how to describe it. A one-minute episode of a baby playing could be described in hundreds of ways. There are different levels of behavior, from heart rate to exploration of the room, and different temporal units, from a fraction of a second to a behavioral unit spanning perhaps the entire minute. Which facts or observations the psychologist chooses from the numerous candidates tells us as much about the psychologist or the psychologist's theory as about the episode of behavior itself. These constraints on what is observed are necessary, of course, because one cannot record everything. Some philosophers and psychologists are *social constructionists*, who propose that science and its theories are one particular view of reality and are always filtered through social–cultural beliefs, values, language, and categories. A scientist's social and political beliefs can be especially biasing in a field such as psychology, in which people are studying people. A psychologist holds a mirror rather than a telescope.

Developmental psychologists do not escape their culture's views. Scarr (1985) argued that we change our scientific lenses as the culture changes: "We pose questions to fit our place and time; we get answers to fit our theoretical niches" (p. 204). She noted that in the 1950s and 1960s social scientists expected, and thus looked for, evidence that boys in "broken homes" were affected negatively by the lack of a father. The finding that these boys, when young, were low in aggression was taken as evidence for poor sex-role development. Since the women's movement, the increasing involvement of fathers with their children, the emergence of nontraditional families, and the increased racial and ethnic diversity of families, it is no longer assumed that nontraditional family situations have a negative effect on children. Moreover, with current less rigid views of gender roles, low aggression in a boy may not be seen as a deficit.

Feminist theories identify biases in science stemming from cultural beliefs about gender and race, including the gender and race of the researcher (that is, the experiences that come with being a particular gender and race). For example, a developmental theorist could focus on mastery, competition, and independence from others or on connections and collaborations with others (Miller, 2000). These critiques from social constructionism and feminist theories have alerted investigators to their own assumptions and biases, which can affect both their theory building and their research.

Individual psychologists' personality and motivations also influence the particular direction their research takes, a point demonstrated by learning theorist E. C. Tolman:

> I started out . . . with considerable uneasiness. I felt that my so-called system was outdated and that it was a waste of time to try to rehash it and that it would be pretentious now to seek to make it fit any accepted set of prescriptions laid down by the philosophy of science. I have to confess, however, that as I have gone along I have become again more and more involved in it, though I still realize its many weak points. The system may well not stand up to any final canons of scientific procedure. But I do not much care. I have liked to think about psychology in ways that have proved congenial to me. Since all the sciences, and especially psychology, are still immersed in such tremendous realms of the uncertain and the unknown, the best that any individual scientist, especially any psychologist, can do seems to be to follow his own gleam and his own bent, however inadequate they may be. In fact I suppose that actually this is what we all do. In the end, the only sure criterion is to have fun. And I have had fun.
>
> *(1959, p. 152)*

Still another example of the informal side of theories is that some theorists draw heavily on imagery, such as diagrams or metaphors, to communicate their theories. Connectionist models, discussed in a later chapter, often include diagrams of several layers of circles and arrows to depict brain networks and the strengthening of associations among multiple units. New technology brings new metaphors, as seen in the early images of the nervous system as a telephone switchboard, the eye as a camera, and an instinct as a hydraulic system, then later images of cognitive development as an equilibration system (Piaget), a computer (information processing), and a neural network (connectionism).

What Is a Developmental Theory?

The above crash course in the philosophy of science suggests that developmental theories are somewhat informal frameworks at present and, like all theories, have a dynamic, nonpublic role as well as a static, public one. Our next question is: What makes these theories developmental? Simply studying children does not make a theory a developmental theory. For example, studying learning in 6-year-olds, or even children of several ages, does not necessarily lead to conclusions about development.

What is critical about a developmental theory is that it focuses on *change over time*. Although developmental theories have nondevelopmental theoretical concepts such as ego, mental representations, and neural networks, they diverge from nondevelopmental theories by emphasizing changes over time in these concepts. Moreover, developmental theories link change over time to what came before and what comes next. That is, a developmental theory attempts to explain *by what process* a phenomenon both emerges from prior development and leads to subsequent development. For example, with increases in the number of representations that can be held in mind simultaneously and manipulated (developmental process), a new strategy of verbally rehearsing a list of items to be remembered may emerge from the prior skill of simply naming these items, and may later join with other strategies to make memory even more efficient.

This concern with change presents developmental theories with three tasks. These tasks are (1) to *describe* changes *within* one or several areas of behavior, (2) to *describe* changes in the relations *among* several areas of behavior, and (3) to *explain* the course of development that has been described. Let us look more closely at each of these three tasks.

1 *A developmental theory describes changes over time in one or several areas of behavior or psychological activity, such as thought, language, social behavior, or perception.* For example, a theory might describe changes in the rules of grammar underlying language in the first few years of life. Although developmental theories tend to stress changes over months or years, an adequate theory ultimately must describe changes over seconds, minutes, and days. For example, Piaget's concept of object permanence, the notion that objects exist even when they are out of sight, may develop over many months during infancy, but a full description would include many "minidevelopments" that occur during the child's moment-to-moment encounters with objects.

As noted earlier, even direct observation is guided somewhat by theoretical notions that distort the flow of behavior in some way. Observers record certain behaviors and ignore others. They divide the stream of behavior into units. They encode the behavior into words that add connotations. They allow inference to creep into their observations. The following descriptions of the same behavior demonstrate that several degrees of inference are possible:

a. The baby's hand came closer and closer to the spinning top.
b. The baby reached for the spinning top.

c. The baby wanted to pick up the spinning top.

d. The baby applied her grasping scheme to the spinning top. (A scheme, according to Piaget, is an organized sequence of behavior that reflects an infant's knowledge in a particular area, such as grasping.)

Much of the early work in developmental psychology was focused on description. In the 1930s, Arnold Gesell's maturational theory of development established norms of physical, cognitive, and motor development through description. Although description is not sufficient for an adequate theory of development, it certainly is necessary. Without a database, we have an "edifice without a foundation" (White, 1969, p. 49).

2 *A second task for a theory of development is to describe changes over time in the relations among several areas of development such as thought, personality, and language.* Thus, developmental theorists are "specialized generalists" in that they have to be knowledgeable about many areas of psychology but specialize in the developmental approach to studying these content areas and their relations.

In the case of the object concept described above, a theory might describe how the concept relates to children's developing memory system and their social relationship with one particular object, their mother. A theory would outline the temporal relations among these areas of development. For example, a theory might claim that a certain degree of memory capacity must be developed before the object concept can emerge, that the mother is the first permanent object, and that subsequent developments within the object concept are correlated with changes in the memory system and children's attachment to their mother. Another example, from Vygotsky (see Chapter 4), concerns the relations between thought and language. Specifically, thought and language are relatively independent until they merge to produce symbolic thought and children can think in words. Both examples describe the organization within children at various points in time. The descriptions refer to certain developmental sequences (first *A,* then *B*) and concurrences (*A* and *B* at the same time).

Of course, any attempt to divide behavior into parts is somewhat arbitrary because there is an interrelated system, or the famous "whole child." Also, theories need to include the sociocultural context in any description, as well as the child, because behaviors develop and occur in particular sociocultural settings. Nevertheless, not everything about a child and the environment can be studied at once. When developmentalists study one aspect of development, they try to do so in the context of the whole child and the social and physical environment.

3 *Even if a theory provides a full description of development, it has not explained why and how children change. Thus, a third task for a developmental theory is to explain the course of development that the other two tasks describe.* In fact, the sequences and concurrences identified in the first two tasks often suggest particular explanations. If skill *A* always appears shortly before the development of skill *B*, a psychologist may hypothesize that *A* contributes to the development of *B*. Skill *A* might add an ability (e.g., improved memory) that makes the development of skill *B* possible, skill *A* might be transformed into *B*, or skill *A* might be replaced by *B*.

With respect to the third task, each developmental theory offers a set of general principles or rules for change. For example, Freud proposed that biologically based drives "move" children from one stage to another, and that the degree of the child's accompanying anxiety depends somewhat on the parents' child-rearing practices. In addition, principles of change hypothesize a set of processes for producing the change. These processes have been as diverse as dynamic equilibration in Piaget's theory, physical maturation biological theories, and the strengthening of a response by reinforcement in learning theory.

Earlier developmental events can influence later ones in complex ways. Sometimes problematic earlier experiences set in motion a trajectory of risk over many years, such that the initial effect increases and spreads to other domains as children and adolescents face increasingly complex developmental demands. This is called a *developmental cascade*. An example is that the effects of a poor parent–child relationship in early adolescence may escalate and expand into later relationships (Oudekerk, Allen, Hessel, & Molloy, 2015). Specifically, parents' attempts to control their 13-year-olds through psychological coercion deprived the adolescents of opportunities to practice negotiating autonomy and relatedness within a relationship, and thus hindered their ability to express autonomy and relatedness with their friends. This poor relationship functioning with their friends then predicted poor romantic relationships at age 18 and then at age 21. Parents' initial undermining of their young adolescents' development of autonomy and relatedness in relationships cascaded over time and relationships, such that their adolescents fell increasingly behind their peers in their social development. Cascading can work in a positive direction as well; earlier opportunities to practice autonomy and relatedness skills may cascade into increasingly healthy relationships later on.

When a theory explains why development proceeds in a certain way, it at the same time explains why certain other possible courses of development did not occur. Why did *A* lead to *B* rather than *X?* The significance of what does not happen is expressed by Sherlock Holmes:

> *" . . . the curious incident of the dog in the nighttime."*
> *"The dog did nothing in the nighttime."*
> *"That was the curious incident," remarked Sherlock Holmes.*
>
> —*Sir Arthur Conan Doyle*

Developmentalists do not necessarily approach these tasks in the above order. A theory of development usually weaves back and forth among the three tasks. Progress in describing children's language at ages 1, 2, and 3 may stimulate progress in identifying causes of language development (e.g., social contributions), which in turn may direct attention to describing parent–child interaction during early social development. A related point is that description and explanation are not independent; a theory's explanatory concepts influence the choice of what is described and how it is described, and the type of explanation a theory offers is somewhat constrained by how it describes behavior. Finally, developmental theories are not equally concerned with these three tasks. For example, Piaget was much more successful at describing the development of thought than explaining this development.

These three monumental tasks, even if incompletely met thus far, provide us with goals by which to measure the success of theories of development. A theory may successfully describe and explain one particular area of development, such as language development, but not other areas. Or a theory may describe several areas but unsuccessfully explain these changes.

Of What Value Is a Developmental Theory?

What does a developmental theory actually do for us when it describes and explains development? A theory makes two contributions: (1) it organizes and gives meaning to facts, and (2) it guides future research. We examine each of these contributions in turn.

Organizing Information

The very success of developmental science has produced an enormous body of information about children. Thus, it now is especially important to have theories to give meaning to facts, provide a framework for facts, identify which facts are most important, and integrate existing facts. Facts do not speak for themselves. As Jules Henri Poincaré (1908/1952) said, "Science is built up of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house." Just as stones need an architect or a blueprint to become a house, so do facts need a theorist to give those facts structure and show their relation to the overall design. One by-product is that by summarizing and organizing information, we are saved from "information overload." It is easier (but perhaps more dangerous) for us to refer to "defense mechanisms" than to state all the separate behaviors to which they refer.

Just as the same stones can be used to make different houses, so can a set of facts be given different meanings by different theories—by organizing them differently, emphasizing different behaviors, and inferring different hypothetical constructs. Consider the following example (McCain & Segal, 1969): At one time, two theories explained the tendency of a falling rock to increase its speed as it approaches the earth. According to a popular Greek theory, rocks and earth like to be with each other because they are made of the same elements. As the rock gets closer to the earth, it travels faster because it becomes increasingly excited. The same fact can also be explained by Newton's theory of universal gravitation. All particles attract each other with a force directly proportional to the product of their masses and inversely proportional to the square of their distances. These two theories are based on the same set of observations, but they assign different meanings to these facts.

When we view development through the lenses of first one theory and then another, we experience a gestalt-like shift. We see children as seething with sexual energy or reflecting on the origins of the universe. We see children as a bundle of learned responses or a highly organized system. These theoretical shifts have been likened to shifts in the perception of ambiguous figures (Averill, 1976), such as the sudden perceptual shift from a duck to a rabbit in Figure 1.1. The information has not changed, but our organization of it has.

Guiding Research

In addition to organizing and giving meaning to facts, a theory serves a second function. It is a heuristic device, a tool to guide observation and to generate new information. A theory's abstract statements predict

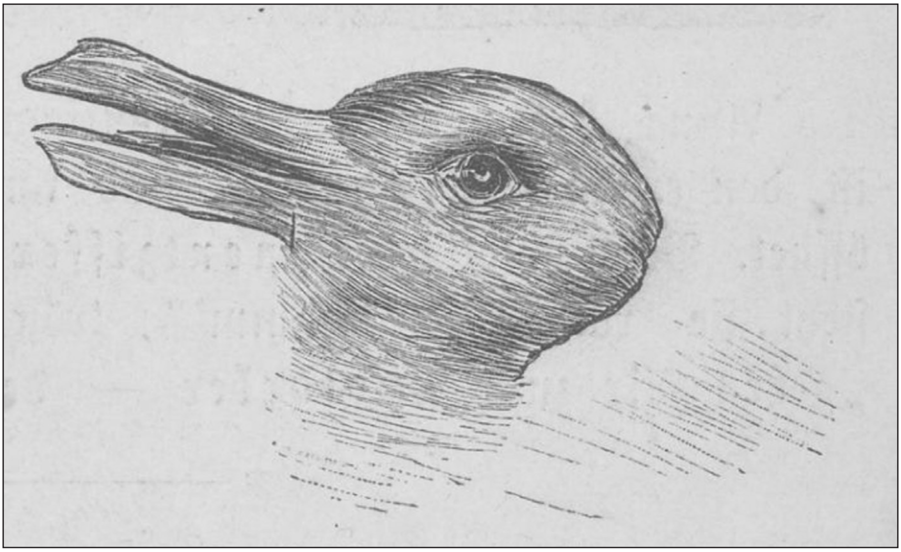

FIGURE 1.1

Similar to the shift in perspective from one theory to another, the lines in this drawing can be perceptually organized to form a duck or a rabbit.
[Fliegende Blätter, 1845–1892.]

certain empirical statements that then are tested. Theories sometimes stimulate new observations. For example, ethology, an approach borrowed from biology, stimulated developmental psychologists to search for innate social behaviors contributing to the adaptation of the species to the environment. A new theory may also make us reexamine familiar behavior. Piaget certainly was not the first person to watch babies play, but he suggested a new way of looking at this behavior: the actions themselves are creating thought, according to Piaget.

Theory's dual role as a stimulator of and interpreter of data is nicely illustrated in a 22-year longitudinal study of aggression (Eron, 1987). Traditional learning theory, with its emphasis on drive reduction, guided the selection of the original variables in 1960. In later years, as new learning theories emerged, investigators interpreted the data first in terms of Skinnerian operant learning (early 1970s), then social learning (mid-1970s), and finally cognitive theory (mid-1980s). Thus, in these four phases of learning-theory development, investigators sought the causes of aggression in frustration (drive reduction), reinforcement of aggression (Skinner), aggressive models (social learning), and finally the child's attitudes toward and interpretation of potential instigators of aggression (cognition).

What Main Issues of Developmental Psychology Do Theories Address?

Although the theories to be covered differ in their content, methods of investigation, and formal nature, all explicitly or implicitly take a position on certain core issues of development:

1. What is the basic nature of humans?
2. Is development qualitative or quantitative?
3. How do nature and nurture contribute to development?
4. What is it that develops?

These issues, which serve as a way of summarizing and contrasting the theories, reappear at the end of each chapter. First, however, some discussion of each issue is in order.

What Is the Basic Nature of Humans?

Theorists' views of development are closely tied to their views of human nature. Their views of human nature, in turn, are closely tied to their *worldviews*—their notions about how the universe works. Philosophers of science have identified several worldviews in the history of the Western world (Pepper, 1942). Three of these can be found in theories of developmental psychology (Overton, 1984; Reese, 1991): the mechanistic, the organismic, and the contextual. We examine each of these.

In the *mechanistic* view, the world is like a machine composed of parts that operate in time and space. For example, the world could be likened to a watch. Forces are applied to the parts and cause a chain reaction that moves the machine from state to state. In principle, then, complete prediction is possible because complete knowledge of the state and forces at one point in time allows us to infer the next state. The mechanistic view has its roots in Newtonian physics. It is also related to the empiricist philosophy of Locke (1632–1704) and Hume (1711–1776), which pictured humans as inherently at rest—passive, and motivated by environmental or bodily forces. Development, consequently, is caused by antecedent forces and events acting on a passive, machinelike mind composed of interlocking parts. One can almost see the wheels turning in the child's head!

In contrast, the *organismic* worldview is modeled on living systems, such as plants or animals, rather than machines. This image derives from Leibniz (1646–1716), who believed that substance is in "a continuous transition from one state to another as it produces these states out of itself in unceasing succession" (Cassirer, 1951, p. 29). Leibniz pictured the world as composed of organized "wholes" that are inherently and spontaneously active and self-regulating. This organization and self-directed activity is necessary, or natural, given the nature of the organism. This view emphasizes the whole rather than its parts, the relations among the parts, and how the whole gives meaning to its parts. In the realm of psychology, for example, one can understand a child's behavior only by viewing it within a larger dynamic system that includes the context as well as the child.

Rather than look for antecedent causes, as the mechanistic world view has done, the organismic view considers inherent properties and goals. A human, by nature, is an active, organized whole and is constantly changing, not randomly but in a particular direction. Development, then, is inherent in humans. New skills emerge as humans mature and engage with the world. Self-initiated behavior and thought lead to changes in both the structure and the content of behavior and thought. White describes an active organism:

> Let us define an active organism as one that gives form to its experience, a passive organism as one that receives form from its experience. Active organisms have purposes and they attend, reason, and selectively perceive. All this enables the active organism to select, modify, or reject environmental influences pressing upon it.
>
> *(1976, p. 100)*

The organismic view is that children "construct" their knowledge by actively formulating and testing hypotheses about categories of objects and the causes of events. In contrast, the mechanistic view is that children passively acquire ("soak up" like a sponge) a copy of reality. Organismic, unlike mechanistic, theories often posit qualitative rather than gradual change, and sometimes they are stage theories.

In the third worldview, *contextualism,* the main metaphor is not a machine or a living system but a historical act or a tapestry. A behavior has meaning (and can be "explained") only in terms of its social–historical context. The pragmatist philosophers such as William James and George Herbert Mead provided the philosophical inspiration. As Pepper described contextualism:

> [It] takes for its root metaphor the textured event, with its richly qualitied strands fading into a past that dies and guiding the changing pattern of a present duration into a future that dawns. The event through its texture extends sidewise in its present duration into neighboring contexts

> which are themselves textures extending into still other contexts. And the texture of each event is internally analyzable into strands, which have individual tensions and references into other textures.
>
> *(1934, p. 183)*

This tapestry extends from the distant past to the distant future and from the proximal to the distal. The horizontal temporal and vertical spatial threads intermesh into a pattern of a human life.

One can study this tapestry of development by looking at ongoing action–event units consisting of meaningful goal-directed activities. As Reese explained it, "Writing is not an act; but writing something with something on something in some situation at some time is an act" (1991, pp. 191–192). Reese listed other components of the contextual metaphor: the meaning of a behavior varies from context to context; a math problem may involve feelings of competence in the school environment but survival for a homeless child who is a street vendor. Moreover, behavior has a purpose that reaches into the past (some proximal "cause") and into the future (some goal). Finally, like the organismic view, the contextualist view is holistic. Not only is a unit greater than the sum of its parts, but a unit-in-context is greater than the sum of a unit *and* its context. To continue the above example, writing a sentence "is an act but is also a part of the larger act that includes writing about the act of writing the sentence, which in turn is part of the larger act that includes writing an entire paper, which in turn is part of the larger act that is the writer's lifetime, which in turn is part of the larger act that includes others' lifetimes, etc." (Reese, 1991, p. 194).

The contextualist belief that children's patterns of development can differ across cultures, subcultures, or historical times contrasts with the mechanistic and organismic focus on universal laws of behavior and development. The main mechanistic approach, learning theory (Chapter 6), posits laws of learning, such as the influence of reinforcement on behavior, that apply across time and place. A main organismic theory, Piagetian theory (Chapter 2), proposes universal stages and mechanisms of development. As will become clear in subsequent chapters, these worldviews ask different questions about development and use different methods to answer those questions.

In addition to these three metaphysical views of humans, the world, and causality are more specific and limited views based on economic and political ideologies. For example, Riegel (1972) related views of childhood and of development to the capitalistic and mercantilistic politicoeconomic systems in the seventeenth to nineteenth centuries. The capitalistic system, largely Anglo-American, saw humans as competitive, as struggling for success. Thomas Hobbes's (1588–1679) pronouncement of humans as selfish and competitive and of life as "nasty, brutish, and short" expressed this notion. The roots continue through Darwin, who stressed the survival of the fittest. In the economic arena, the emphasis was on free trade, competition, and entrepreneurship. The standard of success (as a result of struggle and competition) was the white, middle-class adult male engaged in manufacturing or business. By this standard, children, the elderly, the intellectually disabled, and women were considered inferior. Normative descriptions of each age were developed to detect "abnormal" development and chart children's progress toward the adult standard of success. Society saw children as passive beings who must be molded ("socialized") into appropriate adult roles.

The mercantilistic ideology, in contrast, existed primarily in continental Europe in the seventeenth through the nineteenth centuries. The economy was based on land ownership and state-controlled trading more than on manufacturing and free trade. Distinct social classes enjoyed specified duties and privileges, and little competition between classes occurred. Society emphasized cooperation more than competition, and tolerated differences between groups. The main philosophical spokesman, Jean Jacques Rousseau (1712–1778), saw the child as a "noble savage," basically good but ruined by the adult world. Children were not to be judged by adult standards; children and adults were seen as qualitatively different. From this point of view, the goal of education was self-realization. Consequently, a child-oriented education was developed by Maria Montessori, Eduard Spranger, and others.

In summary, each theory of developmental psychology has a view of humans that reflects philosophical, economic, and political beliefs. This view is often implicit, and sometimes theorists themselves are not even aware of these assumptions. The view influences not only theory construction but also decisions about which research problems are meaningful, what method should be used, and how data should be interpreted. Thus, it sometimes is claimed that it is impossible to integrate or reconcile theories or make crucial tests that support one or the other if they have different worldviews.

Is Development Qualitative or Quantitative?

Closely related to these views of humans is the issue of the form of developmental change: Is it qualitative or quantitative? The mechanistic and capitalistic views emphasize quantitative change, the organismic and mercantilistic approaches emphasize qualitative change, and contextualism permits both. Qualitative changes are changes in kind or type. An example from nature is the following sequence: egg → caterpillar → cocoon → butterfly (Spiker, 1966). New phenomena or characteristics emerge that cannot be reduced to previous elements. Qualitative changes typically involve changes in structure or organization. In contrast, quantitative changes are gradual changes in amount, frequency, or degree. In some cases, the behavior becomes more efficient or consistent.

An example of the contrast between quantitative change and qualitative change can be found in the development of memory. If a 4-year-old can recall three objects and a 7-year-old can recall seven objects from a set of objects seen several minutes earlier, we might infer a quantitative difference in their mental functioning. The older child can remember more. However, if the 7-year-old uses strategies such as sorting the objects into categories of food, furniture, and toys, and rehearsing them, whereas the 4-year-old does not, we would infer a qualitative difference in their mental functioning: They process the information in different ways.

At a more general level, the issue of qualitative versus quantitative change becomes an issue of stage versus nonstage development. Movement from one stage to the next is a qualitative change. When there are similarities in a number of new abilities or behaviors during a period of time, a theorist often infers that the child is in a particular "stage." For example, Piaget posited stages that differed in the structure of thought from birth to adolescence. Stage theorists disagree about the possibility of being in more than one stage at the same time in different domains or of regressing to an earlier stage, and they argue about what causes children to differ in how quickly they pass through the stages.

Stagelike qualitative changes have been identified by scholars other than developmental psychologists. Historians identify periods in history, such as the "industrial age" or the "age of reason." Shakespeare saw seven ages of man from the "mewling and puking" infant to the old person "sans teeth, sans eyes, sans taste, sans everything."

It is surprisingly difficult to tell when developmental change is quantitative versus qualitative. The problem is that change may look abrupt and qualitative if long time intervals separate the times that behaviors are sampled and quantitative if short time intervals are used. For example, when infants' motor skills are observed once per month, infants usually appear to progress abruptly from not having a skill to having it (e.g., from standing to taking a step), but daily observation reveals a more gradual quantitative change, with the new skill gradually strengthening and becoming more stable (Adolph, Robinson, Young, & Gill-Alvarez, 2008).

Some behaviors show both qualitative and quantitative changes, perhaps even alternating during development. For example, an increase in mental capacity (quantitative change) may facilitate the development of a sorting memory strategy (qualitative change). Subsequent increases in the speed and accuracy of this sorting would involve quantitative change.

Qualitative and quantitative changes can be seen in various observed developmental trajectories (Adolph et al., 2008). As described above, some trajectories are quantitative and linear, as when a child gradually acquires more words with increasing age, and some are qualitative and like stair steps, as when a child goes through stages. More interesting are more complex trajectories, such as a period of slow quantitative increase in vocabulary development followed by a somewhat sudden vocabulary spurt that later levels off to a slower gradual increase, or a U-shaped course of development in which acquiring a new rule, such as adding "–ed" to form the past tense leads to errors, such as "goed," but eventually leads to a rule with exceptions ("went"). In this latter case, there seems to be a temporary regression, in that performance seems to get worse, then better. In short, depicting changes in quantitative and/or qualitative development becomes more complex when the rate of change and the positive or negative direction of change are considered as well.

How Do Nature and Nurture Contribute to Development?

Breed is stronger than pasture.

—*George Eliot*

Theorists ask what causes development. How do knowledge and behavior arise from a child's genetic endowment and from experience? The nature–nurture issue is known by several other labels, such as "heredity versus environment," "nativism versus empiricism," "biology versus culture," "maturation versus learning," and "innate versus acquired." This controversy has raged not only within psychology but also within philosophy. The controversy began in classical Greece when philosophers asked whether ideas are innate or acquired through experience. Later, Descartes (1596–1650) believed that certain ideas are innate, while the British empiricist Locke (1632–1704) argued that a newborn's mind is a blank slate (*tabula rasa*) on which experience writes.

Within psychology, the question has changed over time. The original question was "*Which* (heredity or environment) causes a behavior or *how much* of each is needed for a given behavior?" This question was replaced by "*How much of the variation* in a behavior across people is due to hereditary differences and how much to environmental differences?" and "*How* (in what manner) do nature and nurture interact to produce development?" Recently, the questions have become "*Which* genes predispose to *which kinds of* behavior?" "*What* are the environmental triggers for the expression of these genes and *how* do these triggers have their effect on genes?" and "Can environmental modifications of gene expression be passed on to the next generation?" This is an interesting illustration of how progress in a field sometimes involves learning how to ask the right question.

Today it is clear that a complex interaction of innate and environmental factors accounts for both the development of a trait or behavior in an individual and the variations in a trait or behavior among individuals. Nature and nurture are inextricably intertwined from conception throughout the lifespan. Hebb (1980) remarked that behavior is determined 100 percent by heredity and 100 percent by environment. Genes (specifically, particular sequences of DNA) are never expressed directly in behavior. There is a long chain of events, involving genes, physiological processes, and the prenatal and postnatal environment. The intertwining of nature and nurture can be complex and subtle as when genes predispose children to seek particular kinds of environments. For example, an innately active, exuberant child and a passive, quiet, reflective child select different types of play settings and playmates. Thus, they are exposed to different types of experiences. As another example, genes and the environment can be correlated, as when shy parents might both pass on a tendency toward shyness genetically and provide an environment that encourages shyness.

Although all the theories in this volume acknowledge the importance of both nature and nurture, they vary in which they emphasize. Figure 1.2 shows where the theories align along the nature–nurture continuum in terms of their focus. Those theories in the middle give approximately equal attention to both types of influence. The theories also disagree about the process by which either environmental or innate factors have their influence. For example, the environment can "stamp in" associations, provide models to be imitated, supply information to be assimilated, strengthen neural networks, or provide a supportive social system (a helpful parent). Finally, theories differ in how much importance they place on the timing

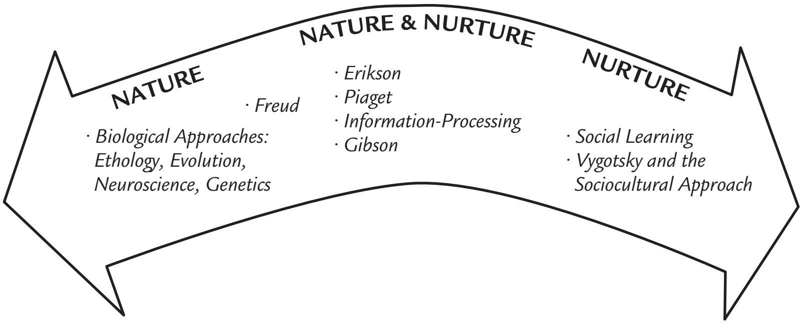

FIGURE 1.2
Locations of the theories along the nature–nurture continuum in terms of their focus.

of a particular experience. Are there "critical periods" in which the child is especially sensitive to a particular experience? Is early experience more influential than later experience?

The nature–nurture issue is at the center of two of the most exciting recent research topics in psychology: genetics and neuroscience (see Chapter 5). In genetics, for example, gene X environment interactions show that a given genetic makeup can result in different behavioral outcomes in different rearing environments, and a given environment can have different effects on people with different genetic makeups. As illustrated in one study (Brody, Beach, Philibert, Chen, & Murry, 2009), parents' behaviors can affect whether a gene known to be linked to certain behavioral problems is actually expressed in their children. In a sample of rural African-American 11-year-olds, some had a genetic makeup known to produce abnormal levels of serotonin for transmitting neural impulses in the brain and some did not. Children genetically at risk show twice as much high-risk behavior (e.g., drug use, sexual behavior) as those not genetically at risk. This indicates the importance of genetic influence. However, the at-risk preadolescents whose families participated in an intervention aimed at strengthening families by teaching parenting skills (e.g., vigilance, emotional support) and improving parent–child communication gained some protection from this genetic predisposition; the adolescents showed fewer high-risk behaviors over the two-year period and in fact at age 14 looked very similar to the group not at genetic risk. Thus, this intervention moderated gene expression, and it was the combination of genetic and environmental risk factors that predicted the course of development. Biology is not destiny: Adolescents with the same genetic makeup showed different behaviors, depending on their environment (i.e., whether they had the family intervention).

The second current boom area addressing nature–nurture, cognitive neuroscience, shows the two-way influence between brain and behavior: The physical maturation of the brain changes cognition and behavior, but cognition and behavior also affect the organization of the brain. The influence of brain maturation on cognition and behavior is more obvious, as, for example, maturation of the cortex improves children's ability to inhibit their impulsive behaviors and to recall information. Causality in the other direction is less obvious. A striking example is that infants are born with the ability to tell apart all the critical phonemic differences (e.g., /p/ vs. /b/ in *p*at vs. *b*at) of all languages. However, over the first year of life as they typically only hear one or two languages, brain pathways for the phonemic differences of other languages are pruned away and infants lose the ability to discriminate these differences (Kuhl, 2010). In this way, experience changes the brain.

What Is It That Develops?

Each theorist makes a claim concerning the "essence" of development, or at least the proper unit of analysis. Throughout this book, we encounter various phenomena, such as cognitive structures, psychological structures (id, ego, superego), cultural tools, neural networks, overt behaviors, strategies of information processing, and perceptual exploration. What theorists focus on depends on where their theoretical assumptions and methods of study place them along several dimensions:

1. Their level of analysis (from cells to societies)
2. Whether they focus on structure (organization of behavior, thought, and personality) or process (dynamic, functioning aspects of the system)
3. What content they emphasize (for example, personality or brain changes)
4. Whether they emphasize overt behavior or covert thought and personality traits
5. Their focus on universal development versus diversity and individual differences
6. What methodology they use to study development

These five dimensions have a chicken-and-egg relationship: Which came first—ethologists' decision to study complex behavior acquired by species in their struggle to adapt to the environment or their choice of a methodology, namely, observations in natural settings? This interrelationship among the dimensions will become more obvious as we examine each theory.

SUMMARY

The traditional view of an "ideal" scientific theory is that it should be a hypothetico-deductive system and include a set of logically interconnected statements. It formally describes psychological structures and processes and relates them to each other and to observable events. Most psychological "theories," however, have failed to reach this level of formality. A theory has not only a public, formal, static nature but also a private, informal, dynamic nature. Moreover, a theory guides the behavior of psychologists doing research. It helps them formulate questions, choose what to study, and decide how to study a problem.

We need developmental theories. They help us describe and explain developmental changes by organizing and giving meaning to facts and by guiding further research. Developmental theories have taken a stand on four issues that are of special importance to the study of development:

1. What is the basic nature of humans?
2. Is development qualitative or quantitative?
3. How do nature and nurture contribute to development?
4. What is it that develops?

We now have a framework for viewing each of the theories in turn.

CHRONOLOGY OF DEVELOPMENTAL THEORIES

A chronology of the major developmental theories provides a useful framework for subsequent chapters. Freud's psychoanalytic theory emerged in the early 1900s. In the mid-1900s arose Erikson's psychosocial theory, Piaget's cognitive theory, Vygotsky's cultural theory, learning theory, and social learning theory. The 1960s and 1970s saw the rise of neo-Piagetian theory, ethology, information processing approaches, and Gibson's theory. Biological approaches other than ethology became especially dominant around the turn of the 21st century. Each chapter will show how each theory continues to have explicit or implicit impact on developmental research today.

ORGANIZATION OF THIS BOOK

The following nine chapters describe the major theories of development plus several other theories or approaches stimulated by them. The focus is on infancy, childhood, and adolescence, though later development receives some attention. Piaget's theory is presented first because many of the current issues in developmental psychology were raised by his theory and several theories arose in reaction to his theory. Next comes the other big theory in the history of developmental psychology: psychoanalytic. The subsequent two chapters address the contributions of the social–cultural environment (Vygotsky's theory and other sociocultural approaches) and biology (ethology and other biological approaches). The remaining chapters present theories focused on particular topics of development: social learning theory, information processing theory, and Gibson's perceptual learning theory. Then, Chapter 9 describes the contemporary theoretical scene and main theoretical trends. The final chapter looks both backward and forward regarding developmental theories. Each chapter follows roughly the same organization in order to make comparisons among the theories easier. At the end of each chapter, theories are evaluated in terms of their strengths and weaknesses according to the current state of developmental psychology. That is, we ask what each theory can contribute to today's developmental researchers, professionals who work with children, and parents.

SUGGESTED READINGS

Shute, R. H., & Slee, P. T. (2015). *Child development: Theories and critical perspectives* (2nd ed.). This book examines the philosophical foundations of developmental theories, the notion of development, the intellectual history of the field, and issues of development.

Adolph, K. E., Robinson, S. R., Young, J. W., & Gill-Alvarez, F. (2008). What is the shape of developmental change? *Psychological Review, 115*, 527–543. This article describes various possible developmental trajectories.

CHAPTER 2

Piaget's Cognitive-Stage Theory and the Neo-Piagetians

[At 7 months, 28 days] Jacqueline tries to grasp a celluloid duck on top of her quilt. She almost catches it, shakes herself, and the duck slides down beside her. It falls very close to her hand but behind a fold in the sheet. Jacqueline's eyes have followed the movement, she has even followed it with her outstretched hand. But as soon as the duck has disappeared—nothing more! It does not occur to her to search behind the fold of the sheet, which would be very easy to do (she twists it mechanically without searching at all).

—*PIAGET, 1937 (1954, p. 36)*

Hub (age 6): Is the moon always round? —*No.* —What's it like? —*Sometimes a crescent, it is very worn out.* —Why? —*Because it has done a lot of lighting.* —How does it come round again? —*Because it is made again.* —How? —*In the sky.*

—*PIAGET, 1926 (1929, p. 281)*

Sergey Nivens/Shutterstock

Intriguing glimpses of children's behavior and thought, such as those above, fired Piaget's imagination. In these unremarkable daily events, Piaget saw a remarkable process of cognitive development. In Piaget's view, moment-to-moment specific encounters with objects or people lead to general ways of understanding the world. This understanding changes during development as thinking progresses through various stages from birth to maturity. Moreover, children themselves actively construct this knowledge.

Piaget has been the most important figure in developmental psychology. His influence spread not only throughout the disciplines of psychology but also into areas such as education and philosophy. In fact, Time magazine named Piaget one of the greatest minds of the 20th century (Papert, 1999). Piaget's theory raised issues about development that the other theories must address. It is appropriate, then, to begin our look at theories with the cognitive-structural theory of Jean Piaget.

This chapter can only hint at the complexity of Piaget's theory. We first delve into Piaget's life in some detail in order to understand his theory better and to illustrate the close relationship between the personal history of theorists and the nature of their theory. After this biography comes a general orientation to the theory, then a description of the stages and other developmental changes, followed by a discussion of the mechanisms of development. The next sections relate the theory to the critical issues of development and address applications of the theory. Then, an evaluation of Piaget's theory is followed by a description of his modifications of his theory late in life, an overview of the work of neo-Piagetians, and a discussion of contemporary research inspired by Piaget.

Biographical Sketch

Most of the material in this biographical sketch comes from Piaget's autobiography (1952a). Jean Piaget was born in 1896 in Neuchâtel, Switzerland. Piaget described his father, a historian devoted to medieval literature, as "a man of a painstaking and critical mind, who dislikes hastily improvised generalizations, and is not afraid of starting a fight when he finds historic truth twisted to fit respectable traditions" (Piaget, 1952a, p. 237). Piaget remembered his mother as intelligent, energetic, and kind, but with a neurotic temperament that drove him to both imitate his father and escape to what Piaget called a "private and nonfictitious world," a world of serious work. Piaget acknowledged that the turbulent family situation aroused his interest in psychoanalytic theory.

It would be easier to list what did not interest the boy Piaget than what did. A sampling of his interests includes mechanics, seashells, birds, and fossils. One of his early writings was a pamphlet (written in pencil because he was not yet allowed to write in ink) describing an "autovap," an intriguing union of a wagon and a locomotive. Piaget's first publication was a one-page article about a partly albino sparrow he had observed in a park. This achievement came at age 10—long before he had heard of "publish or perish." Piaget's interest in the exhibits in the local natural history museum led to an invitation to assist the director with his mollusk (shellfish) collections. Piaget's publications on mollusks attracted notice among natural historians. He was offered, sight unseen, the curatorship of mollusks at a natural history museum in Geneva. He had to decline the offer, however, because he had not yet finished secondary school!

Piaget did not escape the typical social and philosophical crises of adolescence. Conflicts between his religious and scientific teachings stimulated him to read hungrily through Bergson, Kant, Spencer, Comte, Durkheim, and William James, among others. This philosophical turmoil is expressed in his philosophical novel published in 1917. That this novel did not become a bestseller can be surmised from passages such as this one: "Now there can be no awareness of these qualities, hence these qualities cannot exist, if there are no relationships among them, if they are not, consequently, blended into a total quality which contains them while keeping them distinct" (1952a, p. 243). Piaget observed that "no one spoke of it except one or two indignant philosophers" (1952a, p. 243).

Piaget obtained his doctoral degree with a thesis on mollusks at the University of Neuchâtel in 1918 at age 21. Despite his 20 published papers, he was not eager to devote his life to observing mollusks. After visiting psychological laboratories in Zurich and exploring psychoanalytic theory briefly, Piaget spent two years at the Sorbonne studying psychology and philosophy. By luck (for the field of developmental psychology), Piaget met Theodore Simon, a pioneer in the development of intelligence tests, who asked him to standardize Alfred Binet's reasoning tests on Parisian children. Piaget began the work with little enthusiasm. However, his interest was aroused when he began asking children to explain their answers. He became fascinated with the thought processes underlying their answers, especially the incorrect answers. In these "conversations," Piaget used psychiatric interviewing techniques he had acquired at the Sorbonne while working with mental patients. Without Simon's knowledge, Piaget continued this research for two years. Piaget sums up this experience:

> At last I had found my field of research. . . . My aim of discovering a sort of embryology of intelligence fit in with my biological training; from the

> start of my theoretical thinking I was certain that the problem of the relation between the organism and environment extended also into the realm of knowledge, appearing here as the problem of the relation between the acting or thinking subject and the objects of his experience. Now I had the chance of studying this problem in terms of psychogenetic development.
>
> *(1952a, p. 245)*

This research in Binet's laboratory led to three published articles, and to an offer in 1921 to become director of studies at the Institut J. J. Rousseau in Geneva. Piaget planned to spend only five years studying child psychology (a plan that, happily, went awry). The freedom and research facilities of this position resulted in five books: *The Language and Thought of the Child* (1923), *Judgment and Reasoning in the Child* (1924), *The Child's Conception of the World* (1926), *The Child's Conception of Physical Causality* (1927), and *The Moral Judgment of the Child* (1932). To his surprise, the books were read and discussed widely. He became known as a child psychologist, even though he had no university degree in psychology, and his fame grew rapidly in Europe.

In the following few years, Piaget continued his research at the institute, taught philosophy at the University of Neuchâtel, learned about Gestalt psychology, observed his own babies, and even performed some research on mollusks in his free time. During the 1940s and 1950s, he occupied several important academic and administrative positions at the University of Geneva, as well as international posts, such as president of the Swiss Commission of UNESCO. There were productive collaborations with Alina Szeminska, Bärbel Inhelder, and Marcel Lambercier on the manipulation of objects, the development of perception, and the notions of number, physical quantity, and space. Albert Einstein's suggestion that Piaget study children's concepts of time, velocity, and movement generated two provocative books on this topic. Piaget also studied many topics outside of children's thinking: education, the history of thought and logic, and his old passion, epistemology, or theory of knowledge.

In 1969, the American Psychological Association gave Piaget the Distinguished Scientific Contribution Award "for his revolutionary perspective on the nature of human knowledge and biological intelligence" (Evans, 1973, p. 143). He was the first European to receive this award. Piaget pursued the riddle of children's thinking until his death in 1980, at age 84. Even in his final years, books and articles continued to emerge from behind the piles of papers and books in seeming disarray in his office. His flowing white hair, pipe, beret, and bicycle were a familiar sight in Geneva. We have the following description of Piaget at age 70: "He moves deliberately, but his blue eyes sparkle with youth, good humor and zest. Benevolent enough, but not heavy enough, to look like Santa Claus, he reminds one faintly of the pictures of Franz Liszt that have come down to us" (Tuddenham, 1966, p. 208).

Piaget was amazingly productive. He wrote more than 50 books and 500 papers, averaging about one and a quarter books per year from his first volume until his death (Brainerd, 1996). Piaget attributed his productivity, in part, to his helpful colleagues but also gave us the following interesting glimpse into his personality:

> And then, too, I owe it to a particular bent of my character. Fundamentally I am a worrier whom only work can relieve. It is true I am sociable and like to teach or to take part in meetings of all kinds, but I feel a compelling need for solitude and contact with nature. After mornings spent with others, I begin each afternoon with a walk during which I quietly collect my thoughts and coordinate them, after which I return to the desk at my home in the country.
>
> *(1952a, p. 255)*

General Orientation to the Theory

Like a short guided tour in an unfamiliar city, the following attempts to provide an overview of Piaget's theory before exploring the nooks and crannies—and perhaps becoming lost. We examine five salient characteristics of the theory: genetic epistemology, the biological approach, structuralism, the stage approach, and Piaget's methodology. These characteristics relate to Piaget's interests and goals, described earlier. Although this is a chapter on Piaget's theory, Piaget acknowledged the contributions of his co-workers, a main one being Bärbel Inhelder.

Genetic Epistemology

Perhaps the most incomprehensible thing about the world is that it is comprehensible.

—Albert Einstein

Piaget might well have agreed with Einstein, for he had a lifelong fascination with how humans comprehend the world. The branch of philosophy concerned with the study of knowledge is called *epistemology*. As Piaget viewed it, epistemology is "the problem of the relation between the acting or thinking subject and the objects of his experience" (1952a, p. 245). Piaget tackled the same questions that have engaged philosophers for centuries: How do we come to know something? Is objective knowledge, unbiased by the nature of the knower, even possible? Are there certain innate ideas, or must all knowledge be acquired? All of Piaget's writings can be seen as attempts to answer these questions in different content areas, for example, mathematics, moral reasoning, and language. As we saw in the biographical sketch of Piaget, his philosophical quest led him through various schools of philosophy, biology, history, mathematics, and psychology. His search finally stopped at developmental psychology, which was not even an organized field of study at the time.

Piaget's journey to developmental psychology brings us to the "genetic" part of the term *genetic epistemology*. In this context, the word *genetic* refers not to what is innate, the more common meaning of the term today, but to "development" or "emergence." By studying developmental changes in the process of knowing and in the organization of knowledge, Piaget felt that he could find answers to the traditional questions of epistemology. His concern with the classical issues in epistemology explains his interest in what philosophers traditionally have considered the basic categories of knowledge: time, space, causality, and quantity. These concepts are obvious to an adult but, according to Piaget, are not obvious to children. Piaget wondered how and when children understand that no two objects can occupy the same place, that objects exist even when out of sight, and that two contiguous events can have a causal relationship. It may be as difficult for young children to understand these concepts as it is for adults to understand "black holes" in space or the theory of relativity.

Piaget can be called an experimental epistemologist. Unlike most epistemologists, who use logical arguments to support their views, Piaget rejected this armchair approach and formulated testable hypotheses. His epistemology was a marriage of philosophy and the scientific method, of logic and fact. For example, he examined the question of how humans acquire concepts of time, space, and causality by tracing the development of these concepts.

Piaget's simple but revolutionary solution to the problem of epistemology is that knowledge is an action or event rather than a state. It is a relationship between the active knower and an object. A child knows or understands a ball or a rattle by manipulating it—physically or mentally. In this way, people "construct" knowledge. They actively select and interpret information in the environment, thus contributing to the form that knowledge takes. They do not passively soak up information to build a storehouse of knowledge.

Children's knowledge of the world changes as their cognitive system develops. As the knower changes, so does the known. A concrete example is the knowledge of relationships in space. Infants construct a practical, perceptual–motor knowledge of near and far, up and down. Older children construct a more abstract "cognitive map" of the relations among objects in their environment. Infants "know" space by crawling in it and reaching for objects, whereas older children know space by manipulating mental symbols in particular ways. Note that in both cases there is a constant interaction between the knower and the external world.

One implication of Piaget's theory of knowledge is that knowledge is biased, until perhaps the end of the final stage. Experience is always filtered through the child's current ways of understanding. A child's mind is not a camera that takes faithful pictures of reality. However, as the mind develops, it becomes more in tune with reality.

Biological Approach

Beginning with his boyhood interest in shells and birds, Piaget's thinking was firmly rooted in biology. His distinction is that he saw more in mollusks than did most biologists. In the humble mollusk, he saw general principles of how living organisms adapt to the world. Mollusks both adjust themselves to the environment and actively assimilate it in ways allowed by their biological structure. Piaget felt that these principles also apply to human thought: Intelligence is adaptation to the environment. Just as organisms adapt physically to the environment, so does thought adapt to the environment at a psychological level. Piaget hypothesized that the modes of psychological functioning involved in this adaptation are universal, that is, used by all humans worldwide.

Borrowing another concept from biology, Piaget proposed that cognitive growth is much like embryological growth: an organized structure becomes more and more differentiated, and complex, over time. In fact, Piaget (1970) sometimes referred to cognitive development as "mental embryology."

Adaptation, organization, and structure, as well as such other biological concepts as equilibration, assimilation, and accommodation, are discussed later in the chapter, when we turn our attention to processes of development. At this point, however, it should be emphasized that these biological concepts serve as analogies for the way intelligence works. Piaget did not reduce intelligence to the study of neurons and genes.

Structuralism

Because children's thinking seemed systematic to Piaget, he turned to *structuralism*. This helped Piaget express how thought is organized—how the parts relate to the whole. He proposed that a small set of mental operations (mental actions) forms a structure that underlies much of our thinking, even though this thinking may seem very different when we think about different topics. He theorized that the nature of mental structures changes as they develop. An infant's cognitive structures are labeled "schemes" (sometimes translated "schemas" or "schemata"). A *scheme* is an organized pattern of behavior; it reflects a particular way of interacting with the environment. For Piaget, a scheme is whatever is repeatable and generalizable in an action. The sucking scheme, then, is a mental structure that describes the systematic way that children put various objects into their mouths and suck them. As the scheme becomes more differentiated, children classify objects into "suckables" and "nonsuckables," with various subcategories such as hard suckables, soft suckables, good-tasting suckables, and hairy suckables (daddy's leg).

In contrast, the cognitive structures of older children, from roughly age 7 on, are organized abstract mental operations similar to logicomathematical systems. The structuralist framework can be seen in the way these schemes and operations organize themselves into a system that can be applied to various content. For example, addition, subtraction, multiplication, and division are operations that are coordinated in a concept of number that underlies much mathematical understanding. (We return to the notion of cognitive structures later.)

Two points should be emphasized. First, children *actively* construct these structures. Second, Piaget emphasized the feeling of necessity that accompanies the acquisition of a cognitive structure. For example, 2 plus 2 *has to* equal 4; one cannot imagine otherwise.

Stage Approach

Milestones, phases, and ages
render general gauges
While periods, levels, and stages
require pages and pages.

—Leland van den Daele (1969, p. 303)

Perhaps the boldest and most controversial of Piaget's claims is that cognitive development proceeds through a series of stages. For Piaget, a *stage* is a period of time during which the child's thinking and behavior in a variety of situations tend to reflect a particular type of underlying mental structure. Piaget's emphasis on stages is not surprising, considering his years of careful observing and classifying, and studying evolution while a student of zoology. The stages can be thought of as sequential levels of adapting. Just as various species have different ways of adapting to the environment, so do various cognitive levels provide different ways of adapting to the environment. Because stage theories abound in developmental psychology, it will be helpful to characterize Piaget's particular brand of stage theory. There are five salient characteristics.

1 *A stage is a structured whole in a state of equilibrium.* Piaget the structuralist saw a stage as an integrated whole that organizes the parts. The schemes or operations of each stage are interconnected to form an organized whole. Each stage has a different structure, which allows a different type of interaction between the child and the environment, and consequently provides fundamentally different views of the world. The essence of Piaget's stage approach is that movement through the stages involves structural changes that are qualitative (changes in type or kind) rather than quantitative (change in degree, amount, speed, or efficiency). For example, there is a qualitative change when the child moves from structures based on actions in infancy to structures based on mental representation in the preschool years. At the *end* of each major period of development, the cognitive structures are in a state of balance, or equilibrium. (More on the equilibration process appears later in this chapter.)

2 *Each stage derives from the previous stage, incorporates and transforms that stage, and prepares for the next stage.* The previous stage paves the way for the new stage by being reworked to form the new stage. Thus, once children achieve a new stage, they no longer have the previous stage available. Although previous skills remain, their position or role in the organization changes. For example, elementary school children can still roll or hit a ball (a skill acquired during infancy), but they now embed this skill in a number of other skills. Furthermore, a more advanced level of thought controls the old skills of rolling and hitting in order to win the game. Note that regression to an earlier stage is impossible because the previous stage is no longer present. In contrast, Freud's theory of stages holds that a person overwhelmed with anxiety may regress to an earlier stage.

3 *The stages follow an invariant sequence.* Since each stage is derived from the preceding stage, the stages must proceed in a particular order. No stage can be skipped.

4 *Stages are universal*. Because Piaget was interested in how humans as a species adapt psychologically to their environment, he focused on the structures and concepts acquired by humans everywhere—in the African jungle, the American suburb, or the Swiss mountainside. Of course, people with a low IQ may not progress through all the stages or may progress through them more slowly. And people in general vary in how fast they proceed through the stages. However, the crucial claim is that the same stages in the same order are found universally.

5 *Each stage includes a coming-into-being and a being*. There is an initial period of preparation and a final period of achievement in each stage. Unstable, loosely organized structures mark the initial period of transition from the previous stage. Change both within a stage and between stages is somewhat gradual. The description of each stage later in this chapter refers to the final, stable, generalized, tightly organized structure of each stage.

Methodology

One message from the Introduction is that the scientist, the theory, and the methods for gathering data both facilitate and constrain one another. The three develop together in particular directions. Piaget the sparrow watcher and mollusk collector used his observation and classification skills when watching infants master the objects around them and when observing toddlers struggle to express their thoughts in spontaneous speech. Piaget as the Sorbonne student interviewing mental patients soon became known as the man who asked children questions about dreams, the origin of the universe, and quantity. Piaget's early work with preschool and school children typically involved the *clinical method*, which involves a chainlike verbal interaction between the experimenter and the child. Experimenters begin by posing a problem or asking a question, but subsequent questions are guided by the answer the child gave to the previous question. Through this interchange, experimenters try to understand the line of reasoning underlying a child's answers. A talented interviewer avoids biasing the child's answers by refraining from too much suggestion.

The following exchange between Piaget and a 5-year-old illustrates the clinical method:

> Where does the dream come from? —*I think you sleep so well that you dream*. —Does it come from us or from outside? —*From outside*. —What

> do we dream with? —*I don't know*. —With the hands? . . . With nothing? —*Yes, with nothing*. —When you are in bed and you dream, where is the dream? —*In my bed, under the blanket. I don't really know. If it was in my stomach(!) the bones would be in the way and I shouldn't see it*. —Is the dream there when you sleep? —*Yes, it is in my bed beside me* . . . . Is the dream in your head? —*It is I that am in the dream: it isn't in my head(!). When you dream, you don't know you are in the bed. You know you are walking. You are in the dream. You are in bed, but you don't know you are*. . . . Where do dreams come from? —*I don't know. They happen*. —Where? —*In the room and then afterward they come up to the children. They come by themselves.* —You see the dream when you are in the room, but if I were in the room, too, should I see it? —*No, grownups (les Messieurs) don't ever dream*. . . . When the dream is in the room, is it near you? —*Yes, there!* (pointing to 30 cms. in front of his eyes).
>
> *(1926/1929, pp. 97–98)*

In Piaget's later work, such interviews often were combined with the manipulation of objects by the experimenter or child. This was especially likely when Piaget studied numerical and physical concepts or perceptual development. For example, Piaget might spread out a row of objects and ask whether the number had changed.

Infants, of course, cannot fruitfully be questioned about their thoughts. Piaget and his psychologist wife, Valentine, kept a baby diary of observations of their own infants as the infants went about their normal activities. At times, Piaget became a participant–observer by inventing little experiments on the spot, such as hiding a toy and observing whether the infant searched for it.

From these verbal protocols and behavioral observations, Piaget inferred general structures of thought. Because these varied, concrete behaviors were seen through the eyes of Piaget the philosopher and theoretical biologist, the descriptions often were accompanied by long, abstract, theoretical passages. His writings often had a high proportion of theoretical interpretation to actual observation.

One of the challenges to someone encountering Piaget's theory for the first time is to relate the many elusive, abstract features of the theory to the abundant specific behaviors found in each stage. Perhaps the best way to grasp the relationship between the abstract and the concrete is to swing back and forth between the two. Following this strategy, we now swing from the preceding abstract orientation to a description of specific stagelike changes and then swing back to abstract features found in mechanisms of change.

Description of the Stages

In the Introduction to this book, it was proposed that a developmental theory should both describe and explain development. The present section describes the prototypic Piagetian child making her way through the stages of cognitive development. The subsequent section tackles the questions of how and why this particular course of development occurs.

To understand each stage, we need to know not only where it came from but also where it is going. Each stage holds both the fruits of the past and the seeds of the future. Here, then, is an overview of the stages, followed by a more detailed account. The ages listed with each stage are approximate because children vary somewhat in the ages at which they proceed through the stages. Note that although Piaget referred to "stages" of development, he called them "periods," for example, the "sensorimotor period." He labeled the steps within each period as "stages."

1. *Sensorimotor period* (roughly birth to 2 years). Infants understand the world in terms of their overt, physical actions on the world. They move from simple reflexes through several steps to an organized set of schemes (organized sensorimotor behaviors). In babies' play, we see their minds.
2. *Preoperational period* (roughly 2 to 7 years). No longer do children simply make perceptual and motor adjustments to objects and events. They can now use symbols (mental images, words, gestures) to represent these objects and events. They use these symbols in an increasingly organized and logical fashion.
3. *Concrete operational period* (roughly 7 to 11 years). Children acquire certain logical structures that allow them to perform various mental operations, which are internalized actions that can be reversed.
4. *Formal operational period* (roughly 11 to 15 years). Mental operations are no longer limited to concrete objects; they can be applied to purely verbal or logical statements, to the possible as well as the real, to the future as well as the present.

Sensorimotor Period (Roughly Birth to 2 Years)

In Piaget's view, a human starts life with a set of reflexes, a particular physical makeup unique to the human species, and inherited ways of interacting with the environment. These inherited ways of interacting reflect the tendency of thought to be organized and adapted to the environment. The thinking of even Einstein had these humble beginnings. Although newborns know almost nothing about the world, they have the potential to know almost everything. Indeed, one of Piaget's books on infancy is aptly titled *The Origins of Intelligence in Children* (1936). We now trace infants' active construction of a model of the world by means of the sensory (perceptual) and motor (physical movement) systems. Infants progress through six stages to construct a sensorimotor system of thought.

Stage 1: Modification of Reflexes (Roughly Birth to 1 Month) ▸ A newborn is a bundle of reflexes, or "wired-in" responses that are triggered by particular stimuli. Touch a newborn's lips and she sucks, prick her foot and her knee flexes, place a finger in her hand and she grasps it. As these reflexes are activated a number of times, they very gradually are modified. An infant adjusts them slightly to meet the requirements of slightly different circumstances. For example, an infant's mouth must search out the nipple from different angles on different occasions. In addition, the way the mouth and tongue fit around a hard, plastic rattle differs from the way they fit around a finger.

As an expanding number and type of objects serve as "grist" for the sucking reflex, the category of "suckables" grows to include objects ranging from nipples to blankets to bars of the crib. However, at the same time that infants are generalizing their sucking behavior to many objects, they are also increasing their discrimination between objects. Hungry infants never confuse a finger with a nipple. In a sense, they "recognize" objects.

Behaviors such as sucking, grasping, and looking do not remain reflexes; babies come to produce them spontaneously. In fact, they sometimes suck when there is nothing to suck. Piaget claimed that there is an innate tendency for humans to exercise their skills. Babies suck because they *can* suck. Sucking strengthens the sucking skill and leads to further sucking.

In short, in stage 1, babies modify their reflexes and begin to transform them into the "schemes" mentioned earlier. These schemes—organized patterns of behavior—continue to strengthen, generalize, and differentiate throughout the sensorimotor period. Infants are beginning to construct primitive concepts about objects to suck, grasp, look at, hit, listen to, and feel.

Stage 2: Primary Circular Reactions (Roughly 1 to 4 Months) ▸ The behaviors in stage 1 can be called schemes only in a very limited sense because there is so little modification of reflexes. In stage 2, there is widespread and rapid development of schemes because *primary circular* *reactions* can now occur. A circular reaction is a behavior that is repeated over and over again and thus becomes circular. By chance, a baby discovers an interesting result from some behavior and then attempts to recapture this result. As the behavior and its results are successfully repeated, it can be said that a "habit" is formed. These circular reactions are called "primary" because they involve response consequences that are centered on or around the infant's body rather than other objects. Examples include thumb sucking, visually exploring objects, and listening to one's own vocalizations.

Piaget observed primary circular reactions in his own infants. Consider the following example (the three numbers refer to the child's age in years, months, and days):

> From 0;2(3) Laurent evidences a circular reaction which will become more definite and will constitute the beginning of systematic grasping; he scratches and tries to grasp, lets go, scratches and grasps again, etc. On 0;2(3) and 0;2(6) this can only be observed during the feeding. Laurent gently scratches his mother's bare shoulder. But beginning 0;2(7) the behavior becomes marked in the cradle itself. Laurent scratches the sheet which is folded over the blankets, then grasps it and holds it a moment, then lets it go, scratches it again and recommences without interruption. At 0;2(11) this play lasts a quarter of an hour at a time, several times during the day. At 0;2(12) he scratches and grasps my fist which I placed against the back of his right hand. He even succeeds in discriminating my bent finger and grasping it separately, holding it a few moments. At 0;2(14) and 0;2(16) I note how definitely the spontaneous grasping of the sheet reveals the characteristics of circular reaction—groping at first, then regular rhythmical activity (scratching, grasping, holding and letting go), and finally progressive loss of interest.
>
> *(1936/1952b, pp. 91–92)*

These circular reactions become deliberate and seem to be accompanied by feelings of pleasure. Piaget describes a baby who "played with his voice, not only through interest in the sound, but for 'functional pleasure,' laughing at his own power" (1945/1951, p. 91).

Stage 3: Secondary Circular Reactions (Roughly 4 to 8 Months) ▸ Infants are never content with the status quo; they continue to push themselves and expand their world. This expansion is especially striking in the movement from primary to *secondary circular reactions*. Whereas primary circular reactions are centered around an infant's body, secondary circular reactions are oriented to the external world. By chance, an infant does something that leads to an interesting effect in the environment: he shakes a rattle, which produces a noise; he slaps a ball, which causes it to roll. In the previous stage, the shaking or slapping itself was of interest; now the environmental consequences are.

When the secondary circular reactions generalize, Piaget calls them "procedures for making interesting sights last." If kicking their legs vigorously leads to a jiggling mobile a number of times, infants may make this kicking procedure a part of their repertoire. On future occasions when an interesting movement occurs, they may kick in an attempt to sustain or re-create this movement. Sometimes these procedures produce the desired result; sometimes they do not. On one occasion, after watching, in fascination, his father drum on a tin box, 7-month-old Laurent first stared at it, then shook his arm, raised himself, struck his covers, and shook his head in an attempt to capture the box—all to no avail.

One of Piaget's novel observations in this stage is "motor recognition," in which infants show they recognize an object by producing the merest outline of the secondary circular reaction that the object normally would produce. For example, when Piaget's infant daughter, Lucienne, saw a doll that she often had swung in the past, she simply opened and closed her hands or shook her legs; this was a reduced, effortless version of the original behavior.

Stage 4: Coordination of Secondary Schemes (Roughly 8 to 12 Months) ▶ During stages 2 and 3, infants could do some simple coordinating of their schemes, for example seeing and grasping. This coordination of the schemes of looking, grasping, sucking, hearing, and so forth will continue throughout the sensorimotor period. In this way, the cognitive structures become increasingly integrated and organized. In stage 4, infants now can combine their schemes in complex ways. They learn to differentiate an instrumental (or means) behavior (scheme) and a goal behavior (another scheme). Infants know what they want and can put together schemes to achieve that goal. In contrast, in stage 3, infants' discovery of interesting results was fortuitous; only *afterward* did they try to achieve the outcome again. A special feature of this means–end behavior is that it is applied to *new* situations. The schemes are now mobile cognitive tools, freed from their original contexts. Babies use them at will to achieve a variety of goals.

Babies begin to look like planful and intentional creatures. Piaget related various occasions on which he placed his hand in front of a desirable matchbox. Whereas in stage 3 Laurent simply applied (unsuccessfully) his familiar grasping scheme toward the matchbox, in stage 4 he hit his father's hand (means) and grasped the box (end). Laurent had deliberately removed a barrier in order to achieve a goal. Infants also learn to use people as means; an infant may place his mother's hand on the television remote control in order to see the dark screen come alive.

One outcome of the differentiation between means and ends is the anticipation of events:

> At 0;9(16) . . . she likes the grape juice in a glass, but not the soup in a bowl. She watches her mother's activity. When the spoon comes out of the glass she opens her mouth wide, whereas when the spoon comes from the bowl, her mouth remains closed. Her mother tries to lead her to make a mistake by taking a spoon from the bowl and passing it by the glass before offering it to Jacqueline. But she is not fooled.
>
> *(Piaget, 1936/1952b, p. 249)*

Stage 5: Tertiary Circular Reactions (Roughly 12 to 18 Months) ▸ In this stage, infant scientists are at work. Their environment is their laboratory. They perform miniature experiments in which they deliberately vary an action in order to see how this variation affects the outcome, as do scientists. They exploit each object's potential. They seem to be asking, "Is there anything new about this object?" Again, Laurent thoughtfully provides us with a nice example:

> At 0;10(11) Laurent is lying on his back but nevertheless resumes his experiments of the day before. He grasps in succession a celluloid swan, a box, etc., stretches out his arm and lets them fall. He distinctly varies the positions of the fall. Sometimes he stretches out his arm vertically, sometimes he holds it obliquely, in front of or behind his eyes, etc. When the object falls in a new position (for example on his pillow), he lets it fall two or three times more on the same place, as though to study the spatial relation; then he modifies the situation. At a certain moment the swan falls near his mouth: now, he does not suck it (even though this object habitually serves this purpose), but drops it three times more while merely making the gesture of opening his mouth.
>
> *(Piaget, 1936/1952b, p. 269)*

Through deliberate trial-and-error exploration, infants extend the means–end behavior of the previous stage to develop new means. They no longer simply coordinate old schemes. In fact, Piaget often characterized stage 5 as "the discovery of new means through active experimentation." Examples of new means might include pulling a blanket to obtain an object resting on the blanket or positioning a long, thin object in such a way that it can be slipped through the bars of a crib.

Stage 6: Invention of New Means Through Mental Combinations (Roughly 18 to 24 Months) ▸ Stage 6 both closes the curtain on the sensorimotor period and raises it on the preoperational period. The achievements of one period always make it possible for the child to begin the next period. Before stage 6, children have displayed their thinking to the world. Now, thinking begins to go underground. External physical exploration gives way to internal mental exploration. This is possible because children now can use mental symbols to *represent* objects and events.

Lucienne shows us how this mental representation leads to a new way of solving problems:

> At 1;6(23) for the first time Lucienne plays with a doll carriage whose handle comes to the height of her face. She rolls it over the carpet by pushing it. When she comes against a wall, she pulls, walking backward. But as this position is not convenient for her, she pauses and without hesitation, goes to the other side to push the carriage again. She therefore found the procedure in one attempt, apparently through analogy to other situations but without training, apprenticeship, or chance.
>
> *(Piaget, 1936/1952b, p. 338)*

Earlier, Lucienne would have had to solve the problem through trial and error. Now she can solve the problem by "thinking" in symbols.

The emergence of a mental symbol can be seen in one of the most stunning of Piaget's observations. Piaget was playing a game with Lucienne at age 1 year, 4 months, in which he hid from her a watch chain inside an empty sliding matchbox. Lucienne first attained the chain by applying old schemes—turning the box upside down so that the contents spill out through the opening or, with a smaller opening, sliding her fingers into the slot to grasp the chain. Then Piaget surreptitiously slid the box to reduce the size of the opening and Lucienne discovered that it was too small to permit her fingers to reach the chain. Next came the behavior of interest:

> She looks at the slit with great attention; then, several times in succession, she opens and shuts her mouth, at first slightly, then wider and wider! Apparently Lucienne understands the existence of a cavity subjacent to the slit and wishes to enlarge that cavity. The attempt at representation which she thus furnishes is expressed plastically, that is to say, due to inability to think out the situation in words or clear visual images she uses a simple motor indication as "signifier" or symbol.
>
> *(Piaget, 1936/1952b, p. 338)*

When faced with this problem that past methods did not solve, Lucienne thought through the problem, partly by moving her mouth to represent the opening of the box and partly by thinking. She was in transition from action to a true use of mental symbols. These reduced motoric imitations become the mental representations of the next stage.

One achievement of this stage is that an event that has been represented can be evoked at a later time. This absent event is reproduced in part, as seen in the following observation:

> At 1;4(3) J. had a visit from a little boy of 1;6, whom she used to see from time to time, and who, in the course of the afternoon got into a terrible temper. He screamed as he tried to get out of a play-pen and pushed it backwards, stamping his feet. J. stood watching him in amazement, never having witnessed such a scene before. The next day, she herself screamed in her play-pen and tried to move it, stamping her foot lightly several times in succession. The imitation of the whole scene was most striking. Had it been immediate, it would naturally not have involved representation, but coming as it did after an interval of more than twelve hours, it must have involved some representative or pre-representative element.
>
> *(Piaget, 1945/1951, p. 63)*

Overview of the Sensorimotor Period ▸ The sensorimotor period has been presented in some detail because it provides a concrete illustration of the following general characteristics of all four periods:

1. *A child actively learns about properties of objects and relations among them.* In the sensorimotor period, children achieve this knowledge through overt actions, thus, a "logic of action."

2. *Cognitive structures gradually become more tightly organized.* Children coordinate schemes and apply them as solutions to new situations.

3. *Behavior gradually becomes more intentional.* Children differentiate between means and ends, invent new means, and apply them to new ends in new situations.

4. *The self is gradually differentiated from the environment.* Children discover the boundaries of their own body and see themselves as one object in a world of objects.

Concept of Object Permanence ▸ Perhaps the most important concept acquired during the sensorimotor period is the notion of *object* *permanence*: an object continues to exist even when one cannot see, hear, or feel it. This knowledge is necessary for a notion of a stable, predictable world. According to Piaget, the concept develops as follows: During the first few months of life, if an object disappears, infants do not search for it (stages 1 and 2). Their behavior follows the rule "out of sight, out of mind." Later, they search if the object is only partially hidden or if they were doing something with the object when it disappeared (stage 3). However, they give up easily if the object does not reappear quickly. They still think of the object as an extension of their actions on it. Still later, as schemes are coordinated, children have the skills needed to look for hidden objects (stage 4). However, they persist in searching in the place where they searched previously. Thus, when Piaget hid a toy parrot twice under a mattress to his daughter's left and then hid it to her right (as she watched), she immediately searched to the left—in the original hiding place. Piaget's interpretation of this so-called A-not-B error was that she defined an object partly in terms of its position—a "parrot-under-the-mattress."

The next advance is that children can appropriately search for an object even if there are several displacements, but only if they are visible (stage 5). There is a problem with invisible displacements, as when Piaget put a coin in his hand and moved it under a cushion, then under a coverlet, and then out again. However, in the final stage, Jacqueline continued to search for the coin because she now knew that it had to be somewhere (stage 6). She could represent the object mentally, so was not dependent on seeing, or otherwise acting on, the object. At last she understood that objects, including herself, are things that exist in and of themselves.

In variations on a (sensorimotor) theme by Piaget, his *Construction of Reality in the Child* (1937/1954) traces babies' development of concepts of time, space, and causality. This should come as no surprise, given Piaget's interest in these classical philosophical problems of epistemology. The concepts of time, space, and causality are closely linked to the object concept because objects exist, move, and affect other objects in a spatiotemporal field.

Preoperational Period (Roughly 2 to 7 Years)

Ending the first period and beginning the next is like climbing a mountain only to discover that it is merely a foothill to Mt. Everest. The achievements of the sensorimotor period, although monumental, are also preparation for what is to come. In a sense, children start all over again. What they have achieved in the realm of actions on the world is redeveloped, now in the realm of mental representations. They reconstruct notions about objects, relations, causality, space, and time in a new medium (mental representation) and a more highly organized structure. The sensorimotor actions become representational, in preparation for the move to mental actions in the next stage.

Mental Representations ▸ As we noted earlier, the emergence of mental representations in stage 6 of the sensorimotor period is a developmental breakthrough that provides a bridge to the preoperational period. Using mental representations to stand for objects or events is part of a broader skill of using one thing to stand for another. A 4-year-old may use the word "airplane," a swooping hand, a mental picture of an airplane, or a toy airplane to stand for a real airplane.

There are two types of representations: *symbols* and *signs*. Symbols bear some similarity to the objects or events they stand for and have lingering traces of their origins in imitation. Symbols often appear in *symbolic play*, as when Jacqueline pretended that a cloth was a pillow and feigned sleep, laughing hard all the while. In contrast, signs are arbitrarily related to certain events or objects. There is no relationship between the word "table" and the four-legged thing at which we sit, except that our language has assigned a relation between them. This notion that words or other signs are arbitrarily assigned to objects is not easy for a child to grasp. Young children think that an object's name is as intrinsic to the object as are its color and form. When asked why spaghetti is called spaghetti, a young child may say that it looks like spaghetti and feels like spaghetti and tastes like spaghetti, so we call it spaghetti!

Representational thought has obvious advantages over sensorimotor thought. It is faster and more mobile. It can deal with the past, present, and future in one grand sweep and can recombine its parts to create ideas that refer to nothing in reality (for example, monsters that go bump in the night). In contrast, Piaget described sensorimotor intelligence as a motion picture with the action slowed down so that "all the pictures are seen in succession but without fusion, and so without the continuous vision necessary for understanding the whole" (1947/1950, p. 121).

It should be noted that Piaget did not hold the common view that the source of representational thought is the ability to use words. He believed that the opposite is true: The development of representational thought makes it possible to use words as well as other signifiers. Thus, thought is prior to the emergence of language and broader than language. Language is primarily a mode for expressing thought. Although thinking is not dependent on language, language can aid cognitive development. Language can direct children's attention to new objects or relationships in the environment, introduce conflicting points of view, and impart abstract information that is not easily acquired directly. Language is one of many tools in our cognitive "toolkit" (Wertsch, 1991).

Characteristics of the Period ▸ Although thinking through symbols and signs is a tremendous advance over sensorimotor thought, such thinking is limited in a number of ways. As the term *preoperational* suggests, children in this period have not yet acquired reversible mental operations, such as adding and subtracting, which characterize the thinking of the next period, called concrete operations. In many ways, this period is a time of preparation for the next stage rather than a stage in its own right, and Piaget himself typically described preoperational children in terms of what they cannot do, rather than what they can do. The main characteristics of preoperational thought are egocentrism, rigidity of thought, semilogical reasoning, and limited social cognition.

1 *Egocentrism*. Egocentrism does not refer to selfishness or arrogance. Rather, the term refers to (a) the incomplete differentiation of the self and the world, including other people, and (b) the tendency to perceive, understand, and interpret the world in terms of the self. One implication is that children have trouble taking another person's perceptual or conceptual perspective and in fact have no sense of a "point of view." For example, preoperational children do not realize that a person viewing a display from a position different from their own sees the display differently. Similarly, a child holding a book upright points to a picture and asks, "What is this?" He is unaware that his mother, who is facing him, can see only the back of the book. Egocentrism makes it difficult to take the role of another person. This can be seen in a card game when a 5-year-old giggles when she draws a good card. She does not perceive the need for a "poker face" as a card-playing strategy.

Because children cannot easily take another person's role, they make little effort to tailor their speech to meet the needs of the listener. A boy may tell his mother that at a birthday party "he hit her with it," without bothering to explain to what "he," "her," and "it" refer. He may omit essential events, so his mother cannot understand how "he cried" and "he blew out the candles" are related. Egocentric speech is particularly rampant in children's play groups. Children who seem to be engaged in a conversation actually may be engaged in a collective monologue. Each child's remarks are unrelated to anyone else's. For example, one child's statement, "I think I saw Superman in a phone booth yesterday," might be followed by "This sweater makes me itch" from another child.

After the preoperational period, egocentrism continues to decline. However, it never disappears completely, even in adulthood, as when a lecturer pitches his remarks too high or too low for his audience.

2 *Rigidity of thought*. Piaget characterized preoperational thought as frozen. One example is *centration*, the tendency to attend to or think about one salient feature of an object or event and ignore other features. If two identical containers have equal amounts of water and the contents of one container are poured into a taller, thinner container, children center on the heights of the liquids, while ignoring their widths. Consequently, they erroneously conclude that there is now more liquid because the water level is higher. Centration and egocentrism are similar in that they both reflect an inability to deal with several aspects of a situation at the same time; thus they both cause a biased view of the world.

Children also show inflexible thinking in their tendency to *focus on states* and ignore the transformations linking the states. In the above example of liquid quantity, a child thinks about the "before" and "after" states but ignores the process of pouring. Relatedly, preoperational children *lack mental reversibility,* and thus are unable to return the poured liquid to its original container mentally. Finally, children *focus on appearance* rather than reality. If a stick looks like it bends when it is plunged into water, young children assume this perception is true.

Toward the end of the preoperational period, we begin to see "the great thaw," as children's thinking becomes less frozen, more fluid. Showing that there are some positive achievements of the preoperational period, several new cognitive skills pave the way for the mental operations of the concrete operational period. One emerging concept is a *function*—the notion that there is a relation between factors, as expressed in the equation $y = f(x)$. For example, the more one pulls a curtain cord, the farther a curtain opens. However, children cannot yet work out the precise and quantitative nature of the relationship. Another new concept is *identity*, the notion that an object can change its appearance without changing its basic nature, or identity. Putting on a Halloween mask does not change a person into a witch, contrary to the belief of younger children.

3 *Semilogical reasoning*. Piaget's interviews with children about their beliefs concerning the world revealed their preoperational reasoning, such as egocentrism and rigid thinking. The conversations also uncovered some fascinating causal reasoning, which could be considered

semilogical. The following protocol illustrates several facets of semilogical reasoning in a 6-year-old child:

> How did the sun begin? —*It was when life began*. —Has there always been a sun? —*No*. —How did it begin? —*Because it knew that life had begun*. —What is it made of? —*Of fire*. —But how? —*Because there was fire up there*. —Where did the fire come from? —*From the sky*. —How was the fire made in the sky? —*It was lighted with a match*. —Where did it come from, this match? —*God threw it away*. . . . How did the moon begin? —*Because we began to be alive*. —What did that do? —*It made the moon get bigger*. —Is the moon alive? —*No . . . Yes*. —Why? —*Because we are alive*.
> *(Piaget, 1926/1929, pp. 258–259)*

The child tries to explain the mysterious natural events of everyday life in terms of something familiar—human behavior. The sun and moon, like people, are alive, are created by a humanlike action (a god lighting a match), and are tied to human activities (the moon began because people began to exist). Similarly, a preoperational child may assert that snow is made for children to play in and clouds move because they are pulled when people walk.

Thoughts are often linked together in a loose way rather than in a logical relationship. For example, one afternoon when Lucienne had no nap, she reasoned that it could not be afternoon because she had not had her nap. Young children reason from the particular to the particular.

4 *Limited social cognition*. Piaget believed that his theory applied to social objects and events as well as physical ones. We saw this parallel between the physical and the social realms in deficits in role taking and communication resulting from egocentrism, confusions between natural events and human events, and ideas about the identity of persons when physical appearances are changed. In addition, Piaget specifically examined social thought in his work on moral judgments. Preoperational children judge the wrongness of an act according to external outcomes, such as how much damage was done and whether the act was punished. They ignore internal variables, such as the person's intentions. Thus, a boy who breaks five cups while trying to help his mother set the table is considered naughtier than a boy who breaks only one cup while trying to steal cookies from the cabinet.

In one study of children's social understanding, Piaget (1965/1995) asked 200 children about their concepts of national identity and foreignness. Five-year-old Evelyne, a Swiss, said, "I like Italy. It's more beautiful than Switzerland . . . I was there this time during the holidays. They have very good cakes, not like in Switzerland where there are things inside that make you cry" (p. 254). And 7-year-old Herbert, when asked whether people differ from one country to another, said, "Yes, well, Americans are stupid. If I ask them where the rue du Mont-Blanc is, well, they can't tell me" (p. 258). Their social conceptions are limited because they often are based on one or two concrete personal experiences.

Concrete Operational Period (Roughly 7 to 11 Years)

Despite the considerable accomplishments in the preoperational period, in many ways the period mainly prepares children for the pinnacle of cognitive development: the mental operation. An *operation* is an internalized mental action that is part of an organized structure. With the ability to use operations, the child's representations are no longer isolated, rigid, or simply juxtaposed, as in the preoperational period. They are brought to life.

We can most easily see operations at work in Piaget's famous *conservation* task, which we described earlier with respect to liquid quantity. First, the child sees two identical containers equally filled with water and judges them to contain the same amount of water. As the child watches, one container is poured into a container with different dimensions or into several small containers. A "nonconserver" claims that the amount has changed, usually because the water level has changed. Typically, since the water rises higher in a taller, thinner container, the child concludes that the amount has increased. In contrast, a "conserver" believes that the amount has not changed. She realizes that quantity remains the same despite changes in appearance. Piaget usually required that the child give a logical explanation for this judgment before he considered the child to be a true conserver, for example, "You didn't add any water or take any away."

Both nonconservers and conservers have a basis for their answers. In fact, if a tester happens to test the same child twice—once when the child is a nonconserver and later when a conserver—she may face the child's scorn on both occasions. The child on both occasions is likely to think that the tester is dumb to ask the question when the "correct" answer is so obvious.

Conservation is an important concept because it gives stability to the physical world. In addition, Piaget assigned a great deal of importance to the conservation task because he thought it reveals the presence or absence of mental operations. Thus, it is a diagnostic tool that probes the cognitive structures. Piaget asserted that children cannot conserve unless they have certain mental operations, especially *reversibility*. The negation aspect of reversibility is expressed by children who say, "If you pour it back where it was, they will have the same amount." The compensation aspect of reversibility is seen in the explanation, "This one's taller but this one's fatter."

Operations also can be seen at work in the common mathematical operations of multiplying, dividing, ordering (greater than, less than), and substituting (one thing equals another thing). Each operation is related to and obtains its meaning from the entire structure of which it is a part. Thus, addition is coordinated with subtraction, multiplication, and division to form a system of mental actions.

Piaget's interest in logic and mathematics appears in his attempt to describe these systems of concrete operations in terms of logicomathematical structures. Logic and algebra involve purely formal, nonpsychological abstract systems. However, Piaget felt that cognitive structures approximate these logicomathematical structures and that it would be fruitful to look for various types of thinking suggested by the latter.

For example, in the concrete operational period there are nine groupings—logical structures that describe certain logical operations and relationships among these operations. Let us look at Piaget's grouping I. This grouping describes the primary addition of classes and is the simplest grouping. For example, modes of transportation form a classification hierarchy, in which modes of transportation (C) at the top of the hierarchy have two subheadings: ground vehicles (B) and other classes of vehicles (B'). B, in turn, contains cars (A) and other ground vehicles (A'). The system's elements (A, A', B, B', C) can be manipulated according to certain rules based on the grouping's properties, for example, composition ($A + A' + B$) or general identity ($A + 0 = A$). These properties, stated in formal, nonpsychological terms, serve as a model for the properties of thought that underlie the concept of class inclusion.

Class inclusion is the concept that subcategories are part of a broader category. The experimenter shows the child 20 wooden beads, 17 of them brown and 3 white. He asks whether a child could make a longer necklace with the brown beads or the wooden beads. Preoperational children claim that there are more brown beads than wooden beads. They can deal only with the parts (brown or white beads) or the whole (wooden beads), but not both of them simultaneously. They do not understand that the parts and the whole are reversible. In contrast, concrete operational children have the underlying operations (that look like the grouping rules) necessary to derive the correct answer.

Piaget applied his logicomathematical model of concrete operations to a wide variety of physical and social situations. For example, various properties are conserved in addition to liquid quantity, described earlier. The number of objects in a set remains the same when they are spread out; the total length of a stick remains the same if it is pushed ahead of another stick; and the weight of clay remains the same if the clay is broken into pieces.

Operations apply not only to classes, as in class inclusion, or to properties such as amount, as in conservation, but also to *relations*. If concrete operational children know that John is taller than Bill and that Bill is taller than Henry, they can infer that John has to be taller than Henry. In addition, they can order a row of dolls according to height and give the dolls sticks ordered according to length. Operations also are applied to *temporal–spatial representations.* For example, preoperational children draw liquid in a container in such a way that it remains parallel to the base or a side (as in Figure 2.1). Their perceptions are influenced by the immediate surroundings. In contrast, concrete operational children correctly keep the liquid parallel to the larger context, the surface of the earth.

Turning to the social realm, we see that children are overcoming many of the limitations in their reasoning about the social world. They are less egocentric but sometimes still have difficulties with role taking and communication. They can take intentions into account in their moral judgments. They also are increasingly aware of the subtle social relationships in the family, peer group, and larger society. In addition, children are beginning to sort out their various social identities. Piaget found that young children tended to draw two circles side by side to represent

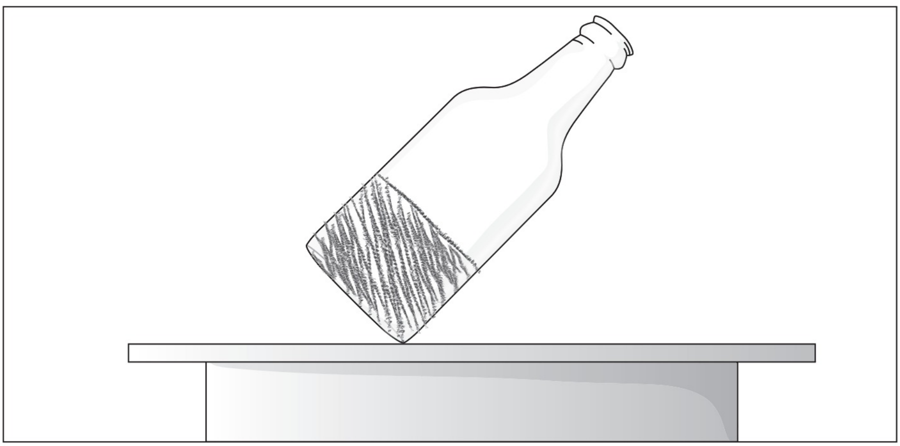

FIGURE 2.1

A typical error on the water-level problem during the preoperational period.

Geneva and Switzerland. Nine-year-old Pierre correctly drew the former as a smaller circle inside the latter but still was struggling to apply his class-inclusion concept to social understanding:

> What is your nationality? —*I am Swiss.* —How come? —*Because I live in Switzerland.* —Are you also Genevan? —*No, that's not possible. . . . I'm already Swiss, I can't also be Genevan.*

Two other 8-year-olds also do not quite have it right:

> Do you know any foreigners? —*Yes . . . those who live far away*. —For example, if you travel to France, could you also become a foreigner in certain situations? —*No, I'm Swiss*. —A Frenchman, could he be a foreigner? —*Oh! Yes, a Frenchman is a foreigner*. —And in France is a Frenchman a foreigner? —*Oh yes*. —What is a Frenchman in Switzerland? —*French, but also a little Swiss if he's here*.
>
> (*Piaget, 1965/1995, pp. 252, 263, 265*)

This list of acquisitions could continue to the end of this book, but the examples we have considered are representative. Two points about concrete operational acquisitions should be kept in mind. First, they do not develop at the same time. In fact, some concepts, such as conservation of weight, often do not appear until near the end of the period. Second, each cognitive acquisition develops over a period of time. At first, it is transitional in nature and is demonstrated only part of the time. It gradually strengthens, stabilizes, and generalizes to a variety of situations.

In summary of Piaget's stages to this point, children move from an understanding of the world based on action schemes, to one based on representations, to one based on internalized, organized operations. Thought now is decentered rather than centered, dynamic rather than static, and reversible rather than irreversible. For the first time, the lawful nature of the world seems to be reflected in a logical system of thought. Thought is in tune, in equilibrium, with the environment. However, the concrete operations are still "concrete." They can be applied only to concrete objects—present or mentally represented. They deal with what "is" rather than what "could be." The final step is to apply the operations to purely verbal or logical statements and to the possible as well as the actual. This story unfolds as we turn to formal operations.

Formal Operational Period (Roughly 11 to 15 Years)

During the concrete operational period, mental operations are applied to objects and events. Children classify them, order them, and reverse them. During formal operations, adolescents carry concrete operations one step further. They can take the results of concrete operations and generate hypotheses about their logical relations. Thus, we now have operations on operations; children can think logically and abstractly about events, even hypothetical ones.

More specifically, formal operational thought resembles scientific thinking. Adolescents formulate a hypothesis about a present or potential event and test this hypothesis against reality. If necessary, they can generate all possible outcomes at the beginning. Piaget typically presented a problem from physics or chemistry and observed how adolescents went about solving it. The problem-solving process, rather than the correct answer, is of interest.

A prototypic task is the pendulum problem. An adolescent observes an object hanging from a string and attempts to discover what determines how fast the object swings. She is shown how to vary the length of the string, the height from which the pendulum is released, the force of the push on the pendulum, and the weight of the object. One or several of these variables might control the speed of the swing. Concrete operational children experiment with the variables and may even arrive at the correct answer (the length of the string), but their approach is haphazard; they have no overall plan. They do not vary one factor while holding the other factors constant in order to systematically isolate the critical factor. For example, they may compare a long, light pendulum with a short, heavy one and conclude that both factors are important. In contrast, formal operational adolescents imagine all possible determinants of the rate of swinging before they begin, systematically vary the factors one by one, observe the results correctly, keep track of the results, and draw the appropriate conclusions. By testing predictions from each hypothesis, they demonstrate *hypothetico-deductive thought*. More generally, as Flavell expressed it, "Reality is thus conceived as a special subset within the totality of things which the data would admit as hypotheses; it is seen as the 'is' portion of a 'might be' totality, the portion it is the subject's job to discover" (1963, pp. 204–205).

Piaget posed several other problems:

1. Determine which mixture of five colorless liquids produces a yellow color.
2. Discover which variables (for example, weight, length, types of material) cause a rod suspended over water to bend down far enough to touch the water.
3. Discover and state the law governing the relationship between the angle at which a billiard ball hits the table wall and the angle of its rebound.

4. Solve a geometric proof.
5. Discover proportional relationships (for example, 16 is to 4 as 4 is to 1).
6. Evaluate syllogisms, such as "All children hate spinach; girls are children; therefore, girls hate spinach."

It should be noted that direct instruction in scientific thought is not necessary for the development of formal operations. Rather, years of common, unremarkable experiences contribute to this achievement. As Einstein remarked: "The whole of science is nothing more than a refinement of everyday thinking."

As in the concrete operational period, Piaget applied logicomathematical models to the child's thought. He identified a system of 16 underlying mental operations he thought necessary for solving the various problems he presented. One operation, for example, is *conjunction*, which refers to the co-occurrence of *x* and *y*. In the problem of what causes rods to bend, a conjunction outcome would be great length, great bending.

In addition to these operations, Piaget's logical model included a system of rules for manipulating the logical relations identified by these operations. For example, in a weight-balance problem, an imbalance can be negated by subtracting the extra weight from the heavier side or adding more weight to the lighter side.

The ability to consider abstract ideas, the future, and various possibilities is evident in adolescents' social world. They dream about their futures and imagine themselves in various occupational and social roles. They may experiment with some of these roles just as they experiment with hypotheses about physical events. They are concerned with the world of ideas. With their friends, they debate various moral and political issues, such as whether wars can ever be moral, whether abortions should be legal, whether there are basic inalienable human rights, and what an ideal community would be like. They can consider these issues from different perspectives and see how the issues are related to a larger set of social relationships. However, there is still a lingering egocentrism. Adolescents are impressed with the power of thought and naively underestimate the practical problems involved in achieving an ideal future for themselves or for society. They feel that the sheer force of their logic will move mountains. Piaget noted that this starry-eyed egocentrism is squelched when adolescents undertake their first real job!

One further difference between concrete operational thought and formal operational thought has implications for both social and physical development. Adolescents can reflect on their own thinking (and that of others). For example, they can think about propositions, which are thoughts. Or, in the social realm, we find the following line of thought: "He's thinking that I'm thinking that he's thinking about her."

By achieving formal operations, adolescents complete their cognitive structures. The various concrete operational logical systems have been combined to create a single, tightly organized system of thought—a unified whole. Thought is logical, abstract, and flexible. Thinking continues to develop throughout adulthood as formal operations are applied to more and more content areas and situations. Egocentrism continues to decline as people broaden their experiences in the world of work and social relationships. However, Piaget thought that these changes after age 15 entail a change not in the structure of thought but only in its content and stability.

An Overview

Now that we have reached the height of Piaget's theory, it would be good to look back over our climb. Perhaps the best way to highlight the differences between periods is to see how a typical child in each period would understand several aspects of reality. First, what is an "object" for a child in each stage? During the sensorimotor period, an object that at first is simply a stimulus for feeding a reflex becomes something on which one can act. Then an object becomes an independently existing entity that is separate from one's actions and can be mentally represented. For a preoperational child, an object can represent another object, can undergo physical changes while maintaining its identity (if not its amount), and can be joined with other objects to form a category of objects. During the period of concrete operations, various operations manipulate the representation of an object; for example, any changes in the object can be reversed, and the object can be fit into a hierarchy of categories. Finally, formal operations involve higher-order operations that allow further mental manipulations of the representation of the object. All the object's possibilities can be examined scientifically.

Another way of slicing the periods vertically is to consider how a child in each period would attack a specific problem. Consider what would happen if we gave children in each stage a tub of water and a number of small objects of various densities, sizes, weights, shapes, and colors. Infants would immediately splash, throw the objects, push the objects to the bottom of the tub, and probably attempt to eat the objects. Toward the end of the sensorimotor period, children might drop the objects from various heights and note that the bigger, heavier objects make bigger splashes than do the smaller, lighter objects. They might also notice that some objects sink while others do not. Preoperational children might imagine that the objects are boats or fish. They would notice that some objects float while others sink, but they would be content to change their reasons from case to case. They might claim that one object floats because it is little, another because it is dry, another because it is a boat, and so on. Concrete operational children are bothered by inconsistencies that did not bother them in the previous stage, such as the fact that some small objects sink while other small objects float. They make comparisons between objects, but they are neither systematic nor exhaustive. For example, they do not hold size constant while varying weights. However, they do develop several categories of "sinkability," for example, always floats (lightweight), always sinks (heavy), and sinks or floats depending on the materials (small objects, lids). Formal operational adolescents have both a plan and the necessary operations to solve the problem. They systematically vary the factors to determine their influence and use the results to test their hypotheses. They know that density is the proportion of weight to volume and that the relative density of the object to the water is the critical factor. Adolescents are able to form a proportion made up of two other proportions: the density for the objects and for the water. These are operations on operations. This general law allows them to predict whether any particular object will sink or float.

Memory

Some of Piaget's most dramatic claims stem from his work on memory. Consider the following typical experiment by Piaget and Inhelder (1969): They showed children an array of 10 sticks of various sizes that were ordered according to size. A week later they asked the children to draw from memory the array of sticks they had seen. Developmental differences emerged. In general, 3- and 4-year-olds drew a few sticks having the same length. The 5- and 6-year-olds tended to draw some tall and some short sticks. Most 7-year-olds could draw the original array correctly. Piaget and Inhelder concluded that the children had processed and interpreted the original array in terms of their present understanding of ordered relations. Only when this understanding is fully achieved can the child accurately remember the array. Thus, memory reflects and depends on the entire cognitive structure. Memory is active understanding rather than a static, passive state—a camera.

Although this is an interesting set of results, the children's behavior six months later when they returned was even more surprising. Although the children were not shown the sticks again, this time 75 percent of the children drew arrays that were more advanced cognitively than those they had produced six months earlier. For example, a child who originally lined up three tall sticks of the same height and three short sticks of the same height later made a row of three tall sticks, three medium-size sticks, and three short sticks. Piaget's interpretation was that such improvements are due to development in their cognitive structures during those six months. Current cognitive structures are applied to the memory process. Note that improvement in memory over time is the *opposite* of what one would expect from most theories of memory or from common sense: a memory trace fades over time. Unfortunately, other researchers have not always replicated Piaget's results. There is more support for the age differences in memory than there is for improved memory of the materials after further cognitive development (see Liben & Bowman, 2014, for a review and critique). Still, Piaget's claim that our knowledge influences, and thus biases, what we know is central to much current research and theorizing on memory development (see Chapter 7).

Piaget offered the following memory from his second year of life to show that memory can be unreliable:

> I was sitting in my pram, which my nurse was pushing in the Champs Elysées, when a man tried to kidnap me. I was held in by the strap fastened around me while my nurse bravely tried to stand between me and the thief. She received various scratches, and I can still see vaguely those on her face.
>
> *(1945/1951, p. 188)*

When Piaget was 15, his parents received a letter from the nurse shortly after she had joined a religious order. She said she wanted to return the watch that had been given to her as a reward for protecting little Jean from the kidnapper. The truth was that she had made up the story that Piaget so vividly "remembered." Piaget believed that he had created a visual memory from the story his parents had told him as a child.

In addition to studying memory performance, Piaget examined children's concepts of memory. This topic was rediscovered by developmental psychologists 50 years later and labeled "metamemory," which is described in Chapter 7. A sample of Piaget's work is the following interview with an 8-year-old innatist:

> *Memory is something in the head which makes us think.*—What do you think this memory is like? —*It is a little square of skin, rather oval, and inside there are stories (les histoires).*—What are they like? —*They are written on the flesh.* —What with? —*Pencil.* —Who wrote them? —*God, before I was born, he put them there.*
>
> *(1926/1929, p. 52)*

Mechanisms of Development

Piaget recognized that it was important not only to describe cognitive stages but also to explain how and why children develop through those stages. In other words, by what processes does a child's thinking progress? How do new forms of thinking emerge? What facilitates or constrains the transition from step to step? Emphasizing the grand stages, which span several years each, can make us forget that thought actually develops in the moment-to-moment, everyday encounters between children and their physical and social environments. Stagelike changes ultimately are due to millions of these minidevelopments.

In Piaget's theory, these small steps are driven by certain functional invariants. The *functional invariants* are thinking processes—organization, adaptation, and equilibration—that operate throughout development. Piaget drew on these processes from biology that define the relationship between the organism and the environment. Our thinking, like the circulatory system and the digestive system, has innate tendencies to be organized and adapted to the environment. With apologies to Descartes, it could be said that "I am, therefore I think."

Cognitive Organization

Cognitive organization, described in the earlier section on structuralism, is the tendency for thought to consist of systems whose parts are integrated to form a whole. These systems, in turn, are coordinated; there are interrelationships among cognitive activities. The mind is not a grab bag of facts. Rather, it is a coherent view of the world. This view becomes more and more coherent and interrelated as children develop. For example, a young infant has separate structures for sucking objects and for grasping them. Only later are these two structures organized into a higher-order structure that allows coordinated reaching for an object and bringing it to the mouth.

Development through the stages involves changes in the nature of cognitive organization as the structures of thought change from stage to stage. As development proceeds, thought may be organized into schemes, functions, concrete operations, or formal operations. Thus, an infant's sucking on a toy and Einstein's insights into relativity both reflect cognitive organization. In principle, one could trace a line of development from the former to the latter.

Cognitive Adaptation

The other basic functional invariant, *cognitive adaptation*, pertains to a fit between the mind and the environment: Intelligent behavior is behavior that is appropriate to the demands of the environment. Adaptation and organization are closely related:

> Organization is inseparable from adaptation: They are two complementary processes of a single mechanism, the first being the internal aspect of the cycle of which adaptation constitutes the external aspect. . . . The "accord of thought with things" and the "accord of thought with itself" express this dual functional invariant of adaptation and organization. These two aspects of thought are indissociable: It is by adapting to things that thought organizes itself and it is by organizing itself that it structures things.
>
> *(1936/1952b, pp. 7–8)*

Adaptation involves two complementary processes: assimilation and accommodation. *Assimilation* is the process of fitting reality into one's current cognitive organization. In every cognitive encounter with objects or events, there is a degree of "bending" or distorting of experience as people attempt to incorporate, understand, or interpret this experience. In other words, people apply what they know in order to understand objects and events. To quote Anaïs Nin, "We don't see things as they are, we see them as we are."

Accommodation is the other side of the coin. This term refers to adjustments in cognitive organization that result when reality does not fit our expectations. Every object has special characteristics that eventually must be taken into account. In a sense, accommodation occurs because of failed assimilation, when the current structure cannot understand a particular object or event. The resulting reorganization of thought leads to a more satisfactory assimilation of the experience. Then that object or event is never again experienced in quite the same way. As Oliver Wendell Holmes commented, "Man's mind stretched to a new idea never goes back to its original dimensions."

Assimilation and accommodation are closely intertwined in every cognitive activity from birth to death. Attempts to assimilate reality necessarily involve slight changes in the cognitive structures as these adjust to the new elements. In true Piagetian style, both a biological example and a psychological example are needed. In the biological realm, food is assimilated into the body as it is changed into a form the body can use. As Piaget expressed it, "A rabbit that eats a cabbage doesn't become a cabbage; it's a cabbage that becomes rabbit—that's assimilation" (quoted in Bringuier, 1980, p. 42). The digestive system accommodates to food by adjusting the mouth opening, chewing, secreting digestive juices, contracting the muscles of the stomach, and so on. Thus, the digestive system both changes and is changed by an environmental event, the presentation of food.

In the psychological realm, consider an infant who has happened onto a sheet of newspaper for the first time. In an attempt to make sense of this new experience, she runs through her repertoire of actions on objects. She applies her current cognitive structures (schemes). She grasps the paper, hits it, sucks it, turns it over, shakes it, and puts it over her head, in her attempts to fit this new object into something she already knows (assimilation). However, a newspaper has certain characteristics foreign to her existing schemes. She is forced to stretch or reorganize (accommodate) these schemes in small ways: Her ideas about the way things sound when they are shaken must be altered to include the rustle of a newspaper. The light weight and the new feel and sight make further demands on her mind. Some properties (for example, ripping the paper) may be quite foreign and startling.

These varying degrees of discrepancy between current schemes and the experience at hand raise the issue of what the limitations are to accommodation. Piaget's answer is that only moderately discrepant events or characteristics can be accommodated to; great leaps are not possible. If reality is too different from the person's current level of understanding, she cannot bridge the gap. Thus, development necessarily proceeds in small steps.

To illustrate this gradual, continual development through accommodation, consider what would happen if children of various ages were given a horseshoe-shaped metal magnet for the first time. Six-month-olds might accommodate to the unfamiliar metallic taste, the peculiar (horseshoe) shape, and the sound of the magnet being dropped. However, they cannot accommodate to its magnetic properties. Three-year-olds, if given an assortment of objects, might accommodate to the fact that some of the objects cling to the magnet and might entertain explanations such as "stickiness" and "wanting to stay together." Nine-year-old children might construct the concept that only metal objects are pulled to the magnet and might notice the conditions in which this occurs—through glass, water, and certain distances. Only adolescents could accommodate by formulating an abstract theory of magnetism and simultaneously consider all of the variables involved, such as the size and shape of the magnet and the distance from the object. Thus, accommodation always occurs in small steps and is relative to the present cognitive level.

In summary, assimilation and accommodation are present in every act and stimulate cognitive development. Attempts to apply one's current intellectual structures typically are only partially successful because most encounters with the environment are new in some way. As a result of this failure to "understand" the object or event, minor cognitive adjustments or accommodations are made. These push children to a slightly more advanced cognitive level, one step closer to reality. However, this new level of understanding makes them aware of other discrepancies in experience, and again assimilation presents new elements and again accommodation occurs. Each accommodation makes new accommodations possible in the future. This spiral continues in our moment-to-moment encounters with the environment throughout our lives.

Cognitive Equilibration

Organization and adaptation imply a third functional invariant, equilibration. Both mollusks and human cognition are self-regulating equilibration systems. In Piaget's view, every organism strives toward *equilibrium* with the environment and equilibrium within itself (among elements of the cognitive system). When assimilation and accommodation are in balanced coordination so neither one is dominant, equilibrium is achieved. This balance is achieved through the development of organized structures that provide ways of interacting with the world. A change in either the organism or the environment leads to a state of disequilibrium, which must be corrected. It should be clear from other parts of Piagetian theory that equilibrium is dynamic rather than static. There is constant activity, but there is a balance, a pattern, to this activity.

For example, in the liquid-conservation task, children are in disequilibrium if they switch back and forth between saying that the tall thin one has more because the liquid is higher or the short fat one has more because the liquid is wider. Acquiring the mental operation, *compensation*, allows them to integrate information about the two dimensions. One dimension compensating for the other eliminates the contradiction and re-establishes equilibrium.

Equilibration, while one of the most important concepts in the theory, is probably also the most difficult and evasive. Part of the difficulty may lie in the fact that equilibration can refer to several spans of time, ranging from a fraction of a second to a number of years. In each case, there is a period of equilibrium, followed by a state of disequilibrium, followed by equilibration, which leads again to equilibrium at a higher cognitive level.

Piaget seems to have at least three spans of time in mind when he applies the notion of equilibrium:

1. A moment-to-moment equilibration process occurs as assimilation and accommodation operate in children's daily activities, even the most mundane. Temporary disequilibrium occurs when children encounter new properties of objects that do not fit into their present cognitive structures. Once the assimilation–accommodation process occurs and discrepancies are resolved, equilibrium is again achieved.
2. Equilibration refers to moving toward the final level of achievement within each period or stage. A child enters a new period in a state of relative disequilibrium because the old cognitive organization has broken down but the new one is still incomplete and unstable. By the end of this new period, a child has achieved equilibrium with respect to the period's new structures. For example, at the end of the sensorimotor period, a child is in equilibrium with the environment in terms of action schemes. Equilibrium is re-achieved in each period at a higher and higher level of abstraction.
3. The entire course of cognitive development can be seen as a process of equilibration as the child proceeds through increasingly "better" forms of equilibrium. The most complete equilibrium is achieved when formal operations bring fully reversible and abstract thought. The earlier states of equilibrium, because they are incomplete, inevitably break down at some point. In a sense, each period or stage eventually self-destructs.

For Piaget, equilibration is the grand process that integrates and regulates all of the elements of development—physical maturation, experience with the physical environment, and the influence of the social environment. These forces together propel children through the stages.

Section Overview

Perhaps the best way to summarize this section on mechanisms of development is to relate it to the earlier sections of this chapter. Knowledge of the world develops through a series of discrete states of equilibrium (stages) between the organism and the environment. This is the essence of Piaget's genetic epistemology. Mental structures, in equilibrium, are constructed as children interact with physical objects and people in an organized way. Here we see Piaget's structuralism. In the innate tendencies toward organization and adaptation (assimilation and accommodation), we see Piaget the biologist explain how minds adapt to the environment. Finally, the particular stages are an inevitable outcome, given the nature of the human organism (its physical structures and cognitive functions) and the nature of the environment.

Position on Developmental Issues

This book's Introduction identified four basic developmental issues on which each theorist takes a stand. Using these issues, we can view Piaget's theory from a new perspective. The issues also provide a means for comparing the diverse theories covered in this volume.

Human Nature

Piaget's worldview clearly was organismic rather than mechanistic or contextual. He posited an inherently active organism. Children tirelessly explore, hypothesize, test, and evaluate; they do this either overtly (particularly in the sensorimotor period) or covertly (as in the manipulation of symbols, concrete operations, and formal operations). No external motivation is necessary. Children are intrinsically motivated; schemes are used simply because they exist. Once activated, they tend to be repeated. In other words, "To be is to do." The Piagetian child is a self-regulating, organized whole striving to maintain equilibrium both internally and with the environment by correcting cognitive imbalances. These tendencies toward inherent activity and self-regulation cause continual change. The organismic worldview also can be seen in the fact that the parts can be understood only in terms of the whole. Any one behavior, scheme, or operation is influenced by and derives its meaning from the whole structure. The same behavior (for example, swinging a pendulum) has a different meaning for a 2-year-old and a 12-year-old.

Qualitative Versus Quantitative Development

Although Piaget saw both qualitative and quantitative changes, he emphasized qualitative changes in structures from stage to stage. Just as the colored plastic fragments rearrange themselves when a kaleidoscope is turned, so does the organization of thought change to form new patterns as the child develops. Quantitative changes occur as schemes, operations, or other cognitive skills become stronger, more easily activated, more efficient, and more consistent. Other quantitative developments are the increased number of schemes in the child's repertoire or the number of "facts" known. A child who can name the capitals of all the states has more information at hand than the child who can name only five capitals. Of course, it should be kept in mind that these facts are always assimilated into structures that undergo qualitative changes.

Qualitative and quantitative changes build on each other during development. A qualitative change in structure makes possible certain quantitative changes. For example, once class inclusion is understood, children can quickly learn about the classifications and relationships in many different content areas, such as animals, people, trees, shapes, and colors. Quantitative increases in amount of information, in turn, may pave the way for further qualitative change as new information challenges the present structures. For example, talking with peers and adults rapidly expands children's knowledge and challenges their present understanding. This new information can stimulate subsequent qualitative change as the system attempts to resolve the contradictions in children's knowledge.

Whether we see quantitative or qualitative change in Piaget's theory depends, in part, on the unit of time we select. If we look at changes over minutes, days, and weeks, we are struck by the gradual nature of development. If we look at changes over months and years, we are struck by the qualitative changes from stage to stage or period to period. For example, from age 4 to 5, children may become more consistent in their grouping of objects according to shape; this is a quantitative change. However, the change from age 5 to 7, when they can sort objects into hierarchies of classes—for example, animals, mammals, brown mammals, and so forth—is qualitative.

Nature Versus Nurture

Piaget was an interactionist through and through. Cognitive development is a by-product of the intertwined influences of innate and experiential factors. Innate factors include physical structures (for example, the structure and positioning of the particular species' eyes), reflexes, physical maturation, and the invariant functions (organization and adaptation). Given these innate factors and the nature of the physical and social world, development inevitably proceeds in the way it does. It could not be otherwise.

Piaget proposed the following four-factor "formula" for development:

Development = Physical maturation + Experience with the physical environment + Social experience + Equilibration

1 The first factor, physical maturation—of the brain, the muscular system, and the like—creates new possibilities for the cognitive system and requires certain adjustments of that system. For example, when physical maturation permits walking, new vistas open up for toddlers. As children actively exploit this new skill, they are forced to assimilate and, whenever possible, accommodate to new experiences.

2 Regarding experience with the physical environment, Piaget emphasized *logicomathematical experience*. This term refers to reflecting on one's own actions on objects rather than on the objects themselves. To illustrate, Piaget referred to a friend's recollection from childhood:

> He was seated on the ground in his garden and he was counting pebbles. Now to count these pebbles he put them in a row and he counted them one, two, three up to 10. Then he finished counting them and started to count them in the other direction. He began by the end and once again found he had 10. He found this marvelous. . . . So he put them in a circle and counted them that way and found 10 once again.
>
> *(1964a, p. 12)*

The child reflected on the results of repeatedly counting and arranging the pebbles and concluded that number is constant despite physical rearrangements. He discovered something (number) that is not intrinsic to the objects.

3 Social experience includes the cultural or educational environment. For example, other people transmit knowledge, either directly, in conversations, or through books, television, and so on. In this way, children can benefit from the experience of others. Of course, a child must be cognitively advanced enough to assimilate the information if it is to be of value. Social experience can also impede learning; not all adult products provide good models to learn from, as seen in a sign that defies class-inclusion logic: "Please do not feed birds or animals."

These three factors are universal. Given the similarities among cultures in children's physical maturation, the physical world, and, in some ways, the social environment, it is not surprising that the four major periods proceed in the same order in all cultures studied. However, given cultural differences, one would expect that, within a stage, some concepts might develop earlier in some cultures than others.

For example, in Mexico, children aged 6 to 9 who grow up in pottery-making families are more likely to be conservers of substance than those who grow up in families engaged in other activities (Price-Williams, Gordon, & Ramirez, 1969). This finding suggests that experience with clay promotes the development of this concept (often assessed with clay as the medium). In addition, Piaget recalled that his daughter Jacqueline, born in the winter, was often bundled up in a carriage, so had less opportunity than children born in warmer weather to develop eye–hand coordination.

4 The fourth factor, equilibration, ties together and controls the interaction of innate and experiential factors. Maturation, experience with the physical environment, and the influence of the social environment constantly cause momentary disequilibrium. In this way, they force the cognitive system to change, to adjust. Through re-establishing equilibrium, the cognitive system reaches a higher level.

What Develops

For Piaget, the essence of cognitive development was structural change, in the schemes and logicomathematical structures. Structural change gives meaning to, and influences change in, the content of thought. Thus, Piaget emphasized change on a molar level as children construct a model of reality, which leads to change at more molecular levels.

The question of what develops is tied to Piaget's methodology. He relied on observations, interviews (the clinical method), and assessment situations in which the experimenter participates. In this way, he kept the organization of the thought processes as intact as possible; too much experimental interference or control would distort the child's normal line of reasoning.

Applications

Educators have applied Piaget's theory to instruction. One example is his notion of "readiness"—that children can profit from instruction only if they are cognitively ready to assimilate the new information to their present cognitive structures or accommodate their structures to the experience. Instruction in calculus would not be successful with most 5-year-olds. Related to this, teachers should teach concepts in a particular sequence of developmental steps, as they naturally would be learned.

Another important notion is that learning is most likely to occur when children actively participate and, for children who have not yet reached formal operations, when teachers present problems in a concrete rather than abstract way. Importantly, for true understanding, children must learn the concepts underlying mathematical and scientific knowledge rather than just memorize facts. A 2-year-old who can count to 10 may not actually understand numbers. Piaget would be critical of "teaching to the test." He criticized typical educational assessments for focusing on correct answers rather than on children's thought processes for reaching the answers. In short, a teacher mainly provides guidance and resources so that children can teach themselves.

The neo-Piagetians, to be described later in this chapter, would add a focus on teacher support for the child's fragile new concepts, for example, encouragement, modeling, hints, or collaboration. They also would encourage teachers to make sure that problems to be solved are presented in a way that does not overload the child's cognitive capacity. Finally, since different children may follow different developmental pathways to acquiring a concept, it is important for teachers to be aware of these individual differences in ways of learning.

Evaluation of the Theory

When Piaget's first writings on children appeared, he was appalled that people evaluated them as though they were final statements on cognitive development rather than the tentative positions he intended them to be. In fact, he continued to modify his theory even into his eighties. After this section on strengths and weaknesses, we will look at some of the modifications that attempt to address some of the weaknesses.

Strengths

We focus on four strengths of Piaget's theory: its recognition of the central role of cognition in development, its discovery of surprising features of young children's thinking, its wide scope, and its ecological validity.

Recognition of the Central Role of Cognition ▸ Cognition now is such a central part of the study of development that it is hard to imagine that this was not always the case. If a developmental psychologist were somehow plucked out of the 1950s and set down today, he would be bewildered by the talk around him. He would hear psychologists discussing children's "theories," strategies, cognitive structures, plans, and representations, instead of stimulus generalization, mean length of utterance, mental age, conditioning, and discrimination learning. To a great extent, Piaget is responsible for this change. He altered the course of psychology by asking new questions that made developmentalists wonder why they had ever asked the old questions in the first place. Once psychologists looked at development through Piaget's eyes, they never again saw children in quite the same way.

Both the state of academic psychology and the history of developmental psychology in the United States created a state of readiness for the assimilation of Piaget. Academic psychology had pushed behaviorism in general and learning theory in particular to their limits and found them wanting. Even when learning theory was modified by such notions as verbal mediation, social reinforcement, modeling, intrinsic reinforcement, and attention, it did not completely satisfy psychologists. There was dissatisfaction with the explanation of language development in terms of imitation, practice, and reinforcement. At the same time, alternative cognitive approaches were emerging, such as Noam Chomsky's transformational grammar and computer scientists' work on information processing.

Within developmental psychology, until the 1950s researchers could be found less often in departments of psychology than in "child institutes" or departments of home economics, pediatrics, public health, education, clinical psychology, and nursing. Developmental psychologists were concerned with poor nutrition, physical and intellectual disabilities, learning disabilities, and emotional disorders. Because of this physical and ideological separation from psychology departments, many developmental psychologists did not become immersed in the behaviorist–experimental zeitgeist of academic psychology of the times and kept one foot in the laboratory and one foot in real-life settings. In addition, developmental psychologists at that time were primarily interested in collecting normative data—descriptions of the behaviors that could be expected at each age. For all these reasons, there was room for Piaget's naturalistic, descriptive approach. The field of developmental psychology was ready for Piaget.

A newcomer to developmental psychology might wonder why Piaget had produced almost a lifetime of work before American academics became interested in him. Certainly the state of academic psychology at that time, described above, provides part of the answer. A further reason is the language barrier. Until the 1960s, much of Piaget's work had not been translated into English. An additional language problem is that Piaget's writings are difficult to understand in any language. Fortunately, several developmental psychologists in the United States served as literal and psychological translators of Piaget's work in the late 1950s and early 1960s. In particular, John Flavell's timely book, *The Developmental Psychology of Jean Piaget* (1963), made Piaget understandable to English-speaking psychologists.

The rest, as they say, is history. Psychology witnessed a flurry of Piagetian replication studies, attempts to fit Piaget into the existing field of developmental psychology, and efforts to train children to acquire various Piagetian concepts, especially conservation. Researchers conducted laboratory studies of variables such as the nature of task materials and instructions, the scoring criteria, and the socioeconomic level of the children. Piagetian-influenced research peaked in the late 1970s through the early 1980s when approximately one-third of the articles in major developmental journals cited Piaget (Iaccino & Hogan, 1994). Piaget's theory spread into areas such as social development, clinical psychology, and education. This was the "Piagetian stage" of developmental psychology.

The purpose of this historical side trip is to show the impact of a theory that recognized the central role of cognition in development. Piaget searched for the modes of thinking underlying the overt behavior studied by behaviorists and by child psychologists constructing norms of development. This focus on cognition provided a new perspective and inspiration for a generation of developmental psychologists. As Lourenco and Machado observed, "Paraphrasing Einstein on Euclid, if Piaget failed to kindle your youthful enthusiasm then you were not born to be a developmental psychologist" (1996, p. 157)

Discovery of Surprising Features of Children's Thinking ▶ Piaget's main legacy may be his rich description of what it is we develop. The thousands of observations by Piaget himself plus the thousands of studies inspired by him constitute a remarkable body of information. Regardless of the final judgment on his theoretical claims and the exact ages at which each concept is acquired, his detailed, sensitive, and astute observations remain with us.

Piaget revealed new developmental phenomena, many of which strike people as surprising, or counter to common sense. Especially notable are the following: Young infants often act as though they do not think that objects are permanent. Preschoolers believe that rearranging objects can change their number and assert that the wrongness of an act depends on how much damage resulted. More generally, most concepts not only take longer to develop than we might think but also go through a number of interesting steps along the way. A further surprise is that children think about such a wide variety of things. Children's thinking ranges from pondering the origin of the universe to solving the problem of how to open doors without dropping what they are holding, from penetrating the nature of society's moral system to determining the speed of the swing of a pendulum. In a discipline that has few real "discoveries" to rival the discovery of a new planet or the structure of DNA, Piaget's surprises about cognitive development are refreshing and his observations remarkable, especially considering that they came from seemingly mundane, everyday behavior.

Wide Scope ▶ Piaget's theory is ambitious, drawing its net over behavior ranging from playing with pebbles to causal reasoning, from the sucking reflex to formal operational structures. The theory attempts to describe and explain both cognitive stages and transitions between those stages. Piaget not only tackled cognitive development but also its implications for other areas of development, such as social and emotional development and learning. He also contributed to other disciplines, such as epistemology, philosophy of science, and education. In Piaget we catch a glimpse of how a complete theory of development might look.

The theory's wide scope obviously increases its attractiveness. At the same time, it increases its vulnerability, as will be seen in the section on weaknesses. The theory may try to do too much.

Ecological Validity ▶ Every psychologist has an intuitive list of what a good theory should do. Many lists would include the requirement that the theory tell us about the real world of children. Although even the most basic research in laboratories has some relevance for day-to-day behavior, some approaches have a closer relationship than others to common, everyday behaviors. Piaget's theory seems to rate well in this respect. The focus is on children's adaptation to the world they encounter every day. Infants try to grasp a rattle just out of reach, replace a pacifier, and figure out where a ball has rolled. Preschoolers divide their cookies with friends, try to express their ideas to others, and chastise those who break the rules of games. Schoolchildren struggle with math problems, try to make sense of social rules, and find their way around their neighborhood or city.

The ecological validity of the theory is more striking for infancy than for the later stages of development. When studying children beyond infancy, Piaget tended to interrupt the flow of behavior with questions or even pose problems from the beginning. The reason is that infants' thinking is expressed in their overt actions, whereas older children's thinking is more covert and must be prodded.

Weaknesses

Although Piaget's theory broke much new ground, it has been heavily criticized as well. The theory provides an easy target because of its methodology, wide scope, and ties to biology and philosophy. We examine the following weaknesses: inadequate support for the stage notion, inadequate account of mechanisms of development, need for a theory of performance, slighting of social and emotional aspects of development, underestimation of abilities, and methodological and stylistic barriers. Lourenco and Machado (1996) can be consulted for a Piagetian defense against some of the criticisms described below as well as other criticisms.

Inadequate Support for the Stage Notion ▸ The strongest attacks on Piaget's theory concerned his notion of stages, the heart of the theory. Are there, in fact, broad stretches during development that have characteristics that apply to all the psychological events during that period? Or does the notion of stages simply confuse and mislead by oversimplifying development and claiming more coherence among concepts than there actually is? It is not clear whether Piaget actually thought that the logical structure of each stage should lead to similarity in thought over a variety of content areas, or whether his logical models were just idealized depictions of each stage. Stages based on logical models might work best as a heuristic that suggests what to look for and provides a framework for interpreting behavior. Perhaps the problem of interpreting what Piaget meant is that "Piaget used too much logic for psychologists and too much psychology for logicians" (Lourenco & Machado, 1996, p. 156).

The evidence does not support a strong structural version of stages, in the sense of concurrent changes across all content areas. However, Piaget himself acknowledged that a structure may apply only to a particular content area and may have to be constructed anew in various domains during a stage. He referred to *horizontal décalages* that occur when a general concept emerges earlier on some tasks than others. For example, in the case of conservation, the conservation of substance typically develops a year or two before conservation of weight. He also probably would not have been surprised by child prodigies whose cognitive achievements in one particular area, such as math, are much more advanced than they are in other areas of thinking. Thus, a weaker structural version of stages may still be viable; some unevenness across domains would even be expected. However, inconsistency over trials in applying even a single concept, such as number conservation, poses a problem even for this weaker version. For instance, Siegler (1995) found that slightly over half of his 5-year-olds classified as nonconservers had generated a correct answer and satisfactory explanation on at least one pretest problem. Thus, variability is as common as consistency, which contrasts with Piaget's emphasis on variability mainly during transition from one period to another. One kind of inconsistency, described later, is when children demonstrate a concept with simpler task demands earlier than with more complex ones. Another form of inconsistency is that "formal operational" adults who can test hypotheses like a scientist in some situations often are poor at doing so regarding matters about which they have intuitive, often erroneous, theories (Kuhn, 1989). They even ignore or distort data that contradict their beliefs. Given these inconsistencies, is the mind less a coherent cognitive system than a "collection of different and unrelated mindlets" (Flavell, 1992) devoted to different contents?

Even if one accepts a weaker stage notion, the problem remains that Piaget did not provide a satisfactory account of what determines whether a structure will be applied to a particular content area. When should we expect generalization, and when should we not? The neo-Piagetians, described later, helped fill this gap.

It is difficult to decide whether the notion of stages is wrong or simply incomplete. Are the logicomathematical structures a philosopher's dream, or, as described at present, are they simply too vague, general, and distant from behavior? Looft and Svoboda voiced some of these doubts:

> While reading Piaget's most recent writings one sometimes acquires an eerie, cold feeling that something very strange is going on in this man's work. In his early writings we read about delightful children playing on the banks of Lake Geneva, expressing their surprise and exhilaration as they make new discoveries about their little worlds. Today we are presented with some sort of cybernetic automata, regulating themselves and pushing themselves to ever higher levels of differentiation and complexity. In short, it would seem that as Piaget's theory has evolved over the past five decades to higher and higher levels of abstraction, people have somehow dropped out and have been replaced by sterile logicomathematical structures.
>
> *(1971, p. 15)*

Later researchers suggested modifications of Piaget's notion of stages, while still retaining his emphasis (e.g., Flavell, 1971b, 1982).

For example, stagelike, qualitative changes appear to be causally linked to more gradual, quantitative sorts of developmental changes, such as an increasing attentional capacity or an increasing stability and generality of concepts. Also, because the development of cognitive items of a particular stage is an extended process, these items may not become tightly organized and interrelated until the very end of that stage. In fact, children may not even achieve the "full functional maturity" of a stage until after that stage has officially ended. Finally, concepts or structures that characterize a stage often are only roughly synchronous in their development. For example, two concepts might begin their development at the same time but complete it at different times. Or they might begin and end their development at different times but have a considerable temporal overlap.

Even though the stages may be less coherent units than Piaget thought, they still are useful ways to organize a large number of diverse behaviors. They are convenient points of reference for accounting for the orderliness of thought. As Flavell and Wohlwill concluded, "To paraphrase Voltaire's dictum concerning the deity: if there were no such structures in the mind of the child, we should have to invent them, to account for the degree of consistency and orderliness that we do find in his cognitive development" (1969, p. 94).

As suggested earlier, the most reasonable way to use Piaget's notion of stages may be to look for stagelike changes limited to a particular content area. Each domain may develop somewhat independently of the others, and thus we would have domain-specific knowledge. This possibility was explored by the neo-Piagetians and by information-processing knowledge-based approaches (see Chapter 7). In the latter view, a child shifts from novice to expert status after experience in a particular domain such as chess, soccer, or dinosaurs. Domain-specific knowledge also is posited by core knowledge approaches (Chapter 9), certain evolutionary approaches (Chapter 5), and the "theory theory" (of mind, biology, physics) approaches (Chapter 9).

Inadequate Account of Mechanisms of Development ▸ We need clarification not only of the criteria for stages but also of mechanisms that drive development both within a stage and from stage to stage. How do children acquire new concepts and ways of thinking? Although Piaget considered explanations of change quite important, he more successfully described than explained development. Functional invariants, such as assimilation and accommodation, provide at best a general framework with which to examine cognitive change. There are no specific, precise statements as to how sensorimotor thought becomes preoperational thought or how preoperational thought becomes concrete operational thought. Furthermore, although the equilibration process is an intuitively appealing idea, it is not clear how children's awareness of a contradiction would lead them to the solution that resolves the contradiction (Bryant, 1986). Simply knowing that something is wrong does not identify the cause of the problem. Moreover, young children do not seem to be very good at detecting logical inconsistencies that might cause cognitive conflict. Not until age 6 do children see a problem with the claim that a man is both tall and very short (Ruffman, 1999).

One way to identify mechanisms of change is to supply certain experiences and see whether they cause cognitive change. The logic is that the experimental conditions that stimulate a new concept might also operate in this way in children's daily lives. Hundreds of training studies looked at conditions such as creating cognitive conflict, teaching underlying operations such as reversibility or compensation, redirecting attention to the relevant feature, such as number, or ensuring memory of relevant information. Even Piagetians, especially Inhelder, studied how training studies stimulate learning (Inhelder, Sinclair, & Bovet, 1974). Unfortunately, training studies only minimally illuminated mechanisms of development. First of all, even if we find that training based on one of Piaget's mechanisms of development (for example, cognitive conflict) causes the child to acquire the concept, there is no guarantee that children progress by this mechanism in real life. Second, when a training study does succeed, that success may be based on mechanisms other than those the investigators thought they were providing. Gelman's (1969) training redirected the child's attention from irrelevant dimensions (for example, length of a row of objects) to the relevant dimension (number). However, this procedure's success could have stemmed from cognitive conflict created when the child's initial answer did not consistently lead to reinforcement (Beilin, 1971). Third, there is not a specific account of why a particular training experience stimulates change in some children but not others. In general, the older children are, the more likely they are to acquire the concept as a result of training, presumably because they are closer to acquiring the concept naturally. However, more refined predictions are more difficult because it is not clear how to assess children's degree of readiness.

Training studies, especially in the United States and England, also were used to try to disprove Piaget's theory by showing that a concept of one stage could be taught to children in an earlier stage, for example teaching conservation to nonconservers. However, Piaget was dubious about the value of trying to intensively teach concepts to children and cautioned that "each time one prematurely teaches a child something he could have discovered for himself, that child is kept from inventing it and consequently from understanding it completely" (1983, p. 113).

Need for a Theory of Performance ▸ Piaget created an elaborate system of cognitive structures that represent children's knowledge about the world. He also provided a rich description of behavior. There is, however, a missing link: a detailed account of exactly *how* the structures are translated into specific problem-solving strategies "on line" in a particular context. Such a theory of performance would explain how children's knowledge is expressed in their behavior at any particular time, with particular materials, in a particular context. To illustrate, in a conservation task, a child must be able to understand the task instructions, attend to number and ignore other attributes such as color and the salient length dimension, be able to count, and have the working memory capacity to remember the equivalence of the rows, the type of transformation, the questions asked (Miller, 1978). Variables that influence these processes might include, for example, the salience of each attribute (shape, color) in the materials, familiarity of the materials, the amount of information to remember, and the complexity of instructions about the task. These factors may account, in part, for the extended, gradual, uneven development of concepts. For example, it may be that the early, fragile form of a concept can be used only if there are not large demands on the child's memory, attentional capacity, and verbal ability. The neo-Piagetians (e.g., Fischer, Case), described later in this chapter, have examined performance factors.

Piaget recognized the importance of these cognitive activities, and in his later years, he and his colleagues studied aspects of performance such as strategies for gathering relevant information (Inhelder & Piaget, 1980; Piaget, 1981/1987). Piaget thought that it was more important to describe development and to identify general cognitive structures first. In contrast, certain other theoretical approaches discussed later in this book, particularly information processing, Gibson's perceptual learning, and learning theory, focus on performance. Such theories may eventually provide the missing link between structures and behavior in Piaget's theory.

Slighting of Social and Emotional Aspects of Development ▸ Piaget thought that social and emotional influences on cognitive development were very important. Social experience was one of the variables in his developmental equation, described earlier. Interacting with other people provides new information to be assimilated. Conversations with parents may be especially important for learning about things that cannot be seen, such as religion (e.g., heaven, God's special powers) and certain scientific concepts, such as the round shape of the earth or the brain basis of thinking (Harris & Koenig, 2006). Recent research shows that children are selective about whose information they trust (Koenig & Sabbagh, 2013). They are more likely to accept new information from people who have been correct in the past, have no apparent ulterior motive, and are similar to themselves.

Another way that social influences are important is that a concept may be expressed earlier in a social context, as when Piaget's daughter Jacqueline showed a more advanced object concept when she played peek-a-boo skillfully with her mother at 8 1/2 months than when tested on nonhuman objects (Piaget, 1937/1954). Regarding affect, Piaget thought that it was very intertwined with intelligence: "Feelings express the interest and value given to actions of which intelligence provides the structure" (1945/1951, pp. 205–206). In a sense, emotions provide the energy behind cognition. For example, feelings influence children's choice of what to apply their structures to; a child with a passion for airplanes is likely to learn a great deal about them.

For Piaget, the social realm was important not only as an influence on cognition but also as the content of cognition, for example, the concepts of morality and of national identity described earlier. More generally, he thought that cognitive structures are applied to social, as well as nonsocial, content.

Despite the importance that Piaget assigned to the social and emotional realms, he paid relatively little attention to them, or to sociohistorical influences, in his work. It has been said that Piaget's epistemic subject has no social class, sex, nationality, culture, or personality—and also has no fun (Murray, 1983, p. 231).

Fortunately, other researchers have filled in the gaps or corrected Piaget's account of social cognition. Kohlberg (1969) adopted Piaget's stage approach to moral judgments and expanded and modified the model considerably. Social cognitive researchers have addressed children's concepts of self, other people, minds, and social interaction (e.g., Banaji & Gelman, 2013). Some work has examined peer interactions, thought by Piaget to be important for creating cognitive conflict that could cause cognitive progress. For example, interactions between nonconservers and conservers prior to deciding on a mutually agreed-upon answer tend to be tilted toward the conserver. These interactions often are very brief—in one study (Russell, 1982) an average of 40 seconds, consisting of little more than the conserver saying, "Same size, OK? . . . Ready!" Finally, the cultural and person-in-context approaches discussed later in this volume greatly expand our knowledge of sociocultural influences on cognitive development.

Underestimation of Abilities ▸ Piaget likely underestimated children's cognitive abilities at each age. The "miracle baby" (Gopnik, 1994, p. 133) experiments suggest that babies know a lot more than Piaget thought. For example, Piaget's requiring infants to search for a hidden object before being credited with the concept of object permanence may have underestimated their competence. Baillargeon (1987) found that 4-month-old infants, who should be too young to understand object permanence, looked a long time (i.e., were surprised) when a screen falling away from them seemed to pass through a box (now out of view) they had seen there earlier. Other examples appear later in this chapter in the "Contemporary Research" section. This "baby assault on Piaget" (Rochat, 2012, p. 71) questioned Piaget's belief that infants have to construct the foundations of a coherent world over the first two years of life.

Similarly, with preschoolers, work on children's "theory of mind" (see Chapter 9) suggests that by age 4 or 5 children know more about another person's perspective than Piaget thought. They know, for example, that another child would think that a crayon box holds crayons rather than candles, even though they themselves know it holds candles. Also, with young children, the verbal nature of much of Piaget's testing raises the possibility of underestimating children's knowledge if they do not understand the language used during testing, for example, the meaning of "same number" and "amount." Or children may not be able to express in words their ideas about quantity, the origin of the universe, the nature of dreams, and so forth. For instance, children may have the concept of conservation but not be able to give an adequate reason for their answer—one of Piaget's criteria for conservation. Or the standard Piagetian procedures may actually be tapping into children's understanding of conversation. An adult asking children about quantity twice (before and after the transformation) may cause children to think that they should change their answer (Siegal, 1991). Children may think that when an authority figure asks a question a second time, this usually means that the first answer was not satisfactory. In all these ways, Piagetian procedures may underestimate children's knowledge.

This concern about tasks' verbal requirements led to a number of interesting attempts to devise nonverbal, or at least less verbal, procedures.

Psychologists cleverly devised ways of using expressions of surprise (Gelman, 1972), heart rate changes (Bower, 1974), and choice of (more) candy to take home (S. A. Miller, 1976) to assess for certain concepts. For example, if an experimenter surreptitiously removes a toy mouse, 3-year-olds are surprised by this changed number of mice (Gelman, 1972), indicating some understanding of number. Some of the studies employing nonverbal assessments found better performance than did Piaget, but others did not.

Underestimation also can come from complex procedures. One way to simplify the task is to use simpler materials. For example, young children show greater knowledge about counting when there are only a few objects than when there are many (Gelman & Gallistel, 1978).

What should we conclude from these many demonstrations that Piagetian concepts appear to emerge earlier than Piaget thought if motor, verbal, and information-processing demands are reduced or eliminated? One possible conclusion is that Piaget did in fact underestimate children's competencies. Some psychologists see this as damaging evidence against Piaget's theory. For example, unearthing the early competencies in infancy has led some developmentalists to argue for innate predispositions that permit the early, rapid acquisition of core knowledge about language, mental states, and objects and their behaviors (e.g., Spelke, Bernier, & Skerry, 2013). However, recall that Piaget's main claims concerned the sequence in which concepts are acquired rather than the particular ages, which he thought would vary. Thus, showing that an ability emerged earlier than Piaget claimed is not necessarily damaging to his theory.

A more intriguing conclusion about these earlier competencies is that they may be less advanced versions of, and precursors of, the later, more advanced concepts described by Piaget. For example, young infants' apparent understanding of object permanence actually may reflect a competency that is more perceptual than conceptual (e.g., Bremner, Slater, & Johnson, 2014). And preschoolers' successful performance on modifications of concrete operational tasks actually may reflect only preoperational concepts, such as the function, described earlier, rather than concrete operational concepts (Lourenco & Machado, 1996). That is, the simplified task provides so much perceptual support that the conditions theoretically necessary for concrete operational reasoning are not present.

The differences in the methodology of Genevan Piagetians compared to researchers in other countries reflect different goals of assessment. Piaget especially wanted to avoid "false positive errors," namely, concluding that children have the concept when in fact they do not. Thus, he sometimes even considered it desirable to have complex materials, a misleading visual array, and heavy verbal demands so that only children who see the concept as logically necessary will prevail. In contrast, the other camp is more concerned about "false negative errors," concluding that children do not have the concept when in fact they do.

In any case, research on early competencies has been quite fruitful, for it has revealed positive acquisitions during the infancy and preschool years that complement Piaget's emphasis on the deficiencies of young children. For example, it turns out that preschoolers know a great deal about number (e.g., Nunes & Bryant, 2015). Gelman and Gallistel (1978) found a sequence of simple principles of counting, such as the principle that numerals must always be used in the same order. That is, children who say "1, 2, 6, 9" follow this counting principle correctly if they always use these numerals in this order for counting. These early principles supplement Piaget's account of the full-blown concept of number acquired several years later. Techniques that simplify the Piagetian tests are more sensitive to earlier forms of concepts than are Piaget's procedures.

It is interesting, however, that in addition to finding Piagetian underestimations, researchers also have found overestimations. For example, as discussed earlier, adolescents and even adults often fail to use formal operational reasoning. In fact, Piaget (1972) later concluded that the stage continued until age 20 or so.

Methodological and Stylistic Barriers ▶ Piaget's critics attack his methodology not only with respect to issues of underestimation and overestimation but also because much of it does not meet the conventions of developmental science. In his infancy research, Piaget observed his own three children. Unfortunately, he did not have 40 or 50 children of his own to give us a more respectable sample size. The small number of research participants, the possible biases in interpreting the behavior of one's own children, the absence of measures of reliability from two independent observers, and the lack of control over the children's immediate environment, possible only in a laboratory, did not endear Piaget to American experimental psychologists. However, subsequent studies by others, with more participants and better-controlled testing situations, generally have replicated the sequences of development, though not always the exact ages at which the changes occur.

In his work with older children, Piaget often tested large samples of children (for example, 2,159 for *Early Growth of Logic in the Child*

(1964b)!). He usually employed the clinical method. Although this method has certain advantages, such as flexibility in tailoring questions to the particular answers given by each child, it also has a number of disadvantages. Two main disadvantages are the danger that examiners may be too leading in their questions or not leading enough and that different children often are asked slightly different questions. Uniform instructions, materials, and measures of response are the backbone of testing in experimental psychology. We are asked to make the leap of faith that Piaget was in fact a sensitive and accurate observer. Piaget himself seemed aware of these problems:

> It is so hard not to talk too much when questioning a child, especially for a pedagogue! It is so hard not to be suggestive! And above all, it is so hard to find the middle course between systematization due to preconceived ideas and incoherence due to the absence of any directing hypothesis!
>
> *(1926/1929, p. 9)*

Piaget's reporting of his experiments also is frustrating to contemporary psychologists. He typically did not report the number of children, their race or socioeconomic level, and details of the testing procedure. Sometimes it is even difficult to tell whether Piaget was referring to hypothetical children or children he had actually tested. He was not impressed with tightly controlled laboratory experiments and statistical analysis. In his words, "acute observation, especially when made by [a good observer] . . . , surpasses all statistics" (1936/1952b, p. 72). Instead of presenting statistical summaries of the findings, Piaget provides sample protocols, which he interpreted at great length. The reader has no idea whether these protocols are representative of all children tested.

What are we to make of these characteristics of Piaget's methodology and writing? Flavell (1963) concluded that Piaget mainly wanted to satisfy his own curiosity, not the requirements of the scientific community. Thus, he played by his own rules when doing research and wrote almost as though he were talking to himself. After all, epistemology, not developmental psychology, was his passion.

Although Piaget's methodology and reporting are annoying to anyone trying to understand and evaluate his theory, they may be somewhat responsible for Piaget's success. His qualitative methods captured the richness of children's thinking, which sometimes is lost when quantitative methods are used. If Piaget had used standardized procedures from the beginning, solidly confirming each finding, he might have missed some fascinating facets of cognitive development and not have progressed as far as he did.

Piaget's Own Modifications of His Theory

Piaget considered himself one of the primary revisionists of "Piaget's theory." Translations of his later works led to some modifications of the "classic Piaget" (see Müller, Carpendale, & Smith, 2010). Although some of this more recent work was presented throughout this chapter, several theoretical changes should be highlighted, particularly regarding developmental change, equilibration, and the logicomathematical model.

In his later years, Piaget (1975/1985) put much less emphasis on stages. In fact, Vuyk concluded that Piaget "now considers development a spiral and though one may call a stage 'a detour of the spiral,' this indicates that periods of equilibrium are relatively unimportant" (1981, p. 192). Piaget began to view development as less steplike, with longer transition periods between stages. He also increased his attention to mechanisms of cognitive change, especially the equilibration process. He further worked out the equilibration processes. In particular, he emphasized mental actions that compensate for the ways the environment does not fit into current cognitive structures and reflective abstraction. In *reflective abstraction,* children construct new knowledge by taking their knowledge to a higher level and reorganizing it at that level. Piaget gave the example that young children can know how to get from home to school in a practical way, using cues to guide them from one point to another. In reflective abstraction, this knowledge is projected onto a representational level—an overall cognitive map of the spatial relations between home and school (Montangero & Maurice-Naville, 1997, p. 58).

Piaget also worked out a new way of describing developmental change, both within a stage and over all the stages: *intra*-, *inter*-, and *trans*-changes. Knowledge about properties of objects (intra) leads to knowledge about relations between object properties or actions (inter) and then to a structure that organizes these relations (trans). For example, a child moves from "A car can be ridden in," to "Cars and buses can be ridden in" and thus go together, to "Cars and buses and other vehicles are modes of transportation within a hierarchical logical system."

Piaget expanded on the role of "possibilities" (the way things might be) and "procedures" (strategies) in the process of development. This contrasts with his earlier emphasis on logical necessity. A new cognitive structure generates new possibilities, which takes children beyond current reality and permits them to try out new procedures on objects. As an example of the increasing awareness of possibilities during development, Piaget (1954/1981) showed children a box with only one side visible under a cloth. At age 5 or 6, children would accept only a single possibility for the color of the hidden side of the box—the same color as the visible side. Thus, a sense of necessity occurs in young children because they can imagine only a single possibility. By age 7 to 10, children recognized multiple, though limited, possibilities: the hidden side might be "green, violet, blue, white, yellow . . . that's all" (Piaget, 1954/1981, p. 44). At age 11 to 12, children realize that the number of possibilities is essentially unlimited. This development is interesting because the concept of unlimited possibilities cannot be observed in the environment. It must be constructed internally.

Piaget further explored the contradiction aspect of equilibration (1974/1980). He presented a row of seven disks, each of which was slightly, but imperceptibly, larger than the one before it. Because the last and largest disk was unattached, it could be moved to, and compared with, each of the six disks attached to the board. Thus, the contradiction facing the child was that any two adjacent disks appeared to be equal in size but the disk at the end of the series was obviously larger than the first disk. Three stages of understanding contradiction emerged. In the first stage, young children were unaware of the contradiction. Next, children had some awareness of the contradiction, but their attempted solutions were not satisfactory. For example, a child might categorize the disks as small ones and large ones, thereby accounting for some of the perceived equivalences between adjacent disks (both are "small") and also explaining the difference in size of the first ("small") and last ("large") disk. Finally, by age 11 or 12, children resolved the contradiction and re-established equilibrium by creating a new structure—quantified seriation of size.

Piaget's most radical changes were in his logicomathematical model of thinking, though his death prevented him from completing the project (Beilin & Fireman, 2000, p. 239). He considered that logic could come from the meanings of objects, developed from infants' actions. Specifically, infants learn that one action on an object is related to other actions; the meaning of actions comes from "what they lead to." That is, one action implies another action, in a sort of "logic of meaning in actions," a "psycho-logic" on objects. For example, infants who push an object away from themselves may infer that the object also can be pulled back. Another example is that "if I release the car down the ramp it will crash into the house at the bottom." This action-based logic later leads to a logic of operations, such as when the pushing–pulling relation leads to the reversal of a mental action. Remarkably, Piaget perceived in infants' coordinations of their actions (a logic of meaning) a sensorimotor counterpart to the 16 binary combinations of formal operations thought.

In category theory, Piaget's previous emphasis on action in the form of mental transformations was supplemented with "correspondences" between two static states (Piaget, 1979). Comparisons of static states are central, as when a preoperational child sees the similarity between a currently perceived object and a previously encountered one, and thereby assimilates the current one. The current object or event is recognized, categorized, or characterized; it therefore "corresponds" (is seen as similar) to other objects or events. Or a child may perceive that each of five dolls of increasing size maps onto five dresses of increasing size (Davidson, 1988). Detecting correspondences can lead a child to notice a transformation. For example, when a picture corresponds to the same picture hung upside down, a mental rotation links the two states and underlies their correspondence.

Piaget's final contributions have had little influence on developmental psychology. The reasons may be (a) doubts about the whole enterprise of logical models and stage theories and (b) the emergence of other attractive theories of cognitive development, discussed in later chapters, that have offered new perspectives and tasks.

The Neo-Piagetians

Many of the problems and limitations raised about Piaget's theory have been addressed by a group of developmental psychologists labeled "neo-Piagetian." They are Piagetian in their belief in structural change and in children's active construction of some sort of stages. In particular, they believe that lower-level concepts are integrated to form more complex higher-level concepts. However, they are "neo" in their inclusion of information-processing constructs (see Chapter 7) such as skills, limited memory capacity, and domain-specific concepts. Domain-specific concepts or cognitive structures are those that pertain only to a particular area or areas, such as role taking or number. Thus, a careful analysis of particular tasks is necessary. In contrast, Piaget emphasized the domain-general application of cognitive structures. Neo-Piagetians also are "neo" in that they draw on the social-contextual idea (see Chapter 4) of social supports for emerging cognitive skills and on dynamic systems theory (see Chapter 9). We examine the theories of Robbie Case (e.g., Case, 1998; Morra, Gobbo, Marini, & Sheese, 2008) and Kurt Fischer (e.g., Mascolo & Fischer, 2015), two main neo-Piagetians (see Morra et al., 2008, for other neo-Piagetian theories).

Robbie Case

Case, like Piaget, addressed cognitive changes from one level to the next. Case, however, attributed much of such change to increased working memory capacity or, in his words, *executive processing space:* "the maximum number of independent schemes a child can activate at any one time" (1985, p. 289). This processing space determines how many things a child can think about at the same time and use for further processing. For Case, children's thinking develops due to their increased efficiency of using their working memory capacity, rather than to Piaget's equilibration process. Capacity can increase in two ways. First, practice with a skill, such as counting, makes it less effortful and more efficient, thus freeing previously needed capacity. A given amount of capacity goes much further if many elements can be processed, rather than a few. This increase in available capacity can be used for additional cognitive activities, for example, both counting and remembering. The faster children can count objects, the better they are at remembering the number of objects in sets in a counting span test (Case, 1985). Second, brain maturation increases the amount of information children can handle. Increased myelination (insulation of neurons) and perhaps increased neural connections between the frontal and posterior lobes increase the efficiency and integration of cognitive functioning. Spurts in neurological maturation are correlated with cognitive spurts (Case, 1985).

Case differed from Piaget in his view of how children's mental structures should be modeled. Case remarked that "it seemed that Piaget's theory was better equipped for representing the structure in the mind of logicians than the structure in the minds of young children" (1992, p. 6). Rather than draw on symbolic logic, Case used constructs from the information-processing framework, particularly (a) children's rich networks of concepts and their relations and (b) *executive control structures*, which help children deal with specific problem-solving situations. He viewed children as problem solvers, with these control structures as their tools. Using these control structures, children can set goals, activate procedures (sequences of schemes) in novel ways for reaching these goals, and evaluate the results of these procedures. Children also can restructure successful procedures so that they later can produce them intentionally, and practice and integrate successful procedures until they are consolidated. For example, with respect to counting, children set a goal (determining the number of objects), generate counting procedures for attaining it, evaluate their success, "mark" the successful sequence, and integrate the successful counting procedures.

When children experiment during attempts to solve problems, they explore objects, observe and imitate other people, and interact with others as together they solve a problem. For example, children might learn about counting by using their own verbal labels as they touch each object during problem solving, counting different types of objects during exploring, observing others count, and trying to count a large set with the help of an adult. If children have the necessary processing capacity, they can take advantage of these experiences to construct more advanced executive control structures (for example, procedures for determining quantity).

Case addressed the debate about general versus domain-specific cognitive structures by proposing a small set of *central conceptual structures* at an intermediate level of generality. They are less general than Piaget's stage structures but more general than a single task. Each central conceptual structure is a representational system of a domain of knowledge such as number, space, or social interaction that should permit a child to apply that knowledge to all tasks in that domain. Thus, children look stagelike, showing similar thinking, across tasks calling for the same central conceptual structure. In contrast, children do not look stagelike, showing different types or levels of thinking, across tasks requiring different central conceptual structures.

Central conceptual structures interpret specific tasks in the domain and assemble problem-solving procedures for these tasks (the executive control structures mentioned earlier), a process that can cause cognitive change at this specific level. These specific level changes, along with increased capacity, in turn stimulate changes in the central conceptual structure *for that domain*. In this way, they bootstrap each other during development.

Case thought that, on a given task, children develop in a qualitative stagelike way, as they learn to use one dimension or component, then two, and then integrate them. For example, when told to tell a story about a little child and an old horse, young children relate a social situation with no mention of motives, whereas slightly older children create a story around the intentions of the central character. Later, children create a chain of two or more event sequences in which the first sequence does not lead to goal satisfaction, while the second sequence does. Finally, at the integrated level, children coordinate multiple attempts at satisfaction into an overall, complex, organized plot. As another example, the representations of spatial relations in Chinese children's drawings show a similar sequence (see Figure 2.2): (a) no real concern with spatial relations, (b) placement of objects into a single spatial dimension, (c) depiction of both foreground and background, and (c) creation of a coherent, unified picture.

Case's theory is an interesting attempt to integrate a structural model and a processing model of development. He showed how limits in

FIGURE 2.2

Typical pictures drawn by children aged 4(*a*), 6(*b*), 8(*c*), and 10(*d*) in Nanjing, China, when told to "draw a picture of a mother and a father holding hands in a park. A baby is in front of them and a tree is very far away behind them."

[Reproduced with permission from "The role of central conceptual structures in the development of children's thought," by Robbie Case and Yukari Okamoto, in *Monographs of the Society for Research in Child Development*, 1996, *61*(1–2), Serial No. 246, p. 139. © 1996 by the Society for Research in Child Development with permission from Wiley Publishers.]

processing capacity and social experience limit logical reasoning and constrain what the child can learn at any developmental level. By the same token, an increase in capacity creates a new opportunity for the further development of logical thinking. He examined a variety of skills, such as spatial representation, social cognition, eating with utensils in infancy, using vocalizations for social purposes, manipulating other people's feelings, storytelling, understanding emotions, and judging intelligence in others.

Kurt Fischer

Fischer agrees with Case in many ways. Fischer's particular contribution is that he addresses one of the main challenges to Piaget's stage theory—the observed variability in children's behavior, when Piaget would predict stagelike consistency. In Fischer's view, "Variations in developmental level are routine and pervasive and they need to be explained, not ignored" (Fischer & Hencke, 1996, p. 209). Fischer's *dynamic structuralism* posits that children's thinking can be variable, but also structured and predictable. Thus, Fischer, like Case, keeps Piaget's notion of cognitive structures but argues that they are not static; whether children express them or not depends on the support in a particular social setting.

Children gradually construct their thinking and learning skills as they use them in activities in various contexts. A *skill*, defined as "the capacity to act in an organized way in a specific context" (Fischer & Bidell, 2006), includes abilities such as storytelling, counting, forming relationships with others, and reading. A child may show variability in the use of a skill across contexts, as when a child may be able to add numbers at school when watching a teacher's actions but not when doing homework alone at home. Fischer called a child's variability in performance a *developmental range*. At one end of the range, with contextual supports such as social prompts or physical cues, children operate at their maximal, *optimal level*. At the other end, in a setting devoid of meaning, value, or support, or under conditions of fatigue, emotional stress, or distraction, children are unlikely to express their skill. Children can even operate beyond their optimal level with adult social scaffolding, in which an adult more fully participates in the child's activity by providing instruction or carrying out part of the action (see also Vygotsky's "zone of proximal development," Chapter 4). In short, children's level of thinking has to do with the fit between children and their environment, not the children alone.

A child also may show variability across skills, such that the child's thinking seems to be at different cognitive levels in different domains. Children are most likely to be advanced in a skill, such as counting, if they are raised in an environment with support for developing and using this skill, such as when parents play counting games with their children. Such children may be less advanced with respect to other skills, such as reading, generally considered to be in the same stage, if they have had little support or training for those skills. Thus, children are not "in" one stage or another. Rather, they will show various levels of cognitive functioning across various domains, depending on the opportunities for developing a particular skill in their social environments. On the other hand, thinking can appear stagelike and domain general if there is support in many domains.

Fischer uses the term *dynamic skills* because children are constantly having to adjust their skills to changing conditions and people and even to reorganize their skills. They use "not only their brains but also their bodies, the objects and people around them, and the roles, norms, and values of their culture" (Fischer & Bidell, 1998, p. 545). Through studying children's actions in context, Fischer tries to map the "dynamic structures" of human behavior. He draws on dynamic-systems theory (see Chapter 9) to capture the orderly patterns of development within children's variable behavior.

Still another aspect of variability in Fischer's model is that a child may follow several different developmental routes for different skills, and different children may follow different pathways to one particular skill. He contrasts his view with traditional metaphors of development, such as a ladder, in which all children begin at one point and move from one formal structure to the next to a final point. He offers an alternative metaphor—a "developmental web": "Unlike the steps in a ladder, the strands in a web are not fixed in a determined order but are the *joint product* of the web builder's constructive activity and the supportive context in which it is built (like branches, leaves, or the corner of a wall, for a spider web)" (Fischer & Bidell, 2006, p. 319). Thus, like a spider who must shift the direction and form of a web when a nonsupportive leaf breaks off, young children who develop their storytelling skills in a particular direction but find that their parents ignore this emergent skill may turn to their peers for listeners. Because adults and peers provide different sorts of feedback and support for this emerging skill, the children develop this skill along a different developmental pathway, perhaps toward more violent action and less coherence in the stories. In other words, different children encounter different settings that impact skills differently. Another example is that abused children are not simply socially unskilled but have developed alternative cognitive and social pathways to cope with their abuse. Thus Fischer provides a way to think about individual differences not only in how advanced children are along a normative pathway but also in terms of how children's pathways can differ.

Like Piaget and Case, Fischer believes that children develop through a sequence of tiers. Fischer proposes four tiers of increasing complexity from birth through early adulthood—reflexes, sensorimotor actions, representations, and abstractions (Mascolo & Fischer, 2015). Moving from one tier to the next involves cognitive reorganization, much as in Piaget's theory, and spurts in performance. Within each of the four tiers, children go through the same sequence of four levels: single sets, then mappings (coordination) between sets, then a system of mappings, then a system of systems. This system of systems then becomes the first level (single set) of the next tier. For example, in the sensorimotor actions tier, a single action, such as an infant reaching, is followed by a two-action connection in which an infant reaches for a ball in order to look at it. Next come connections between two-action systems, such as moving a rattle in various ways in order to look at different parts of it. Finally, a system of action systems (level 4) becomes level 1 (a single representation) of the next tier—the tier of representations. This new tier permits a coordination of two or more action systems from the sensorimotor tier, as when a toddler pretends that a doll is walking. This cycle of levels is then repeated: single representations, then two connected representations, systems of representations, then, systems of representational systems (level 4 of the representational tier).

As another example, single representations of doctor and patient become mapped into each other in the doctor–patient roles; during play, the doctor doll gives medicine to the patient doll after she complains of a stomachache. Later, children coordinate two mappings and perhaps show a person in two roles simultaneously (e.g., doctor and father). Finally, the various roles of two or more people are integrated into a system of representations, which also is a single abstraction for the next tier, and so on.

A child might appear to advance in a stagelike way when simultaneous changes in several domains, such as spatial understanding, object permanence, and pretend play, merge to cause a developmental spurt. A period of rapid brain maturation also could cause rapid changes across many domains. At other times, development across domains occurs at different times, and thus thinking does not seem stagelike.

Note that these tiers become increasingly abstract and bear a marked similarity to Piaget's stages. Fischer's contribution regarding stages is to show the same sequence of substages across all four tiers, and in diverse content areas such as gender-role development, reading, emotional development, adolescents' relationships, and planning.

Neo-Piagetian Themes

In summary, neo-Piagetians enrich and specify Piaget's theory, rather than contradict it. Their main contributions are to draw on information-processing and dynamic systems theories to (1) propose a promising set of processes, such as social support and increases in working memory, that account for developmental change and intrachild and interchild variability, and (2) clarify and refine the notion of stages, for example, by attempting to differentiate domain-general and domain-specific achievements. As Flavell observed, "Cognitive development might appear to be more general-stagelike than many of us believed, if only we knew how and where to look" (1982, p. 1).

Contemporary Research

In a broad sense, much of the current research on cognitive development is Piagetian. Although many psychologists claim that the influence of Piagetian theory has waned greatly, this decline may be more apparent than real. Even though there are few explicitly Piagetian studies, particularly with Piagetian tasks such as conservation and class inclusion, many Piagetian concepts, from object permanence to scientific reasoning, are still studied. Moreover, so many of Piaget's assumptions about the nature of cognitive development are assimilated into the thinking of researchers that Piaget's ongoing influence often is not recognized. As Flavell notes, "I think we are in more danger of underappreciating Piaget than of overappreciating him, for much the same reason that fish are said to underappreciate the virtues of water" (1996, p. 202). Examples of this pervasive but invisible Piagentian presence are the following: It is taken for granted that children actively construct knowledge rather than simply absorb information; to a great extent children teach themselves. Researchers routinely search for an organized conceptual minisystem underlying several different behaviors in a particular domain, for example, the organized theorylike understanding underlying children's grasp of the nature of mind—theory of mind (see Chapter 9). They also regularly look at the sequence in which concepts in a particular domain are acquired, for example, studies of the order in which children acquire various theory-of-mind concepts in various cultures (Shahaeian, Peterson, Slaughter, & Wellman, 2011). Researchers look for the processes by which a new concept arises from a previous one, and try to identify when a child is ready to learn. Developmentalists also continue to be informed by the "wrong" or "cute" notions that preschool children have about the world that are a symptom of a complex, probing intellectual system trying to make sense of the world. Finally, researchers continue to try to teach new concepts before they are acquired naturally, in part to test the limits of, or constraints on, the ability to learn.

These Piagetian influences particularly play out in three topics today: infants' advanced competencies, children's domain-specific concepts, and mechanisms of development. These topics address three current areas of contention: How early are various concepts acquired? To what extent is knowledge organized by domains versus applied to multiple domains? How can we account for new knowledge? These lines of research began in earlier challenges to Piaget's theory (especially the stage notion), described previously in this chapter, thus setting in motion major themes in developmental research today.

Infants' Advanced Competencies

New methods not available to Piaget, particularly measuring infants' longer looking time at events that violate their expectations, continue to detect seemingly remarkable knowledge in infants that Piaget thought developed much later. Young infants appear to imitate others, detect their intentions, understand physical qualities of objects such as permanence and containment, and categorize objects (including people). One striking example is that infants seem to understand adults' intentions, even if they do not see adults achieve their goal, as when 7-month-olds reach for an object that they saw an adult reach for unsuccessfully (Hamlin, Hallinan, & Woodward, 2008). In contrast, they do not imitate an action with an ambiguous goal, even if the adult successfully attained the goal. That is, they can analyze the goals of even uncompleted actions and imitate only those behaviors that are goal directed, regardless of whether they are successful. Another example is that 6-month-old infants' looking shows that they can discriminate between small sets of numbers, such as 1 versus 2, 2 versus 4, and 4 versus 8, indicating some sense of number (Starr, Libertus, & Brannon, 2013). Infants also appear to form concepts of categories such as shapes and animals (Sloutsky, 2015). For example, infants are familiarized with exemplars from a category, such as dogs, and then presented with a new category member and a noncategory object. Given infants' preference for novelty, their looking at the noncategory object is taken as evidence that infants have constructed a category of dogs. Finally, infants seem to have some moral sense—a tendency to see certain actions and people as good or bad. They can infer intentions from the behaviors of puppets or animated shapes that help or hinder someone's behaviors toward a goal (Hamlin, 2013). For example, infants watched a puppet unsuccessfully attempt to climb a hill, and either a "helper" aided the climber by bumping him up or a "hinderer" bumped the climber back down the hill. Even 5-month-olds seemingly detected the positive motive of the "helper" and preferred (i.e., they reached for) the helper rather than the hinderer. Infants also seem to approve of retribution against those with these antisocial mental states. For instance, when they had to take a treat away from someone, they took it from the bad individual (Hamlin, Wynn, Bloom, & Mahajan, 2011).

The debate continues over whether these seemingly precocious concepts are simply earlier, more perceptual, versions of concepts that Piaget thought emerged later (e.g., Bremner et al., 2014) or are the same concepts, but detected earlier due to more sensitive assessments. Early detection of a perceptual discrepancy may lead to a later conceptual understanding.

Domain-Specific Concepts

Having turned away from grand stage approaches, researchers continue to study the development of an organized understanding specific to a particular domain, in domains examined by Piaget, particularly number, moral reasoning, space, biology, physics, and people. They also research other topics mapped out by Piaget, such as scientific reasoning, symbols, social understanding, and reasoning (e.g., Liben & Müller, 2015). Much of this contemporary work falls within the *theory theory* approach (see Chapter 9), which examines children's organized "foundational" concepts about physics, psychology, and biology that are important to learn quickly early in life, in order to adapt and thrive. Knowing that objects fall down rather than up, distinguishing between animate and inanimate objects, and understanding others' intentions and beliefs are examples. These organized, coherent systems of knowledge about a domain obviously retain important elements from Piaget's theory.

Mechanisms of Development

Cognitive developmentalists today continue Piaget's quest for the mechanisms that move cognitive development along. Of particular interest are increases in working memory, speed of processing, a growing knowledge base in particular domains, inhibitory control of thinking, and brain maturation (Keating, 2012). Although Piaget considered maturation an important contributor in his formula for development described earlier, only recently has it been possible to examine brain maturation (see Chapter 5). Developmental cognitive neuroscience, particularly neuroimaging methods such as fMRI, is documenting the role of brain functioning in children's cognitive development (see Johnson & de Haan, 2015, for an overview). For example, maturation of the cerebral cortex correlates with cognitive milestones during development (Sowell et al., 2004).

One powerful mechanism of cognitive development due to the maturation of the frontal cortex is the inhibition of dominant but less mature responses. On Piaget's A-not-B task described earlier, infants' tendency to look under the first hiding place rather than the final one may indicate not a lack of understanding of object permanence, but rather their inability to inhibit their highly practiced tendency to search the first hiding place (Diamond, 1985). Moreover, studies of brain activity related to inhibition show that children have to be able to inhibit their length-equals-number strategy before they can give a conservation answer on a conservation-of-number task (Linzarini, Houdé, & Borst, 2015). Interestingly, adults also show a pattern of brain activity suggesting that they have to inhibit a childlike nonconserver tendency that competes with their logic-based concept of conservation. Thus, mechanisms of development operate not only by leading children to new concepts but also by helping them leave behind old ways of thinking.

Piaget's constructivist approach to explaining development is captured in the *neuroconstructivism* approach (Karmiloff-Smith, 2012). The process of development is key to understanding adult brains. The brain is constantly changing and reorganizing due to two-way interactions among genes, brain, cognition, behavior, and environment during development. Small initial differences in the focus of various brain regions, when combined with experience during development, result in specialized regions. Moreover, neurodevelopmental disorders are due to small initial differences between typically and atypically developing children in brain functioning or environments that, over the course of development, cascade into much larger differences in brain functioning, cognition, and behavior.

Other research on the process of change from one cognitive level to another has tried to identify conditions in which children are most likely to advance cognitively from new experiences or direct instruction. An example is children who give the wrong answer on a conservation task but show their correct implicit understanding in their hand gestures (Church & Goldin-Meadow, 1986). Some widen the space between their hands, indicating their awareness of the increased width of the container of liquid even though their answer is based on how high the liquid rises. These children progressed more after conservation training than did nonconservers whose hands agreed with their words by indicating liquid height. Such work on discordant representations provides a new perspective on cognitive readiness to learn from experience and thus advance cognitively.

SUMMARY

Piaget's theory posits universal, invariant stages in how children acquire knowledge about the world (genetic epistemology). In the first two years of life, children construct sensorimotor schemes based on physical action upon the world. The schemes become more intentional and integrated during that time. During the preoperational period, approximately age 2 to 7, children exploit their newly acquired symbolic ability. Despite the limitations of egocentrism, rigid thought, and limited role-taking and communication abilities, children combine symbols into semilogical reasoning. During the concrete operational period, roughly age 7 to 11, children acquire logicomathematical structures. Now thought is operational and consequently more flexible and abstract. Actions are still the main source of knowledge, but the actions now are mental. Finally, during the formal operational period, age 11 to 15, these operations are no longer limited to concrete objects. Operations can be performed on operations, verbal propositions, and hypothetical conditions.

These stagelike changes involve changes in the structure of thought. Thought becomes increasingly organized, always building on the structure of the previous stage. Evidence for these structural changes comes from observations of infants and from interviews or problem-solving tasks with older children.

Movement through the stages is caused by four factors: physical maturation, experience with physical objects, social experience, and equilibration. Experience brings cognitive progress through assimilation and accommodation. These functional invariants help children adapt to the environment by strengthening and stretching their current understanding of the world.

Piaget viewed children as active and self-regulating organisms who change by means of interacting innate and environmental factors. He emphasized qualitative change but identified certain quantitative changes as well. The essence of cognitive development is structural change. Piaget drew on the equilibration model and the logicomathematical model to describe these changes. His theory has contributed many educational concepts, for example, "readiness to learn" and the "active learner."

The theory's main strengths are its recognition of the central role of cognition in development, discovery of surprising features of young children's thinking, wide scope, and ecological validity. The main weaknesses include its inadequate support for the stage notion, inadequate account of mechanisms of development, need for a theory of performance, slighting of social and emotional aspects of development, underestimation of abilities, and methodological and stylistic barriers.

Some of these problems have been addressed by the neo-Piagetians, particularly Case and Fischer, who include the contributions of working-memory capacity and cultural support to the variability and consistency of children's thinking. In addition, Piaget himself continued to modify his theory in his later years, particularly with respect to the nature of logic and the mechanisms of development.

Today, researchers continue to examine the key issues of cognitive development identified by Piaget and by those who challenged and expanded his theory. Particularly active areas include infants' advanced competencies, domain-specific concepts, and mechanisms of development.

What should be our final judgment on Piaget's theory? This flawed but amazingly productive theory gives us a framework for viewing the richness and complexity of cognitive development. Even when it has failed, for example, by providing no adequate explanation for conservation despite hundreds of studies, the theory has led to interesting discoveries about development. Examples include surprisingly sophisticated infant knowledge and rudimentary numerical skills in preschoolers that may lead to conservation. Furthermore, the theory has raised issues that all theories of development must address. In short, we must pay attention to this "giant in the nursery" (Elkind, 1968).

SUGGESTED READINGS

Much interesting material about Piaget can be found on the website of the Jean Piaget Society: http://piaget.org/

Numerous books and articles have been written about Piaget and research that his work stimulated. The following are a good start:

Martí, E. & Rodríguez, C. (Eds.). (2012). *After Piaget.* New Brunswick, NJ: Transaction Publishers.

Müller, U., Carpendale, J. I. M., & Smith, L. (Eds.). (2010). *The Cambridge companion to Piaget*. New York: Cambridge University Press.

Lourenco, O., & Machado, A. (1996). In defense of Piaget's theory: A reply to 10 common criticisms. *Psychological Review*, *103,* 143–164.

The following books by Piaget are two of his more readable and clearly written publications:

Piaget, J. (1967). *Six psychological studies*. New York: Random House.

Piaget, J., & Inhelder, B. (1969). *The psychology of the child*. New York: Basic Books.

CHAPTER 3

Freud's and Erikson's Psychoanalytic Theories

I dreamt that it was night and that I was lying in my bed . . . . Suddenly the window opened of its own accord, and I was terrified to see that some white wolves were sitting on the big walnut tree in front of the window. There were six or seven of them. The wolves were quite white, and looked more like foxes or sheep-dogs, for they had big tails like foxes and they had their ears pricked like dogs when they pay attention to something. In great terror, evidently of being eaten up by the wolves, I screamed and woke up.

—*"The Wolf Man" quoted in Freud, 1918 (1955e, p. 29)*

The most significant sex difference was the tendency of boys to erect structures, buildings, towers, or streets . . . The girls tended to use the play table as the interior of a house with simple, little, or no use of blocks . . . . Simple enclosures with low walls and without ornaments were the largest item among the configurations built by girls. However, these enclosures often had an elaborate gate . . . A blocking of the entrance or a thickening of the walls could on further study be shown to reflect acute anxiety over the feminine role.

—*Erikson, 1963, pp. 102–105*

Sergey Nivens/Shutterstock

Psychoanalytic theory has great historical significance for developmental psychology. To meet the source of the theory, we move from Geneva to Vienna, where Freud spent most of his life. We also move our focus from cognitive development to personality development. The development of the theory followed a tortuous course, full of dazzling insights, diverging ideas, and clashing personalities. Although many figures are responsible for the psychoanalytic movement, we must limit our attention to the main ones who influenced developmental psychology—Sigmund Freud, who began the movement, and Erik Erikson, who subsequently constructed a life-span view of development. Both proposed that personality development proceeds through a series of stages. In each stage, the child copes with certain conflicts stimulated, to a great extent, by biological changes during development. Freud's theory, although developed prior to Piaget's theory, is presented here after the Piagetian chapter because Freud's stage theory can be more easily understood after the fuller discussion of issues about stages in the Piagetian and neo-Piagetian tradition. This chapter proceeds in the following order for both the Freud and Erikson sections: biography, general orientation, description of stages of development, mechanisms of change, the theory's stand on critical issues, applications, contemporary research, and evaluation.

FREUD

Biographical Sketch

Much of the material in this section comes from Ernest Jones's three-volume biography (1953, 1955, 1957) of Freud. Sigmund Freud (1856–1939), an Austrian neurologist, was the father of psychoanalytic theory. He was the eldest of eight children born to a wool merchant and his wife. Freud believed that he was a favored child and that great things were expected of him. As he expressed it, "A man who has been the indisputable favorite of his mother keeps for life the feeling of a conqueror, that confidence of success that often induces real success" (quoted in Jones, 1961, p. 6). He had a voracious appetite for books on history and philosophy, as did Piaget. He and a friend taught themselves Spanish so that they could read *Don Quixote* in the original. In secondary school, he read an essay by Goethe on nature that awakened an interest in science. He entered medical school with the goal of becoming a researcher. It is interesting, given the eventual focus of his theory, that his first major research project was on the structure of the testes in eels.

The goal of becoming a research scientist had to be set aside when his poor economic situation and barriers against advancement for a Jew in academia forced him to enter private practice, where he used his neurological training to treat "nervous disorders." At the time, this branch of medicine was at a very primitive level, and its practitioners could give little help to the mentally ill. Doctors typically prescribed hydrotherapy (various types of baths) and electrotherapy (mild electric currents passed through the body).

Freud was fascinated with hysteria, a disorder characterized by such symptoms as paralysis, numbness, squinting, and tremors. His contact with the French neurologist, Jean Charcot, and the Viennese physician, Josef Breuer, aroused his interest in a possible new treatment, hypnosis. Charcot could produce symptoms of hysteria in people by means of hypnotic suggestion, which suggested that the malady had a psychological basis. As Freud began to use hypnosis with his patients, he was impressed that they could recall important incidents and feelings while under hypnosis that were otherwise inaccessible. This was the puzzling observation that Freud developed his theory to explain: How and why do we hide parts of our past from ourselves? Despite the general belief among neurologists that hypnotism was fraudulent and dangerous, Freud enthusiastically experimented with this technique: "There was something positively seductive in working with hypnotism. For the first time there was a sense of having overcome one's helplessness; and it was highly flattering to enjoy the reputation of being a miracle-worker" (1925/1959, p. 17).

Freud also was influenced by Breuer's discovery that symptoms of hysteria could be alleviated simply by having his patients talk about (and "relive") their emotion-laden experiences from early life. With a sense of excitement, Freud experimented with what Breuer called the "talking cure." In a letter to his friend Wilhelm Fliess in 1895, Freud described how psychology possessed him: "A man like myself cannot live without a hobbyhorse, without a dominating passion: in fact, without a tyrant, to use Schiller's expression, and that is what it has become. For in its service I know no moderation. It is psychology" (quoted in Jones, 1961, p. 226).

Freud's study of his patients' dreams and childhood memories led to his first major publication, *The Interpretation of Dreams* (1900/1953a). Although this book was ignored by medical and scientific circles, as well as by the general public, Freud was not discouraged. He produced a succession of fascinating books in the following years and eventually began to attract a small following, including Carl Jung and Alfred Adler. The new psychoanalytic movement strengthened, even while the European medical establishment spurned it. A turning point came in 1909, when the eminent American psychologist G. Stanley Hall invited Freud to speak in the United States. As Freud described it, "In Europe I felt as though I were despised; but over there I found myself received by the foremost men as an equal" (1925/1959, p. 52). Interestingly, he was not enamored of American culture, and told his biographer "America is a mistake; a gigantic mistake, it is true, but none the less a mistake" (Jones, 1955, p. 60). He appeared on the cover of Time magazine in 1924 and began to achieve international recognition. Psychoanalysis began to influence not only psychiatry and the social sciences but also fields such as literature, art, ethics, and education. "Subconscious" and "ego" became household words. A popular song cautioned, "Don't tell me what you dream'd last night/For I've been reading Freud!" (Burnham, 1979, p. 129). Of course, much of the reaction was far from positive; many people were shocked at the claim that children have a sexual nature. The attacks on psychoanalytic theory continued throughout Freud's lifetime.

Freud's theory evolved over the years. In fact, he made some basic changes in his views when he was in his seventies. By the end of his life, his psychoanalytic writings filled 23 volumes. When the Nazis took over Austria in 1937, he was forced to flee to England, where he died in 1939.

Freud's notion that behavior and development are directed by powerful unconscious drives shook 20th-century thought. Concepts such as infantile sexuality, the anal personality, and the teeming desires of the unconscious jarred a Victorian society that covered piano legs to hide their nakedness. Freud's view of the human potential for destructive behavior could not be so easily dismissed after two world wars and the political crimes of the times. It was a theory whose time had come.

Regardless of one's judgment about the scientific merit of the theory, it is, without doubt, the most widely influential psychological theory in history. Its impression on society may equal that of Marx and Darwin. The theory's influence reached into nearly every area of 20th-century thought. Freud described unconscious motivation in the areas of anthropology (*Totem and Taboo*, 1913/1955c), art ("The Moses of Michelangelo," 1914/1955d), religion (*The Future of an Illusion*, 1927/1961c), literature ("Dostoevsky and Parricide," 1928/1961d), sociology (*Civilization and Its Discontents*, 1930/1961e), and history (*Why War?* 1933/1964b).

The general public became familiar with many of his ideas. Slips of the tongue became more embarrassing than before, and people began to take their dreams seriously. The belief that weaning and toilet training should not be sudden and harsh is often attributed to Freud's ideas.

Freud's work on emotional and nonrational aspects of personality significantly influenced psychology and psychiatry, especially in child and adult therapies. Various followers further developed his theory and, in some cases, broke away from Freud. Some of the best-known neo-Freudians were Carl Jung, Otto Rank, Alfred Adler, Karen Horney, Harry Stack Sullivan, Erik Erikson, Melanie Klein, Anna Freud, Heinz Hartmann, and David Rapaport. Their work led to the various branches of psychoanalysis found today. Over the years, psychoanalytic theories increasingly emphasized rational, reality-oriented thought and close social relationships.

Freud's stage theory deeply influenced developmental psychology in the 1940s and 1950s. Most prominent were Erikson's stage theory of psychosocial development; direct observations of children by Anna Freud, Ernst Kris, Sybill Escalona, and Rent Spitz; John Whiting and Irvin Child's cross-cultural work; and John Bowlby's early studies on infant social attachment (see Chapter 5). Psychoanalytic theory also touched the early work of social learning theorists (see Chapter 6).

Today, Freud's theory remains a vital force within child clinical psychology, child psychiatry, and counseling psychology. However, developmental experimental psychology has ignored Freud's theory for decades, in part because his theory is not based on scientific evidence. In the major journals of contemporary developmental research, one rarely finds "tests" of the theory or references to psychoanalytic work. However, as with Piaget, some of his ideas, such as the special impact of early social experiences and identification with parents, are so much a part of developmental psychology that his contributions are no longer recognized as being specifically his.

General Orientation to the Theory

Accounts of Freud's theory are somewhat contradictory, because various sources give differing accounts and because Freud revised his ideas over the years. Fortunately, despite changes in the details of the system, there is constancy in the general approach. Six general characteristics emerge: a dynamic approach, a structural approach, a topographic approach, a developmental stage approach, a normal–abnormal continuum, and psychoanalytic methods. We look at each of these characteristics and, when useful for clarifying the theory, compare them with those of Piaget's theory.

Dynamic Approach

Freud noted powerful drives in his patients, which led him to see personality as dynamic. He described his theory as "a sort of economics of nervous energy" (quoted in Jones, 1953, p. 345). This nervous energy is variously termed *psychic energy, drive energy, libido*, and *tension*. Analogous to energy in physics, psychic energy builds up and can be distributed, tied to certain mental images, transformed, and discharged. Psychic energy is a general energy source that can be likened to an electricity supply, which can be used to toast bread, shave, bake, and so forth (Hall, 1954, p. 84). Thus, psychic energy can be used to write a book, jog, watch television, and make a bookcase.

In the same way that physical energy is transformed but not destroyed, psychological energy is transformed into anxiety; displaced into a physical structure that causes a symptom, such as paralysis; or transformed into a thought, such as an obsession. The *pleasure principle* states that whenever possible, energy is discharged without delay. The organism strives toward the immediate, direct reduction of tension, which reduces pain and produces pleasure. Hunger leads to eating; the need to suck leads to sucking one's thumb. In the *reality principle*, small amounts of energy are discharged, but only in an indirect route, and after a delay. The mental apparatus scans reality and evaluates various possible courses of action before allowing energy to be discharged. For example, an angry child may tell his friend he is angry with him rather than hit him and risk punishment.

Where does this psychological energy come from? The human body has certain instincts (biological drives) that make demands on the mind. Freud posited two basic instincts—*Eros* (sex, self-preservation, love, life forces, striving toward unity) and the *destructive instinct* (aggression, undoing connections, the death instinct, hatred). Freud assigned the term *libido* to the available energy of Eros. There is no analogous term for the energy of a destructive instinct. His interest in the destructive instinct came late in life and is attributed to his horror at the atrocities of World War I and the anti-Semitic feelings of his times.

Instincts involve excitation in some region of the body, particularly the oral, anal, and genital areas for the sex drive. The change in the site of excitation underlies the movement from stage to stage, as we shall see later. This internal excitation stimulates the mind and creates a "need." In the close interplay between mind and body, psychic energy is derived from biological energy. The *aim* of the sex drive, or of any instinct, is to remove this bodily need, discharge tension, and experience pleasure. This ultimate goal is achieved through such subordinate goals as finding and investing energy in sexual objects, either a real person or object or a representation of a person or object. Libido becomes attached to or, in Freud's terminology, *cathected* to an object. Infants cathect to their mother and other objects that satisfy their needs.

Drives can be satisfied either fully or in a partial and roundabout way. Freud believed that da Vinci's interest in painting Madonnas was a way of partially satisfying his desire for his mother, from whom he had been separated early in life. One object can substitute for another object, as when an adult's oral needs are satisfied by playing a trumpet. In some cases, a culturally or morally "higher" goal object is substituted for the truly desired object. This is labeled *sublimation*. An angry person might sublimate his desire to attack other people by painting violent scenes. Another common type of object substitution is *compensation*, in which people make up for their failure in one area by applying themselves in another area. A 5-foot, 6-inch basketball player may eventually become a sports announcer.

Structural Approach

The previous section creates the image of a human hydraulic system with powerful forces surging through the body and the mind. The other part of the story is the psychological structures through which these forces flow. These structures mediate between the drives and behavior. There is, then, an architecture of the mind. Mental processes take place within the structures, between the structures, and by means of the structures. There are three major structures: the id, ego, and superego. Roughly speaking, the *id* is the seat of biologically based drives, the *ego* is the mechanism for adapting to reality, and the *superego* is analogous to the conscience. We examine each "province of the mind" (Freud, 1933/1964a, p. 72) in turn and then portray their overall organization.

Id ▸ As the novelist Peter De Vries humorously expressed it in *Forever Panting,* "'Id' isn't just another big word." The id is the seat of innate desires and is the main source of psychic energy. It is the "dark, inaccessible part of our personality . . . a chaos, a cauldron full of seething excitations" (Freud, 1933/1964a, p. 73). The id wants immediate satisfaction, in accordance with the pleasure principle described earlier. The energy of the id is invested either in action on an object that would satisfy an instinct or in images of an object that would give partial satisfaction. For example, infants may satisfy their oral-hunger drive directly by sucking a nipple and receiving milk or partially and indirectly by imagining a bottle of milk. This hallucinatory wish fulfillment is called *primary-process thought*.

In contrast to young infants, older infants, children, and adults have an ego and a superego in addition to an id. The id, however, continues to operate throughout life, especially in our nighttime dreams, daydreams, imagination, and impulsive, selfish, and pleasure-loving behavior. The id has been called the "spoiled child of the personality" (Hall, 1954, p. 27).

Much of Freud's knowledge about the id came from his study of dreams. The desires of the id appear in dreams in either an obvious or a disguised fashion. One does not need psychoanalytic training to interpret a hungry person's dream about a chocolate cake. However, some urges are so threatening that they must be rendered less obvious. According to Freud, clothes and uniforms sometimes represent nakedness; water can stand for birth; a journey can mean death.

Ego ▸ In the beginning, there is id. The id, armed with primary-process thought (hallucinatory wish fulfillment), makes its demands. However, babies soon discover that thinking something does not make it so. The image of the mother and milk and the memory of warmth do not quiet the pangs of hunger. They learn that there is a difference between images and reality, between the self and the outer world.

The id's inability to always produce the desired object leads to the development of the ego. The ego, the mind's avenue to the real world, is developed because it is needed for physical and psychological survival. It aids in survival because it possesses *secondary-process thought*. Secondary-process thought is rational and includes intellectual activities such as perception, logical thought, problem solving, and memory. It is more organized, integrated, and logical than primary-process thought, in which contradictions abound. Most of the intellectual abilities studied by Piaget would fall into Freud's ego domain. The ego is the executive who must make the tough, high-level decisions. It evaluates the present situation, recalls relevant decisions and events in the past, weighs various factors in the present and future, and predicts the consequences of various actions. The ego's decisions are aided by feelings of anxiety, which signal that certain actions would be threatening. Above all, the ego's decision making involves the *delay* of energy discharge, the reality principle mentioned earlier. Freud described the thinking of the ego as "an experimental action carried out with small amounts of energy, in the same way as a general shifts small figures about on a map before setting his large bodies of troops in motion" (1933/1964a, p. 89).

The small quantities of energy at the disposal of the ego come from the id. As the ego acquires more and more energy and gains experience using secondary-process thought during development, it becomes stronger and more differentiated. Of course, the ego, with its secondary-process thought, does not replace the primary-process thought of the id. Rather, it simply adds another level to thought. Gratification can be achieved either by finding appropriate real objects in the environment after a delay or by hallucinating and dreaming. Throughout life, we use a mixture of primary- and secondary-process thought. However, as development proceeds, the secondary-process aspects of thought become more dominant.

The ego serves "three tyrannical masters": id, superego, and external world (Freud, 1933/1964a, p. 77). Freud described the ego's position in an analogy:

> The ego's relation to the id might be compared with that of a rider to his horse. The horse supplies the locomotive energy, while the rider has the privilege of deciding on the goal and of guiding the powerful animal's movement. But only too often there arises between the ego and the id the not precisely ideal situation of the rider being obliged to guide the horse along the path by which it itself wants to go.
>
> *(1933/1964a, p. 77)*

The ego mediates between the id and the external world: "Thus the ego is fighting on two fronts: it has to defend its existence against an external world which threatens it with annihilation as well as against an internal world that makes excessive demands" (Freud, 1940/1964c, p. 200).

These constant threats and dangers from the id and the environment arouse anxiety. When possible, the ego tackles the problem in a realistic way, using its problem-solving skills. However, when the anxiety is so strong that it threatens to engulf the ego, *defense mechanisms* come into play. They control and thereby alleviate anxiety by distorting reality in some way. Although defense mechanisms allow only partial satisfaction of the drives, for the organism in a state of tension, some satisfaction is better than none. Freud and his daughter, Anna Freud, identified several defense mechanisms.

For example, *repression* involves preventing a threatening thought from reaching consciousness. The principle seems to be "What we don't know can't hurt us" (Hall, 1954, p. 85). If anxiety-arousing thoughts cannot surface, we do not experience anxiety. For example, to avoid anxiety, we forget to pay a bill that would put a severe strain on the budget. Freud thought there was massive repression of memories of childhood sexuality once children reach grade-school age. Only with great difficulty could Freud help his adult patients recover early painful memories. Freud's ideas about repression developed from his observations in therapy. When a patient reported her thoughts during "free association," she would often stop abruptly and claim that her mind had suddenly gone blank, just at the moment when important memories of the past seemed about to emerge. As Nietzsche remarked, "One's own self is well hidden from oneself: of all mines of treasure one's own is the last to be dug up."

If people depend too heavily on this defense mechanism, they may develop a repressed personality: withdrawn, inaccessible, nonspontaneous, and rigid. Also, there can be some loss of contact with reality as they make serious and frequent mistakes in remembering, speaking, and perceiving or develop symptoms of hysteria. For example, hysterical deafness may prevent a person from hearing something she does not want to hear.

Two other defense mechanisms are *reaction formation* (acting the opposite of the way one feels) and *regression* (returning to an earlier form of behavior). For example, a young child who feels angry and insecure when parents switch most of their attention to a newborn sibling may shower the newborn with extravagant affection (reaction formation) or start crawling or sucking her thumb again (regression).

In the defense mechanism *fixation*, one component of personality development comes to a halt. A portion of the libido remains tied to an earlier period of development and does not allow the child to proceed fully to the next stage. Fixation can occur when the present mode of satisfaction, for example, sucking a breast or bottle, is so gratifying that the child does not want to give it up, even under pressures to become weaned. Fixation can also occur when the next step appears to be too frightening or demanding or unsatisfying. The initiation of toilet training, if too harsh, may cause a toddler to remain partially in the oral stage rather than progress through the anal stage. Fixation is tied to regression in that a person is more likely to regress in the face of a barrier if there has been fixation at an earlier point in development.

Defense mechanisms are a necessary evil. We need them to deal with high anxiety but at the cost of "wasting" our energy when it could be put to better use in ego development, for example, for creative thought or the development of problem-solving skills. Furthermore, if too much energy is tied up in the defense mechanisms, personality may not develop normally because the person distorts reality and deceives himself. This situation makes subsequent adjustments to reality even more difficult.

Superego ▸ The superego is the last to develop. It arises when children resolve their Oedipus complex and develop identification with their parents. That story is told in the section on stages.

The superego is composed of two parts: the conscience and the ego ideal. In general, the conscience is negative, and the ego ideal is positive. The *conscience* is composed of the parents' prohibitions, their "Thou shalt nots." Just as the parent has punished the child for his transgressions, so does the conscience punish the person with feelings of guilt, the "accidental" cutting of one's finger, or intentionally self-destructive behavior. Curiously, the superego often becomes even more severe than the parents were. The *ego ideal* refers to standards of conduct toward which the child strives. Just as the child has been rewarded for certain behavior by the parents, she is rewarded by the ego ideal with feelings of self-esteem and pride. These are echoes of early years when a parent said "Good girl!" to the young child.

The superego opposes both the id and the ego. It rewards, punishes, and makes demands. The superego watches over not only behavior but also the thoughts of the ego, and even considers thinking as bad as doing. The superego is society's way of achieving order. Unrestrained sexual and aggressive behavior would destroy the always tenuous social structure. Freud noted that if the ego represents the "power of the present" and the id represents the "organic past," then the superego represents the "cultural past" (1940/1964c, p. 206).

Structural Relationships ▸ We have dissected the personality into id, ego, and superego. However, personality is an organized whole—a unique constellation of forces and structures. Freud sketched out the relationship among the mental "areas," as seen in Figure 3.1. He cautioned that we should not regard the id, ego, and superego as sharply

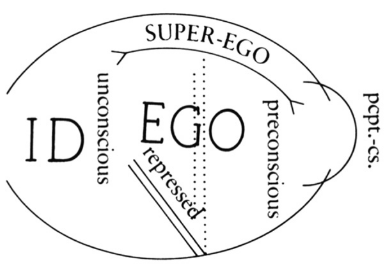

FIGURE 3.1

In Freud's sketch of the structure and topography of the mind, which also depicts the process of repression, the label "pcpt.-cs." refers to the perceptual-conscious, usually called the conscious.

["Diagram on p. 98", from New Introductory Lectures on Psycho-Analysis, by Sigmund Freud, translated and edited by James Strachey. Copyright © 1965, 1964 by James Strachey. Used by permission of W.W. Norton & Company, Inc. and Random House Ltd.]

defined areas and certainly not as locations in the brain. Rather, they are "areas of color melting into one another as they are presented by modern artists" (Freud, 1933/1964a, p. 79). The superego, for example, blends into the id and, in fact, is intimately related to the id. This close relationship is most clearly seen in the Oedipus complex, discussed later, in which strong urges in the id necessitate the development of the superego and are subsequently controlled by the superego. Or in another instance, the id and superego may join forces in attacking supposedly "immoral" persons as in witch burning or the cruelty of the Inquisition (Hall, 1954, p. 48).

These structures contain a closed-energy system, in which a certain amount of energy is distributed to the three parts. A gain in energy in one part strengthens that part but at the same time weakens the other parts. Under ordinary circumstances, the three systems work together as a team in relative harmony rather than war against each other.

The ego is central in this structural relationship. It is brought into all conflicts between the id and the superego because each is trying to use the ego to meet its own needs. The ego must both obey and control the id, superego, and external reality. It survives by compromising. If the id says "yes" and the superego says "no," then the ego says "wait" (Hall, 1954, p. 47). Freud summed up this relationship as follows:

> Thus the ego, driven by the id, confined by the super-ego, repulsed by reality, struggles to master its economic task of bringing about harmony among the forces and influences working in and upon it; and we can understand how it is that so often we cannot suppress a cry: "Life is not easy!"
>
> *(1933/1964a, p. 78)*

Yet Freud remained optimistic about human reason:

> The voice of the intellect is a soft one, but it does not rest till it has gained a hearing. Finally, after a countless succession of rebuffs, it succeeds. This is one of the few points on which one may be optimistic about the future of mankind, but it is in itself a point of no small importance.
>
> *(1927/1961c, p. 53)*

Topographic Approach

Everyone is a moon and has a dark side which he never shows to anybody.

—*Mark Twain*

Freud's observations that his patients seemed to have "areas" of their mind that were inaccessible to them led him to develop a geography (or topography) of the mind, which is depicted in Figure 3.1. The map of the mind displays three regions: the unconscious, preconscious, and conscious. The unconscious is largely unknown territory; the preconscious and, especially, the conscious have familiar terrains.

1 The *unconscious* consists primarily of thoughts and feelings that are repressed and therefore unknown. This material is incapable of breaking into consciousness without certain changes or interventions, such as an increase in the drive, a weakening of ego defenses, or the guidance of a therapist.

2 The *preconscious* is capable of becoming conscious because it is not actively barred from consciousness. It is a great deal closer to the conscious than is the unconscious. Preconscious thought becomes conscious by forming mental images or linking up with language.

3 The *conscious* (or perceptual conscious) is synonymous with what a person is aware of at the moment. It is a "highly fugitive state" (Freud, 1940/1964c, p. 159) because thoughts can rapidly slip back and forth between the preconscious and the conscious. Since energy is required for a thought to enter into consciousness, only a few thoughts can be conscious at any one time.

Freud used a metaphor to describe the relationship between the unconscious and the preconscious and conscious:

> Let us therefore compare the system of the unconscious to a large entrance hall, in which the mental impulses jostle one another like separate individuals. Adjoining this entrance hall there is a second, narrower, room—a kind of drawing-room—in which consciousness, too, resides. But on the threshold between these two rooms a watchman performs his function: he examines the different mental impulses, acts as a censor, and will not admit them into the drawing-room if they displease him.
> *(1917/1963b, p. 295)*

Returning to Freud's sketch, we see how the id, ego, and superego (structures) are related to the unconscious, preconscious, and conscious (topography). All the id resides in the unconscious. The unconscious id is a large area, and in fact Freud corrected his drawing by noting that the space taken up by the unconscious id should have been much greater than that of the ego or the preconscious. If the mind is like an iceberg, then the conscious is only the exposed tip of the iceberg; most of the iceberg (the unconscious) remains hidden. Both the ego and the superego span the three layers. For example, the ego is unaware of the action of its defense mechanisms.

Developmental changes occur in the relative size of the unconscious, preconscious, and conscious. An infant's mind is almost completely unconscious. With increasing age, the preconscious and conscious occupy more and more of the mental territory. Even among adults, however, the unconscious is the largest area.

Although Freud described the unconscious, preconscious, and conscious as though they were separate entities, he constantly noted that no such separation exists. Rather, he was simply abstracting three aspects of mental functioning. Reading obituaries in the newspaper can be traced to both unconscious (fear of death) and conscious (keeping track of elderly friends) motivations.

Freud placed great importance on the role of the unconscious: "For the property of being conscious or not is in the last resort our one beacon-light in the darkness of depth-psychology" (1923/1961a, p. 18). The notion that there is a vast unconscious that controls behavior emerged from Freud's early psychoanalytic sessions with his patients. Patients had sexual fantasies or impulses of which they were unaware but which led to certain inexplicable behavior. For example, a patient with a healthy visual system was unable to see because seeing was too painful; seeing activated painful memories in the unconscious. Additional evidence for the existence of an unconscious came from posthypnotic suggestion, in which patients perform some action that was suggested to them while under hypnosis, or from slips of the tongue, accidents that were not really accidental, selective forgetting (as when someone forgets a dental appointment), and dreams.

Stage Approach

Freud made two bold claims about human development. One is that the first few years of life are the most important years for the formation of personality. The other claim is that this development involves psychosexual stages.

The notion that early experience is crucial seems obvious and noncontroversial to the modern student of development. This idea, however, had not really been taken seriously until Freud systematically developed it. According to Freud, a behavior can be understood only if one knows how it developed in the person's early history. Both normal behavior and abnormal behavior have their roots in the early years, when the basic structure of the personality is laid down. The early interactions between children's drives and their social environment set the pattern for later learning, social adjustment, and coping with anxiety.

It is interesting that a therapist who studied and treated adults would develop a theory of child development. Early in his work, Freud discovered that attempts to trace the cause of a disturbed personality usually led to traumatic, unresolved sexual experiences of childhood. The distant past was very much alive in his patients' current lives in dreams, anxiety from repressed childhood desires, and defense mechanisms acquired in childhood. From information revealed in sessions with patients, Freud was able to reconstruct the sequence of stages of childhood.

Freud, like Piaget, focused on stages. We look at the general nature of the five stages here and leave a fuller description for later. Each stage is defined in terms of the part of the body around which drives are centered. The eye of the storm shifts from the oral to the anal to the phallic area during the first five years. Then a period of latency in middle childhood is followed by the genital stage of adolescence. Each stage presents new needs that must be handled by the mental structures. The way in which these needs are met (or not met) determines not only how drive satisfaction is achieved but also how children relate to other people and how they feel about themselves. Children develop characteristic attitudes, defenses, and fantasies. Unresolved conflicts in any stage may haunt people throughout their lifetimes. This is one's personality.

Because the movement from stage to stage is biologically determined, it occurs whether or not there is unfinished business in the stage that is ending. This notion of stage development is very different from Piaget's, in which one stage must be essentially completed before the next stage may begin. The two theories, however, coincide in their claim that the stages follow an invariant order. For Freud, the invariant order comes almost entirely from physical maturation. For Piaget, it comes not only from physical maturation but also from physical and social experiences and innate ways of functioning mentally.

The two theories differ in the relationship between the stages. In Freud's theory, each stage is characterized by one dominant trait (for example, anal concerns) but does not form a tightly knit, structured whole, as does a stage in Piaget's theory. Freud's stages form layers, with each stage only loosely integrated into the next, in contrast to the reorganization of previous knowledge in each of Piaget's stages. Also in contrast to Piaget's stages, one stage does not contain the germ of the next. The oral stage does not *become* the anal stage in the way that concrete operations become (are transformed into) formal operations.

Although a stage builds upon and is dominant over the previous stage, it does not completely replace that stage, according to Freud. No stage is ever given up entirely. Freud offered a simile of an army that advances into new territory but leaves forces en route to send on supplies or provide a place to retreat to if difficulties arise. In the same way, a child can escape unbearably tense experiences by regressing to earlier behavior, such as sucking the thumb or hallucinating the desired object. Also, earlier modes of satisfaction may be retained, as when thumb sucking persists throughout the preschool years. Or, anal concerns may still be present, but they are suppressed, sublimated, and displaced until they bear little resemblance to their earlier form (for example, giving gifts in adulthood). There is a partial integration in the last stage, the genital, when the component instincts (oral, anal, and phallic) merge to form adult genital sexuality.

Normal–Abnormal Continuum

Psychologists often understand behavior through comparisons—of cultures, of humans with other primates, and of atypical with typical development. Just as today psychologists might draw on research with children with autism to better understand typical development, Freud drew on his interactions with people with malfunctioning personalities to develop a theory of normal development. For example, patients suffering from delusions of being observed by unknown persons who distrusted them and expected them to transgress and be punished clarified the workings of the conscience in what he considered normal people. The only difference was that the internal was projected to the external in "abnormal" cases. Freud explained the value of studying abnormal behavior:

> Pathology, by making things larger and coarser, can draw our attention to normal conditions which would otherwise have escaped us. Where it points to a breach or a rent, there may normally be an articulation present. If we throw a crystal to the floor, it breaks; but not into haphazard pieces. It comes apart along its lines of cleavage into fragments whose boundaries, though they were invisible, were predetermined by the crystal's structure. Mental patients are split and broken structures of this same kind. . . . They have turned away from external reality, but for that very reason they know more about internal, psychical reality and can reveal a number of things to us that would otherwise be inaccessible to us.
>
> *(1933/1964a, pp. 58–59)*

Freud argued not only that atypical personalities heighten our understanding of typical development but also that there is no sharp cleavage between the abnormal and the normal. Abnormal and normal personalities obey the same principles and merely occupy different positions along a continuum ranging from the very disturbed to the very healthy. In an abnormal personality, psychological processes simply are exaggerated or distorted. A person with depression is only more depressed than most people. A sadistic killer has a strong, uncontrolled aggressive drive. An amnesiac must repress all of a painful past. Yet every normal personality has traces of depression, aggression, and unaccountable forgetting, as described in the appropriately titled *The Psychopathology of Everyday Life* (Freud, 1901/1960). When reality becomes too painful or impulses of the id intensify, the ego's frantic attempts to keep in touch with reality or fortify the barriers against the id or superego ultimately fail. Neurotic symptoms or even a psychosis results. In Freud's words, "The threatened ego throws itself into the arms of the unconscious instinctual forces in a desperate revolt" (1933/1964a, p. 16).

Methodology

It might seem odd that Freud did not study children directly as he built a theory of development. His rationale for studying only adults was that our childhoods remain with us always, in that our adult personalities are residues of our childhoods. In addition, his patients happened to be adults rather than children. For these reasons, he devoted his efforts to developing methods for eliciting information about childhood from adults. Freud also conducted a self-analysis, beginning in 1897 and continuing throughout his life. He reserved the last half hour of each day for this purpose. This increased his confidence, if not that of the scientific community, in his theory of personality.

Freud's methods of free association and dream analysis at first shocked the psychiatric profession and the public but eventually won the acceptance of many therapists. The method of *free association* requires that patients verbally report their ongoing stream of thought. The patient would relax, usually on the famous couch, in a quiet room, while Freud sat near the patient's head but out of sight. He instructed his patients to report every thought, regardless of how trivial it seemed, omitting or censoring nothing. This relaxed, accepting state promoted the ego's relaxation of control over unconscious thoughts. Repressed thoughts might then emerge, though often in disguise. Occasionally, if the patient fell silent, Freud would ask a question or even "lay on hands"—put his hand on the patient's forehead—and tell the patient that new memories would come.

The theoretical rationale for the free-association technique is as follows: Freud believed that every psychological event has a meaning. That is, a thought or feeling is caused; it does not occur randomly. If one thought typically leads to another, there is a reason for it—they are connected in some way. If a patient talked about her deceased father and then abruptly changed the subject to a planned trip, Freud inferred that she was troubled by her father's death. (Freud thought that a journey is often a symbol for death.) In this way, he abstracted common themes underlying seemingly unrelated thoughts or behaviors. More generally, he tried to describe the organization of the patient's mind. The central concepts of Freud's theory arose from the free-association sessions.

A second method is *dream analysis*. If all thoughts are causally related and significant, then psychologists cannot ignore dreams. During dreams, the usual psychological controls are "sleeping" and thus allow disturbing unconscious thoughts to be expressed and wishes to be fulfilled. These thoughts, however, are often disguised until they are unmasked during psychoanalysis. For example, kings and queens might represent parents, little animals or vermin might stand for siblings, and snakes and trunks might represent sex organs (Freud, 1916/1963a, pp. 153–157).

In summary, Freud's methodology was to listen to troubled adults talk. He did not perform controlled experiments and, unlike Piaget, did not observe children's behaviors. Instead, he studied individual adults in depth, sometimes spending hundreds of hours with a single patient. As if putting together a jigsaw puzzle, he put together pieces of information from patients' free associations, dreams, expressions of emotion, use of defense mechanisms, slips of the tongue, and so on:

> He that has eyes to see and ears to hear may convince himself that no mortal can keep a secret. If his lips are silent, he chatters with his finger tips; betrayal oozes out of him at every pore. And thus the task of making conscious the most hidden recesses of the mind is one which it is quite possible to accomplish.
>
> *(Freud, 1905/1953b, pp. 77–78)*

Freud organized this information into a coherent picture in his case studies. Several long case studies were published and became well known. For example, the "Rat Man" (1909/1955b) had the obsession that his father and girlfriend would be punished with hungry rats fastened to their buttocks. The "Wolf Man" (1918/1955e) reacted to viewing the "primal scene" (sexual intercourse between his parents) by dreaming about wolves (see the dream report at the beginning of this chapter).

Description of the Stages

Oral Stage (Roughly Birth to 1 Year)

During infancy, the mouth rules. Oral experiences introduce a baby to both the pleasure and the pain of the world. Pleasure flows from the satisfaction of the oral drives. Sucking, chewing, eating, and biting give sexual gratification by relieving uncomfortable sexual excitations. The oral activities cause pleasant sensual feelings in the lips, tongue, and membranes of the mouth. These pleasant feelings need not be linked with the satisfaction of hunger because the oral activities themselves are satisfying. The outcome of all of this, in Freudian terminology, is that libidinal energy is cathected (invested) in the oral erogenous zone. The salient social and nonsocial experiences in the oral stage center around oral concerns.

In addition to experiencing oral pleasure, an infant feels pain from frustration and anxiety. Sexual tensions are pleasant if they are satisfied but painful if they are not and continue to intensify. A preferred object, such as a nipple, may not be present at the moment an infant wants it. She must wait, a situation that she finds frustrating and anxiety arousing. She may lapse into hallucinatory wish fulfillment as she imagines the desired nipple. Or she may suck her fingers, a blanket, or a soft toy. Still, satisfaction is not complete. Other frustrations come when parents demand that the nighttime feeding be given up, that certain objects not be chewed because they are unsanitary or unsafe, and, especially, that the breast or bottle be given up for the cup. The cultural demands of one's society are expressed through the parents. Parents teach the infant how to satisfy her drives in ways that are acceptable to the society. Conflict is inevitable. In small ways, the infant discovers that life has its frustrations as well as its pleasures, its "downs" as well as its "ups." She develops ways of coping with these frustrations that will form the basis for her later personality.

As babies seek gratification and valiantly struggle to overcome barriers to this satisfaction, there is an important psychological principle at work: Infants are in developmental trouble if they obtain either too little or too much oral gratification. The side effects of too little gratification are frequent anxiety, continual seeking of oral gratification in later years, and pessimism. Too much gratification may make it difficult for children to shift their cathexes to new objects, as demanded by a new stage. In this case, fixation can occur. Furthermore, relatively minor anxiety in a later stage may cause regression to highly cathected objects of the oral stage. For example, the initiation of toilet training during the anal stage may cause a child to return quickly to thumb sucking. The goal, then, is to achieve an optimal level of oral gratification so that one need not carry unfulfilled needs into later stages or feel unwilling to move on to a new stage.

Each of several oral "modes of functioning" during infancy forms a prototype (model, plan, or blueprint) for adult personality: (1) taking in, (2) holding on, (3) biting, (4) spitting out, and (5) closing (Hall, 1954, p. 104). Infants learn characteristic oral reactions in each of these types of situations, which lead to certain attitudes, behaviors, and life goals in adulthood:

1. The infant who found pleasure from taking in food becomes an adult who voraciously "takes in," or acquires, knowledge or power and who incorporates or identifies with significant other people.
2. Trying to hold on to the nipple when it is removed may lead to determination and stubbornness.
3. Biting is the prototype for destructiveness, "biting" sarcasm, cynicism, and dominance.
4. Spitting out becomes rejection.
5. Closing the mouth firmly leads to rejection, negativism, or introversion.

Note that these adult behaviors range from the literally oral, as in smoking, nail biting, and eating, to the metaphorically oral, as in being gullible (swallowing anything) and obstinate (holding on). These modes of functioning also show that humans are both positive and negative about others. Just as an infant both sucks and bites a nipple, a person may both love and hate another person.

All these characteristics are found in every personality to some degree. However, some people have a personality structure that is dominated by one or several of these prototypes from the oral modes. In particular, certain traits may dominate because of extremely pleasant or unpleasant experiences in infancy. For example, an infant with unaffectionate parents may become an adult who seeks to "take in" love symbolically by acquiring power or vast amounts of money.

Perhaps the most momentous event of the oral stage is the formation of attachment to the mother (though fathers' contributions are also addressed today, e.g., Parke, 2013). Freud proclaimed that the mother's importance is "unique, without parallel, established unalterably for a whole lifetime as the first and strongest love-object and as the prototype of all later love-relations" (1940/1964c, p. 188). Because typically it is the mother who satisfies needs such as food, sucking, and warmth, she becomes the primary love object in an infant's life. An infant invests a great deal of libidinal energy in her. Emphasizing the importance of an emotional attachment to the mother is one of Freud's main legacies to the field of developmental psychology, and it inspired Spitz's (1945) work on disturbed mother–infant relationships. After observing that many infants left in foundling homes became depressed and that some even died, Spitz concluded that the lack of mothering contributes to psychological and health problems. Subsequently, Bowlby's (1958) seminal work on attachment (see Chapter 5) led to research by many other investigators in recent years.

Although it may seem counterintuitive, attachment seems to lead to an infant's healthy sense of separateness from his mother. Winnicott (1971) stressed that this gradual differentiation is necessary for a clear sense of self and for normal interpersonal relations later. Before this differentiation, an infant–mother matrix gives little sense of separation of the self and the world. What Winnicott called "good-enough mothering" involves a synchrony, or match, between an infant's needs and spontaneous behaviors and the caretaker's activities. Consequently, the infant feels omnipotent because he can magically obtain his every desire. However, babies inevitably encounter delays in gratification, interact with various "not-me" objects, and discover their own resources for interacting with the world, thereby developing their ego. This process of individuation can be threatening, and in severe cases, child psychosis results from a faulty individuation process (Mahler, Pine, & Bergman, 1975). Object loss, particularly the real or perceived loss of the mother, is one of the most significant events that can occur in early life. Fortunately, the "holding environment" with the mother, as well as "security blankets" or other cuddly, comforting objects, provide a secure base and ease the separation process.

Mothers also design "play dialogues," which involve a mutual regulation of the interaction between themselves and their infants. A mother uses her infant's gaze and state of arousal as cues for the timing and intensity of her facial expressions and talking (Stern, 1974, 1985, 1995). Thus, the ideal mother tries to avoid both stimulus overload and boredom. The important outcome is that in the context of a social relationship, children use feedback regarding their effect on the mother to construct their self-concept. In other words, babies express and define their true selves by being with their mother and seeing the effects of their spontaneous actions toward her.

Thus, attachment is a vital process for development because it serves as a building block for later social relationships. Furthermore, it facilitates a mother's attempts to socialize her child by using her attention to reward desirable behavior. However, in Freud's somewhat pessimistic theory, all silver linings are covered by clouds. Thus, attachment has its dangers. If the attachment is too strong, infants may become overly dependent on their mother or anxious about her possible rejection of them. Then, later in life, they may develop a generally passive personality, depending on others to do things for them and even do their thinking for them.

Anal Stage (Roughly 1 to 3 Years)

By the end of the oral stage, infants have developed the rough outlines of a personality. This personality consists of attitudes toward themselves and other people, mechanisms for achieving gratification within the demands of reality, and interests in certain activities and objects. As maturation moves infants to the anal stage, the concerns move from the oral area to the anal area. The new needs of this stage set in motion new conflicts between children and the world. The way in which children resolve these new conflicts further differentiates and crystallizes the rudimentary personality structure. The expression of oral needs does not stop, of course. Children simply face a new set of needs and demands that require their immediate attention.

The physiological need to defecate creates tension, which is relieved by defecation. This anal stimulation and subsequent reduction of tension produces pleasure. As in the oral stage, the erogenous zone brings frustration and anxiety as well as pleasure. Society, as represented by the parents, demands toilet training, and thus self-control. Consequently, the desire for immediate gratification is frustrated. In a small but momentous way, children enter into conflict with authoritarian adult society. Children all over the world face and resolve this conflict in some way. Obviously, many variables affect how much conflict a child feels and how she adapts to the demands placed on her. These variables include the age at which toilet training is begun, how strict or relaxed the training is, and the mother's attitude toward defecation, control, and cleanliness.

If toilet training is particularly harsh or premature or overemphasized by the parents, defecation can become a source of great anxiety for children. This anxiety can generalize to other situations in which an external authority makes demands or children must control their own impulses. Some children react to strict toilet training by defecating at inappropriate times or places, such as the supermarket. The child may become a messy, dirty, and irresponsible adult or, at the other extreme, a compulsively neat, orderly, and obstinate adult. These potential negative outcomes in the anal stage certainly are not comforting to the prospective parent!

As in the oral stage, the goal is to allow enough, but not too much, gratification and to develop enough, but not too much, self-control. If this goal is adequately achieved, a child will have developed a more mature ego because it has been sharpened by its confrontation with reality. A child who survives the anal period relatively unscathed is ready to tackle the third stage, the phallic stage, when it arrives.

Phallic Stage (Roughly 3 to 5 Years)

The child's solution to problems of the oral and anal stages sets a pattern for solving later problems of adjustment. This development is continued in the phallic stage, so named because the possession of the phallus in boys and its absence in girls is a major concern of children, according to Freud. In this stage, pleasures and problems center on the genital area. The problem of this stage is that the sexual urge is directed toward the parent of the other sex. In boys, this situation is the well-known *Oedipus complex*. (In Greek mythology, Oedipus killed his father and married his mother.)

Freud emphasized the development of boys more than girls in the phallic stage because he believed that the conflict is more intense for boys. A young boy has sexual desires for his mother and does not want to share her with his father. At the same time, the boy fears that the father, in retaliation, will castrate him. As a way out of this highly anxious situation, the boy represses both his desire for his mother and his hostility toward his father.

The most important outcome of the Oedipus complex is that a boy comes to identify with his father. That is, he develops a strong emotional bond with the father, strives to be like him, and "internalizes" him—his beliefs, values, interests, and attitudes. Identification is very important because it serves as a basis for much of socialization. In particular, the development of the superego and behavior considered appropriate to one's sex are by-products of this identification. The superego increases the child's self-control and adherence to the parents' morality.

Identification is a reasonable solution to the demands of the ego and id in this stage. The ego is partially satisfied because anxiety is reduced.

The id is partially satisfied because a boy can "have" the mother vicariously through the father. Again, as children try to cope with both their drives and the prohibitions of society, they achieve a compromise solution that advances their psychological maturity.

Freud argued that, in comparison with boys, girls face a similar, but much less intense, conflict during the phallic stage. He proposed that a girl desires her father and experiences penis envy as she realizes that the father has a prized object that she does not have. In Freud's words, "She makes her judgment and her decision in a flash. She has seen it and knows that she is without it and wants to have it" (1925/1961b, p. 252). The girl begins to feel that she has been castrated and blames her mother for this loss because she "sent her into the world so insufficiently equipped" (p. 254).

As in the case of boys, society does not allow the full expression of the sexual desire for the parent. However, because castration is not possible, girls feel less threat from the mother than boys do from the father. Freud thought that since there is less anxiety and consequently less repression, girls have a weaker identification with the mother than boys do with the father. Freud then concluded that girls have a weaker conscience than do boys, a claim that is not supported by research. Freud's views on the Oedipus complex and penis envy are perhaps the most controversial aspect of his theory and have been rejected by many.

In actuality, there is always identification with both parents. Both sexes retain a strong cathexis for the mother because she is the most important object in the two previous psychosexual stages.

In psychoanalytic sessions, Freud found powerful and lasting influences from the phallic stage. For example, women often had disturbing sexual fantasies about their fathers that had never been resolved. More generally, lasting attitudes toward the opposite sex and toward people in authority could be traced to this stage.

With the achievement of identification and the waning of the phallic stage, children's basic personality is set, and conflicts are resolved in characteristic ways. Personality changes, but it does so primarily by further differentiation of the basic structure.

Period of Latency (Roughly 5 Years to the Beginning of Puberty)

After the *Sturm und Drang* of the first three stages, there is a period of relative calm, when sexual drives are repressed and no new area of bodily excitement emerges. Children conveniently "forget" the sexual urges and fantasies of their earlier years. They turn their thoughts to school activities and play, primarily with children of the same sex. This is a time for acquiring cognitive skills and assimilating cultural values as children expand their world to include teachers, neighbors, peers, club leaders, and coaches. Sexual energy continues to flow, but it is channeled into social concerns and into defenses against sexuality. Thus, the ego and superego continue to develop.

Genital Stage (Adolescence)

The sexual impulses, which were repressed during the latency stage, reappear in full force as a result of the physiological changes of puberty. These sexual impulses are fused with the earlier ones but are now channeled into adult sexuality. Love becomes more altruistic, with less concern for self-pleasure than in earlier stages. The choice of a partner is influenced by attitudes and social patterns developed in the early years. For example, a woman may choose a "father figure."

Although some internal conflict is inevitable throughout life, a relatively stable state is achieved by most people by the end of the genital stage. Typically, an individual achieves a fairly strong ego structure that makes coping with the reality of the adult world possible. One important achievement is a balance between love and work.

Case Study of "Little Hans"

The above outline of the psychosexual stages cannot capture the vivid, powerful conflicts that operate in an individual child's life. Thus, we turn to one of Freud's most famous case studies, the "Analysis of a Phobia in a Five-Year-Old Boy" (1909/1955a) or, as it is more commonly known, "Little Hans." This case study was unique because it was Freud's only analysis of a child and because Freud conducted the analysis by mail in a series of letters with the boy's physician-father, who made the observations. The study was a central force in the formation of one of Freud's most important developmental concepts: identification.

When Hans was 5 years old, anxiety attacks, a phobia, and a fantasy appeared. His phobia, the fear that a horse would bite him or fall down, was so strong that he would not leave his house. He was especially afraid of horses that pulled heavy loads in carts or vans or were white with a black muzzle and wore blinders. In Hans's fantasy, during the night "there was a big giraffe in the room and a crumpled one; and the big one called out because I took the crumpled one away from it. Then it stopped calling out; and then I sat down on top of the crumpled one" (quoted in 1909/1955a, p. 37).

After sifting through the evidence, Freud identified three themes: an Oedipus conflict, sibling rivalry, and fear of punishment for masturbation. Thus, in the phobia, the horse represented Hans's father, who had a mustache (a black muzzle around the horse's mouth) and eyeglasses (blinders) and was, as Hans remarked, "so white" (like the white horse). Hans feared that the horse would bite (castrate) him because of his sexual longing for his mother and his masturbating. Anxiety about masturbation may have been prompted by his mother's threat that if his masturbation continued, she would send him to the doctor to cut off his "widdler." The fear that a horse might fall down was interpreted as a fear that his father might die or go away, as he sometimes wished when he wanted his mother alone. Significantly, Hans had remarked, "Daddy, don't trot away from me" (p. 45). The giraffe fantasy might be interpreted as a wish for possessing the mother, as Hans imagined he sat on the smaller giraffe (mother), which he had taken from the larger giraffe (father). Note the phallic symbol in the giraffe's long neck.

Hans's feelings of loss of attention and love after the birth of his sister were expressed in the fear that a cart might be upset and spill its contents (his mother might give birth again). In the fantasy, Hans destroyed his younger sister when he sat on her (the small giraffe).

Hans eventually identified with his father, thereby resolving his conflicts and recovering from his fear of horses. He continued to develop a healthy personality and later became an opera producer. More recently, interesting material uncovered about the Little Hans case stimulated several fascinating papers (King, Neubauer, Abrams, & Dowling, 2007).

Mechanisms of Development

Both Freud and Piaget have a "trouble" theory of development. Development proceeds because of disturbances to the system (disequilibrium). Development is hard work, because children must continually try to re-establish a state of relative calm. For Freud, emotion-laden thoughts rather than objective information about the physical world cause the disequilibrium. He was more concerned with psychological pain than logical inconsistency, with energy in repose than mental actions in balance. Freud's equilibration system is less open (less responsive to external information) than Piaget's. Piaget spoke of continual assimilation and accommodation as new experiences are encountered.

In Freud's system, there is more resistance to change. The system is also closed in that there is a certain amount of energy that can be changed in form but never in amount.

Freud identified several sources of conflict or psychological disruption that stimulate development—physical maturation, external frustrations, internal conflicts, personal inadequacies, and anxiety (Hall, 1954, p. 72):

1. *Maturation* involves changes in the nervous system, motor development, hormonal changes, drives, and so on. Each change brings new possibilities and new problems. As we saw earlier, the drives are particularly important. These maturational forces both propel children into activity as they try to satisfy the drives and move them from stage to stage as the bodily site of pleasure changes.
2. *External frustrations* come from people or events that do not allow the immediate expression of needs. They cause a painful buildup of tension and force children to delay and detour their discharge of energy.
3. *Internal conflicts* arise from the battle among the id, ego, and superego or, more specifically, between drives and forces of repression.
4. *Personal inadequacies* are certain skills, knowledge, expertise, or experience that the person needs but lacks. For example, a child may want to join a peer group but be too shy to enter the group or too clumsy at the game they are playing.
5. Finally, *anxiety* is an unpleasant feeling that occurs when the child anticipates physical or psychological pain. The fear of losing a valued love object is a common example.

All these elements cause an unpleasant state of tension, which the child attempts to rectify in accordance with the pleasure principle and the reality principle. These disturbances, however, merely initiate change. Other mechanisms actually accomplish change. The ego has the primary responsibility for guiding the course of change. Its perceptual and cognitive systems gather relevant information about the current situation, recall useful information from past experiences, and use whatever defense mechanisms are most appropriate. The ego develops methods for keeping distressing sexual thoughts from becoming conscious and placates the id and superego. The ego, then, mediates change from moment to moment. The accumulation of these small changes adds up to long-term change. Over time, the ego gathers strength, and personality crystallizes and becomes further differentiated into complex attitudes, interests, and behaviors.

Several developmental acquisitions also serve as mechanisms of further development. The most notable are attachment and identification.

As mentioned earlier, both lead to other important acquisitions, such as gendered behaviors and moral development in the case of identification.

Position on Developmental Issues

Human Nature

Hall and Lindzey summarize Freud's view of the person as

> a full-bodied individual living partly in a world of reality and partly in a world of make-believe, beset by conflicts and inner contradictions, yet capable of rational thought and action, moved by forces of which he has little knowledge and by aspirations which are beyond his reach, by turn confused and clearheaded, frustrated and satisfied, hopeful and despairing, selfish and altruistic; in short, a complex human being.
>
> *(1957, p. 72)*

This description of the conflicted, contradictory nature of humans stands in sharp contrast to Piaget's rational human, calmly searching for epistemological truth in a predictable world. Freud was concerned with emotions, particularly their role in forcing the development of personality and thought as children strive to cope with these emotions. By nature, people have strong passions that color their perceptions throughout life.

Freud's theory has elements of both the mechanistic and organismic worldviews. It is mechanistic in its likening of psychological energy to a hydraulic system. It is organismic in its view of the mind as a structured whole consisting of id, ego, and superego in a dynamic balance that changes developmentally. However, for Freud, a psychological being is a loosely organized whole rather than the tightly knit, integrated, equilibrated whole of strongly organismic Piagetian theory.

Although human beings are passive in that drives force them into action, they are active, and therefore organismic, in their attempts to cope with these drives and maintain a state of equilibrium. The ego, in its executive role, actively organizes incoming information from the self (for example, anxiety about some impending event) and the social environment, and directs the behavior chosen. Still, for Freud, children act because drives force them to act, whereas for Piaget, children act because they are inherently active and self-regulated.

Qualitative Versus Quantitative Development

As in Piaget's theory, the stagelike changes proposed by Freud imply that development involves qualitative change. There is a change in which aspect of the sexual drive is dominant: the oral, anal, phallic, or genital.

There is also qualitative change in the psychological organization as new acquisitions, such as defense mechanisms and the superego, appear. Still, there is some quantitative change, as the developing child exhibits a gradual strengthening of the ego, superego, and various defense mechanisms.

Nature Versus Nurture

It typically is claimed that Freud has a biologically based theory of development. Although he emphasizes maturation and the biologically based drives, he also sees experience as quite important: "The constitutional factor must await experiences before it can make itself felt; the accidental factor must have a constitutional basis in order to come into operation" (Freud, 1905/1953b, p. 239). Although drives derive from a person's biological nature, their expression is always modified by the social milieu. The people or objects available and the behaviors allowed by parents or other authorities direct the satisfaction of the drives. The demands of civilization are as real as the demands of the body. Within the category of nurture, Freud saw the experiences of the first five years of life as especially important, particularly relationships with parents, mainly mothers.

What Develops

The essence of development is the emergence of structures—the id, ego, and superego—that channel, repress, and transform sexual energy. These structures and their dynamic processes are both affective (emotional) and cognitive. Although Freud typically is not considered a cognitive psychologist, in many ways he was. Thought—whether unconscious, preconscious, or conscious and whether primary or secondary process in nature—always accompanies feeling.

Applications

This chapter provides many examples of applications of Freud's theory to clinical practice. These applications continue today with adults and children, and include even parent–infant psychotherapy (Dugmore, 2014). The Little Hans case study shows how one might analyze a single child in depth. Freud's message for parents is to be sensitive to the conflicts among id, ego, and superego in their child and to provide support for the resolution of these conflicts. A secure attachment between parent and child is particularly important, as is the later relationship during children's identification with their parents.

Freud's claim that people can repress painful memories for years has arisen again in recent clinical and legal issues about adults' recall, decades later, of childhood sexual abuse. Freud at first believed his patients' accounts of these events but later concluded that it was unlikely that there were so many Viennese parents who had sexually abused their children. He then viewed these memories as fantasies or perceptions distorted by sexual desire, but he still thought that, true or false, they were important because they affect the course of personality development. This issue about his patients has never been resolved, and psychologists today continue to debate the accuracy of recovered memories of early abuse (see Chapter 7).

Evaluation of the Theory

Although rejection of certain aspects of Freud's theory is reasonable, experimental psychologists' overall rejection of the theory may have deprived the field of a valuable perspective on development. Despite the paucity of research today that is explicitly Freudian, this approach can provide some insights into current issues in developmental psychology. Thus, the following section on strengths focuses on two that are of potential contemporary relevance, namely, the theory's discovery of central developmental phenomena and its focus on nonlogical thought.

Strengths

Discovery of Central Developmental Phenomena ▸ Although Freud's influence is rarely acknowledged explicitly in current developmental research, many core concepts were introduced or significantly developed by him: developmental stages, psychological structures, unconscious motivation, and the importance of early experience. In addition, the theory stimulated research in the areas of moral development, sex typing, identification, parent–child relations, attachment, aggression, and self-regulation. These remain active areas of research today.

Focus on Nonlogical Thought ▸ Psychoanalytic theory's focus on emotions and nonlogical thought could enrich contemporary cognitive approaches, which focus on rational problem solving: how thought becomes increasingly organized, efficient, abstract, and objective. This type of thought characterizes that of an adult scientist, the goal of cognitive development in Piaget's view. This viewpoint emerged clearly in Piaget's emphasis on logical operations and on concepts of the physical world. The information-processing approach, described in a later chapter, also pictured a developing child as an organism that relentlessly searches for truth in an increasingly efficient and rational way. Although this view characterizes part of cognitive development, it does not tell the whole story. Humans probably are not as rational as these theories propose. As Wason and Johnson-Laird express it, "At best, we can all think like logicians; at worst, logicians all think like us" (1972, p. 245).

Irrational thought processes are as important as the more frequently studied rational ones; in fact, the former may occur more frequently than the latter. Thus, Freud's theory poses two challenges for developmentalists. One challenge is to study how emotions affect thinking in children. Do children reason differently when angry or frustrated than when calm? A second challenge is to examine whether the mental processes underlying primary- and secondary-process thought and the defense mechanisms differ from the mental processes described by Piaget and the information-processing psychologists. For example, how is Piaget's notion of mental reversibility related to Freud's notion of reaction formation, in which a negative attitude toward a person or an object is transformed into a positive attitude? Are conflicting feelings and logically contradictory ideas resolved in the same way? What are the mental processes underlying self-deception? What cognitive acquisitions are necessary for understanding displaced aggression (taking one's anger out on an innocent person)?

Psychoanalytic theory also suggests that the *content* of children's thought is more wide ranging than recent research would indicate. Freud would point out that children do not think only about quantity, spatial relationships, justice, objects, and causality. They also try to understand, and mentally adjust to, the violence on television or in their home, love, bullying, their parents' physical and emotional relationship, their own sexual or aggressive feelings, the tendency of adults to say one thing and do the opposite, frustration when their needs are not met, and failure in social interactions. Adding this content to the logical, rational, linear thinking studied by Piagetian and information-processing theorists (see Chapter 7) would give a more balanced view of children's thinking.

This suggested new direction for research on cognitive development is particularly promising because it is compatible with current interest in *social cognition*, especially children's *theory of mind* (understanding of people's mental states). Such research seldom addresses the problematic or troublesome content of thought just described. A child's theory of mind would influence his understanding of the psychological defenses used by others as well as himself, desires, the nature of dreams, and the distinction between fantasy and reality.

Weaknesses

Freud made it difficult for anyone to criticize his theory: "No one has a right to join in a discussion of psycho-analysis who has not had particular experiences which can only be obtained by being analyzed oneself" (1933/1964a, p. 69). Nevertheless, we now critically look at two weaknesses of the theory: uncertain testability of central claims concerning development and overemphasis on childhood sexuality.

Uncertain Testability of Central Claims Concerning Development ▸ The scientific community requires that theories be based on empirical observations that can be replicated by other scientists. Freud's methodology makes this type of data gathering nearly impossible. His methods of free association and dream analysis pose three major difficulties:

1. According to Freud, these methods require that the experimenter be trained in psychoanalysis. Because such training is a long, expensive process, few people would be qualified to test the theory. Furthermore, those who are psychoanalytically trained tend to be "believers." An involved, possibly biased participant–observer, who selectively records the patient's responses, is a dubious source of objective data for testing the theory.
2. Freud's methods lend themselves to experimenter error. Freud made notes about the psychoanalytic sessions after they occurred, often hours later. It is ironic that someone who demonstrated the distortions of memory in his patients should be so oblivious to that possibility in himself. There is a danger that he selectively remembered only that which fit into his theory. Another source of experimenter error is the possibility that the patient's line of thought is influenced by the nature of the therapist's questions or even the timing of his grunts and silences.
3. Adults' recollections of childhood and recent dreams are unlikely to be completely accurate. Introspection has a poor reputation in psychology. It is not easy to report objectively even one's current mental state or recent dream states; mental states from 50 years earlier pose even more difficulties. Freud himself knew that these verbal reports were not reliable, but he felt that the patient's experience of the earlier events, whether accurate

or distorted, is what was most relevant to therapy. Still, the fact that therapists usually cannot know whether the reports are accurate limits their assessment of the patient's perception of reality.

The problem of definition also poses a challenge to experimental psychologists. There are many vague, imprecise, poorly defined terms because Freud used analogies to communicate the meaning of the terms. Also, many of Freud's notions have an uncertain relationship to observable behavior, in part because of the considerable distance between the two. A therapist takes verbal reports, nonverbal behavior (for example, facial expressions, crying, and physical accidents), dreams, and forgetting and interprets them in terms of distant theoretical concepts, such as defense mechanisms, drives, and unconscious motivation. For example, Freud made a large jump from a patient's dream about an oven to the interpretation that this image represents the uterus.

One way to state the problem with Freud's methods is that in Freud's system, a psychological attribute can refer to several different behaviors. An "anal personality" can be expressed in either a compulsively neat or an overly messy person. Or a patient's problem can be diagnosed as an Oedipus complex if he either talks constantly about his mother or never mentions her (due to repression). Conversely, a particular behavior can stem from several different psychological attributes, as when an inability to eat can stem from hysteria (perhaps caused by a fear of seeming to be pregnant) or paranoia (perhaps a fear of being poisoned). It is unclear how one would "test" these notions.

There have been numerous attempts to test Freud's theory either clinically, often with hypnosis or projective tests in which the subject must interpret inkblots or pictures, or experimentally (e.g., Fisher & Greenberg, 1996). However, the procedures may not adequately test the theory. For example, exposing a boy briefly to an aggressive, hostile male adult and subsequently observing how much the boy imitates the male's behavior is not a fair test of the notion that the Oedipus complex leads to identification with the aggressor. The long-term, emotionally powerful experiences of real life cannot be translated easily into brief, simplistic, experimental episodes. In short, psychologists are in a bind: They cannot adequately test the most crucial theoretical notions outside the psychoanalytic session, but the psychoanalytic session does not lend itself to experimental procedures.

Even if the theory cannot be tested scientifically, it can serve as a springboard for more limited, testable hypotheses. For example, in the 1950s, learning theorists took Freudian notions such as sex typing, dependency, identification, and defense mechanisms and studied their development within a learning framework (see Chapter 6). Also, hypnosis has been used to test hypotheses concerning the unconscious. Reyher (1967) provides an example. Hypnotized college students were told a story designed to arouse unconscious Oedipal feelings. They were told they would not remember anything about the story after awakening but would have strong sexual feelings when certain words were mentioned after they awakened. As predicted, the critical words, but not neutral words, aroused sweating, trembling, and guilt, indicating unconscious conflicts.

Freud's notion of the scientific approach differed from that of the scientific community. He looked for converging evidence for a particular interpretation. If dream reports, memories from childhood, physical symptoms, slips of the tongue, and accidents all suggested that the patient had not resolved her feelings of sibling rivalry in childhood, then Freud believed he had proved his case. He integrated facts from several sources to form a consistent picture. He felt that his interpretations were further bolstered if several patients illustrated the same relationship between variables. For example, patients with paralysis of a limb (hysteria) often reported unresolved sexual conflicts from childhood. The lack of experimental rigor was not of great concern to Freud. His goal, after all, was to provide clinical insights that would help him formulate a theory that would improve therapy.

Overemphasis on Childhood Sexuality ▸ Freud's emphasis on sexuality brings to mind the greeting card that begins, "SEX—Now that I have your attention . . ." Not surprisingly, claims about childhood sexuality both captured the attention of psychologists and the public and alienated many. Freud's answer to those who saw little evidence that sexuality pervades childhood was that his critics were repressing their own strong sexual memories from childhood!

For most developmental psychologists, claims about infantile sexuality in normal children strain the theory's credibility. The bulk of the developmental research of the last 50 years portrays infants and children as curious, self-motivated, social creatures who seek stimulation and relationships, rather than driven, anxiety-ridden beings who seek the reduction of tension. Research on infants' surprisingly sophisticated concepts, described in Chapter 2, shows that even a young infant is much more than id.

Freud's theory demonstrates the mutual constraints among culture, method, data, and theory (see Chapter 1). His data on the sexual fantasies of neurotic middle- and upper-class adults during the sexually repressive Victorian era may have little generality to children developing today. Furthermore, the specific claims about sexuality may reflect the biases of a male-oriented society. Years ago, Horney (1967) suggested that one could find as much evidence for womb envy in boys, due to their inability to have children, as for penis envy in girls. Still, it is possible to reject Freud's primary focus on sexual content without rejecting the entire theory. Also, it is possible to recast some of Freud's claims about childhood sexuality in fruitful ways. For example, an influential critique of Freud's analysis of girls' development has focused on gender differences in the development of relationships. Chodorow (1978) proposed that infant boys and girls become attached to their mother but later follow different developmental pathways. Boys are encouraged to separate themselves from their mother and establish autonomy, whereas girls are encouraged to develop further their close relationship with their mother. Consequently, the self-concept of girls, but not boys, may be based on a sense of relatedness that directs girls toward interpersonal relationships. Given increased flexibility in gender roles in recent decades, this gender difference may be much weaker now.

Contemporary Research

The most active current Freudian-inspired topic in developmental psychology is early relationships, reflecting Freud's emphasis on early social experience, emotional relationships with parents, and infants' construction of representations about significant others. A main shift in psychoanalytic theory after Freud's death was object relations theories and related approaches, particularly relational theories. *Object relations* refers to "enduring patterns of interpersonal functioning in intimate relationships and the cognitive and emotional processes that mediate those patterns" (Westen, Gabbard, & Ortigo, 2008, p. 67).

In developmental psychology, infants' mental representation of the parent–infant relationship is depicted, from Bowlby's study of infants' attachments (see Chapter 5), as *internal working models* (for a recent review, see Sherman, Rice, & Cassidy, 2015). An infant constructs internal working models—a mental representation of a significant adult, of herself, and of their interactions—as she becomes attached to her caregivers (mothers usually are studied). This representation includes certain assumptions and expectations about whether the parent will be responsive to her needs and whether the infant herself is worthy of love.

This internal working model is a cognitive framework that serves as a template for the development of later relationships, especially peer and romantic relationships. The model generates expectations about these relationships and affects the person's interpretation of others' behaviors. Mental models also affect one's self concept, as well as behaviors directed toward others, for example, how the person reacts to the perceived threat of rejection. These ways of relating to others then confirm and thus perpetuate children's expectations about self and others. That is, people make decisions that are consistent with working models, which in turn solidify these models. In this way, disturbed relationships can lead to disturbed working models and thus to psychopathology, as when expectations of rejection and abuse from others may lead to withdrawal and depression.

Working models also spill over later into parents' relationships with their children. For example, pregnant women's reports of the security or insecurity of their childhood attachment to their mother are related to the types of attachment relations they then form with their own infants (Steele, Steele, & Fonagy, 1996). For instance, some mothers respond more sensitively to their infants than do others. A mother's mode of communication then biases her child's development of working models (Bretherton & Munholland, 1999), and the cycle continues. In this way, secure or insecure relationships are transmitted from one generation to the next. Clearly, the infant and preschool years are a critical time for the development of working models that are the foundation for social relationships throughout the lifetime. This work is consistent with Freud's claim that stable personality patterns begin to develop during early childhood and continue into adulthood. Of course these patterns can change somewhat during adulthood, due to social experiences.

Recent theoretical work that attempts to bring together contemporary attachment theory and psychoanalytic approaches emphasizes the importance of the mother's and infant's awareness of each other's mental states, especially intentionality, in developing a secure and trusting relationship (Fonagy & Campbell, 2015). Children need to experience their mothers as accurately reflecting their emotional state. When a mother who is sensitive to the child's mental states mirrors the child's anxiety, this experience helps the child represent, organize, and understand his experience and his emotion. In contrast, a mother's inappropriate, confusing reactions to the infant's behavior may, over time, lead to child psychopathology. More generally, it is essential to develop an information-processing system capable of representing experience and controlling one's cognition, and thus regulating the self.

Neuroimaging research has explicitly tied evidence of infants' implicit, unconscious processing of emotions in the right brain hemisphere to psychoanalytic theory (Schore, 2014). Healthy mother–infant attachment, developed through well-regulated emotional interactions, appears to facilitate the development of infants' processing of emotional information in the mother's voice, face, and touch. This developed circuitry in turn supports further social interaction and infants' emotional self-regulation, including coping with stressors. Insecure attachments may make babies vulnerable to psychopathology. According to this "neuropsychoanalysis," the attachment relationship is a major organizer of brain development; it promotes the development and maintenance of neural networks in the right hemisphere. More generally, one of the hottest areas of current developmental research is on developmental social (or affective) cognitive neuroscience (see Chapter 5). Topics such as the processing of emotional information and the often unconscious role of emotions in cognitive processing now can be examined in terms of neural pathways.

Another active area of research examines, more generally, the effects of early social experience on later outcomes, especially psychopathological ones, a central concept in Freud's theory. Recent research on the effects of early social and emotional experiences on later development has profited from methodological and statistical breakthroughs that have generated powerful predictive models (e.g., Fraley, Roisman, & Haltigan, 2013). Applying these models to longitudinal data provides more precise predictions from early to later development. These techniques identify direct pathways, as when early disordered parent–child relations directly predict later psychopathology, and indirect pathways as when this relation is mediated by another factor. The main current challenge is to identify these mediators, and thus the developmental mechanisms by which early experience is somehow carried forward to later childhood or adulthood. Chapter 5 will address possible biological mechanisms by which early chronic stress or trauma is translated into negative physiological changes and even changes in gene expression, resulting in poor health or psychological outcomes. That is, children carry this early experience throughout childhood through their bodies. Alternatively, early cognitive change may mediate the later outcomes. Early trauma can cause children to expect uncertainty and danger, thus heightening their attention to potential threats. For example, early maltreatment may cause biased attention to angry faces and resulting intense negative affect, which in turn may contribute to aggression problems (Shackman & Pollak, 2014).

Still another main Freudian-inspired area of contemporary research is renewed interest in the distinction between conscious and unconscious processes. It appears that consciousness plays a much smaller role than cognitive psychologists have believed. Much of the brain's work occurs at the unconscious level (Morsella, Godwin, Jantz, Krieger, & Gazzaley, in press). Consciousness is "just a bit player" (Kluger, 2015) that might, for example, initiate a motor behavior after all the hard unconscious processing work is done. Another example is *implicit memory*, which refers to memory without awareness. For instance, people remember how to ride a bicycle or play the piano without consciously thinking about it or verbalizing it. Recently, connectionist models of thinking in cognitive science (see Chapter 7) posit that we construct concepts as we detect, without our awareness, regularities in objects and events, such as extracting what is common across many dogs to form the concept of "dog."

ERIKSON

Powerful theories spawn "neo's": neo-Piagetians, neo-Freudians, neo-behaviorists, and so on. Freud's theory, despite its limitations, inspired a diverse group of brilliant and creative theoreticians, researchers, and therapists. They stretched, patched, and rearranged Freud's vision in two main ways that had consequences for developmental psychology.

First, several neo-Freudians, especially Hartmann (1958), stressed the development of conflict-free ego functions, such as perception, memory, and logical thought. Whereas Freud's ego defends and inhibits, the neo-Freudian's ego integrates and organizes personality. The emphasis on the ego's cognitive processes as a way of adapting to reality can be found in works by Rapaport (1960), Gill (1959), and Klein (1970). Furthermore, White (1963) identified such ego satisfactions as exploration and competence at performing tasks well. These satisfactions are independent of satisfactions of the id. It is clear that psychoanalytic theory can address normal, as much as abnormal, behavior. (See Palombo, Bendicsen, & Koch, 2009, for an account of psychoanalytic approaches since Freud.)

Second, many neo-Freudians moved away from Freud's emphasis on biology and emotional disorders, and considered the vast influence of society on normal development, including the importance of social relationships. The trends toward ego and social–cultural influences came to developmental psychology largely through the work of Erik Erikson, and we now look at his contributions.

Biographical Sketch

Erik Erikson was born in 1902 in Germany. His wanderlust and desire to be an artist drew him away from formal schooling. After several years of drifting, studying art, and painting children's portraits, Erikson was hired to teach art and other subjects to children of Americans who had come to Vienna for Freudian training. This accidental entry into the vigorous Freudian circle led to his studying at the Vienna Psychoanalytic Institute. His own psychoanalysis, part of the usual training program, was conducted by Anna Freud. Erikson also learned from Freud himself and other gifted analysts.

The threat of fascism brought Erikson to the United States in 1933. Despite his lack of a college degree, he became Boston's first child analyst and obtained a position at the Harvard Medical School. Later he held positions at several eminent institutions, including Yale, Berkeley, and the Menninger Foundation. During the McCarthy era, Erikson's (1951) concern that California's loyalty oath was a danger to personal and academic freedom precipitated his move back to the East Coast and to the Austen Riggs Center in Stockbridge, Massachusetts, to Harvard, and to several other eastern universities. He died in 1994 at age 91.

These diverse settings, from clinician's chair to professor's podium, fueled an energy that spread Erikson's interests over a remarkable area. He studied combat crises in troubled American soldiers in World War II, child-rearing practices among the Sioux in South Dakota and the Yurok along the Pacific Coast, and the play of disturbed and typically developing children. He also studied the conversations of troubled adolescents suffering identity crises and social behavior in India. These observations molded his ideas, which he expressed in many publications, including the well-known *Childhood and Society* (1963) and *Identity: Youth and Crisis* (1968). He was concerned about the rapid social changes in America and wrote about issues such as the generation gap, racial tensions, juvenile delinquency, changing gender roles, and the dangers of nuclear war. He was a gifted author whose writings have been described as "Freud in sonnet form" (Hopkins, 1995, p. 796). It is clear that psychoanalysis had moved far from a doctor's couch in Vienna.

General Orientation to the Theory

Erikson accepted the basic notions of Freudian theory: psychological structures, the unconscious and conscious, drives, psychosexual stages, the normal–abnormal continuum, and psychoanalytic methodology.

However, he expanded Freud's theory by constructing a set of eight psychosocial stages covering the life span, by studying the development of identity, and by developing methods that reach beyond the structured psychoanalytic setting used with adults. A look at these three contributions serves as an orientation to the theory. He has been described as "a moralist, artist, and intellectual trying to deal with a culture that has begun to lose its power as an instrument for fulfilling the potential and the aspirations of those who live within it" (Bruner, 1987, p. 8).

Psychosocial Stages

Erikson's work in various cultures convinced him of the need to add a life-span psychosocial dimension to Freud's theory of psychosexual development. In Table 3.1, columns A to D describe several aspects of Erikson's theory, and column E names the Freudian psychosexual stage corresponding to each of Erikson's psychosocial stages. The difference between psychosexual and psychosocial components can be seen in Erikson's (1959, p. 115) contrast of a toddler's oral pleasure when making speech sounds (psychosexual component) with the role of speech communication in shaping his relationship with his parents and significant others (psychosocial component).

In the psychosocial view, physical maturation has personal and social repercussions. Maturation brings a new skill that opens up new possibilities for a child but also increases society's demands on him, for example, pressure to talk instead of cry when he wants something. There is a "fit" between children and their culture. Societies have evolved agreed-upon ways of meeting children's new needs in each step of their maturation. These include parental care, schools, social organizations, occupations, a set of values, and so on. Erikson spoke of a "cogwheeling" of life cycles, as when adults' needs to become caretakers coincide with children's needs for caretaking. In other words, each child is a life cycle in a "community of life cycles" (Erikson, 1959, p. 121). A child is surrounded by others who are also passing through various stages. While the culture, over many generations, has adapted itself to the needs of children, each child in turn adapts himself to the culture, as when a new kindergartner adjusts to a bewildering new set of experiences called "school."

Psychosocial development is culturally embedded in two ways. First, although children in all cultures go through the same sequence of stages, each culture has its own idiosyncratic way of directing and enhancing a child's behavior at each age. For example, Erikson observed that the Sioux allowed nursing for several years in the spirit of overall generosity that pervaded the Sioux value system. They also thumped the teething male babies on the head for biting the mother's nipples in the belief that their crying rage would turn them into good hunters, and they trained their girls to be bashful and afraid of men in preparation for serving their hunter-husbands. Second, cultures change over time. Institutions that meet the needs of one generation may prove inadequate for the next. Industrialization, urbanization, immigration, the Depression, and the civil rights movement brought changes in what children needed to be taught in order to develop a healthy personality at their time in history.

Psychosocial development proceeds according to the *epigenetic principle,* a term derived from *epi,* which means "upon," and *genesis,* which means "emergence." This principle is borrowed from fetal development:

> Somewhat generalized, this principle states that anything that grows has a ground plan, and that out of this ground plan the parts arise, each part having its time of special ascendancy, until all parts have arisen to form a functioning whole. At birth the baby leaves the chemical exchange of the womb for the social exchange system of his society, where his gradually increasing capacities meet the opportunities and limitations of his culture.
>
> *(Erikson, 1968, p. 92)*

Like the fetus, the personality becomes increasingly differentiated and hierarchically organized as it unfolds in, and is shaped by, a particular environment. As summarized in Table 3.1, this unfolding involves several dimensions. There is movement through a set of psychosocial "crises" or issues as the child matures, and there is an expansion of his radius of significant relations. Other dimensions include the translation into the child's terms of certain elements of social order or structure and the progression through a set of psychosocial modalities or ways of "being" and interacting in society. Put succinctly, the child has inborn laws of development "which create a succession of potentialities for significant interaction with those who tend him" (Erikson, 1968, p. 52).

We now look at the general nature of the eight stages and leave a specific description of each stage for a later section. Maturation and society's expectations together create eight crises, or issues, that a child must resolve. Each issue is most evident at a particular stage in the life cycle but appears in some form throughout development. For example, autonomy is the dominant concern of the second year of life, but it is prepared for in the first year and elaborated on in later stages.

Erikson described each crisis in terms of a dimension with both positive and negative outcomes possible, for example, autonomy versus

Table 3.1 Erikson's "worksheet" summarizing the eight stages of development

Stage	A Psychological crises	B Radius of significant relations	C Related elements of social order	D Psychosocial modalities	E Psychosexual stages
1	Trust vs. mistrust	Maternal person	Cosmic order	To get To give in return	Oral-respiratory, sensory-kinesthetic (incorporative modes)
2	Autonomy vs. shame, doubt	Parental persons	"Law and order"	To hold (on) To let (go)	Anal-urethral, muscular (retentive-eliminative)
3	Initiative vs. guilt	Basic family	Ideal prototypes	To make (= going after) To "make like" (= playing)	Infantile-genital, locomotor (intrusive, inclusive)
4	Industry vs. inferiority	"Neighborhood," school	Technological elements	To make things (= completing) To make things together	"Latency"
5	Identity and repudiation vs. identity diffusion	Peer groups and outgroups; models of leadership	Ideological perspectives	To be oneself (or not to be) To share being oneself	Puberty
6	Intimacy and solidarity vs. isolation	Partners in friendship, sex, competition, cooperation	Patterns of cooperation and competition	To lose and find oneself in another	Genitality
7	Generativity vs. self-absorption	Divided labor and shared household	Currents of education and tradition	To make be To take care of	
8	Integrity vs. despair	"Mankind," "My kind"	Wisdom	To be, through having been To face not being	

shame and doubt. Ideally, a child develops a favorable ratio, in which the positive aspect dominates the negative. For instance, a person needs to know when to trust and when to mistrust but generally should have a trusting attitude toward life. If the childhood crises are not handled satisfactorily, a person continues to fight his early battles later in life. Many adults are still struggling to develop a sense of identity. Erikson optimistically claimed that it is never too late to resolve any of the crises.

With respect to the integration of successive stages, Erikson's theory lies between that of Piaget, with his tight integration, and that of Freud, with his loose integration. Each stage builds on the previous stages and influences the form of later stages. As Erikson expressed it, "Each stage adds something specific to all later ones, and makes a new ensemble out of all the earlier ones" (quoted in Evans, 1967, p. 41).

Emphasis on Identity

Today you are you! That is truer than true! There is no one alive who is you-er than you!"

— *Dr. Seuss,* Happy Birthday to You!

In contrast to Freud's concern with how people defend themselves from unpleasant tension, Erikson takes a more positive approach. He holds that a main theme of life is the quest for *identity*. This term refers to "a conscious sense of individual identity . . . an unconscious striving for a continuity of personal character . . . a criterion for the silent doings of ego synthesis . . . a maintenance of an inner solidarity with a group's ideals and identity" (Erikson, 1959, p. 102). Stated differently, identity is the understanding and acceptance of both the self and one's society. Throughout life, we ask "Who am I?" and form a different answer in each stage. If all goes well, at the end of each stage, a child's sense of identity is reconfirmed on a new level. Although the development of identity reaches a crisis during adolescence, Erikson notes that it begins when a baby "first recognizes his mother and first feels recognized by her, when her voice tells him he is somebody with a name and he's good" (quoted in Evans, 1967, p. 35). Thus, identity is transformed from one stage to the next, and early forms of identity influence later forms. This process is similar to the reworking of a concept (such as causality) in each successive stage in Piaget's theory.

Erikson, the wandering youth and the American immigrant, had felt marginalized in society. As a part of two cultures, he lived with the need to establish an identity: "As an immigrant . . . I faced one of those very important redefinitions that a man has to make who has lost his landscape and his language, and with it all the 'references' on which his first sensory and sensual impressions, and thus also some of his conceptual images, were based" (quoted in Evans, 1967, p. 41). His conversations with Huey P. Newton (Erikson, 1973) demonstrated that he was particularly sensitive to the problems that minority groups have when trying to form an identity. He began using the term "identity crisis" to describe the loss of identity he observed in World War II soldiers. He saw a similar problem among troubled adolescents "who war on their society" (Erikson, 1968, p. 17). Eventually, Erikson realized that the problem of identity appears, though usually on a smaller scale, in all lives. He also recognized that identity is a central problem of modern times: "If the relation of father and son dominated the last century, then this one is concerned with the self-made man asking himself what he is making of himself" (quoted in Evans, 1967, p. 41).

Expansion of Psychoanalytic Methodology

Erikson contributed to three methods for studying development: direct observation of children, cross-cultural comparisons, and psychobiography. His early experiences with children and his contact with Anna Freud, who was developing child observations and play therapy, immersed him in the world of both normal and disturbed children from the beginning of his career. In moving from the clinician's couch to the playroom, he asserted that "we must study man in action and not just man reflecting on reality" (quoted in Evans, 1967, p. 91).

Erikson's writings are sprinkled with contrasts between cultures. He was fascinated with how the solutions to the challenges of universal stages vary from culture to culture. His forays into cultural anthropology pointed out the limitations of classic Freudian theory, which was based almost completely on psychologically troubled patients in turn-of-the-century Vienna.

Some of Erikson's most interesting writing is found in his "psychobiographies." These are analyses of the psychosocial development of well-known people, which show how a single person can represent the central preoccupation of a society at a particular time. Erikson believed that Hitler's rise illustrates the meshing of an individual's particular needs for identity and a nation's need for a more positive identity (Erikson, 1963). In *Young Man Luther* (1958), Erikson described a troubled youth who defied his strict father who wished him to study law, rebelled against the authority of the church, and followed a belief that gave him an honest sense of identity. Other historical “patients” include Maxim Gorky (1963) and George Bernard Shaw (1968). His biography *Gandhi's Truth* (1969) won a Pulitzer Prize and the National Book Award in philosophy and religion.

Description of the Stages

Erikson divided the entire life cycle into “the eight ages of man.” Each of the eight ages has a critical issue, a lifelong ego concern that reaches a climax. (Table 3.1 provides an overview of each stage.)

Stage 1: Basic Trust Versus Basic Mistrust (Roughly Birth to 1 Year)

In Table 3.1, we see that the critical issue is trust, and the main task of infancy is to acquire a favorable ratio of trust to mistrust. If the balance is weighted toward trust, a child has a better chance of weathering the later crises than if it is weighted toward mistrust. Erikson defined *basic trust* as “an essential trustfulness of others as well as a fundamental sense of one's own trustworthiness” (1968, p. 96) and the sense that “there is some correspondence between your needs and your world” (quoted in Evans, 1967, p. 15).

Infants with an attitude of trust can predict that their mother will feed them when they are hungry and comfort them when they are frightened or in pain. They will tolerate having their mother out of sight because they are confident she will return. The mother, then, is all important, as in Freud's theory. Babies also develop trust in themselves from the feeling that others accept them and from increased familiarity with their bodily urges. This faith in themselves and their small world corresponds to religious faith in the “cosmic order” of the universe (column C). From the mother's side of the interaction, there must also be trust—trust in herself as a parent and in the meaningfulness of her caretaking role. Erikson (1950) referred to a remark from Benjamin Spock: “To be a good parent you have to believe in the species—somehow.”

Some mistrust is necessary at all ages in order to detect impending danger or discomfort and to discriminate between honest and dishonest persons. However, if mistrust wins out over trust, the child, or later the adult, may be frustrated, withdrawn, suspicious, and lacking in self-confidence.

The specifically oral experiences—sucking, biting, teething, and weaning—are prototypes for the psychosocial modality of getting and giving (Table 3.1, column D). Babies "take in," or "incorporate," stimulation through all the senses, much as a Piagetian child "assimilates." By taking from the mother and the world, babies are laying the foundation for their later role as a giver to others.

Stage 2: Autonomy Versus Shame and Doubt (Roughly 2 to 3 Years)

Further neurological and muscular development permit walking, talking, and the potential for anal control. As children become more independent physically and psychologically, there are new possibilities for personality development. At the same time, however, there are new vulnerabilities, namely, anxiety over separation from parents, fear that anal control may not always be possible, and loss of self-esteem when failure does come.

A clash of wills is inevitable. Erikson referred to the "sinister forces which are leashed and unleashed, especially in the guerrilla warfare of unequal wills; for the child is often unequal to his own violent drives, and parent and child unequal to each other" (1959, p. 66). Ideally, parents create a supportive atmosphere in which children can develop a sense of self-control without a loss of self-esteem.

While the positive component of this stage is autonomy, the negative components are shame and doubt: "Shame supposes that one is completely exposed and conscious of being looked at—in a word, self-conscious . . . 'with one's pants down.' Shame is early expressed in an impulse to bury one's face, or to sink, right then and there, into the ground" (Erikson, 1959, pp. 68–69). Doubt has to do with the unknown "behind" that the child cannot see yet must try to control. Shame and doubt about one's self-control and independence come if basic trust was insufficiently developed or was lost, if bowel training is too early or too harsh, or if the child's will is "broken" by an overcontrolling parent.

The culture, expressed through the parents, shapes and gives meaning to the toddler's new competencies. For example, cultures vary in how much they pressure toward early anal control. Erikson pointed to the machine age's ideal of a "mechanically trained, faultlessly functioning, and always clean, punctual, and deodorized body" (1959, p. 67). This attitude contrasts to the lack of concern with such matters in the Sioux culture, where children simply imitate older children in order to achieve bowel control by the time they begin school.

The psychosocial modality is holding on versus letting go, the counterpart to retention and elimination. This ambivalence pervades the child's behavior and attitude. For example, toddlers often zealously hoard toys or other objects and anxiously guard them in their hiding place but then casually throw them out the window of a moving car or give them to a friend. One morning a mother is late to work because her 2-year-old adamantly insists on buttoning every single shirt button himself, while the next morning the young Dr. Jekyll–Mr. Hyde screams with rage because his mother has not helped him get dressed. Failure to coordinate the opposing tendencies to hold on and let go can lead to the "anal personality" described by Freud—overcontrolled, compulsive, messy, stingy, or rigid.

In this second stage, children encounter rules such as when they can have bowel movements or which areas of the house they are allowed to explore. These rules are an early hint of the "law and order" society they will face (column C of Table 3.1). The issue here, according to Erikson, is "whether we remain the masters of the rules by which we want to make things more manageable (not more complicated) or whether the rules master the ruler" (1959, pp. 72–73). In a well-functioning society, the sense of autonomy encouraged in children is maintained throughout their lives by that society's economic and political structures.

Stage 3: Initiative Versus Guilt (Roughly 4 to 5 Years)

"Being firmly convinced that he *is* a person, the child must now find out *what kind* of a person he is going to be. And here he hitches his wagon to nothing less than a star: he wants to be like his parents, who to him appear very powerful and very beautiful, although quite unreasonably dangerous" (Erikson, 1959, p. 74). The theme of this stage is children's identification with their parents, who are perceived as big, powerful, and intrusive. Erikson accepted the basic outline of Freud's account of how children achieve identification through the Oedipus complex, but he emphasized the social components more than the sexual. As we saw in Freud's theory, identification brings with it a conscience and a set of interests, attitudes, and sex-typed behaviors.

The basic psychosocial modality is "making," namely, intrusion, taking the initiative, forming and carrying out goals, and competing. We might conclude, with T. S. Eliot in "The Love Song of J. Alfred Prufrock," that the stage-3 child dares to disturb the universe. The child intrudes "into other bodies by physical attack . . . into other people's ears and minds by aggressive talking . . . into space by vigorous locomotion . . . into the unknown by consuming curiosity" (Erikson, 1959, p. 76). This initiative is supported by advances in mobility, physical dexterity, language, cognition, and creative imagination.

Children settle somewhere along a dimension ranging from successful initiative to overwhelming guilt due to an overly severe conscience that punishes sexual fantasies and immoral thoughts or behavior. In addition to guilt, another danger is that children may forever feel that they must always be doing something, always competing, always "making," in order to have any worth as a person. For this stage the related elements of social order are "ideal prototypes" (column C)—social roles such as police officer, teacher, astronaut, president, and "hero."

Stage 4: Industry Versus Inferiority (Roughly 6 Years to Puberty)

The "industrial age" begins. Children now want to enter the larger world of knowledge and work. Their theme is "I am what I learn" (Erikson, 1959, p. 82). The great event is entry into school, where they are exposed to the technology of their society, such as multiplication tables, maps, and microscopes. Learning, however, occurs not only in school but also on the street, in friends' houses, and at home.

Successful experiences give children a sense of industry, a feeling of competence and mastery, while failure brings a sense of inadequacy and inferiority, a feeling that one is a good-for-nothing. Children strive to make things well and complete what they have begun. The years spent establishing basic trust, autonomy, and initiative were preparation for this energetic entry into our technological society. Erikson noted that this stage differs from the first three in that "it does not consist of a swing from a violent inner upheaval to a new mastery" (1959, p. 88). It is a calmer period, a time of psychosexual latency.

Stage 5: Identity and Repudiation Versus Identity Diffusion (Adolescence)

Erikson quoted a saying that hangs in a cowboy bar in the West: "I ain't what I ought to be, I ain't what I'm going to be, but I ain't what I was" (1959, p. 93). In an earlier section, we saw that the quest for identity is the undercurrent running through all the stages. The trust, autonomy, initiative, and industry of earlier stages contribute to a child's identity. In the fifth stage, however, this concern reaches a climax. Rapid physiological changes produce a "new" body with unfamiliar sexual urges. These changes, along with social pressure to make rational and educational decisions, force adolescents to consider a variety of roles. The basic task for them is to integrate the various identifications they bring from childhood into a more complete identity. Erikson emphasized that this whole (the identity) is greater than the sum of its parts (previous identifications). This reassembled identity is appropriate for the new needs, skills, and goals of adolescence. If adolescents cannot integrate their identifications, roles, or selves, they face "identity diffusion." The personality is fragmented, lacking a core. Erikson quoted Biff in Arthur Miller's *Death of a Salesman*: "I just can't take hold, Mom, I can't take hold of some kind of a life" (1959, p. 91). The problem may be exacerbated by one's minority-group status, uncertainty about one's sexual orientation, an overly strong identification with a parent, or too many occupational roles from which to choose.

The psychosocial modality of this stage is to be oneself or not to be oneself. Hamlet's "to be or not to be" soliloquy voices this alienation and role confusion (Erikson, 1968). Youths seek their true selves through peer groups, clubs, religion, political movements, and so on. These groups provide opportunities to try out new roles much in the way someone might try on jackets in a store until finding one that fits. The ideology of society, this stage's counterpart in the social order, guides this role playing by conveying which roles are valued by society.

Stage 6: Intimacy and Solidarity Versus Isolation (Young Adulthood)

Only if a reasonably well-integrated identity emerges from stage 5 can psychological intimacy with other people (or even oneself) be possible. If a youth fears that she may lose herself in someone else, she is unable to fuse her identity with someone else. Although young people usually form important romantic relationships during this time, their friendships and even their access to their own intimate feelings and thoughts also mark this stage. These relationships, by enhancing one's own identity, further the growth of personality. One aspect of intimacy is the feeling of solidarity of "us" and the defense against "them," the threatening "forces and people whose essence seems dangerous to one's own" (Erikson, 1959, pp. 96–97). If a youth's attempts at intimacy fail, she retreats into isolation. In this case, social relationships are stereotyped, cold, and empty.

Stage 7: Generativity Versus Stagnation and Self-Absorption (Middle Adulthood)

Generativity refers to "the interest in establishing and guiding the next generation" (Erikson, 1959, p. 97) through child rearing or creative or productive endeavors. Simply bearing children does not, of course, ensure that a parent will develop a sense of generativity. Faith in the future, a belief in the species, and the ability to care about others seem to be prerequisites for development in this stage. Instead of having children, one may work to create a better world for the children of others. Stage 7, then, provides the mechanism for the continuity of society from generation to generation. A lack of generativity is expressed in stagnation, self-absorption (self-indulgence), boredom, and lack of psychological growth.

Stage 8: Integrity Versus Despair (Late Adulthood)

In this final stage, people must live with what they have built over their lifetime. Ideally, they will have achieved integrity. *Integrity* involves the acceptance of the limitations of life, a sense of being a part of a larger history that includes previous generations, a sense of owning the wisdom of the ages, and a final integration of all the previous stages. The antithesis of integrity is despair—regret for what one has done or not done with one's life, fear of approaching death, and disgust with oneself.

Mechanisms of Development

The epigenetic principle describes the forces that underlie movement through the stages. Physical maturation writes the general timetable for development. Within these limits, one's culture pushes, slows down, nurtures, and destroys. In Erikson's view, society exerts its influence on the developing organism at many levels, ranging all the way from its abstract ideology to a parent's caress. Other Eriksonian mechanisms of development come from Freud: drives, frustrations from external and internal forces, attachment, and identification. However, Erikson made little use of Freud's tension-reduction equilibration process. Instead, he viewed development as the resolution of conflict from opposing forces. A child integrates holding on and letting go, initiative and guilt, the biological and psychological, and so on.

Erikson (1977) also elaborated on a more specific mechanism of development: play. Play is used in a broad sense to mean the use of imagination to try out ways of mastering and adapting to the world, to express emotions, to re-create past situations or imagine future situations, and to develop new models of existence. Problems that cannot be solved in reality can be solved through doll play, dramatics, sports, art, block play, "playing house," and so on. Play, however, is not limited to children. Play includes Einstein visualizing a model of time and space, an adolescent fantasizing about entering various occupations, or a man rehearsing what he will say to his boss the next day. Play is often ritualized and becomes a somewhat formal, enduring, culturally agreed-upon way of interacting with others. For example, an adolescent who is "messing around" with his friends is acquiring culturally approved patterns for interacting with other people. Another example is that the child care rituals of infancy pass on "proper" ways of recognizing and greeting other people. Rituals are mechanisms of development because they bring humans in every stage into the cultural mainstream and provide ready-made solutions to the problems of everyday life.

Position on Developmental Issues

Erikson's position on the four issues is close to Freud's but differs in emphasis. Erikson, like Piaget, had a more optimistic view of human nature. Children and adults not only seek to avoid pain but also actively seek to develop a positive sense of identity. The existential human is in a process of "becoming" throughout life. This development is primarily qualitative because changes are stagelike, but it is also somewhat quantitative in that one's identity becomes stronger and one's convictions solidify.

Unlike Freud's theory, Erikson's has elements of the contextualist worldview. He saw a changing child in a changing world and a system of culturally constructed contexts devoted to the socialization of children into that culture. The nature of these settings contributes to, and affects the resolution of, the crisis of each stage.

Like Freud, Erikson believed that nature determines the sequence of the stages and sets limits within which nurture operates. Heredity ensures that certain crises arise, but the environment determines how they are resolved. Erikson, however, more than Freud, emphasized the role of culture in nurturing and shaping development. Not only the person's past and present but also society's past and present influence the developing person. In addition, Erikson rejected Freud's claim that development is essentially complete after the first five years of life. Development is a lifelong process; sometimes childhood conflicts are not resolved satisfactorily until adulthood. Finally, for Erikson, the essence of development is the formation of an identity that gives coherence to one's personality.

Applications

As mentioned earlier, Erikson applied his theory to problems such as adolescent identity crises, conflict between generations, post-war adjustment of soldiers, race relations, and child rearing. Today, counselors continue to draw on his work on adolescence in particular to help young people form a coherent identity and successfully make personal and occupational decisions. Adults can facilitate their children's development by helping them achieve a balance between each end of the continuum in each stage, such as between trust and healthy mistrust.

Evaluation of the Theory

Because Erikson's theory is an extension of psychoanalytic theory, much of the earlier evaluation of Freud's theory is relevant here. Instead of reiterating those comments, the present section focuses on the unique strengths and weaknesses of Erikson's theory.

Strengths

Expansion of Psychoanalytic Theory ▶ By widening the empirical base of psychoanalytic theory, Erikson increased its credibility and application. He added the psychosocial to the psychosexual, the cultural to the biological, the ego identity to the ego defenses, the normal to the abnormal, the cross-cultural to the culture-specific, child observations to adults' reconstructions from childhood, and adult development to child development. The theory is remarkable in its power to integrate a wide variety of situations. Erikson's version of development seems well grounded in the everyday lives of the majority of people as they struggle to find coherence and meaning in their lives. He "looks for the hopeful and active part of the person and for how human experience and human potential are organized in the communal environment, within a radius of significant social encounters" (Schlein, 1987, p. xxv). This broadened psychoanalytic framework has been a valuable heuristic for counseling and therapy. Erikson's emphasis on culture and life-span development was especially important for developmental psychology, and contributed to today's life-span approach. However, his work stimulated little research on the specific claims of his theory, such as the ordering of the stages or, at a more concrete level, sex differences in children's play.

Broad Perspective ▶ Erikson's relevance for contemporary views of development lies in the broad perspective he gives to children's behavior.

He has been described as "perhaps one of the last great synthesizers in the behavioral sciences" (Hopkins, 1995, p. 796). A specific behavior of a specific child is influenced by his past history, the present situation, and the past and present history of his own culture and even the world society. All levels of society, from international relations to the nation's political structure to the interaction within the family, influence behavior. Erikson's writings conjure up the image of a system of interlocking forces uniting the child and the universe, the distant past and the distant future. Although many developmentalists agree with this position, with few exceptions (see Vygotskian and sociocultural theories in Chapter 4) they do not seriously examine these social and historical variables. Instead, the behavior of children is typically studied in isolation.

Weaknesses

Lack of Systematicity ▶ Erikson's theory is a loose connection of observations, empirical generalizations, and abstract theoretical claims. Consequently, it is difficult to state his claims in a way that can be tested or relate his empirical findings to the more abstract levels of the theory. As with Freud, much of the problem lies in the methodological inadequacies, particularly the lack of controlled experimentation. In Erikson's case, the observations are laden with interpretations that are difficult to evaluate. For example, in Erikson's observation at the beginning of this chapter, do boys build towers because of their phallic, intrusive orientation, as Erikson claimed, or simply because they like to knock tall things down? His psychobiographies are fascinating but are necessarily speculative. A related problem is that the terms he selects can be confusing. For example, "generativity" and "integrity" do not have their usual meanings.

Lack of Specific Mechanisms of Development ▶ It became clear in the earlier section on mechanisms of development that Erikson did not explain in any detail how a child moves from stage to stage or even how he resolves the crisis within a stage. He states *what* influences the movement (for example, physical maturation, parents, cultural beliefs, the extent to which earlier crises were resolved) but not specifically *how* the movement comes about. By what mechanisms does an infant learn when to trust and when to mistrust? Why does the resolution of the initiative–guilt polarity lead to the industry–inferiority conflict rather than to some other conflict? The validity of many of Erikson's notions, such as the conflict-resolution model, rests on the ability to describe in detail the mechanisms of development.

Contemporary Research

Unlike Piaget and Freud, Erikson emphasized development over the entire life span, a thriving area of research today. Some contemporary research continues to examine Eriksonian issues, such as generativity and adult development. For example, adults who feel they have a purpose in life live longer than their counterparts (Hill & Turiano, 2014). As the number of elderly adults has increased, researchers have become increasingly interested in this final phase of life. And as more and more people attend college and delay marriage, parenthood, and entry into full-time employment in industrialized societies, researchers have identified a new phase in the life span between adolescence and young adulthood, called *emerging adulthood* (Arnett, 2015a).

During this developmental phase, from the late teens through the mid-20s, many young people are adults in terms of age but are not yet adults in terms of achieving financial independence, living independently from parents, and establishing a family. Although college undergraduates have been convenient sources of research participants for years and data on them is the basis of most of our knowledge about many areas of psychology, this now also is seen as an age group undergoing development. They are continuing to explore their identities in work and relationships and to develop a philosophy of life. Emerging adulthood is marked by identity exploration, instability, focus on self, feeling in between childhood and adulthood, and a focus on possibilities (Arnett, 2015a). Despite the instability and uncertainty they face, emerging adults are skilled at living with contradictory emotions. For the most part, they are confident though cautious, and optimistic though aware of the uncertainty of success.

Consistent with Erikson's focus on culture, researchers have studied cultural variation in emerging adulthood. For example, in Europe, identity development is focused on freedom and leisure, whereas Asian countries tend to focus on values of family obligation (Arnett, 2015b). The stage of emerging adulthood primarily is found in economically developed countries, does not yet exist in developing countries, and is a recent phenomenon in some countries. For example, in Japan few young women could, until recent years, go against convention and stay single for a long period of time and thus have a time of emerging adulthood (Rosenberger, 2007). In the United States, emerging adulthood is experienced differently by youths in various racial and ethnic populations (Syed & Mitchell, 2013). For instance, those of Latin American or Asian (especially East Asian) backgrounds often feel torn during emerging adulthood between their sense of duty to enter the roles that their families desire for them and their wish to explore other identities and careers (Fuligni, 2007).

A main active area of current research is identity development during adolescence and early adulthood (e.g., McLean & Syed, 2015). For example, Marcia (Kroger & Marcia, 2013; Marcia, 1967, 2007) has expanded two of Erikson's notions, crisis and commitment: "Crisis refers to times during adolescence when the individual seems to be actively involved in choosing among alternative occupations and beliefs. Commitment refers to the degree of personal investment the individual expresses in an occupation or belief " (1967, p. 119). The presence or absence of crisis or commitment defines four *identity statuses*. An *identity-diffused* person, because she has experienced neither an identity crisis nor a commitment, is easily influenced by others and may change her beliefs often. A *foreclosure* person has made commitments without experiencing an identity crisis. She unquestioningly accepts beliefs, attitudes, and an occupation based on the views of others. An example is entering a career that her parents want for her. A *moratorium* person is in a state of identity crisis and is not yet able to make commitments. Thus, she is still searching. Finally, an *identity-achieved* person has successfully passed through an identity crisis and has made a set of personal commitments. Young people tend to make progress through the four statuses, but many still are not identity achieved by young adulthood (Kroger, Martinussen, & Marcia, 2010). Much of the research examines the differing backgrounds and characteristics of adolescents and adults in the four identity statuses. For example, achieving identity is associated with having a secure attachment style and having achieved intimacy (Arseth, Kroger, Martinussen, & Marcia, 2009).

Contemporary research on identity, a key Eriksonian concept, explores diverse developmental pathways to achieving identity as a function of gender, race, ethnicity, class, sexual orientation, and nationality, and their intersections. Achieving an integrated identity is particularly challenging for those who hold minority status in these categories. Immigrant youth, in particular, may face not only the usual identity developmental task of adolescence and early adulthood, but also, like Erikson himself, the challenges of adjusting to a new culture.

Common challenges to this adjustment include economic difficulties and ethnic and racial stratification. Some studies find that retaining the cultural values of one's culture of origin is a buffer against the strains of identity development in immigrant youth. That is, developing an ethnic identity and not completely assimilating into dominant U.S. culture can protect against negative outcomes. For example, the development of ethnic and racial identity is associated with positive psychosocial, academic, and health risk outcomes among African-American adolescents (Rivas-Drake et al., 2014). Moreover, retaining the value of family obligation—respecting, supporting, and caring for one's family—is associated with healthy psychological development in Mexican-American adolescents (Telzer, Tsai, Gonzales, & Fuligni, 2015). Finally, the fact that first-generation Asian-Americans endorse model minority pride more strongly than second-generation Asian-Americans shows that the generational status of immigrants influences how they cope with social marginality (Mahalingam, 2006).

SUMMARY

Two of Freud's ideas formed the backbone of developmental psychology. First, he proposed that the first few years of life are critical because one's basic personality is formed during that time. Second, he believed that personality is developed as a child copes with an invariant sequence of conflicts. Each conflict involves a different domain: oral, anal, phallic, and adult genital. The way that children satisfy the drives in each stage forms the basis of their personality. Although Freud's psychosexual focus has little influence today in academic psychology, the notion of stages has greatly influenced research and therapy with children. Also, his account of attachment has stimulated current research on internal working models and their long-term effects on development.

Using an energy model from physics, Freud described a system of psychological energy that is distributed, transformed, and discharged within a psychological structure. This structure consists of the id, ego, and superego in a delicate balance. The ego considers its available defenses, its perceptions of reality, the demands of the id for drive reduction, and the prohibitions of the superego before deciding on a course of action. Most of the "mind" is unconscious because knowledge of the thoughts and wishes hidden in the id, ego, and superego would cause unbearable anxiety.

Most of Freud's evidence came from his patients' free associations concerning their childhood, dreams, and present concerns. Freud believed that the workings of abnormal minds clarify the nature of normal personality because there is a continuum of behaviors ranging from the abnormal to the normal.

Freud viewed humans as driven by instincts but actively trying to cope with various internal and external conflicts. He stressed qualitative, stagelike changes in development but also included quantitative change. Although he emphasized biological influences, especially drives, he also recognized the role of experience, particularly social experience in the first five years of life. The essence of development is the emergence of psychological structures that mediate all experience and behavior. Freud's theory introduced new psychological phenomena to Western culture and has the potential to broaden future research on cognitive development by including emotion-laden thoughts and defense mechanisms. However, the theory has methodological inadequacies, and its claims may not be testable. In addition, its focus on infantile sexuality has limited its acceptance in academic psychology. Contemporary research on attachment, effects of early experience on later outcomes, and unconscious mental processes indicates that many of the developmental issues raised by Freud are still relevant.

What is Freud's heritage for developmental psychology? He began by asking why his patients suffered and ended by giving us a new perspective on human development. Hall and Lindzey noted that whereas Freud may not have been the most rigorous scientist or theorist, "he was a patient, meticulous, penetrating observer and a tenacious, disciplined, courageous, original thinker" (1957, p. 72).

Erikson's psychosocial theory of development modified Freudian theory in two important ways. First, Erikson identified important social influences on development throughout the life span. His research in various cultures and social settings within a culture suggests that every society tries to deal with the biologically based changes occurring during development. Ideally, there is a fit between a child's needs and the society's needs at each point in development. In each of eight stages, there is a psychosocial crisis in which there are two possible extreme outcomes: (1) trust versus mistrust, (2) autonomy versus shame and doubt, (3) initiative versus guilt, (4) industry versus inferiority, (5) identity and repudiation versus identity diffusion, (6) intimacy and solidarity versus isolation, (7) generativity versus stagnation and self-absorption, and (8) integrity versus despair. Eriksonian-inspired research on identity continues today.

Erikson's second major contribution to psychoanalytic theory is his notion that life is a quest for identity. Thus, he focused on ego processes. The work on both social and ego processes greatly expanded psychoanalytic theory and provided a broad perspective on development. However, the theory is rather unsystematic and lacks specific mechanisms of development. Erikson's influence can be seen in contemporary research on emergent adulthood and the diversity of identity development.

Freud and Erikson produced different yet complementary perspectives on development. A remark by Kierkegaard expresses an integration of the two views: "Life can only be understood backwards; but it must be lived forwards."

SUGGESTED READINGS

This paperback is a short, lucid introduction to Freud's theory:

Hall, C. S. (1954). *A primer of Freudian psychology*. New York: World.

This book describes various psychoanalytic theories of development:

Palombo, J., Bendicsen, H. K., & Koch, B. J. (2009). *Guide to psychoanalytic developmental theories*. New York: Springer Science+Business Media.

Because Freud was a talented and provocative writer, his ideas should be explored in his own writings:

Strachey, J. (Ed. and Trans.). (1953–1966). *The standard edition of the complete psychological works of Sigmund Freud* (24 vols). London: Hogarth Press. Particularly recommended are "An Outline of Psycho-Analysis" (Vol. 23, pp. 144–207), "New Introductory Lectures on Psycho-Analysis" (Vol. 22, pp. 5–182), and any of the case studies.

This book provides a nice introduction to Erikson's theory:

Stevens, R. (2008). *Erik Erikson: Explorer of identity and the life cycle*. New York: Palgrave Macmillan.

Three of Erikson's books provide readable accounts of his ideas:

Erikson, E. H. (1963). *Childhood and society* (2nd ed.). New York: Norton.

Erikson, E. H. (1968). *Identity:Youth and crisis*. New York: Norton.

Erikson, E. H. (1982). *The life cycle completed: A review*. New York: Norton.

Erikson's psychobiographies are a source of fascinating reading, especially this Pulitzer Prize-winning one:

Erikson, E. H. (1969). *Gandhi's truth*. New York: Norton.

Sergey Nivens/Shutterstock

CHAPTER 4

Vygotsky and the Sociocultural Approach

The experimenter has removed a crayon of a needed color before the child begins to draw. The child talks to himself: Where's the pencil? I need a blue pencil. Never mind, I'll draw with the red one and wet it with water; it will become dark and look like blue.

—*Vygotsky, 1962, p. 16*

Mothers and their children construct a jigsaw puzzle together.
A 2-year-old:
C: Oh. (glances at model, then looks at pieces pile) Oh, now where's this one go? (picks up black cargo square, looks at copy, then at pieces pile)
M: Where does it go on this other one? (child puts black cargo square back down in pieces pile, looks at pieces pile)
M: Look at the other truck and then you can tell. (child looks at model, then glances at pieces pile, then looks at model, then glances at pieces pile)
C: Well . . . (looks at copy, then at model) . . . I look at it. . . . Um, this other puzzle has a black one over there. (child points to black cargo square in model)
M: Um-hm.
C: A black one . . . (looks at pieces pile)
M: So where do you want to put the black one on this puzzle? (child picks up black cargo square from pieces pile, looks at copy)
C: Well, where do you put it there? Over there? (inserts black cargo square correctly in copy)
M: That looks good.

—*Wertsch, 1979, p. 13*

A 4-year-old:
C: I'll tell you when I need help, Mom.

—*Wertsch & Hickmann, 1987, p. 261*

Development is not just about individuals. It is also about their surroundings, including the other people in their lives. An infant is born with biologically based potential and tendencies but would become a different adult in China, Uganda, and Texas. Yet, most of the theories that have influenced developmental research in the Western world have viewed individuals as separate from their social and physical environments. These theories, such as Piaget's, depict development primarily as an individual activity. Most approaches view the environment as simply an "influence on" an individual's development. In North America in particular, a democratic political philosophy, a focus on the rights of individuals, and, historically, the romantic ideal of a lone explorer separated from family in search of new land have directed developmental psychologists to an isolated autonomous individual. The environment simply facilitates or restricts development.

In contrast, a number of other social belief systems and their corresponding psychological theories, many of them Eastern, challenge this view (e.g., Markus & Kitayama, 2010). Of this group, the most influential for present-day developmental psychologists is the approach developed by the Soviet psychologist Lev Vygotsky and, more generally, sociocultural theorists. In the Vygotskian–sociocultural view, humans are embedded in a sociocultural matrix and human behavior cannot be understood independent of this ever-present matrix. As Bhaskar said, "To think of contexts as existing in addition to or apart from practices is like imagining smiles alongside or beside faces" (1983, p. 87)—like a Cheshire cat in Lewis Carroll's *Alice's Adventures in Wonderland*.

Like Erikson's theory, Vygotsky's theory directs our attention to cultures other than our own in order to more clearly see the role of culture in development. The theory complements Piaget's theory by looking at how culture might account for children showing greater understanding in some contexts than in others—the domain-specific concepts discussed in the chapter on Piaget. The neo-Piagetians, particularly Fischer, drew on Vygotskian theory to explain variability in development. Vygotsky and the socioculturalists point out that a culture defines what knowledge and skills children need in that culture and gives them tools such as language, technology, and strategies for functioning in that culture. Thus, the sociocultural approach balances the Piagetian (and Freudian) focus on the individual.

Chapters 2–4 present the "Big 3" theorists in the history of developmental psychology. These theorists provide three very different perspectives on development, which provide a foundation for the rest of the book. Freud emphasized biological forces that mold personality, Vygotsky focused on cultural contributions to cognition, and Piaget took an interactionist stance regarding biology and the environment.

The organization of this chapter is as follows: First, in true Vygotskian style, a biographical sketch gives a cultural and historical perspective on Vygotsky. Much of the material for this sketch came from Luria (1979), Cole and Scribner (1978), and Wertsch (1985). Next is a general orientation to sociocultural theory, followed by sections on mechanisms of development, the theory's position on developmental issues, applications, and strengths and weaknesses. Final sections describe the contextual approach, which is closely associated with sociocultural approaches, and contemporary research.

Biographical Sketch

Lev Semyonovich Vygotsky was born in 1896, the same year as Piaget, into an intellectual Russian Jewish family. His large family valued stimulating conversations while having tea around the samovar. By age 15, Vygotsky was called the "little professor" because of his reputation as a leader of student discussions (Wertsch, 1985). He often organized debates and mock trials in which his friends took the roles of historical figures such as Aristotle and Napoleon (Wertsch, 1985). Vygotsky was well educated. He received a degree in law from Moscow University but also read widely in literature, linguistics, psychology, the arts, social science, and philosophy. He later wrote his dissertation on Shakespeare's *Hamlet*. He expressed this interest in language and literature in his later work on cognitive development. Vygotsky taught psychology at a teacher's college in a provincial town in western Russia. In his work, he encountered children with disabilities such as blindness, deafness, and intellectual delay. As he sought ways to help these children fulfill their potential, his theory developed.

Vygotsky's systematic work in psychology began in 1924 when the Russian psychologist Alexander Luria, impressed by the brilliance of one of Vygotsky's lectures, obtained a position for him at the Institute of Psychology in Moscow. Luria described this event starring an unknown young teacher from the provinces:

> When Vygotsky got up to deliver his speech, he had no printed text from which to read, not even notes. Yet he spoke fluently, never seeming to stop and search his memory for the next idea. . . . Instead of choosing a minor theme, as might befit a young man of twenty-eight speaking for the first time to a gathering of the graybeards of his profession, Vygotsky chose the difficult theme of the relation between conditioned reflexes

> and man's conscious behavior. . . . It was clear that this man from a small provincial town in western Russia was an intellectual force who would have to be listened to.
>
> *(1979, pp. 38–39)*

Vygotsky's speeches continued to inspire his listeners in the following years. Students sometimes even listened to his lectures through open windows when the auditorium was overflowing.

Vygotsky, Luria, and Leontiev, the "troika" of the Vygotskian school (Luria, 1979), enthusiastically constructed a new psychology based on Marxism as part of the construction of a new socialist state following the Russian Revolution. As Luria described it, "Our aim, overambitious in the manner characteristic of the times, was to create a new, comprehensive approach to human psychological processes" (1979, p. 40). Vygotsky's lack of formal training in psychology was not a problem to such a radical group! It was largely because of the great social upheaval that Vygotsky was able to develop his theory and influence the psychology and education of the times (Wertsch, 1985).

The work of Vygotsky and his colleagues shows the close connection between economic/political systems and psychology. They wanted to change citizens' thinking from a feudal (landlords and serfs) mentality of helplessness and alienation to a socialistic mentality of self-directed activity and commitment to a larger social unit based on sharing, cooperation, and support. In the new Soviet view, each person was responsible for the progress of the whole society. A main goal was to eliminate the massive illiteracy of Soviet society. In reaction to previous Russian psychologists, Vygotsky and his colleagues constructed a cultural–historical view of developmental psychology and emphasized higher mental activities such as thinking, memory, and reasoning. Vygotsky drew on Pavlov's work on "higher nervous activity" and was aware of European psychologists such as Piaget, Binet, and Freud. In fact, several of his publications critiqued Piaget (e.g., Vygotsky, 1962).

Vygotsky extended Marx and Engels' ideas about economics and politics to psychology in three main ways, all of which will be described more fully later. First, he extended to human development their argument that humans transform themselves, as well as nature, through labor and tool use. The hand creates the mind. The mode of economic production—for example, socialist, capitalist, or feudal—determines people's working conditions and social interactions. These experiences in turn shape their cognition—cognitive styles, attitudes, perception of reality, and beliefs. Vygotsky applied to children's development this fascinating idea that the labor system creates the social structure, which in turn creates the fundamental nature of human thinking: Children's interactions with others and the culture's "psychological tools," such as language used in these interactions, shape children's thinking. In an analogy with labor, children's actions with these tools create thought. Thus, both Piaget and Vygotsky thought that interaction with objects and materials direct cognitive development, but Vygotsky emphasized social interaction. Also, Vygotsky pointed out the cultural origins of physical objects such as machines and toys.

Second, Vygotsky argued that the economic collectivist principle of shared goods runs parallel to socially shared cognition. The adult collective is responsible for sharing its knowledge with children and other less advanced members of society in order to advance their cognitive development. Third, Vygotsky used the Marxist principle (from Hegel) of *dialectical* change—that all phenomena constantly undergo change and move toward a synthesis of conflicting, contradictory elements. For Vygotsky, this process constitutes development. Human thought, like other phenomena, can be understood only by examining its history. Conflict can occur between developing psychological structures, between a currently held concept and a new one, between children and their environment, between nature and nurture, and so on.

Vygotsky remained interested in education, especially of those with mental and physical disabilities and medical problems such as blindness, aphasia, and severe intellectual disability. In fact, he undertook medical training for several years. He established several research laboratories, some of them dedicated to the study of children with physical or mental problems. Vygotsky lectured widely, conducted research continually, and published approximately 180 works on topics as diverse as intellectual disabilities, language, deafness, play, emotions, personality, concepts, multilingualism, memory, mathematics, perception, and attention. Other interests included schizophrenia, negativity in adolescents, the psychology of art, and even creativity in actors.

In the early 1930s, Vygotsky fell victim to the political strife surrounding Stalin's rule. The government accused him of being a "bourgeois psychologist" of the ilk of Piaget and other suspect Western psychologists. In fact, Vygotsky was viewed suspiciously for often referring to these writers. The government also criticized him for suggesting that nonliterate minority people in the remote, nonindustrialized parts of Russia had not yet developed the intellectual prowess of those in more modern sections. Particularly suspect was his interest in intellectual testing—a "pedagogical perversion" denounced by the Communist Party. The party blacklisted him during the Stalinist purges, as it did many psychologists. From 1936 to 1956, the government banned his work, though his writings continued to circulate underground. Vygotsky's influential book *Thought and Language* was published in Russia in 1934, the year of his death. He died of tuberculosis at age 37 after only 10 years of professional work in psychology—though they were 10 quite remarkable years. Vygotsky's early brilliance and premature death led him to be called the "Mozart of psychology" (Toulmin, 1978). His theory "was sketchily proposed by a young genius in a mortal race with tuberculosis, during an intellectual revolution on foreign soil, over a half-century ago" (Rogoff & Göncu, 1987, p. 23).

Vygotsky's ideas continued through the work of Luria and others, particularly those in the Soviet Union who were building a "theory of activity." Only a few short articles by Vygotsky were available in English until a translation of *Thought and Language* was published in 1962. The efforts of several scholars, including Michael Cole, Barbara Rogoff, James Wertsch, Jean Valsiner, and Ann Brown in the United States, made Vygotsky's ideas more accessible to the English-speaking world. The sociocultural approach inspired by Vygotsky is a major current theoretical perspective, and Vygotsky's work continues to influence educational practices. Both the growing racial and cultural diversity of children within the United States and the globalization of contemporary life make it imperative that we understand cultural contributions to development. We need Vygotsky's theory to help us conceptualize development in our changing world.

General Orientation to the Theory

Vygotsky and present-day sociocultural psychologists share certain assumptions, which will be described below. However, they have differences, mainly in emphasis. The main characteristics are the child-in-activity-in-cultural-context as the unit of study, the zone of proximal development, the sociocultural origins of mental functioning, the mediation of intellectual functioning by tools provided by culture, and sociocultural methodology.

Child-in-Activity-in-Cultural-Context as the Unit of Study

Sociocultural psychologists view a child-in-context participating in some activity as the smallest meaningful unit of study. This may not seem like a radical concept because psychologists often talk about social or cultural influences. However, the sociocultural approach differs from these other approaches in two ways. One is the view that it is a distortion to separate individuals from their sociocultural contexts. When other approaches address social influences, they are separating person from context and then asking how the context influences the person. Instead, sociocultural approaches see individuals as always fused, or embedded, in some culturally infused context. The second difference is the focus on activity. People do something in some setting for some purpose, and this is how children are socialized into the culture—through daily activities with other people in the culture. Both of these ideas are illustrated in the following exchange between a mother and her 24-month-old:

> M: Did you like the apartment at the beach?
>
> C: Yeah. And I have fun in the, in the, in the water.
>
> M: You had fun in the water?
>
> C: Yeah. I come to the ocean.
>
> M: You went to the ocean?
>
> C: Yeah.
>
> M: Did you play in the ocean?
>
> C: And my sandals off.
>
> M: You took your sandals off?
>
> C: And my jamas off.
>
> M: And your jamas off. And what did you wear to the beach?
>
> C: I wear hot cocoa shirt.
>
> M: Oh, your cocoa shirt, yeah. And your bathing suit?
>
> C: Yeah. And my cocoa shirt.
>
> M: Yeah. Did we walk to the beach?
>
> C: Yeah.
>
> *(Hudson, 1990, pp. 181–182)*

A theorist, such as Piaget, focused on an individual, would ask what the child knows and how well she remembers, and perhaps how the mother influences her thinking. However, this is somewhat a distortion of the event, because the dyad *together* is carrying out the process of remembering. It is hard to say what knowledge or memory skills are in the child's head because the child's mind extends beyond her skin: Her remembering flows into her mother's as her mother's remembering flows into hers. In short, there is no universal child developing in a vacuum. Rather, the mind is inherently social: "The path from object to child and from child to object passes through another person" (Vygotsky, 1978, p. 30). The child, the other person, and the social context are fused in some activity. One might say that the mind is "socially distributed" (Hutchins, 1991). This observation also illustrates that children become members of their culture by engaging in the activities of the culture. The mother is conveying to the child that it is important to remember shared activities, that the child is capable of remembering more than she does at first, that the child's efforts at remembering are valued, and perhaps that family vacations are important. These cultural beliefs typically are not conveyed explicitly and directly but rather are expressed in people playing, talking, or working together. In other words, enculturation is not something that happens to children; it is something that children do.

Cultural practices, which occur routinely in daily life in the culture, include sleeping arrangements, games, household work with adults, conversation patterns, storytelling, classroom instruction, and family mealtime. Children actively engage in these practices in order to achieve goals—planning a birthday party, trying to convince their parents to buy them a bicycle, attempting to remember which friend borrowed their baseball glove, and figuring out whether they have enough money to buy a candy bar. Social problem solving and communicating one's feelings and desires to others are not just "special cases" of predominantly "cold" cognition unrelated to personal needs; they are the fabric of everyday life and the essence of cognition.

In sum, children actively participating in culturally organized activities try to make sense of them and the larger society. In this way, cognition develops—as a by-product of engaging in these cultural routines. Thus, cognition is a dynamic process of trying to understand rather than a set of static stored knowledge. Much of development has to do with changes in what cultural practices they can engage in and how they participate in them. Older children can participate in some activities, such as going to the mall with friends or playing in a band, that younger children cannot. Cooking with a parent eventually leads to cooking alone. These changes in participation cause, and are caused by, increased knowledge and skills. Doing creates knowledge and knowledge makes doing possible.

Now we turn to a more explicit definition of culture. Although there are different definitions of culture, a common one is that culture consists of shared beliefs, values, knowledge, worldview, structured relationships, skills, ways of doing things (customs), and socialization practices. Cultures also have shared symbols, such as spoken and written language, images, and narratives, to make sense of their experiences. All of this is passed on to children at many levels, ranging from engagement in societal-level institutions such as schools, to family routines such as sharing stories, to interactions with another person, such as a parent. In the United States, culture creates settings such as malls, suburbs, schools, and movie theaters, and artifacts such as tools, computers, television, and art. The culture organizes these settings, which can be seen, for example, in the different kinds of instructional practices in the schools of different cultures. As children participate in these activities and settings, they assimilate these beliefs and develop the cognitive system necessary to support the belief system.

The various levels of cultural settings form a system in which changes at one level affect the other levels. A recession may cause parents to lose their jobs. This may lead to tension at home, which in turn may cause a child to have problems at school. Such rippling effects can move in the opposite direction as well (from developing child to culture) and bring about social change. Thus, individuals and cultural communities mutually create each other.

Within the overall culture, ethnic subcultures or various family structures (traditional, single parent, blended, gay) present different contexts. For example, processes of child rearing differ among different races, ethnicities, social classes, dual-career versus one-career families, rural versus urban communities, single- versus two-parent families, and so on. These aspects of culture influence (1) what children think about and acquire skills in (for example, academics, sports, weaving); (2) how children acquire information and skills (for example, explicit instruction versus learning by observing); (3) when in development children are allowed to participate in certain activities (for example, adult work, sex, care of younger siblings); and (4) who is allowed to participate in certain activities (for example, only one gender, certain social classes).

Culture also incorporates physical and historical influences. The climate, type of terrain, urban or rural setting, population density, health care, and physical risks are intertwined with social contexts. Culture is, to a great extent, a group's response to its physical ecology, which biases toward certain forms of economic activity, such as farming or industry. These activities in turn dictate a particular social organization and division of labor, which in turn influence child-rearing practices, which influence children's concepts. Vygotsky also emphasized that the history of a culture powerfully shapes all levels of context. Wars, natural disasters, revolutions, economic depressions, and civil rights movements reverberate at all contextual levels. At any one point in history, a culture is both a product of its own history and a provider of settings that shape children's development and, consequently, the future of the culture.

Vygotsky and his colleagues provide a striking illustration of how socioeconomic–cultural change brings psychological change in a naturally occurring experiment involving illiterate peasants working on small farms under a feudal lord in a remote area of the Soviet Union

(Luria, 1976). As part of the movement toward a modern socialist state, the peasants became involved in collective farming practices that required meetings to plan production and make other decisions. They also learned to read and write. Among the illiterate peasants without these new experiences, classification, concept formation, reasoning, and problem-solving skills were concrete and practical. For example, when told that all bears in the far north are white, the peasants would not predict what color a particular bear there would be. A typical reply was, "I don't know what color the bears there are; I never saw them" (p. 108). After even minimal schooling, the farm workers, in contrast, could consider this logical problem in the abstract and give an answer based on logic. It should be noted that Vygotsky may have overestimated the concreteness of the peasants' thinking (Cole, 1988). More recent research in traditional societies shows that such groups do think in a logical abstract manner in certain contexts. The schooling and training may simply have taught the peasants to use their abstract thinking in contexts in which they previously did not use it.

A main current discipline associated with the Vygotskian approach is *cultural psychology*. Earlier, cultural psychologists studied culture by comparing cultures and emphasizing differences in behavior between cultures. In fact, the field often was called *cross-cultural psychology*. This approach considered culture to be yet another independent variable that affects individual psychology, the dependent variable. However, from a cultural psychology perspective, this view is problematic. As noted earlier, culture cannot be separated out and treated as an external factor; culture is everywhere, and it is a system of meaning that serves to organize all experience. That is, culture can be studied even within a single culture. Researchers need not only to identify cultural differences in practices (regular, organized activities) but also to understand the processes by which culture permeates all settings; particular cultures are only particular cases of culture. For example, as discussed later in this chapter, parents convey cultural values to their infants by directing their attention to particular aspects of the setting. In the above conversation between mother and child, culture, through the mother, organized the child's experience and nurtured her development. Another difference between the cultural and cross-cultural approaches is that cross-cultural studies tend to take a task or procedure that had been studied in one culture to another culture in order to compare the outcomes: "When inconsistent, they are interpreted as cultural idiosyncrasies of the non-Western children" (Gauvain & Perez, 2015, p. 856). In contrast, cultural psychologists tend to select a task or procedure that makes sense within whatever culture is being studied. In this way, they try to understand a culture on its own terms.

These two approaches have attracted developmentalists because they show that the way of developing in one's own culture is only one of many possible ways to develop. If Piaget surprised us by showing that our thinking is rooted in infant motor behavior and Freud shocked us by showing us our darker unknown side, then sociocultural approaches challenged us by showing that culture permeates every part of our lives.

As noted earlier, the more "distant" levels of culture, such as cultural beliefs about what kinds of skills children should acquire, often reach a child through the immediate social situation in which a child engages in activities with a parent, sibling, or peer who encourages these skills. Vygotsky expressed this process in his most well-known concept within developmental psychology—the *zone of proximal development*, our next topic.

Zone of Proximal Development

Vygotsky defined the zone of proximal (nearby) development as the distance between a child's "actual developmental level as determined by independent problem solving" and the higher level of "potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (1978, p. 86). A more competent person collaborates with a child to help him, through guided practice, move from where he is now to where he can be with help. This more advanced person accomplishes this feat by means of prompts, clues, modeling, explanation, leading questions, discussion, joint participation, encouragement, and control of the child's attention. As Vygotsky explained, "learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers" (1978, p. 90). The more skilled adult or peer builds on the competencies the child already has and presents activities supporting a level of competence slightly beyond where he is now.

One example of the zone is the observation at the start of this chapter in which a mother, helping her child construct a puzzle identical to a completed model, directs his attention to particular puzzle pieces in the model, points to corresponding pieces in his puzzle, and says the names of parts of the puzzle. The mother engages in "building bridges" (Rogoff, 1990, p. 8) between the child's present abilities and new skills. She does this by arranging and structuring his behavior in the task. An example from infancy is that parents draw their infants' attention to important aspects of the environment by carrying them close to, or pointing to, certain objects and events.

Evidence that guided participation through the zone of proximal development can be more beneficial than working on one's own comes from Freund (1990). Children ages 3 and 5 helped a puppet move his furniture into his new house—basically a sorting task in which dollhouse furniture was sorted into a living room, kitchen, and so on. The experimenter told the children to put the objects into the rooms in which they belonged. A child could, for example, place a sofa, chair, small table, and lamp into one room and label it a living room. In the same way, children formed other rooms as well. This procedure assessed how well they could perform on their own—their current level of functioning. Next, half of the children interacted with their mothers on easy and difficult versions of the task. The latter had more rooms and more objects. The experimenter instructed the mothers to help their children but not explicitly teach them. The other half of the children spent this time working on the tasks by themselves rather than with their mothers; the experimenter did, however, give them the correct solution at the end. In a posttest, the children performed a similar task on their own.

The children who had worked on the problem with their mothers performed at a more advanced level on the posttest than the children who had practiced on their own, even though the latter had been given the correct solution by the experimenter. Mothers acted in the way advocated by Vygotsky for optimal movement through the zone of proximal development. In particular, they adjusted their behavior to the child's cognitive level. For example, they gave more specific content (such as "That stove goes in a kitchen") to the 3-year-olds than to the 5-year-olds. Mothers gave the older children more general help such as planning and keeping the goal in mind (e.g., "Let's make the bedroom and then the kitchen"). Mothers' sensitivity to the 3-year-olds' greater potential on the easy task than the hard one led them to give these general prompts to some extent on the easy task. Mothers tended to talk more in the difficult version. Thus, the mothers were giving their children as much responsibility as they thought they could handle, given their age and the difficulty of the particular task. They tried to structure their children's activities so that the children could move through the zone and gradually take on more responsibility for placing the objects. The children also contributed to the exchange by actively attempting to solve the problems and adjusting their behavior in response to feedback.

The zone has an emotional plane as well as an intellectual one. For preschoolers who have trouble regulating their negative emotions (frustration and anger), focusing their attention, and controlling their own behavior, it is especially important to engage in somewhat structured planning activities with their mothers, working together toward some goal (Perez & Gauvain, 2009). Importantly, the better emotional functioning in these goal-oriented collaborations was associated with improved school performance.

Each culture has its own "cultural curriculum" (Rogoff, 1990, p. 190). Children in various cultures learn skills valued by the culture—weaving, hunting, sorcery, healing, reading, taking a bus, or operating computers—by observing others and responding to their informal instruction. For example, a nomadic tribe of magicians and other entertainers in Pakistan highly values the skills of careful observation, refined visual discrimination, sensitivity to the characteristics of other people, and selective attention to the important aspects of a task (Berland, 1982). When adults were tested on a conservation task, if even a single grain of rice spilled out during the pouring or a few drops of water remained in the transfer container, they judged that there now was less. As one adult explained, "When there is little food and many stomachs, our eyes, ears, and noses are more sensitive than goldsmiths' scales" (p. 174). The adults engage in everyday activities with children that encourage these perceptual skills, which are relevant to their nomadic life (for example, acute awareness of surroundings) and magic performances (for example, control of the audience's attention). Thus, adults provide "user-friendly" contexts that help children perfect skills that are needed to survive or succeed in the culture.

Vygotsky described the relation between the actual and the potential levels as follows:

> The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the "buds" or "flowers" of development rather than the "fruits" of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively.
>
> *(1978, pp. 86–87)*

Vygotsky and other socioculturalists believe that development can be understood only by looking directly at the process of change, not at a static child frozen in one developmental moment. In other words, "It is only in movement that a body shows what it is" (Vygotsky, 1978, p. 65). Process is more important than product (for example, correct or incorrect answers). Socioculturalists look directly at a child's series of actions and thoughts as she tries to solve a problem and, in the process, advance her own thinking. Rather than focus on what concepts a child "has," they examine what a child actually does over time when involved in an activity, typically with other people and objects.

The above descriptions of parents teaching in the zone with much verbal interaction and direct instruction is typical of a European-American dyad. The interaction may differ in other cultures, for example, indigenous communities of the Americas (Rogoff, 2014). In such cultures, most of the child's learning takes place through the child watching the mother and other adults doing important daily activities. In Rogoff's (1990; 2014) extension of the notion of the zone to include *guided participation*, children can learn from skilled adults or more competent peers by engaging in everyday activities, practices, and collaborative problem solving—"learning by observing and pitching in" (Rogoff, 2014). Learning is a natural by-product of involvement in these tasks. Any verbal explanation occurs naturally while they are working collaboratively rather than as part of intentional instruction. Interactions in the zone do not have to be verbal, especially those involving infants and young children. Adults guide children's participation in these activities, helping them adapt their knowledge to a new situation and encouraging them to try out their emerging new skills. Children share in the views and values of the more expert partner, offer their own views, and engage "in the process of stretching their concepts to find a common ground" (p. 196).

For example, Mayan girls learn how to weave, an important skill in that culture, by watching their mothers and other adult women weave on a loom. By age 5, they are plaiting long leaves on a play loom fashioned from pieces of thread they find. By age 7, they weave, with help, on real looms, and by age 9, they weave simple items alone (Rogoff, 1990). Rogoff uses the metaphor of apprenticeship. These cultural apprenticeships "provide the beginner with access to both the overt aspects of the skill and the more hidden inner processes of thought" (p. 40). Mayan girls not only learn how to weave, but also to plan the pattern, relate the parts to the whole, and think about the relations between their hands and the thread. Their behaviors resemble "those appropriate for anyone learning in an unfamiliar culture: stay near a trusted guide, watch the guide's activities and get involved in the activities when possible, and attend to any instruction the guide provides" (Rogoff, 1990, p. 17).

Learning within the zone is possible in part because of *intersubjectivity*—shared understanding, based on a common focus of attention and a common goal, between a child and a more competent person. For infants and young children, this person usually is a parent because their frequent experience together builds these shared understandings. For example, in a laboratory classification task, a mother related the task to the kitchen in the child's home: "We're going to organize things by categories. You know, just like we don't put the spoons in the pan drawer and all that stuff" (Rogoff & Gardner, 1984). It is important to note that intersubjectivity not only contributes to learning from social interactions but also results from these interactions. Each builds on, and contributes to, the other throughout development.

Sociocultural psychologists sometimes use the metaphor of "scaffolding." Much as a temporary framework supports workers and materials involved in work on a building, more skilled people temporarily support a child's emerging skills. They structure the interaction and adjust their degree of support according to how much help the child needs. It must be emphasized, however, that the child's behavior affects the adult's behavior as much as the adult's behavior affects the child. Children actively contribute to their own learning in that, motivated to learn, they "invite" the adult to participate, actively construct new knowledge, and gradually take on more responsibility for carrying out the activity. Thus, they "collaborate."

Although the zone usually refers to child–adult or child–skilled-peer interactions, Vygotsky actually had a broader definition in mind. The zone can refer to any situation in which some activity is leading children beyond their current level of functioning. Thus the zone can operate during play, work, school studies, and other activities. Play supports young children's emerging ability to use objects in a symbolic way—to substitute one object for another and thereby separate the object's meaning from the object itself. When children "ride" a stick, they separate the stick from its usual meaning. They can think of a stick as both a stick and a horse. Play creates a zone of proximal development for these children for they can operate at a higher level than is possible in nonplay activities: "In play it is as though he were a head taller than himself" (Vygotsky, 1978, p. 102).

The Sociocultural Origins of Individual Mental Functioning: The Intermental Constructs the Intramental

Children are not expected just to act like others in their cultural community; they are expected to think like them, too.

—*Gauvain & Perez, 2015, p. 863*

What happens to children cognitively when they interact with adults? Vygotsky's answer is that interaction between a child and an adult or older child on the intermental (between-minds) plane becomes internalized into the child's mind, the intramental (within-mind) plane. External interaction becomes internal interaction. In this sense, thinking is always social and reflects the dyad's culture. Culture flows through adults to children. Thinking, remembering, and attending are activities not only of an individual; they first were carried out between individuals. A mental activity "appears twice, or on two planes. . . . It appears first between people as an intermental category, and then within the child as an intramental category" (Vygotsky, 1960, pp. 197–198).

This movement from the intermental to the intramental is related to the first two characteristics described in this section. First, it explains why a child-in-activity-in-context is the smallest possible unit to study. Intramental activity cannot be divorced from intermental activity between children and other people, as in the vignette of the mother and child remembering together. Second, the internalization of social processes occurs during a child's movement through the zone of proximal development. Children eventually internalize the more advanced mode of problem solving that was first supported socially. As Vygotsky expressed it, "Children grow into the intellectual life of those around them" (1978, p. 88). They actively internalize both social nonverbal interaction and the language involved. In a sense, children mentally interact with themselves as they did earlier with other people. Learning to have a conversation with someone else leads to the ability to mentally talk to oneself when thinking through a problem; an external dialogue becomes an internal dialogue. In this way, children gradually take on more and more responsibility for problem solving and become self-regulated rather than other-regulated.

Different types of settings offer different types of interpsychological activities. Teacher–student cognitive activities may be more formal, verbal, and objective than parent–child or older-peer–younger-peer activities. Abstract thinking may emerge from the first, whereas intuitive, concrete thought may be more prevalent in the latter two. Because children encounter a variety of settings, they incorporate a variety of mental processes (Tulviste, 1991).

Both Vygotsky and Piaget emphasized the active internalization of interaction between a child and the world. However, Vygotsky stressed the internalization of patterns of social interaction and languge, whereas Piaget was more interested in the internalization of regularities in the child's motoric interactions with physical objects. For Piaget, for example, physical reversibility, such as crawling from A to B and back to A or pouring liquid from container A to B and back to A, later becomes the important concrete operation of mental reversibility. The process, but not the content, is similar for Vygotsky. For Vygotsky, the structure of conversations becomes the structure of thought. Although Piaget also recognized the influence of other people on a developing child, he did not address the pervasive impact of culture or how a changing society can lead to cognitive change.

Intramental processes and structures do not copy intermental ones perfectly. Rather, intermental processes are transformed during the internalization process. Thus internalization is active, not passive. For example, inner speech, to be described later, is an abbreviated, personal version of external speech. Rogoff emphasizes that children actively constrain what they retain from social exchanges, a process that she calls *appropriation*. During a shared activity a child assimilates (much as Piaget uses the term) certain meaning but not other possible meanings. Rogoff (1990) uses an analogy of the constant exchange of water and air between the body and the environment. Just as bodies filter and transform air and water to meet biological needs, so do our minds actively and selectively assimilate the social activities in our "social sea" to our current needs and abilities. The child learns something and can now better handle another, similar situation.

A child's selective appropriation of a new idea from a social exchange can be seen in the following conversation between a mother (P. Miller) and her (then) 4-year-old daughter:

> M: What do you think you'd like to be when you grow up?
>
> C: A mommy!
>
> M: That's nice . . . but if you want, you can be a mommy and something else.
>
> C: I just want to be a mommy.
>
> M: You know, I'm a mommy and a teacher—two things. You could do that too.
>
> C: I just want to be a mommy.
>
> (This continues for a while until the child concedes—sort of.)
>
> C: Okay . . . I'll be a mommy and a bird!

The child appropriated certain meanings from this conversation and ignored other aspects of the mother's meaning.

Tools Provided by a Culture Mediate Intellectual Functioning

As mentioned earlier, Vygotsky and other Soviet social theorists claimed that humans create themselves (that is, their intellectual functioning) through activity: "Humans master themselves from the outside—through psychological tools" (Vygotsky, 1981, p. 141). Peers and adults assist in this self-shaping process by helping children learn how to use their culture's psychological and technical tools. Psychological tools include language systems, counting systems, writing, diagrams, maps, conventional signs, and works of art. Other examples are various strategies for learning, attending, or memorizing taught in school. Some tools that influence thinking are physical devices such as computers and robots. Tools have ideas and skills built into them. For example, research shows that playing video games sometimes improves cognitive functioning (Best, 2014). People use psychological tools to control thought or behavior, just as they use technical tools such as axes, plows, and bulldozers to control nature.

Each tool involves a different cognitive skill or style. For example, the invention of paper influenced cognition by making the rote memorization of oral texts less important; using computers for writing made it possible to reorganize ideas in a manuscript quickly. We know little about the effects of electronic tools on thinking: Has the Internet altered children's cognitive strategies for seeking information? Does the organization of websites affect children's cognitive maps of domains of knowledge? Are social networking sites changing children's social cognition? It has been argued that new media communication technologies are making children and adolescents more individualistic (Manago, Guan, & Greenfield, 2015).

These examples show that a culture's tools connect children, through their activities, with the physical and social world. A culture creates these tools to help people master the environment, the favored tools are passed on to children during social interchanges, and in turn, the tools shape children's minds. Children use tools to help themselves think; the tools actually transform thought. For example, once children learn to use language to help them remember, the nature of remembering may change to a more verbal form.

Different cultures emphasize different kinds of tools (for example, verbal or nonverbal), skills (reading, mathematics, or spatial memory), and social interaction (formal schooling or informal or formal apprenticeships) because of different cultural needs, values, and resources. Rogoff (1990) noted that in 1744 a group of North American Indians politely declined an invitation from commissioners from Virginia to send boys to William and Mary College. The Indian leaders explained that several of their youths who had been instructed in such institutions returned "ignorant of every means of living in the woods; unable to bear either cold or hunger; knew neither how to build a cabin, take a deer, or kill an enemy . . . neither fit for hunters, warriors, or counselors; they were totally good for nothing" (Drake, 1834, p. 25).

Cultures differ in the type of tools provided by schooling. A culture that emphasizes the memorization of religious texts instills different cognitive skills than a culture with schools stressing conceptual understanding and scientific reasoning. The latter are intellectual skills needed in a highly technological society relying heavily on abstract thinking and communication through books and other symbolic media. Language also may be more necessary for learning in industrialized cultures because children are separated from adults and thus have little opportunity to learn by observing and participating in adult daily activities. In contrast, indigenous cultures may provide opportunities for children to learn nonverbally by simply watching the adults around them—observing their actions, direction of gaze, and facial expressions (Rogoff, 2014).

Verbal tools are not even helpful for some tasks. As an example, Australian aboriginal children of desert origin outperformed European-Australian children at memorizing a visual array (Kearins, 1981). The European-Australian children tried to use verbal mediational strategies, such as rehearsing the names of the items, which were ineffective for this type of task. The aboriginal children were more successful because they used relevant visual strategies, developed to help them find their way around the desert.

For Vygotsky, language is the most important psychological tool for development. It frees us from our immediate perceptual experience and allows us to represent the unseen, the past, and the future. Acquiring language transforms the process of thinking. In Vygotsky's words, "Just as a mold gives shape to a substance, words can shape an activity into a structure" (1978, p. 28). Language goes into the mental underground to direct thinking, control the child's behavior, and organize categories of reality. Again, the intermental becomes intramental. When children use language, they are using a system of meanings constructed by their culture. In this way, they use the lens of their culture to make sense of their experiences.

Language also transforms the way children use technical tools. It reorganizes and controls their behavior with these objects, thus permitting new forms of problem solving. For example, Vygotsky (1978) described Levina's observations of children trying to obtain a piece of candy out of reach in a cupboard. Preschoolers typically first tried to get the candy silently and then began to talk aloud to themselves about the problem. Eventually, the speech became more planful and addressed, for example, the possible usefulness of a stool and a stick. Vygotsky concluded: "Children not only speak about what they are doing; their speech and action are part of one and the same complex psychological function, directed toward the solution of the problem at hand. . . . Children solve practical tasks with the help of their speech, as well as their eyes and hands" (pp. 25–26). Language is a tool and works in conjunction with other tools.

Vygotsky thought the route toward using language as a cognitive tool is as follows: Speech and thought at first are independent. Babbling and other such sounds are speech without thought. Infants' sensorimotor thinking, from Piaget's work, is thought without speech. Vygotsky felt that speech and thought begin to merge at around age 2. At that time, "the knot is tied for the problem of thought and language" (Vygotsky, 1962, p. 43). Children learn that objects have names, and thus they use words as symbols. Next, at about age 3, after children learn to talk, speech between people splits into communicative speech to others and *private speech* (sometimes called "egocentric speech" or "speech for self"). In private speech, children talk aloud to themselves in a running dialogue but use this speech to guide their thinking, to think through a problem and plan their actions. An example mentioned earlier is children talking to themselves while trying to obtain out-of-reach candy. By approximately age 7, private speech becomes *inner speech*. Children now can silently "think in words," though inner speech is more abbreviated, idiosyncratic, and fragmented than spoken language. Just as children earlier used language only to influence others, they later use it in private and inner speech to influence themselves. In this way, internalized language reflects its social origins: "When children find that they are unable to solve a problem . . . instead of appealing to the adult, children appeal to themselves" (Vygotsky, 1978, p. 27). The intermental becomes the intramental; interpersonal communication is internalized into intrapersonal communication.

Note that in form (auditory spoken), private speech is like speech between people. However, in function it is like inner speech because both serve to direct thinking and behavior. Private speech is spoken because children do not yet fully differentiate speech for others (communicative speech) and speech for self. As evidence, Vygotsky observed that children produced less private speech in situations in which communication with others was impossible or difficult (a noisy room, a deaf or foreign-speaking peer, no one present) or undesirable (a stranger present). When children differentiate speech for others and speech for self, private speech becomes inner speech.

Vygotsky found that private speech increased when he made the task more difficult so that children could not solve it with other available tools. Some of Vygotsky's manipulations were to remove paper or a pencil of a needed color before a child began to draw, as seen in the protocol at the beginning of this chapter. With these impediments, private speech nearly doubled among 5- to 7-year-olds (Luria, 1961). Recent research on private speech (Alderson-Day & Fernyhough, 2015; Winsler, Fernyhough, & Montero, 2009) generally supports Vygotsky's predictions that such speech first increases during development and then decreases (as it becomes inner speech), and is much more prevalent when solving difficult tasks. This research also reveals, more specifically, how private and inner speech facilitate executive control of thought, by aiding working memory, shifting from one way of thinking about a problem to another, and inhibiting behaviors that interfere with task performance. Moreover, on some difficult tasks private speech actually continues into adolescence or even adulthood. We might expect to see adults muttering to themselves while filling out income tax forms or assembling a bookshelf.

Although Piaget also studied private speech, he thought it simply reflected the child's egocentric inability to adapt communication to the listener. It has no cognitive use to children. In contrast, Vygotsky thought that such speech helps children direct their problem-solving activities. Another difference is that Piaget thought that private speech just fades away, whereas Vygotsky thought it becomes inner speech. More generally, Piaget and Vygotsky have very different views of the relationship between language and thought. Piaget thought that cognition is prior to, and broader than, language. Children develop through the sensorimotor period before acquiring language, and language is but one expression of the emerging ability to use symbols around 18 to 24 months. In contrast, Vygotsky felt that language and thought begin independently and then partially merge, to the benefit of cognition.

Speech and thought never completely overlap, even in adults. There is always some nonverbal thought, such as that involved in tying one's shoes or playing the piano, and some nonconceptual speech—rote verbalizations such as saying a familiar address. Even when thoughts are expressed in words, they are never the same thing, according to Vygotsky. There is always a hidden subtext in our speech. For example, Vygotsky (1962) described a passage by Dostoevsky in which six drunken workmen conduct a brief, but complex, conversation, though the only word they speak is a single profane word. Depending on the way it was spoken, it indicated contempt, doubt, anger, delight, and so on. The developmental implication is that language acquisition is more than learning language structure and word meanings; it also requires that the child understand intonations of speech and the dynamics of social contexts and infer the mental state (e.g., belief or emotion) of the speaker. Vygotsky was years ahead of his time in this very contemporary-sounding view of language pragmatics and understanding mental states (theory of mind).

Methodology

For Vygotsky, methods must capture the dynamic nature of development and social interaction. He favored a *dynamic assessment* of children's potential developmental levels rather than only a static assessment of their actual levels. He felt that what children can do with the assistance of others (the zone of proximal development) is a better reflection of their intellectual ability than what they can do alone. A child "is" what he "can be." A dynamic assessment directly measures children's readiness or potential for learning rather than the products of previous learning. Standardized intelligence tests assess the latter.

One can assess the zone of proximal development in several ways. For example, an adult might provide an increasingly specific series of clues and determine how many are needed for a child to solve the problem. Using this approach, Ferrara, Brown, and Campione (1986) asked children to pretend they were a spy who wanted to send a message in a secret code. To figure out the code, they had to find the pattern in a series of letters and add the next four letters, for example, "NGOHPIQJ _ _ _ _." The first clue was "Is this problem like any other you've seen before?" A later clue was "Point to the *N* and *O* in the alphabet . . . and to the *G* and *H* . . . . Does that help at all?"

Vygotsky's studies of the zone illustrate his more general method of studying development by looking at change during one or several experimental sessions. This is called the *microgenetic method*, which also is used in contemporary research on cognitive development (see Chapter 7). The researcher studies the *process* of problem solving and tries to capture a "developmental moment." For example, Vygotsky set up obstacles that disrupted routine procedures of problem solving and observed the child's attempts to cope with this change (see the first observation at the beginning of this chapter). Or he provided various materials or tools that could be used for problem solving and then observed how children of different ages selected from, and used, these objects. Because the task typically exceeded children's cognitive level, they must construct a new skill. For example, Vygotsky gave children a task with blocks (now cleverly called "Vygotsky blocks") that could be solved on a nonsymbolic (perceptual, e. g., color) or symbolic (conceptual, i.e., word) basis. By observing children's choice of blocks, response to feedback, and remarks while thinking about the problem, Vygotsky inferred the small cognitive advances emerging during the session as children gradually learned to use the symbolic feature to solve the task.

Contemporary sociocultural research often uses conventional observational methods to study dyads or larger social groups, rather than a child alone. Young children often show greater social cognition in family contexts in their daily lives than they do when tested individually in the laboratory. At home, they effectively use their social intelligence on what matters most to them emotionally—their own rights, needs, and interests. For example, Dunn (1988) described a 24-month-old whose older sister had three imaginary friends—Lilly, Allelujah, and Peepee. The younger child taunted her sibling by announcing that she was Allelujah! This rather advanced understanding of what would upset her sister and the ability to pretend to have a different identity are skills that are more advanced than those usually seen in the laboratory in children this young.

As mentioned earlier, cultural psychologists often compare children in two or more countries or study some cultural difference within one region. As an example of the latter, one could compare children of the same socioeconomic level who attend school and some who do not to clarify the effects of schooling. However, such studies must be interpreted carefully, because unschooled children, who appear to perform poorly, may simply be unfamiliar with the language and procedures of testing—the "rules of the game" of testing. Moreover, a culture's move to formal schooling typically is confounded with other changes, such as a shift away from subsistence agriculture, large families, and sole use of indigenous language. Thus, it is difficult to determine whether cognitive change reflects schooling or other cultural changes.

Researchers also study the effects of societal changes, such as urbanization and globalization, on children. They may compare generations of children over decades or several generations at a single point in time (see the later section on social change). Finally, other sociocultural methods include ethnographies (interpretive descriptions of a culture) and other interpretive methods, often taken from cultural anthropology.

Researchers must be very careful when choosing the methods for assessing abilities in cultures other than their own (for a review, see van de Vijver, 2015). Consider how one might assess whether a person can classify objects in an abstract way, characteristic of adults in literate societies. Cole, Gay, Glick, and Sharp (1971) reported that African Kpelle farmers, when asked to put together the items that go together, sorted 20 objects into functional groups (for example, knife with orange, potato with hoe) rather than into abstract categorical groups (for example, foods, tools). Knife and orange go together, for example, because you cut an orange with a knife. (Such functional groupings are also typical of young children in literate societies.) At one point, the experimenter happened to ask how a fool would do it. The farmers immediately put the foods together, the tools together, and so on, as adults in literate societies would! It should not be concluded that people do not possess a particular cognitive skill when they do not demonstrate it. They may be capable of abstract thinking but simply consider other ways of thinking to be more useful for certain everyday activities. Cultural groups differ in cognitive functioning not so much in what processes they possess as in which settings they use them in—which psychological tool they select from their cognitive toolkit in a particular setting (Wertsch, 1991).

Similarly, the selection of tasks to assess a particular ability, such as intelligence, should reflect the culture's definition of this ability. For instance, adults in a Ugandan village describe an intelligent person as slow and careful, whereas westernized groups emphasize speed of thinking (Wober, 1972). In a number of African communities, intelligence is defined as socially responsible intelligence—perceptive social cognition plus readiness to put this knowledge into action (Super, Harkness, Barry, & Zeitlin, 2011). Such a person would have a sympathetic understanding of the world and an ability to attain social goals. Parents see this intelligence in their children when they carry out their household chores without being told and without supervision. Although Western parents would value this kind of behavior in their children, it likely would be viewed as obedience much more than intelligence.

Mechanisms of Development

Vygotsky focused on change and its mechanisms, more than on the outcome—the child's level of performance. For Vygotsky, development follows a *dialectical process* of thesis (one idea or phenomenon), antithesis (an opposing idea or phenomenon), and synthesis (resolution), which produces a higher-level concept or more advanced functioning. An example is a spontaneous, intuitive concept versus a scientific concept. These opposing elements confront each other, intertwine, and become transformed into a new and higher level. Thus, conflict and its resolution play a major role in development. Vygotsky's dialectical process often occurs when children interact with adults or more advanced peers, play, or use technological and psychological tools.

This idea that there is continual conflict punctuated by momentary stable structures is similar to Piaget's notion of equilibration. However, Piaget did not include a changing society as a possible source of disequilibrium. That is, he saw an active changing organism but a somewhat static environment. Vygotsky, of course, assigned a major role to social forces, such as parental guidance, teacher instruction, and language. Another difference is that Piaget emphasized how a child works out the conflict himself, whereas Vygotsky emphasized the collaboration of people or ideas in this process, perhaps while moving through the zone of proximal development.

Another mechanism of development is the internalization (or appropriation) process, as the intermental becomes intramental. Language (or other cultural tools) and nonverbal learning from observing other people's activities contribute to the process of change. Once inner speech and various skilled activities are acquired, they in turn stimulate more advanced thinking.

Language also is a mechanism by which children can advance their intersubjectivity, which permits further learning. In conversations, children compare their own mental state with that of someone else, detect a discrepancy, and attempt to understand that person's mental state. This is illustrated in the following exchange in which a young girl is trying to understand what her mother has in mind:

> C: 1, 2, 3, 4. (counting the insect's legs)
>
> M: 5. I think he's having a bad day.
>
> C: Because he's, because he's?
>
> M: Because he's missing a leg. He should have six.
>
> *(Ensor & Hughes, 2008, p. 213)*

Position on Developmental Issues

Human Nature

Sociocultural theories obviously fall within the contextualist worldview. Human nature is created in the medium of culture and thus can be understood only in cultural context. Humans are not independent entities that engage their environment; they are part of it—a person-in-context. A child is an active, inherently social organism in a broad system of interacting forces in the past, present, and future. A child's actions occur in the context of others' actions. Children actively seek out, and respond to, a variety of social and physical contexts. These activities in turn change children cognitively, and this subsequently changes the nature of their future activities. Children cognitively transform their social experiences rather than passively internalize them. They contribute to, and select from, their participation in cultural practices and thus transform the interpersonal plane into the intrapersonal plane.

Qualitative Versus Quantitative Development

In Vygotsky's view, development is both quantitative and qualitative, with periods of calm alternating with periods of crisis or "turning points . . . spasmodic and revolutionary changes" (1978, p. 73). In a dialectical process, two elements may develop in a quantitative way, but then, as a result of the process of synthesis, a qualitatively new form emerges. Important examples of qualitative change are the acquisition of inner speech, moving from an intuitive, spontaneous concept to a scientific (logically defined) concept, and progressing from concrete perceptual to abstract categories. During such qualitative changes, the psychological system reorganizes itself.

Although socioculturalists typically do not posit stages of development, they are not opposed to them. Vygotsky and his colleagues did sketch out some possible themes for stages: affiliation (infancy), play (early childhood), learning (middle childhood), peer activity (adolescence), work (adulthood), and theorizing (old age).

Nature Versus Nurture

Although socioculturalists mainly study cultural processes, they see nature and nurture as intertwined. Vygotsky stated that biological and cultural forces "coincide and mingle with one another. . . . The two lines of change interpenetrate one another and essentially form a single line of sociobiological formation of the child's personality" (1960, p. 47). Thus, for socioculturalists, the question is not "how much" culture affects development; rather, the question is, "By what process do biology and culture co-construct development?" New information from neuroscience and genetics (see Chapter 5) documents that the environment (organized by culture) alters brain organization and the expression of genes. In recent years, a new field, *cultural neuroscience* (Chiao, Cheon, Pornpattananangkul, Mrazek, & Blizinsky, 2014), has been documenting differences in brain organization, functioning, and development that result from cultural diversity in experience.

Even biological influences are mediated by culture, as when the impact of a newborn's sex on subsequent development depends on the culture's views about gender roles. Also, cultures can vary in their reactions to an infant's temperament. In many cultures, parents prefer an "easy" baby who is calm, attentive, and easy to care for. However, a study of Brazilians who live a hard life in the harsh environment of the slums found a preference for "fighters":

> I prefer a more active baby, because when they are quick and lively they will never be at a loss of life. The worst temperament in a baby is one that is dull and *morto de esprito* [lifeless], a baby so calm it just sits there without any energy. When they grow up they're good for nothing.
>
> *(Scheper-Hughes, 1987, p. 194)*

Socioculturalists consider certain aspects of nurture as especially important: verbal interaction and collaborative activities with others, formal and informal learning from others, and the use of technical and psychological tools. Vygotsky, of course, also emphasized the sociohistorical forces expressed in the environment, although today little attention is given to these forces. Finally, Vygotsky pointed out that people change their environments to some extent through the use of technical and psychological tools.

What Develops

The Vygotskian view of what develops is very broad, from cultural–historical change to change over one's lifetime to microgenetic moment-to-moment change. An active-child-in-cultural-context is the unit that develops. This unit constructs a variety of cognitive skills, most importantly a system of meaning and its psychological tools—a culturally constructed system of knowledge. Goals, values, and motivation are inseparable from cognitive activity, and thus follow a parallel developmental course. Development has no universal ideal endpoint; what constitutes an ideal endpoint depends on the goals of a particular culture. This contrasts with the way Piaget privileged thinking like a scientist. However both Vygotsky and Piaget favored higher mental functions, particularly abstract concepts.

Applications

Vygotsky's notion of the zone of proximal development has important implications for both assessment and instruction (e.g., Wass & Golding, 2014). Assessments should measure not what children know and understand right now, the typical approach of such tests, but what they *can* know and understand with help. Dynamic assessments often reveal performance gains that are undetected by standard assessments. This is especially true of "underachievers," who do not typically work up to their ability level. To illustrate how dynamic and traditional assessments can lead to different conclusions, Vygotsky presented the following example:

> Imagine that we have examined two children and have determined that the mental age of both is seven years. This means that both children solve tasks accessible to seven-year-olds. However, when we attempt to push these children further in carrying out the tests, there turns out to be an essential difference between them. With the help of leading questions, examples, and demonstrations, one of them easily solves test items taken from two years above the child's level of (actual) development. The other solves test items that are only a half-year above his or her level of (actual) development.
>
> *(1956, pp. 446–448)*

These two children with the same score obviously are not the same cognitively. One can proceed far with help, and thus is said to have a "wide" zone; the other cannot and thus has a "narrow" zone.

Similarly, instruction, whether formal schooling or informal apprenticeships, should be based on children's potential level (their "readiness") more than on their actual level. Specifically, teachers should assign the hardest tasks that students can do with teacher assistance. They should provide only enough assistance to ensure that students can gradually take on more responsibility and eventually complete the task on their own. Teaching and learning are a cooperative, collaborative enterprise, involving a shift from teacher-regulated activity to the student's self-regulation. There are recent attempts to capture these features in computerized instruction. Such programs guide the student's learning, provide feedback, and pace learning activities (De Marsico, Sterbini, & Temperini, 2013).

Teacher-student collaboration and tailoring of instruction to an individual child's potential is difficult to achieve in large classrooms, where teachers often have to spend more time trying to control children's attention, motivation, and learning. A greater focus on teachers controlling the learning process characterizes the instruction traditionally found in Western schools—what Rogoff (2014) calls "Assembly-Line Instruction."

Children also can learn through peer collaborative learning, in which students work together and learn from each other. An increasingly popular form of instruction thought to encourage collaborative learning is called "problem-based learning." A small group of students works together to extend their current knowledge and to apply it to solving a problem. For example, in one study with adolescents (Peace & Kuhn, 2011), a problem involved a letter from the International Institute of Parapsychology to a physics class asking whether electromagnetic theories can support the existence of phantoms in the Matusita House (a Peruvian urban legend). This problem required knowledge about electromagnetic fields and the ability to apply this knowledge to the specific circumstances of the problem. The students together generated solutions and provided empirical and logical support for them, thus solidifying and extending their understanding of physics.

Vygotsky thought schooling was very important because in this way a culture turns children's intuitive, concrete concepts based on everyday experience into formal abstract *scientific concepts* (even though they need not have science content). In contrast, *spontaneous concepts* are intuitive, concrete concepts based on everyday experience. For example "grandmother," as a spontaneous concept, is defined as "She has a soft lap" (Vygotsky, 1978, p. 50). As a scientific concept, "grandmother" is understood as an abstract familial relationship that includes many different specific people, some of whom may not have soft laps. Vygotsky thought that scientific concepts formed one of the most powerful psychological tools developed by modern society. Through language, children enter into this type of thinking with their teachers and subsequently internalize it.

However, "development in children never follows school learning the way a shadow follows the object that casts it" (Vygotsky, 1978, p. 91). Rather, children's minds are "ready" to accept this overlay; abstract thinking simply formalizes their preexisting intuitive concepts from everyday experience. Scientific concepts handed down from above by teachers meet children's intuitive concepts halfway and become intertwined with them. Scientific concepts become more concrete, and spontaneous concepts become more logical and abstract. Vygotsky gave the example that when teachers introduce the abstract concept of social class conflict, children use their concrete personal knowledge ("spontaneous concept") of poor and rich people to assimilate the new concept. As intuitive concepts are transformed into scientific concepts, they are decontextualized—taken from the child's concrete experience into a context-free formal system. Children then use the scientific concepts in a variety of contexts. This "meeting of the minds" that characterizes the interaction between teachers and students during the process of acquiring scientific concepts is yet another example of both the social nature of learning and movement through the zone of proximal development.

Another important message from cultural research for teachers is that in many cultures children are taught behaviors that, in a school or testing setting, would make it appear that they do not know something. Examples are not to talk back to a person of higher status, not to act in a way that would draw attention to themselves, not to initiate a conversation, not to appear to be a fool by giving an obvious answer, and not to produce information that the questioner might not have. Navajo children, for example, tend to pause when they answer a question, which gives a non-Navajo teacher the impression that they have finished their answers. Thus, they often are interrupted before they have finished their answers (White & Tharp, 1988). As another example, children from traditional cultures in Belize, Nepal, Kenya, and Samoa rarely ask "Why?" questions (Gauvain, Munroe, & Beebe, 2013), which might be misinterpreted as a lack of intellectual curiosity.

Evaluation of the Theory

The strengths of the sociocultural approach are widely acknowledged today. Thus, they will be described briefly, and more attention will be paid to weaknesses, particularly limitations, with an eye toward needed future research. The strengths are the theory's attention to the social–cultural context, integration of learning and development, and sensitivity to the diversity of development. Weaknesses include the vagueness of the notion of the zone of proximal development, insufficient attention to issues of development in the zone, difficulties of studying cultural–historical contexts, and failure to provide a legacy of prototypic tasks revealing interesting developmental phenomena.

Strengths

Attention to Social–Cultural Context ▶ Vygotsky is the main developmental theorist to seriously address the broader sociohistorical context of development. He wove together insights from history, sociology, economics, political science, linguistics, biology, art, and literature into psychology. This broader context is not simply another "influence" on children. Rather, it defines children, their activities, and development: Development occurs at the child–society border rather than in the individual child. This notion is very difficult for the Western mind to assimilate. We tend to dichotomize the individual and the external world, including society, and to situate development within the individual. Thus, by "correcting" theories focused on individuals, Vygotsky's view challenges our basic assumptions about psychological development and how to study it.

Vygotsky's theory gives us a different perspective on major developmental milestones. For example, the significance of attachment is that it serves not only to establish a foundation for later social relationships and to develop a sense of trust in others but also to involve infants in shared activities with adults and the cultural practices of society. In this way children acquire language and other cultural tools.

The theory provides a set of theoretical concepts to guide research on developmental mechanisms underlying change: movement through the zone of proximal development, intersubjectivity, and internalization. The next step is to identify the *specific processes* involved in dynamic interchanges between child and culture as they co-construct her development. For example, what happens cognitively moment to moment when a parent and a child have a conversation? Is being able to infer the other person's mental state—her emotions or knowledge—a cause of, or result of, intersubjectivity and internalization? What motivates children to move through the zone?

Integration of Learning and Development ▸ A main theoretical contribution is the account of the relations between development and learning—one of the most important issues of development. Vygotsky argued that learning drives development. As children learn (proceed through the zone of proximal development), they achieve a higher level of development. In turn, children's level of development affects their readiness to learn a new concept. This theoretical focus on change, along with the method of dynamic assessment, makes this a truly developmental theory (but see the section on weaknesses below).

Children learn how to use materials and people in their specific circumstances to obtain goals: "Cognitive development consists of coming to find, understand, and handle particular problems, building on the intellectual tools inherited from previous generations and the social resources provided by other people" (Rogoff, 1990, p. 190).

Sensitivity to Diversity of Development ▸ Most developmental theories focus on universal aspects of development. In contrast, sociocultural psychologists acknowledge both individual differences within a culture, such as wide versus narrow zones, and differences among cultures. This sensitivity to diversity is quite important, because most of the knowledge base of contemporary developmental psychology comes from research on Western (mostly North American) children—the "weirdest people in the world"—white, educated, industrialized, rich, and of democratic origin (Henrich, Heine, & Norenzayan, 2010, p. 61). Yet, this group is a small minority of the world's children. Even in the U.S., as of 2014 only 52 percent of children were non-Hispanic White (Federal Interagency Forum on Child and Family Statistics, 2015), and that percentage continues to decline. For a satisfactory theory of development, it is important to know which developmental findings are universally true and which vary across cultures and subcultures. Shweder et al. (2006) used the phrase "one mind, many mentalities" to express the idea that the mind is both universal and specific to its cultural milieu. Different historical and cultural circumstances may encourage different developmental routes to a developmental endpoint.

Weaknesses

Vagueness of the Notion of the Zone of Proximal Development ▶ There are two main ambiguities or limitations of Vygotsky's concept of the zone (Paris & Cross, 1988). First, knowing only the width of children's zones (how far they can go with help) does not provide an accurate picture of their learning ability, style of learning, and current level of development compared to other children of the same age. For example, children who have narrow zones may have so little inherent learning ability that they are unable to profit from assistance. These children may be functioning at a very low level. Or children with narrow zones may be successful independent learners who nearly have achieved their potential. Consequently, social assistance helps them only slightly. Similarly, low-achieving children who have wide zones may be unable to solve problems independently and so rely on help from adults. Or high-achieving children may have wide zones because they have high learning ability but, due to low motivation or lack of appropriate learning strategies, rely on adults for help. Thus, having a wide zone (or a narrow zone) can be desirable or undesirable, depending on its causes. Moreover, children may appear to have a narrow zone simply because adults have failed to provide appropriate instruction. In short, simply assessing children's zones provides a very incomplete developmental picture.

Second, the zone has problems of measurement. Although the metaphor of a spatial zone implies a metric of distance, there currently is no metric for determining this "distance" (Paris & Cross, 1988).

For example, one child needs help sounding out words during reading, a second child needs help connecting ideas across sentences, while a third only needs encouragement. Even if these children need an equal number of prompts, do they actually have equally wide zones? No common scale exists for answering this question. Vygotsky sometimes measured the zone in terms of age, such as when a child with an actual level of functioning of age 6 and a potential level of functioning of age 9 has a zone of 3 years. Yet this is a very global metric, and it cannot be assumed that the difference of three years between ages 2 and 5 is equal to that between ages 6 and 9.

There are still other issues about the zone notion. One, mentioned earlier, is that the exact psychological processes involved in internalization of the intermental to the intramental (Vygotsky) or appropriation of a shared activity (Rogoff) remain unclear. For example, what sorts of mental representations of social interaction do children form? Also, we know little about the generality and stability of an individual child's zone. Does a child tend to have a wide zone (or a narrow zone) across most domains? Is the size of the zone a stable individual characteristic that is constant over the years? Is improvement resulting from the zone long-lasting? Can it generalize to other similar situations?

Another limitation is that most of our knowledge about the zone concerns mother–child and, to a lesser extent, peer dyads. Do father–child, adult–infant, sibling, and multiperson units operate in the zone in different ways? Also, not all parents are eager and competent guides, and children reared in hostile environments may learn not to seek contexts with adults. Finally, we know little about the role of affect in the zone. Children often have a preexisting emotional (positive or negative) relationship with the people in these contexts that colors the nature of their social interaction. A child asks her mother to show her how to ride a bicycle because she wants to be able to engage in this activity with her friends. Another child is asked by a disliked relative to listen to instructions on using a vacuum cleaner so that she can help clean the house. The nature of learning in the zone will differ in these two cases.

Insufficient Attention to Developmental Issues ▸ Although Vygotskian theory is a quintessential developmental theory, in some ways the approach does not really seem very developmental. As Bronfenbrenner noticed decades ago, "In place of too much research on development 'out of context,' we now have a surfeit of studies on 'context without development" (1986, p. 288). We need a more developmental account of both contexts and children. Regarding contexts, we have little description of contexts of children of various ages or developmental levels, and how that varies, or is the same, across cultures. A culture has different expectations for children of different ages and thus places them in different settings. As children grow older, the culture puts new pressures on children and grants them new social freedoms. Society introduces older children to schooling, work responsibilities, clubs, and organized athletic and social activities. It allows or encourages different activities at different ages.

Similarly, children's abilities, needs, and interests at each age influence the nature of the settings they seek out and the effect that a particular setting has on them. We have little idea how a child's cognitive level both permits and constrains processes in the zone of proximal development. We do know, for example, that among children who cannot count by themselves, 4-year-olds are more likely to shift to counting with their mothers' help than are 2-year-olds (Saxe, Guberman, & Gearhart, 1987). Profiting from hints, modeling, direct instruction, and explanations requires certain developing cognitive skills such as attention, memory for action sequences, mental imagery for comparing the actions of the self and others, verbal encoding, and inference of intentions. Which activities are most effective for learning surely differ for children of different cognitive or social developmental levels. For example, modeling may be a more effective clue than verbal explanation for 4-year-olds because of their limited verbal comprehension. Language development also is important in that children's improved ability to use their own language to regulate their behavior would facilitate moving through the zone (Luria, 1961). Vygotsky suggested that, in addition to emerging speech, mobility after the first few months of life dramatically changes children's potential for social interaction and the kinds of settings they can enter. Thus, Vygotskian theory would be more developmental if we knew more about the impact of developing skills on learning in the zone.

Vygotsky's concept of intersubjectivity has been transformed into a developmental account by Tomasello (2014; see also Chapter 5). He emphasizes the development of shared intentionality, of being able to understand and establish common ground in order to be able to engage in cultural learning. The origins of this ability may lie in infancy, when parent and infant have shared attention on some object. In one account, during development, the main mechanism of cultural learning is imitation, then instruction, then collaboration (Tomasello, Kruger, & Ratner (1991). Children become increasingly able to take the perspective of other people. Nine-month-olds can acquire new behaviors through *imitation* because they understand that people are intentional agents.

They know what goal the other person is trying to achieve through his behavior. Around age 4, children see others as having representations of the situation and try to reconcile it with their own. As a result, they can benefit from *instruction* from others and can internalize the instructions, which is similar to Vygotsky's notion of internalizing dialogue. By age 6, they can engage in *collaboration* with a peer at their level of competence because they can integrate the mental perspectives of two people who can think about each other's thinking. With a peer they co-construct knowledge and internalize the co-construction. In this model, intersubjectivity, because it permits social perspective taking, is central to cultural learning.

The overall point here is that a child's cognitive and physical developmental level influences (1) what contexts a child enters, (2) the nature of the social–cognitive processes involved in the dyadic interaction, (3) the amount, speed, and type of learning in the zone, and (4) the effect of sociohistorical events on the child. Children of different developmental levels bring to a setting different knowledge, motives, reasoning skills, attentional biases, metacognition, social skills, language ability, self-concept, and so on.

Difficulties of Studying Cultural–Historical Contexts ▸ Nearly all developmental psychologists would agree that it is important to examine the social, cultural, and historical contexts of development. Yet few studies do this. Why this discrepancy between attitudes and behavior? A main reason is the practical difficulty of conducting this type of research. Observing parent–child or older peer–younger-peer dyads in action is difficult and time consuming. Investigators must develop a sensible classification system for coding the behaviors, use this system to code the videotaped interactions, establish interrater reliability, and then code all of the tapes. Cross-cultural research often requires expensive travel, extensive learning about the other culture, careful translation of materials, and identification of appropriate testers. And it is difficult to interpret cultural differences in the results because they could be caused by many differences between the cultures. It is even more difficult to study historical influences because the relevant events no longer are occurring. Also, it is difficult to detect which of the many differing aspects of a major historical event, for example, an economic depression, is responsible for the behavior. The links between broad historical–cultural forces, such as class struggles, racial unrest, and marginalization of certain groups, and specific parent–child interactions, in particular, need to be worked out better.

No Legacy of Prototypic Tasks Revealing Interesting Developmental Phenomena ▸ One reason that Piaget's theory stimulated much productive research by others is that he provided several tasks that revealed interesting, even surprising, developmental phenomena. The conservation, object permanence, spatial perspective-taking, and class inclusion tasks come to mind. These served as arenas for fruitful empirical skirmishes for many years. Similarly, information-processing investigators (see Chapter 7) developed problem-solving, attention, and memory tasks; ethology (Chapter 5) had imprinting, attachment, and peer-dominance hierarchies; social learning (Chapter 6) had imitation paradigms; and Gibson (Chapter 8) had the visual cliff and infant locomotor tasks. No such prototypic tasks from sociocultural approaches have caught the imagination of current developmentalists and stimulated an outpouring of research. Vygotsky typically described his tasks and procedures in a very sketchy way and presented little or no data, relying instead on general summaries. His studies were more like pilot studies, or demonstrations used to illustrate what he saw as the basic principles of cognition and development. Given the urgency of his mission and his chronically poor health, he directed his energy toward opening up new lines of research rather than fully examining any one area.

A Related Approach: Developing-Person-In-Context

Closely associated with Vygotsky–sociocultural approaches are *contextual* approaches, which emphasize the settings in which people develop (e.g., Lerner, 2006). Contextualism arose in reaction to the decontextualized, reductionist (nonholistic) laboratory studies of children that dominated the 1960s and 1970s. Like Vygotsky and the sociocultural psychologists, contextualists insist on the situated nature of all behavior and thinking and often study behaviors in everyday contexts. An additional contribution of person-in-context approaches is that they typically describe multiple levels of contexts in which developing children are embedded. Contextualists also examine whether one context supports another. For example, do parents ensure that children do the homework assigned at school? Contextual approaches have extended their inquiry throughout the life course and looked at the links between a changing person and a changing world (Elder, Shanahan, & Jennings, 2015).

Another important notion in person-in-context approaches is the goodness of fit between a child and her context. A particular school may work well for one child but not another. A poor but talented musician is more likely to obtain the needed musical training in a culture that values and supports its musical culture.

The discussion here will focus on one of the most influential contextual models—Urie Bronfenbrenner's *bioecological theory* (Bronfenbrenner & Morris, 2006), earlier called *ecological-systems theory*. The Russian-born Bronfenbrenner created the groundbreaking field of human ecology and was a co-founder of Head Start. He advanced developmental psychology by providing a coherent framework for understanding development in context. He viewed the context of development as a set of nested structures, like nested Russian wooden dolls. Bronfenbrenner posited four levels of contexts that influence children, ranging from the immediate face-to-face interaction with another person, the level "closest" to the child, to very general cultural belief systems, the level "furthest" from the child. By including sociology, anthropology, economics, and political science in these contexts, he built bridges between psychology and these disciplines.

As Bronfenbrenner (1989a, pp. 226-229) described these layers:

1 A *microsystem* is a "pattern of activities, roles, and interpersonal relations experienced by the developing person in a given face-to-face setting." The setting includes (a) particular physical and material features and (b) other people with particular temperaments, personalities, and systems of belief. A child's home, school, and peer group are important microsystems. Transitions from one microsystem to another can be difficult, for example from elementary school to middle school.

2 The *mesosystem* includes "the linkages and processes taking place between two or more settings containing the developing person." For example, we might ask whether the peer group and school system support or contradict the parents' value system. Thus, a mesosystem is a system of microsystems.

3 The *exosystem* "encompasses the linkage and processes taking place between two or more settings, at least one of which does not ordinarily contain the developing person." Events in this system "influence processes within the immediate setting that does contain that person." An example is the relation between the home and the parent's workplace. A stressful work environment may increase a parent's irritability at home, which could lead to child abuse. In this level are the major institutions of society, such as the economic system, transportation system, local government, and mass media. As an example of the latter, watching television may interfere with family interaction.

4 The *macrosystem* "consists of the overarching pattern of micro-, meso- and exosystems characteristic of a given culture, subculture, or other broader social context." Of particular importance are the "belief systems, resources, hazards, life styles, opportunity structures, life course options, and patterns of social interchange that are embedded in each of these systems." The macrosystem is a general cultural "blueprint" that helps design the social structures and activities occurring at lower, more concrete levels. This blueprint influences how parents, teachers, and significant others in the child's life "consciously or unconsciously define the goals, risks, and ways of raising the next generation."

There tends to be consistency among the important settings of a particular culture. Bronfenbrenner pointed out that within a given society, one elementary school classroom looks and operates much like every other. The nature of the prototypic classroom reflects unstated beliefs of the society, for example, an emphasis on individual learning versus collaborative learning, or self-esteem versus group solidarity.

These four levels change over time, as parents and children age, schools incorporate more testing, the economy waxes and wanes, and the population and its belief systems become more diverse. Also, a change in any level causes changes in the other levels. For example, in the macrosystem the Great Depression and World War II (Elder et al., 2015) obviously changed family structure and functioning and thus children, through parents losing their jobs, a decline in family income, loss of parents and siblings in the war, and the entry of women into the labor force. As a contemporary example, the emergence of electronic social networks has changed social interaction in the other levels. Other examples appear in the Social Change section below; modernization and globalization are changing the contexts of development in cultures around the world.

Causality lies in the other direction as well. As children develop in a particular sociohistoric time, they change the contexts at all levels. Moreover, children to some extent select their contexts of development. For example, personal attributes encourage or discourage reactions from other people that facilitate or damage psychological development (see also Bandura's "triadic reciprocal determinism" in Chapter 6). A fussy baby, a scowling preschooler, or a hyperactive school-age child may discourage attention from adults. A happy, smiling baby, an affectionate preschooler, or a good-natured, calm 8-year-old has the opposite effect and thus creates a different environment for herself. She is likely to respond in kind to warm social attention, setting in motion a chain of reciprocal exchanges that chart a course of development for her that is rather different from that of the other kind of child.

Another way in which children shape their contexts is that they display individual differences in their tendency to approach or avoid particular aspects of the social and physical world. Temperamental differences are expressed in social extroversion, shyness (avoiding social stimulation), resistance to changes in the environment, a high activity level, and so on. Consequently, different children seek out different types of contexts and thus engage in somewhat different developmentally relevant activities. One child may prefer to be a "child-in-structured-quiet, two-person context," whereas another may tend to be a "child-in-unpredictable, loud, multiperson context." In this way, different skills and learning styles may develop.

Bronfenbrenner's final accounts (e.g., Bronfenbrenner & Morris, 2006) before his death in 2005 have an even more developmental and interactive flavor. In his bioecological model of a changing organism in a changing environment, Bronfenbrenner emphasized the *processes* by which child and context directly (proximally) affect each other during frequently occurring interactions. These processes are the "engines of development" (p. 825). The specific processes during these interactions between child and other people or objects depends on characteristics of the developing person (such as temperament, abilities, knowledge, and experiences) and of the environment in which the processes are taking place. Each child has a biological potential (the "bio" part of bioecology), whose expression depends on the contexts of the child's development. Taken together, interaction among these forces leads to both stability and change in children and in the contexts in the various levels. Bronfenbrenner was concerned about disruptive changes taking place in contemporary society—youth crime and violence, teenage pregnancy, poor academic performance, dropping out of school, and drugs. Such contexts hinder development. Recent contextualist-oriented work has studied contexts that can promote positive youth development (e.g., Lerner, Lerner, Bowers, & Geldhof, 2015).

Recent contextualist approaches have taken Bronfenbrenner's theory one step further by even more strongly emphasizing the dynamic, interactive nature of development. These systems theories (see Chapter 9) envision a complex system of two-way influences among contexts, and between contexts and children. The various levels of organization, ranging from biology to culture to history, are an integrated system, in which everything influences everything else.

Contemporary Research

Present-day sociocultural psychologists have focused on several research areas with direct ties to Vygotsky: collaborative problem solving, research across cultures, social change, immigrant families, and development through narratives and conversations.

Collaborative Problem Solving

A central idea in Vygotskian and other cultural approaches is that children learn through collaborative problem solving with adults or more advanced peers. Both developmentalists and educators have been particularly interested in this form of learning because collaboration is considered a "21st-century skill" (Dede, 2010), necessary for success today. In contemporary research, small groups of children are usually assigned a problem and asked to work together to find a solution.

Peer collaborations differ from parent–child ones because peers' competencies are more equal. Also, conflict may be more frequent than with a (typically) more patient adult. Experiences within a more equal relationship may provide opportunities to learn how to take the perspective of others and how to resolve conflicts. As in parent–child collaborations, a critical element is shared understanding of what the activity is all about. Researchers have shown cognitive advance through peer collaborations in a variety of countries. For example, collaborative reasoning promoted moral reasoning in Chinese and U.S. fourth- and fifth-graders (Zhang et al., 2013).

The nature of peer collaborations may differ across cultures, even within the U.S. For example, in one study (Budak & Chavajay, 2012), siblings aged 6 to 12 were observed while trying to solve a problem together—putting block connectors together to form a track for marbles. The African-American siblings collaborated more than European-American siblings, who tended to divide up the activities and direct each other when constructing the marble track. Related results were found in a study (Mejía-Arauz, Rogoff, Dexter, & Najafi, 2007) in which triads of school-age children in the U.S. were shown how to make an origami figure by the "Origami Lady" and then were left to work together. Triads of children from indigenous heritage regions of Mexico tended to collaborate with each other, whereas triads of European-heritage children tended to work alone or in dyads. Mexican-heritage triads whose mothers had extensive schooling resembled the European-heritage triads or showed an intermediate pattern. Similarly, Guatemalan-Mayan fathers with little or no schooling encouraged collaborative problem solving in child triads (Chavajay, 2008). Fathers with 12 or more years of education more often encouraged a division of labor, with each child working alone and perhaps occasionally checking in with the others. Fathers with intermediate levels of schooling showed an intermediate pattern. Thus, these studies show that both culture and schooling affect the tendency to collaborate. Western schooling may be changing the collaborative indigenous Mayan families.

Cultures vary in whether children choose to collaborate with parents or peers, which may lead to differences in the relative influence of parents and peers. For example, U.S. adolescents of Chinese, Vietnamese, Filipino, and Mexican descent value discussions with their parents and other relatives when making important decisions more than do adolescents of European descent (Cooper, 1999). This was true even for their degree of comfort with discussing sensitive topics such as sexuality and school performance.

Despite the value of collaboration illustrated in many studies, overall the evidence concerning the benefit of peer collaboration compared to working alone is mixed (Kuhn, 2015). The outcome seems to depend on "who is learning what and under what conditions" (p. 46). The children's ages and mix of abilities, instructions given to the group, and the kind of problem to be solved all seem to be important. As Kuhn notes, some "collaborations" are not true collaborations in which all members work together in a coordinated manner and all members benefit. Rather, sometimes the more knowledgeable members simply transmit their knowledge to the rest. In these cases, the new knowledge may be superficial and transient. In the more successful groups, the children engage each other's thinking in a deep way. Kuhn concludes that one kind of collaborative-learning setting that does have demonstrated cognitive benefits is argumentative discourse between members who have opposing positions. Finally, children may have to be taught how to collaborate: "It is not enough simply to put individuals in a context that allows for collaboration and expect them to engage in it effectively. Intellectual collaboration is a skill, learned through engagement and practice and much trial and error" (p. 51).

Some of the current issues in this area are the following: Do adult–child and peer collaborations differ in their effectiveness and, if so, under what circumstances of age, gender, setting, and expertise? Are the patterns of thinking and talking together and the mechanisms of change different for adult–child, sibling, and peer collaborations? Which specific aspects of collaboration affect which specific aspects of cognitive progress?

Research Across Cultures

Cross-cultural research is one method within cultural psychology. Such research on cultures other than one's own or on several cultures contributes to our understanding of development by identifying what is universal about development, what is culture specific, and what mechanisms mediate the effect of culture on development. In this way, we can see what is "invisible" in our own culture, such as the effects of schooling, because we are so accustomed to its presence. Thus, cross-cultural research prevents us from overgeneralizing our findings and increases our understanding of mechanisms of development.

Since parent–child interaction is a main mechanism by which culture affects development, we begin by sampling research on parent–child interaction. Included in the research are comparisons of two or more countries, or, in a sort of natural experiment, comparisons of immigrant parents in the U.S. with those in their culture of origin and with nonimmigrant parents in the U.S. This latter sort of study identifies changes in parental behavior after entering a new culture and clarifies the mechanisms by which parents transmit culture.

One good example of how cross-cultural research can identify specific cultural practices that lead to particular child behaviors is infant sleeping arrangements. These arrangements are thought to be important because they affect parent–child interaction and influence the development of independence. Many American babies sleep in their own beds and, by the end of infancy, if not sooner, in a different room from the parents. This practice seems wrong and bizarre to adults in many parts of Asia, Africa, and Central America, where children sleep with their parents even when there is plenty of sleeping space for separate sleeping arrangements (Shweder, Balle-Jensen, & Goldstein, 1995). Mayan mothers, for example, expressed pity for babies in the United States when told that they sleep in their own rooms (Morelli, Rogoff, Oppenheim, & Goldsmith, 1992). They consider this practice harmful for the babies. Japanese parents believe that babies are born separate beings who must be taught feelings of interdependence with other people, and sleeping with parents is thought to encourage feelings of closeness and solidarity with others in the family (Caudill & Weinstein, 1969). In contrast, many U.S. parents believe that babies are born dependent and must develop independence; a separate bed is thought to facilitate this. Thus, even very early experiences are organized by culture.

Another way that culture is expressed is in adult–infant interactions that shape infant attention. What a culture (through the parents) encourages infants and children to look at is important, because this affects what information children process and how they learn. Bornstein and his colleagues (i.e., Bornstein, Cote, Haynes, Suwalsky, & Bakeman, 2012) have examined Japanese, American, and Japanese-American immigrant mothers and their 5-month-old infants. This comparison provides interesting information because both Japan and the U.S. are child-oriented modern cultures. They found both universals and culture-specific features in the interactions. In all groups, mothers successfully guided their infants' attention. Moreover, in all groups, mothers and infants were attuned to one another. For example, mothers who encouraged their infants to look at them more had infants who looked at them more. These behaviors were contingent; shortly after a mother encouraged her baby to look at her, the baby did so.

However, one way attention was culture specific concerned nonsocial objects. Only in the European-American sample was there a pattern of mothers encouraging their infants to look at objects, followed by infants doing so. This finding may reflect cultural differences in the value placed on nonsocial objects. Another cultural difference concerned whether the mother or infant tended to initiate episodes of shared attention. Japanese mothers tended to anticipate and direct their infants, perhaps encouraging dependence on the mothers and thus expressing the cultural valuing of harmony and interdependence among people. This behavior blurs the distinction between self and other. In contrast, European-American mothers tended to respond to their infants, perhaps as a way of encouraging infants' independence and sense of personal agency. The fact that the mother–infant interaction patterns of Japanese-Americans in many ways were similar to those of European-Americans suggests that they were beginning to adopt European-American cultural beliefs about childrearing.

When Japanese children enter preschool, this setting continues to instill the value placed on group harmony (Cole, 1992). For example, American educators viewing a videotape of a Japanese preschool were shocked that there were 30 preschoolers and only one teacher. In contrast, Japanese educators viewing the American classroom with only a few students per teacher expressed concern for the children: "There is something kind of sad and lonely about a class that size" and "I wonder how you teach a child to become a member of a group in a class that small" (Tobin, Wu, & Davidson, 1989, p. 38). In the Japanese mind, "A child's humanity is realized most fully not so much in his ability to be independent from the group as [in] his ability to cooperate and feel part of the group" (p. 39). As Markus and Kitayama (1991) observed, in America "the squeaky wheel gets the grease" and in Japan "the nail that stands out gets pounded down."

The differing orientations to one's social group in Eastern and Western children later is seen in their moral reasoning. Fourth- and fifth-graders in China and the U.S. wrote a reflective essay after reading a story involving a moral dilemma (Zhang et al., 2013). Compared to the U.S. children, whose essays focused on self-interest (e.g., protecting themselves), the Chinese children's essays focused on altruistic moral principles of upholding obligations to help friends, keeping promises, and maintaining trust. For example, Chinese children were concerned that not telling on a friend who cheated and lied would encourage him to continue along a negative pathway.

The connections between cultural beliefs and cultural practices affecting children's attention also can be seen in work on other cultures. In one study, children aged 5 to 11 from different cultures varied in how much they learned by observing their sibling being shown how to construct a novel toy, even when not instructed to observe (Correa-Chávez & Rogoff, 2009). Children from Guatemalan-Mayan traditional families (with little maternal exposure to Western schooling) showed more attention to, and learning from, the sibling's learning activity than did children from Guatemalan-Mayan families with extensive exposure to Western schooling or European-American children with extensive family exposure to Western schooling. This learning-by-observation of others, often in a community setting, may indicate the sense of community typically found in these villages. Community members may share in the socialization of the young and even reprimand misbehavior in other people's children. Moreover, the children in these cultures often are encouraged to participate in daily activities within the community in contrast to the segregation of children from community work and social activities in middle-class European-American communities. Children's learning through observing and pitching in, mentioned earlier, involves helping without being asked. In order to detect what kind of help is needed, children show "helpful attention"—being attentive to what is going on in the context in order to detect what kind of help is needed (López, Ruvalcaba, & Rogoff, 2015).

Culture touches concepts even as objective and universal-sounding as mathematics. First, numerical symbol systems differ. For example, the Oksapmin, a remote Papua, New Guinea group, traditionally have used the names of parts of the body for their counting system. Counting begins with the thumb of one hand and progresses through 27 separate locations (each finger, wrist, elbow, shoulder, right ear, right eye, nose, left eye, and so on) to the far side of the other hand (Saxe, 2012). Interestingly, with recent changes in their economic exchange and schooling, this system has been altered in order to solve new kinds of mathematical problems. Thus, a culture adapts to social change by creating new mathematical representations.

Second, the form of mental calculation varies as a function of the culture's symbol system. In many Asian countries, people often use abacuses to solve math problems. At least among older children who achieve expertise, these devices encourage people to solve calculation problems in their head by forming a mental image of the abacus (Stigler, 1984). As evidence, when people in these cultures make an error, it is of the type that would be expected if they were reading off of a mental image rather than the type of error made by people in cultures where the abacus is not used.

Third, cultures vary in the contexts in which children develop mathematical skills. One example comes from Saxe's (1999) research on child candy vendors on the streets of Brazil. These 6- to 15-year-old boys are poor, and many have little or no schooling. Many need the money to help their families survive and may work as many as 14 hours per day and 60 to 70 hours per week. When selling their products, they must very quickly perform various numerical activities—purchase candy in bulk, decide on a sale price per unit that ensures enough markup, negotiate the price (for example, a discount for larger quantities), make change, and so on. Despite their generally disadvantageous childhood environment, they develop impressive mental calculation abilities. They often perform mathematical calculations in their heads, adjust for inflation, and use a complex system to figure out markups. For example, 10-year-old Luciano paid 7,000 cruzeiros at a wholesale store for his 30-unit box of candy bars and must calculate how much to sell the candy for so that he sells it quickly and makes a good profit. This competency is especially remarkable given that, because of inflation, the child vendors have to deal with very large numbers, often in the thousands. They have constructed their own mathematical system and strategies that bear little resemblance to those taught in schools. For example, a child might use a strategy of many-to-one correspondences: setting three bars to one 1,000 cruzeiros bill and then adding together many of these sets. In Vygotskian fashion, older children, storekeepers, or parents serve as social supports for the young vendors by helping them set the markup. Developmental changes in participation in the social practice, such as figuring out markup by oneself, lead to cognitive changes, such as an increasingly abstract and hypothetical selling plan. Interestingly, when researchers ask child street vendors to solve similar math problems, but without the vending context, they perform much more poorly; nonvendors show the opposite pattern (Carraher, Carraher, & Schliemann, 1985).

An example of cultural support for participation in mathematical activities is that Asian children surpass American children in their mathematical prowess (though not in overall intelligence) (National Center for Education Statistics, 2011). This difference is apparent even among 4-year-olds (Paik, van Gelderen, Gonzales, de Jong, & Hayes, 2011). One cause may be that Asian mothers generally attribute mathematical performance to trying hard and not giving up, and they instill these behaviors in their children. This attitude is consistent with their cultural belief in improving oneself through hard work. In contrast, American mothers tend to emphasize inherent ability, an attribution that does not encourage studying hard or trying harder next time if one does poorly on a test (Stevenson, Lee, & Stigler, 1986). Surprisingly, American mothers tend to overestimate their children's abilities and are more satisfied with their children's performance than are Chinese or Japanese mothers. Another cultural influence may be that the Japanese language system encourages attention to the quantitative aspect of reality. Japanese has separate words for counting people; birds; four-legged animals; broad, thin objects such as sheets of paper; and long, thin objects such as sticks. And Japanese mothers encourage even very young children to play counting games, such as "Let's count birds" (Hatano, cited in Siegler, 1998).

Social Change

In our rapidly changing world, can sociocultural research help us understand the effects of cultural change on human development? Although much of the research described in this chapter gives the impression that cultures are static, cultures in fact change, and the world now is undergoing rapid, permanent change. Increased industrialization and communication with other cultures are changing the contexts of childhood. Parents try to raise their children to adapt to the world they will encounter as adults, but during times of rapid change, they can only guess at what that world will look like.

We now turn to two main models concerning the social change occurring in most countries of the world—one from Greenfield (2009; 2015) and the other from Chen (2015). Unlike Vygotsky's focus on cognitive change, these models emphasize changes in social behaviors as well.

Greenfield theorizes that different kinds of behaviors are adaptive in different kinds of societies, and thus children are socialized toward these adaptive behaviors. In her model, demographic shifts change cultural values and learning environments, which in turn shift developmental pathways. Many countries currently are moving from rural living, informal education at home, subsistence economy, poverty, ethnic and cultural homogeneity, and low-technology environments to urban living, formal schooling, commerce-based affluence, ethnic and cultural diversity, and high-technology environments. This change is shifting cultural values toward individualism (Zeng & Greenfield, 2015), egalitarianism (e.g., attitudes about gender roles, Manago, 2015), and relativism.

Individualism changes children's learning environment inside and outside the home. Children adapt to these new social values as they are socialized toward greater independence (for example, less body contact and more face-to-face contact during infancy), competition, and more abstract cognition (especially through formal schooling) (Maynard, Greenfield, & Childs, 2015). Children's relationships are shifting from being lifelong, with kin or neighbors who spend their entire life in the same community, to more fleeting relationships, often with nonrelatives, peers (more than multiage relationships), and strangers (such as store clerks). Exposure to others' perspectives, perhaps in part through books and other media, may change cognition in the direction of increased perspective taking (Gauvain & Munroe, 2014). Among four cultures, the most industrialized, the Samoans, outperformed children in Belize, Kenya, and Nepal on perspective taking tasks. Children also are shifting toward fewer opportunities to observe and thus learn from adult activities in the family and community as more adults work away from home.

As families become smaller, there is less need for children to care for their younger siblings, and families become more child centered, with possible effects on children's self-concept. Mothers in the United States perceive children's self-esteem to be much more important than do grandmothers, and in Taiwan, only half of the grandmothers were even familiar with the concept of self-esteem, though most of the mothers were, thus showing generational change (Cho, Sandel, Miller, & Wang, 2005).

This pattern of social change involves the movement from collectivism to individualism. Collectivism facilitates the socialization of compliant–cooperative behaviors and forms of thinking that are bound to a particular context. In contrast, individualism encourages independent behavior and valuing of more abstract cognition. Garcia, Rivera, and Greenfield (2015) studied three sites in Mexico undergoing social change. Over several recent decades, the children showed increased competition and decreased cooperation when playing a game. Also, individualism has increased in recent decades in China, as seen in changing frequencies of Chinese words indexing individualistic or collectivistic values in digitalized books (Zeng & Greenfield, 2015).

Greenfield has found that the most rapidly changing facet of a culture tends to exert the main influence. For instance, over four decades in a Mexican Maya community, more children are approaching visual problem solving in an abstract way and have shown greater understanding of novel stimuli (Maynard et al., 2015). However, in the first two decades, participation in commercial activity drove this change, whereas in the second two decades, formal education was more influential. This shift reflected first the transition from subsistence to commerce, followed by the expansion of formal schooling.

Chen's (2015) *pluralist–constructive* model proposes that immigration, advances in information technology, and interaction among political, economic, and cultural systems across regions have resulted in diverse values, beliefs, and lifestyles today. Individual adaptation to social change often involves the coexistence, and even integration, of these diverse values and practices. Chen sees this as a positive development, for it helps children develop flexibility in adapting to different circumstances. Individualism helps them achieve personal goals, and collectivism helps them develop social support systems, both so important for psychological well-being. Both one's own interests and group harmony can be goals. Children exposed to both collectivism and individualism ideally will develop both the ability to work alone and with others. Although it often is claimed that collectivist societies become more individualistic during globalization, Chen argues that, in addition, individualistic societies become more inclusive, more accepting of differences. In these ways, both kinds of cultural systems profit from these social changes. Thus, as societies change, cultural values change. These are translated into changes in the contexts in which children develop socially and cognitively.

Immigrant Families

The number of immigrant families has rapidly increased and is now a quarter of U.S. families (Child Trends, 2015). This increase has created the opportunity to study the process of development in the context of adapting to a new culture. Looking at how children, adolescents, and their families rise to the challenge of cultural adaptation also has made it possible to expand and clarify our understanding of developmental and family processes by studying, for example, socialization processes.

Such research can reveal new mechanisms of development or show that the same child or parent behaviors have different meanings in different cultures. We now turn to several examples of these contributions.

In Chapter 3, research showed that adolescents in immigrant families face challenges in forming an identity that integrates their old and new cultures. Here we consider that the meeting of two cultures in immigrant families can affect family dynamics, as well as show links between family conflicts and mental, physical, and educational outcomes. For example, Chinese-American adolescents and their parents have everyday conflicts about both seemingly minor issues and acculturation-based conflicts (Juang, Syed, & Cookston, 2012). The fact that these two types of conflict are correlated and have similar developmental trajectories suggests that they are related. That is, in immigrant families, everyday conflicts may actually reflect larger issues involving conflicting cultural values and beliefs. Moreover, these conflicts were associated with poor psychological adjustment (though the specific pattern of predictions varied for the two types of conflict).

A two-year longitudinal study (Juang & Cookston, 2009) showed changes in family dynamics in Chinese-American families, a culture wherein fulfilling family obligations is expected and valued. Adolescents with high levels of family obligation were more protected against later depression than those with low levels. Thus, assimilation to the majority culture in the United States was not advantageous in this respect. Moreover, adolescents showing increasing family obligation behaviors over the two-year period also showed fewer depressive symptoms. Interestingly, Chinese-Americans born in the United States rather than in China held the family obligation value less strongly, a sign of a shift away from Chinese culture to that of the United States, which values autonomy. Overall, family obligation decreased over time, but only with regard to behaviors—not attitudes—which suggests that it is important to consider both attitudes and behaviors when looking at culture-related developmental change; immigrant adolescents may continue to endorse traditional cultural values, even if not behaviors, in a new culture.

The outcomes for children in immigrant families sometimes are negative, but there is some evidence that immigrant children actually are doing better than children of native-born parents (Marks, Ejesi, & Garcia Coll, 2014). Also, interesting recent work shows that bilingualism—a characteristic that often goes along with being a child in an immigrant family—often is associated with superior control of one's cognitive functioning (e.g., Bialystok, 2015). The now large body of research on immigrant families has shown that any theorizing about immigrant families and developmental outcomes must consider many accompanying variables that are as important as, or more important than, immigration per se (Crosnoe & Fuligni, 2012). Variables critical to child outcomes are parents' education before migrating, child's birth before versus after the family's immigration to the U.S., the age at which the mother came to the U.S., the part of the U.S. to which the family immigrated, gender, and immigrant status (documented versus not).

Parents from different cultures or subcultures vary in how they attempt to instill values in their children. One particularly compelling case concerns Baumrind's (e.g., 1973) often-cited research demonstrating the superiority of the authoritative pattern of child rearing (a combination of firmness and support) over highly controlling or permissive patterns for increasing achievement and independence in children. This conclusion was questioned by the later finding (Dornbusch, Ritter, Leiderman, Roberts, & Fraleigh, 1987) that this result more accurately describes European-Americans than African-Americans, Asian-Americans, or Hispanics. For example, the Asian-American parents were high on control, but their children generally received high grades in school. And controlling parents were associated with low grades among Hispanic girls but not boys. Thus, the same parental behaviors may have different meaning in different cultures. Parental control may be interpreted as negative in one culture and as caring in another.

Development Through Narratives and Conversations

Probably all cultures use narratives, or stories, for organizing experience over time, interpreting human action, maintaining social relationships, and preserving culture. Through narratives, people and culture construct each other. People's stories contribute to the culture, and the culture helps people make sense of their experiences and their life. Narratives provide a way to pass on the culture; thus, they contribute to children's socialization and their development into members of their cultures. As a device for socialization, these cultural practices maintain the moral system of the culture. These myths and moral tales communicate "lessons" about cultural beliefs and practices.

Cultural themes are expressed not only in narratives shared by the entire culture but also in "family stories"—personal narratives within families. Research comparing middle-class Chinese families in Taipei, Taiwan, and middle-class European-American families in Chicago (Miller, Fung, Lin, Chen, & Boldt, 2012) provides an example of how cultures use such stories for different purposes. Chinese families used family stories about their children as an opportunity to teach moral lessons. Chinese families were more likely than the ones in Chicago to tell stories about the child's past misbehaviors and to weave into the stories moral and social rules about these transgressions. These children then developed the ability to initiate stories on moral topics and reason in complex ways about their past transgressions. They also learned to listen well to stories told by their parents, perhaps in part because listening is a way to show respect and affection for their parents as moral authorities.

In contrast, European-American families used stories to focus on their child's strengths. When these families did construct stories about the child's misdeeds, they tended to downplay this aspect of the story. The Chinese parents may have been operating within a Confucian emphasis on teaching, strict discipline, social obligations, self-improvement, and the value of feeling shame, whereas the American parents may have been more concerned with the child's self-esteem. Thus, cultures select differently from the past when constructing personal narratives and, consequently, children learn what experiences are important and how they should assess them as well as construct their identities as members of their families and societies and as individuals. This research provides yet another example of how looking at cultures other than European-American ones modifies our theories about the mechanisms by which children are socialized.

The telling of stories also is culturally constructed in that this activity is embedded in cultural beliefs about gender (Fivush & Zaman, 2015). Parents are more elaborative and emotionally expressive when reminiscing about the past with daughters than sons. This leads to girls gradually developing more elaborative and emotionally expressive personal narratives compared to boys. Girls also seem to situate their identities within family stories more than do boys. Moreover, when parents tell their children stories about their own childhoods, these narratives about mothers also are more elaborative and emotionally expressive than those about fathers. This research is a good example of the implicit nature of most of parental teaching about culture.

Thus, the social uses of language help children move from the private world of infancy to the "community of minds" of their culture (Nelson, 2008). Much of development involves "meaning making" as children try to make sense of their experiences and, through language, share these meanings with others in conversations and stories. They form social connections with other people and draw on these social guides to aid their making sense of the world. This metaphor of the child as sense-maker and a member of a community of minds contrasts with Piaget's metaphor of the child as miniature scientist.

Concluding Comments About Contemporary Vygotskian–Sociocultural Research

Finally, we look at two contemporary themes about Vygotskian–sociocultural developmental approaches. One theme concerns the assimilation of Vygotsky's theory into contemporary developmental theorizing. The question is "How much of contemporary 'Vygotskian' research is actually Vygotskian?" A second theme concerns several current trends in developmental cultural psychology research and theorizing.

Assimilation of Vygotsky's Theory into Contemporary Developmental Theories ▸ The assimilation of Vygotsky's theory into contemporary work on developmental psychology provides an interesting case study of how any discipline incorporates a theory from another time and place. The assimilation usually is selective and distorted in some way—much like the distortion that occurs when people assimilate, in the Piagetian sense, something into their current mental structure. In the case of Vygotsky, something is lost in the translation, so to speak. What contemporary developmental psychology needed from Vygotsky was a sensitivity to the social and cultural context of development and a way to conceptualize the cultural origins of a developing mind. And that is what we took, as seen in the studies in this chapter on the zone, guided participation, intersubjectivity, internalization, and cultural tools. In this sense, there now have been numerous Vygotskian studies. However, certain main aspects of Vygotsky's theory do not fare as well in the Western individual-oriented worldview and so have been relatively ignored. Specifically, much current sociocultural research looks at how sociocultural settings influence behavior, how cultural differences lead to psychological differences, and how a child's performance shifts from setting to setting. Few studies start with the child-in-context as the basic unit, as noted earlier. The social context is grafted on to individual development, rather than considered an inherent part of it.

Moreover, the notion of the zone of proximal development has been plucked out of its social–political context. Vygotsky saw interactive learning processes in the zone as an expression of collectivism; society shares its mental skills during "shared consciousness" much as it shares its material goods. In contrast, current Vygotskian research still conveys the impression that an individual child's cognitive development is guided by an individual adult rather than by society in general as a shared endeavor.

Finally, many recent studies of the zone that are presented as Vygotskian-inspired are little more than traditional studies of mother–child interaction in learning situations and do not incorporate the principles that distinguish Vygotskian studies from any study of adult–child interaction. Researchers still view cognition as something that happens inside a child's head—an adult simply helps put it there. Truly Vygotskian studies must (1) look at both adult and child behavior, at their shared understanding, and at how each adjusts to the previous response of the other, (2) assess what a child can do both alone and with an adult's help, and (3) look at the gradual shift in responsibility from adult to child over the course of the session. Such studies must also (4) assess how the adult structures the learning process, tries to pull the child to a slightly higher cognitive level, relates the problem to the child's previous experience, and adjusts the amount of help to the difficulty of the task, and (5) examine how the culture and its history shape the nature of the parent–child interaction. Very few studies include all five aspects.

It is not necessarily wrong to selectively assimilate a theory. Scientific progress often comes from taking only what is most useful from a theory. But it should be recognized that Vygotsky's theory is more often appropriated than internalized.

Current Trends in Cultural Psychology Research ▸ Because culture is such an umbrella term, researchers have tried to identify more specific dimensions. One example is the contrast between individualistic cultures and collectivist ones. However, this dimension does not capture the heterogeneity within each type of culture. As we become more familiar with cultures around the world, we become more aware of their subcultures and the subtle differences among them. Overly general terms, such as "Hispanic," mask major differences among peoples from countries such as Mexico, Cuba, Puerto Rico, Costa Rica, and Colombia. Even within a country, especially large ones, there can be diverse subcultures. An example of a within-country difference is that preschoolers in two quite different regions of China (Beijing and Chengdu) follow a different sequence of theory-of-mind development (Duh, Paik, Miller, & Gluck, 2015). Preschoolers in the traditional Chengdu region were more advanced than Beijing or U.S. children in understanding hidden emotions. Similarly, an adequate cultural account of development must attend to intersections of culture with factors such as gender and social class. For example, for young Latino immigrants in the U.S., transition to a new culture may differ for females and males, and for lower-income and middle-income families. Moreover, these patterns may vary as a function of age.

One solution to this dilemma of how to capture the diversity within what from the outside might be seen as a single culture is the "cultural practice" approach (Rogoff, Najafi, & Mejía-Arauz, 2014). This approach asks what people *do*—the cultural practices in which they participate—rather than what people *are* (e.g., Chinese)—the "categorical box" approach focused on language or country. Any community has a constellation of social practices, which show connections among occupations, schooling, family size, urban versus rural residence, indigenous versus modern birthing and spiritual practices, and modes of learning (e.g., by observing and pitching in, described earlier). Although communities derived from the same cultural group historically may even live in the same city, their differing histories of cultural practices can lead to quite different constellations of cultural practices. For example, in Guadalajara, Mexico, among three communities with historical connections to indigenous communities who from the outside "are" indigenous, there is wide variation in what they "do," their pattern of cultural practices involving schooling, religious festivals, and specific indigenous practices, such as burying a baby's umbilical cord (Rogoff et al., 2014). A group that has experienced cultural change may show interesting transitional practices, such as keeping the umbilical cord without knowing why or not burying it. An individual thus may participate in two communities of practices—indigenous and cosmopolitan—and the practices may be similar, complementary, or conflicting. This cultural-practices approach provides a way to study both stability and change over generations as communities are touched by industrialization and technology or families emigrate. Families immigrating to the U.S. may use a combination of their culture of origin, for example, learning by observing and "pitching in," and more Westernized socialization practices. Thus, social change within a nation or participation in two cultures after immigration can be studied by looking at changing constellations of cultural practices.

The field appears to be in transition toward a truly cultural approach. For many years, culture has been considered an "add on" to descriptions of what was considered "normal" or typical development (usually from studies of white middle-class children). However, this approach has been challenged, because all children have a culture, and focusing on one particular group provides only one particular view of development and thus should not be considered the norm by which to compare other cultures. Thus, the field is starting to construct a broad developmental perspective that starts with cultural diversity rather than ends with it. That is, the new view is that any aspect of development can be understood fully only by studying it in its various cultural contexts; the behavior of children in different cultural settings must be fully interwoven throughout developmental science. Culture is not something separate that we study. Also, studying a culture other than one's own has suggested previously unstudied mechanisms of development that will lead to more complete theories of development.

SUMMARY

Developmental sociocultural approaches have many roots, but Vygotsky was the main historical force. Vygotsky's theory has impacted developmental research by directing attention to the cultural origins of thinking and, more generally, stimulating researchers to consider the historical–cultural context of development. Unlike most theories, the sociocultural approach focuses on the child-in-activity-in-cultural-context, rather than on the child alone. Thinking is inherently social; children use cultural tools, such as symbol systems, to solve problems in their everyday attempts to meet their goals within a social reality. Culture constructs settings and shapes the interactions of people in them. A child's participation in various cultural routines nurtures particular ways of thinking. Cultural beliefs, knowledge, values, artifacts, and physical settings influence what settings children are encouraged to enter and when they can enter them, what they learn in these settings, how they acquire skills, and who can enter particular settings. Thus, sociocultural approaches force researchers to reexamine dichotomies such as culture versus mind, thought versus action, and person versus context.

Children develop in a zone of proximal development—the distance between what a child can do without help and what he can do with help. A more skilled person uses prompts, discussion, modeling, explanation, and so on to guide and collaborate with children to move them through the zone. Because the child and a familiar adult share a past and have a common goal in the task, they have a shared understanding of the problem. Children actively contribute to their movement through the zone by seeking out particular settings, influencing the course of the activity, and bringing personal qualities and developmental skills to the interaction. Vygotsky argued that only by looking directly at moment-to-moment change over time can we understand development; intelligence is not what you know but what you can learn with help. Thus, only a dynamic assessment of a child's potential level of development, rather than a static assessment of the current level, gives an accurate picture of the child's ability.

As children engage in activities with others, intermental activities, particularly dialogue, become intramental. In this way, individual mental functioning has sociocultural origins. Language between people eventually becomes spoken speech for self (private speech) and then silent, mental, speechlike inner speech. Children internalize (Vygotsky) or appropriate (Rogoff) information and ways of thinking from their activities with parents, teachers, other adults, and more skilled peers. Technical and psychological tools provided by the culture mediate intellectual functioning. Language, in particular, helps children direct their own thinking efficiently; they plan, think logically, and form abstract concepts. However, nonverbal interaction with others encourages cognitive skills as well.

The microgenetic method involves an analysis of moment-to-moment changes as a child moves through the zone of proximal development. For Vygotsky, the most general mechanism of development is the dialectical process in which two contradictory ideas or phenomena are synthesized into a new idea or phenomenon. The dialectical process operates mainly during interaction with adults, more skilled peers, or peers of equal ability, and during play. Movement through the zone is a dialectical process as the child collaborates with another person and they co-construct the meaning of the task, a goal, and a solution.

Regarding the theory's position on developmental issues, it holds a contextualist view of human nature; human nature develops in a social context. The temporal dimension (past, present, and future) is cross-woven with the spatial dimension (social settings). Development is both quantitative and, when synthesis results during the dialectical process, qualitative. Nature and nurture also enter into a dialectical process, but socioculturalists focus on the social strands of this process. Finally, what develops is an active-child-in-context.

Regarding applications, Vygotsky wrote about learning in the classroom and about children with special needs. More recent applications focus on collaborative peer learning and the zone of proximal development. The strengths of the sociocultural approach are its attention to the social–cultural context of development, integration of learning and development, and attention to the diversity of development. Weaknesses are the vagueness (or limitations) of the notion of the zone of proximal development, insufficient attention to setting and child-developmental aspects of the zone of proximal development, the difficulties of studying cultural–historical contexts, and the failure to provide prototypic tasks revealing interesting developmental phenomena. The developing person-in-context approach, associated with Vygotskian and sociocultural theories and exemplified by Bronfenbrenner, embeds development within a social ecology consisting of various levels from near to far. Sociohistorical events, such as the Great Depression, provide contexts that shape development, but children are active participants in these contexts as well.

Current Vygotskian–sociocultural research focuses on collaborative problem solving, developmental processes in various cultures or during times of cultural change, immigrant families, and acculturation through narratives and conversation. Although sociocultural theory has stimulated research on sociocultural influences, few studies have incorporated the aspects of the theory that do not fit easily into the contemporary Western cultural belief system. Vygotsky's theory is important for understanding development in our rapidly changing global, multicultural world. The field of developmental psychology is advancing toward a perspective in which specific dimensions of cultural diversity are identified and cultural processes are fully integrated into any account of development.

SUGGESTED READINGS

The following two books by Vygotsky provide a good introduction to his theory:

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language*. Cambridge, MA: MIT Press.

Vygotsky's works have been collected into a series:

Rieber, R. W. (Ed.). (1987–1999). *The collected works of L. S. Vygotsky* (Vols. 1–6). New York: Plenum Press.

Rieber, R. W., et al. (Eds.). (2004). *The essential Vygotsky*. New York: Kluwer Academic/Plenum Publishers. This is a "Vygotsky sampler" of his most important and interesting contributions from the above six volumes.

The following provides a useful overview of culture and cognitive development:

Gauvain, M., & Perez, S. (2015). Cognitive development and culture. In R. M. Lerner (Series Ed.) & L. S. Liben & U. Müller (Eds.), *Handbook of child psychology and developmental science: Vol. 2. Cognitive processes* (7th ed., pp. 854–896). New York: Wiley.

This study of a Mayan midwife illustrates how cultural practices are preserved yet modified during social change.

Rogoff, B. (2011). *Developing destinies: A Mayan midwife and town*. New York: Oxford University Press.

CHAPTER 5

Biological Approaches: Ethology, Developmental Neuroscience, Genetics

At the beginning of these experiments, I had sat myself down in the grass amongst the ducklings and, in order to make them follow me, had dragged myself, sitting, away from them. . . . The ducklings, in contrast to the greylag goslings, were most demanding charges, for, imagine a two-hour walk with such children—all the time squatting low and quacking without interruption! In the interests of science I submitted myself literally for hours on end to this ordeal.

—*Lorenz, 1952, p. 42*

The initial phase, that of protest, may begin immediately or may be delayed; it lasts from a few hours to a week or more. During it the young child appears acutely distressed at having lost his mother and seeks to recapture her by the full exercise of his limited resources. He will often cry loudly, shake his cot, throw himself about, and look eagerly towards any sight or sound which might prove to be his missing mother. . . . During the phase of despair, which succeeds protest, the child's preoccupation with his missing mother is still evident, though his behavior suggests increasing hopelessness. The active physical movements diminish or come to an end, and he may cry monotonously or intermittently. He is withdrawn and inactive, makes no demands on people in the environment, and appears to be in a state of deep mourning.

—*Bowlby, 1969, p. 27*

Adenine-Thymine
Guanine-Cytosine
Adenine-Thymine
Cytosine-Guanine

—*Genetic Code*

Developmental psychologists have not taken Shakespeare's advice, "Neither a borrower nor a lender be." Some of the most fruitful ideas about development have been borrowed from other areas of psychology and even other sciences. Developmental psychology has borrowed heavily from biology for clues about where to look for connections between body and mind and behavior. In this chapter, we look at several biological perspectives on development that are heavily influencing developmental psychology—ethological theory (including evolutionary psychology), developmental neuroscience, and genetics.

We focus on ethology because of its long history of contributions to developmental psychology, especially infants' attachment to their parents, but give careful attention to recent major contributions from the other two areas. Developmental neuroscience and genetics probably are the fastest-growing areas within developmental psychology currently and are changing the way developmentalists think about how nature and nurture co-construct development. Much of the progress is due to new tools for imaging the brain and analyzing genes, but also to new theoretical models that capture the complex interactions of various levels of biology, from cells to brain organization to behavior (and back again).

This chapter first describes ethology, including evolutionary psychology. Next is an account of developmental neuroscience, followed by genetics. The chapter ends with models that integrate genes, brain, and experience.

Ethology

Ethology is the study of the evolutionarily significant behaviors of a species in its natural surroundings. As a subdiscipline of zoology, it looks at the biological and evolutionary blueprints for animal behavior. Ethology places humans into a broad context: the animal world and our distant past. It is humbling to contemplate the fact that there are more species of insects in a square kilometer of Brazilian forest than there are species of primates in the world (Wilson, 1975). The English geneticist Haldane, when asked about the nature of God, is said to have remarked that he displays "an inordinate fondness for beetles" (as quoted in Hutchinson, 1959, p. 146). The human species is just one small part of the huge, evolving animal kingdom of approximately 3 million to 10 million species.

This section on ethology begins with a history followed by a general orientation. Then come sections on the main contributions of ethology to developmental psychology, mechanisms of development, the theory's position on developmental issues, applications, an evaluation, and contemporary research.

History of the Theory

Whoever achieves understanding of the baboon will do more for metaphysics than Locke did, which is to say he will do more for philosophy in general, including the problem of knowledge.

—Charles Darwin

Ethology is linked to the German zoologists of the 1800s who studied innate behaviors scientifically. Darwin's painstaking observations of fossils and variations in plant and animal life added an evolutionary perspective to the field. He, along with Alfred Wallace, concluded that nature ruthlessly selects certain characteristics because they lead to survival: "What a book a devil's chaplain might write on the clumsy, wasteful, blundering, low, and horribly cruel works of nature" (Darwin, quoted in Shapley, Rapport, & Wright, 1965, p. 446). As a result of this selective force, species changed and sometimes differentiated into subspecies. Thus, many animals, including humans, are related through common ancestors. Darwin proposed that intelligence and other behaviors, as well as physical structures, were products of evolution. If they increased the chances of survival to the age of reproduction, they were retained; if they did not, they disappeared. Darwin's claim of a common ancestry of humans and other primates was not received well in Victorian England: Montagu (1973) related an anecdote about a shocked wife of an English bishop. She said that she certainly hoped that the theory was false, but if it were true, that not many people would find out about it!

Darwin's careful observing and cataloging of plants and animals was imitated by ethologists years later. Just as he carefully described animal and plant life, Darwin also described his own infants' behavior, as in the following excerpt on fears:

> Before the present one was 4 months old I had been accustomed to make close to him many strange and loud noises, which were all taken as excellent jokes, but at this period I one day made a loud snoring noise which I had never done before; he instantly looked grave and then burst out crying. . . . May we not suspect that the vague but very real fears of children, which are quite independent of experience, are the inherited effects of real dangers and abject superstitions during ancient savage times?
>
> *(1877, p. 289)*

Ethology as a distinct discipline began in the 1930s with the European zoologists Konrad Lorenz and Niko Tinbergen. They developed, often in collaboration, many of the key concepts discussed in the next section. Their observations of species as diverse as ducklings, butterflies, and stickleback fish gave scientific meaning to the sometimes mystical term "instinct." Many of Lorenz's observations were of wild animals that wandered freely in and around his home. Lorenz and Tinbergen's work was honored with the Nobel Prize in medicine or physiology in 1973, which they shared with another ethologist, Karl von Frisch.

Developmental psychology was receptive to ethology because developmentalists have a tradition of naturalistic observations of children and consideration of the biological basis of development. Many developmentalists continued to conduct natural observations of children even through psychology's behaviorist years and welcomed ethology as a way to correct the extreme environmentalism of learning theory. The most important figure to bring ethology to the attention of developmental psychologists was John Bowlby. His turning from a Freudian to an ethological account of infant–caretaker social attachment in the 1950s in England laid the groundwork for subsequent research in this area in both Europe and North America. (His work is described later.)

The contemporary study of animal behavior has many subfields, such as comparative psychology, behavioral ecology, and evolutionary biology. In general, this work is more empirical and experimental and less observational, speculative, and theoretical than the earlier European classical ethological studies. The majority of the approaches favor a reductionist approach and study cells, neural connections, and hormones rather than the behaviors of the whole organism in its ecological niche.

Ethology was soon joined by *sociobiology*, defined by its main spokesman, E. O. Wilson, as the "study of the biological basis of all social behavior" (1975, p. 4). Although ethology and sociobiology overlap a great deal, sociobiology focuses on population genetics and kin selection. Because close relatives share most of one's genes, people can pass on their genes not only by reproducing but also by furthering the survival of the genes of kin through altruistic behavior. Altruistic behavior may endanger oneself but benefit the species. Sociobiology minimally influenced developmental psychology, though there was some interest in such topics as reproductive patterns and parenting.

Evolutionary psychology, which arose after some of the criticisms of sociobiology as deterministic, reductionist, and socially conservative, has had more impact on developmental psychology. This field combines evolutionary biology, paleoanthropology, and cognitive psychology

(Tooby & Cosmides, 2005). Evolutionary psychologists use primatology, archaeological data, cultural anthropology, neuroimaging, genetic analyses, and data on contemporary human universals to discover how the mind has been shaped by natural selection to solve problems of adaptation faced by our hunting-and-gathering ancestors.

A developmental perspective is important for all these approaches: "The gap between molecular biology and natural selection will be filled by developmental analysis of the nervous system, behavior, and psychology" (Gottlieb, 1979, p. 169). Today, a discipline called evolutionary developmental biology (or "evo-devo") compares the developmental processes of various animals to determine how developmental processes evolved.

General Orientation to the Theory

Ethology is characterized by four basic concepts: (1) species-specific innate behavior, (2) an evolutionary perspective, (3) learning predispositions, and (4) ethological methodology.

Species-Specific Innate Behavior ▸ Ethologists focus on behaviors that, like organs of the body, were considered primarily innate, adaptive, and essentially the same in all members of a species. Of course, any "innate" behavior is influenced by the environment, because it has to be developed within prenatal and postnatal environments. Ethologists consider a behavior primarily innate if it has these four characteristics (Cairns, 1979):

1. It is stereotyped in its form (that is, has an unvarying sequence of actions) across individuals in a species.
2. It is present without relevant previous experience that could have allowed it to be learned.
3. It is universal for the species (that is, found in all members).
4. It is relatively unchanged as a result of experience and learning after it is established.

For example, in certain songbirds, the same song appears in all members of the species at sexual maturity, even if they have never heard the song sung by other members of the species. As this example illustrates, some innate behaviors are not present at birth but appear later as a result of physical maturation. In contrast to primarily innate behaviors, learned behaviors vary in form from individual to individual, require relevant previous experience, usually vary in their occurrence among members of the species, and change as a result of subsequent experience.

Innate behaviors are termed *species-specific*, which means they occur among all members of the species or at least a particular subgroup, such as all the males or all the young. If another species also has the behavior, two inferences are possible. One is that the two species are related, perhaps having split into separate lines at some point in their evolution. Or, the behavior may have evolved independently in the two species, perhaps because they had similar physical environments and needs. For example, in many species, the young cling to the mother's fur—a necessity for survival if infants must travel with their mothers as they move throughout an area in search of food or flee from predators. Also, the same behavior may have different meanings in the two species. An example is tail wagging in dogs and cats, thought to indicate contentment in dogs and conflict in cats.

Two types of innate behaviors are *reflexes* (wired-in responses to stimuli) and *fixed action patterns*. Examples of human infant reflexes are grasping a finger placed in the hand, spreading the toes when the bottom of the foot is stroked, and turning toward a nipple when it brushes the cheek. Any long-haired parent would agree that infants are particularly likely to grasp hair, especially during feeding. Ethologists speculate that this reflex originally served to facilitate clinging to the mother's fur. Many such reflexes are quite strong. A premature baby can grasp a clothesline and support its own weight, for instance. This ability is later lost. More complex reflexes are coordinated swimming, crawling, and walking movements when the body's weight is supported in newborns or young infants.

A fixed action pattern is a complex innate behavior that promotes the survival of the individual and thus the species. It is a "genetically programmed sequence of coordinated motor actions" (Hess, 1970, p. 7) that arises from specific inherited mechanisms in the central nervous system. Without being taught, squirrels bury nuts, birds perform courtship "dances," spiders spin webs, and stickleback fish fight to protect their territory. Fixed action patterns can become very elaborate, as when the male bowerbird spends hours building a love nest decorated with flowers, fruit, shells, and colorful beetles to attract a mate. He adjusts a twig here, adds a flower there, and seemingly stops to admire his work from time to time. Fixed action patterns involving social behavior are of particular interest. The adaptive value of fixed action patterns lies in the fact that they often end in eating, mating, or avoiding predators.

A fixed action pattern is elicited by a *sign stimulus*—a particular stimulus whose presence automatically releases a particular fixed action pattern. Lorenz (1966) likened this process to a key opening a lock. For example, the red belly of a male stickleback fish venturing into another stickleback's territory is a sign stimulus that triggers fighting behavior. A decoy that only vaguely resembles the stickleback in shape, but is red on its lower half, elicits this fixed action pattern, whereas an accurately shaped decoy without the red area usually does not (Tinbergen, 1951). Thus, the sign stimulus is specific, and sometimes it must be in a particular orientation or position. Tinbergen (1958) discovered this particular sign stimulus when he noticed that his sticklebacks in an aquarium near a window facing a street would become agitated at a certain time of the day. He eventually realized that a red mail truck passed by at that time, a stimulus that approximated the natural sign stimulus. A further example of the specificity of the sign stimulus is that a hen will not rescue a distressed, flailing chick she can see under a glass bell but cannot hear. However, she will rescue the chick immediately if she can hear the distress cries even if she cannot see it (Brückner, 1933). When people fish, they sometimes use lures that exaggerate the natural prey (the sign stimuli) of larger fish.

Innate reflexes and fixed action patterns enhance young infants' survival by allowing them to seek food and hide from predators on their own or binding them to an adult caretaker by crying, grasping, sucking, or smiling. This fit between the organism's needs and its innate behaviors is the product of a long evolutionary history. It is not always easy to infer the adaptive value of a characteristic, however. It was once claimed that flamingos are pink because that makes it difficult for predators to see them against the sunset (Thayer, 1909).

Despite the focus on innate behaviors, ethologists think that learning is important. Most behavior is viewed as an interweaving of innate and learned components. A raven innately knows how to build a nest, but through trial and error learns that broken glass and pieces of ice are less suitable than twigs for this purpose (Eibl-Eibesfeldt, 1975). An innate skill can easily be adapted to new situations, as when English titmice quickly learned how to use innate gnawing behaviors to open milk bottles.

Waddington (1957) proposed an influential model of how biological regulating mechanisms constrain the course of development while allowing for the modification of development by the environment. He presented development as a ball rolling down an "epigenetic landscape." As the ball descends, this landscape becomes increasingly furrowed by valleys that greatly restrict the sideways movement of the ball. Slight perturbations from the developmental pathway can be corrected later through a "self-righting tendency," and the ball returns to its earlier groove. Thus, the general course of development is set, but some variation is possible because of particular environmental events.

Evolutionary Perspective ▶ As Samuel Butler (1878) commented, "A hen is only an egg's way of making another egg." Evolution involves *phylogenetic* change, or change in a species over generations, in contrast to *ontogenetic* change, or developmental change in a single lifetime. Each species, including humans, is a solution to problems posed by the environment—an experiment in nature. These problems include how to avoid predators, how to obtain food, and how to reproduce.

The course of development within an individual follows a pattern that was acquired by the species because it facilitated survival. The young must adapt to their environment in order to reach the age at which they can reproduce and transmit their genes to the next generation. Just as certain physical characteristics, such as the upright stance and the hand with opposable fingers and thumb, facilitated making and using tools, so did certain behaviors, such as reflexes and fixed action patterns, facilitate survival through mating, food gathering, and caretaking. Social behaviors, such as interindividual communication and cooperation, encouraged group cohesion and thereby increased the chances of survival. New behaviors arose through natural genetic variations or mutations and, if they allowed the organism to survive long enough to reproduce, were genetically transmitted to the next generation. These successful behaviors gradually became more common in the whole population over many generations. Specifically, *if* genes are expressed in behavior (see later in this chapter) and if the behavior is adaptive, then it can be selected for during evolution.

Contemporary evolutionary theory has been changed dramatically by modern genetics. Theorists are increasingly aware of complex interactions of genes and environments. As explained later in this chapter, it is not just a matter of an environment simply triggering innate behaviors. Evolutionary models now also draw on population genetics to detect evolution by tracking changes over generations in the relative frequencies of various genes. One current notion, for example, is that sudden changes during evolution may have been more common than Darwin thought. Also, more attention is given now to the role of the environment, especially social environments. After all, species-specific behaviors have evolved within environments that are typical for that species. In a sense, "individuals inherit not only a species-typical genome but also a species-typical environment" (Bjorklund & Ellis, 2014, p. 230).

Humans have evolved few fixed action patterns. Rather, human *plasticity* has evolved as a successful strategy for enabling an organism to adapt to local conditions, including atypical environments. Plasticity refers to the flexibility of the brain, the hormonal system, and the expression of genes. Plasticity starts to act even prenatally; chemical signals from the mother may prepare a fetus for a harsh and unpredictable environment. Specifically, prenatal exposure to high levels of stress hormones from the mother is associated with child behaviors such as high anxiety, fearfulness, aggression, and risk taking (Pluess & Belsky, 2011), which may be adaptive. However, infants typically delay significant changes in their developmental trajectory to match local conditions (e.g., a harsh or supportive environment) until they have had enough time to adequately process information about their environment (Frankenhuis & Panchanathan, 2011).

Note that both Piagetian and ethological approaches are concerned with how an organism adapts to its environment. Both identify biological predispositions toward learning, for example, the assimilation–accommodation process (Piaget) and specialized learning abilities (ethology).

Learning Predispositions ▸ Ethologists see the biological control of behavior not only in largely innate behaviors acquired during evolution but also in predispositions toward certain kinds of learning. Species differ in which aspects of their behavior are modifiable, in what kinds of learning occur most easily, and in the mechanisms of learning. *Sensitive,* or *critical, periods* are specific time frames in which animals are biologically ready to learn from particular experiences. During this time, they are biologically pretuned to notice certain types of objects, sounds, or movements, and produce certain behaviors that are particularly susceptible to modification. After the end of the sensitive period, animals can acquire the behavior with great difficulty or even not at all.

An example of a sensitive period is Lorenz's observation that, shortly after birth, certain birds (for example, geese) are most able to learn the distinctive characteristics of their mother and therefore their species. During this sensitive period, the young learn to follow a stimulus and come to prefer that stimulus—a phenomenon called *imprinting*. Imprinting increases the survival of the young because it ensures that they stay close to the parent and, therefore, near food and shelter and far from predators and other dangerous situations. The stimulus to be followed must meet certain criteria; for example, it makes a particular call note or type of movement. The criteria vary from species to species, but the mother always meets these criteria. In the wild, a row of ducklings scurrying after their mother is a common sight. However, as

Lorenz discovered, certain "unnatural" objects also meet the criteria. Young birds have become imprinted on flashing lights, electric trains, moving milk bottles, and a squatting, quacking Konrad Lorenz (see the excerpt at the beginning of this chapter). Horses and sheep have also become imprinted on humans.

In many species, imprinting has a long-term effect on sexual behavior. Lorenz (1931) discovered that jackdaws raised by humans will join a flock of jackdaws but return to their first love, a human, during the reproductive season. They try to attract the human with their species' courting patterns.

Ethologists also have identified sensitive periods for behaviors such as learning bird songs, learning to distinguish males and females of the species, acquiring language, and forming a bond between a newborn and her mother. For example, mother goats form a bond with their young in the first five minutes after birth. If the young are removed right after birth for two hours, the mother attacks them upon their return. Waiting five minutes after birth before removal, however, leads to their acceptance later (Klopfer, 1971).

Developmental psychologists have drawn on the concept of a sensitive period to argue that early experience is particularly important for adult behavior, as suggested by Freud and others. Furthermore, all stage theories claim that at each stage the child is particularly sensitive to certain experiences, such as motor exploration in the sensorimotor period (Piaget), the meeting of one's needs by other people in the stage of trust versus mistrust (Erikson), and the satisfaction or deprivation of anal drives during the anal stage (Freud). Most nonstage theories also use the concept of readiness—the idea that a child is most likely to learn from an experience if it comes at the optimal time. The child may not profit from being shown how to put objects to be remembered into categories when she is 3 years old but may have increased recall as a result of this experience at age 6. Moreover, sensitive periods are a central notion in prenatal development. A particular drug taken by a pregnant woman may have no effect or a devastating effect on the fetus, depending on its stage of development.

In addition to sensitive periods, a second way in which biology indirectly affects learning is through *specific and general learning skills*. Each species learns some things more easily than others. Digger wasps have excellent spatial memory. They can inspect up to 15 nests, decide how much food is needed by each nest, and retain this information for the entire day. Babies may be born biologically pretuned to learning language quickly. They rapidly acquire language early in life, show universal forms of early utterances, and show babbling even if their parents are deaf and have no spoken language. Although a fear of snakes is not innate, infants as young as 7 months are predisposed to learn to associate snakes with fear and to respond quickly to the sight of a moving snake (DeLoache & LoBue, 2009). Moreover, 9-month-old infants are more attentive to evolutionarily fear-relevant sounds (e.g., hissing snake, crackling fire) than to modern fearful sounds (e.g., bomb exploding, tires screeching) or pleasant sounds (Erlich, Lipp, & Slaughter, 2013). Young infants also are experts in processing human faces. Early on, they can categorize female faces as attractive or unattractive (based on adults' ratings of attractiveness) and even prefer the attractive faces (Langlois et al., 1987; Ramsey, Langlois, Hoss, Rubenstein, & Griffin, 2004), well before they possibly could have been taught about cultural norms regarding attractiveness.

In addition to these specific learning predispositions, human infants have evolved a tremendous general ability to learn. Humans are "specialists in nonspecialization" (Lorenz, 1959). We can construct novel solutions to problems in various types of environments and can learn from the consequences of our behavior. We also have hands that can perform many different actions and a language system that permits symbolic thought and verbal communication. The advantage of this flexibility is that we can adjust to a changing environment. The disadvantage of flexibility is that humans are born with few specific ready-made behaviors, such as running, that lead to survival.

As a result of humans' biologically based general ability to learn, we have developed cultures to help us adapt. The culture is passed on to the next generation by imitation, instruction, and other forms of learning. Thus, even cultural adaptation has its biological origins.

Methodology ▶ Ethologists rely on two general methods for studying behavior: naturalistic observation and laboratory experimentation. The insistence on observing organisms in their natural environments most clearly differentiates ethology from related disciplines such as evolutionary psychology and sociobiology. Ethologists' particular version of naturalistic observation ranks as one of their main contributions to psychology.

Naturalistic Observation ▶ Theories and methods are closely connected. Given the goal of understanding a behavior by seeing its function for adaptation, it is necessary to observe an animal in its typical environment. Giraffes' long necks make sense when we see giraffes eating leaves from tall trees; we understand young gulls' innate "freezing" rather than fleeing in the face of danger by noting that their nests are built on narrow ledges or steep cliffs (Eibl-Eibesfeldt, 1975). In contrast, learning theorists (see Chapter 6) observed rats pressing bars and pigeons playing tennis in the laboratory—hardly typical species-specific behaviors. Interesting natural behaviors, such as defending a territory or building a nest, are not likely to occur in barren laboratory cages. From the viewpoint of ethologists, psychology has worked backward historically by performing laboratory research before obtaining a sufficient database of naturalistic observations.

Observations of animals in captivity are inadequate because their behavior may be abnormal due to their atypical environment. One cause of abnormal behavior in this setting is the absence of sign stimuli that would release fixed action patterns. Thus, behavior is often redirected. Animals in laboratories or poorly designed zoos may restlessly pace back and forth, constantly rock, and kill their young. Ironically, giving too much care to a captive animal may cause problems. Titmice in a zoo threw their young out of the nest soon after birth. The problem was that food was provided by the zoo. The young quickly became full, stopped gaping, and consequently were taken for dead by the parents. Young titmice in the wild never stop gaping unless they are sick or dead (Koenig, 1951). In humans, abnormal behavior—for example, rocking—has been observed in children in unnatural environments such as orphanages and hospitals.

Ethologists' naturalistic observations focus on developing an *ethogram*—an extensive, detailed description of the behavior of a species in its natural environment. This inventory includes the animal's behaviors, the characteristics of the setting, and the events immediately preceding and following each behavior. The ethogram spotlights adaptive behaviors, such as nesting and food gathering, and notes their frequency, stimulus context, function, and ontogenetic development. A complete description of the setting is particularly important, for it essentially defines the animal that inhabits it: "If we specify in detail the niche of a fish (its medium, its predators and prey, its nest, etc.), we have in a way described the fish" (Michaels & Carello, 1981, p. 14). Ethologists sometimes study human behavior by examining contemporary hunters and gatherers in order to understand the environment in which current human behaviors evolved. Finally, data about the frequency of behaviors is important for interpreting a behavior when it occurs. The problem of not having scientific data about frequency was noted long ago by Thorndike: "Dogs get lost hundreds of times and no one notices it or sends a scientific account of it to a magazine. But let one find its way from Brooklyn to Yonkers and the fact immediately becomes a circulating anecdote" (1898, p. 4).

Interestingly, ethologists have detected previously unnoticed patterns of behavior by speeding up or slowing down their observational videos. For example, a slower rate revealed an unnoticed part of the flirting sequence—raising the eyebrows for only one-sixth of a second (Eibl-Eibesfeldt, 1975). A fast speed showed that people who eat alone look up and around after every few bites, as if scanning the horizon for enemies, as baboons and chimps do (Eibl-Eibesfeldt, 1975). This is much less obvious at a normal speed.

Once the function of a behavior is known from the ethogram, ethologists can understand the behavior further by comparing it with similar ones in other animals. For example, they may find mother–child attachment only in species in which the young are helpless, which suggests the reason for that behavior.

Laboratory Studies ▸ For an ethologist, a behavior has both a phylogenetic cause and an immediate cause. Phylogenetically, a spider spins a web "because" that innate food-gathering behavior has allowed the species to survive. Immediate causes could include specific physiological events, particular inborn neurological pathways, the presence of a sign stimulus, or motor experience. Ethologists clarify these various causes of behavior suggested by the observational studies with controlled experiments, similar to those done by psychologists. For example, by systematically varying stimuli, they determine which attributes of a stimulus are critical for eliciting the response. They also examine the underlying physiological mechanisms. Although the laboratory experimental method is shared with experimental psychology, ethology maintains its distinctiveness by the content it chooses to study: behaviors tailored to the survival of the species.

One laboratory method associated with ethology is determining whether a behavior is primarily innate by preventing experiences that could teach the behavior. For example, an ethologist interested in the origin of nut-burying behavior raised squirrels in a cage with a bare floor and provided a diet of only liquid food. The squirrels had no exposure to other squirrels (who could serve as models), nuts, or earth (which could provide digging practice). Under these conditions, squirrels demonstrated nut-burying behaviors at the same age as do squirrels in the wild. When presented with a nut, they dug an imaginary hole in the concrete floor, pushed the nut into the "hole" with their snouts, covered it with invisible soil, and carefully patted down the "soil" to finish the job (Eibl-Eibesfeldt, 1975). Thus, since they had no opportunity to learn this behavior, it must be an innate fixed action pattern of the species.

Contributions to Human Developmental Psychology

Ethologists are interested in the same categories of adaptive behaviors in humans as in other animals, for example, feeding, communication, parent–child interaction, and reproduction. The study of children has focused primarily on infant attachment but also has examined topics such as peer interaction and problem solving. A look at representative research in each of these areas will show ethology's imprint on both the content and the methodology of developmental research.

Infant–Caretaker Attachment

Bowlby's Theory ▸ John Bowlby (1907–1990), a London psychoanalyst, is credited with bringing ethology to the attention of developmental psychologists. Because World War II had left many children as orphans, there were concerns about the effects of maternal deprivation. Bowlby's observations of infants separated for a long time from their mothers (see the excerpt at the beginning of this chapter) led him to conclude that early social attachment between infant and caretaker is crucial for normal development. Infants show their attachment when they cry when a parent leaves, smile and babble when she returns, and seek her out when they are stressed.

Drawing on observations of mother–infant attachment in nonhuman primates, Bowlby (1969/1982) proposed that human attachment evolved because it promotes the survival of helpless infants by keeping them close to their mother and thus protected from predators or exposure to the elements. One newborn reflex related to attachment is grasping an object such as a finger or the hair when it contacts the infant's palm, just as many mammalian infants stay with the mother by clinging to her hair. Another reflex is an embracing movement in response to a sudden loud sound or a loss of support. This reflex may have helped ancestral infants avoid falling when the mother suddenly ran from a predator.

Of course, human infants today do not depend on these reflexes for survival, because they need not physically attach themselves to their parent. Of more importance to human babies are signaling mechanisms such as crying, babbling, and smiling. These behaviors communicate infants' needs and encourage adults to come to infants, since young babies cannot go to adults. Just as following the imprinted object in ducklings maintains proximity, signaling behaviors serve this purpose in humans. Another ability found in young infants that may facilitate their relationship with their parents is imitation of parents' head movements and tongue protrusions (Meltzoff & Moore, 1989). As infants mature, other behaviors, such as crawling, walking, and talking, facilitate contact between parent and child.

Research supports Bowlby's notion that at least some signaling behaviors are innate (and possibly even fixed action patterns). Even infants born blind or blind and deaf acquire a social smile at approximately 6 weeks, as do seeing and hearing infants. In fact, children blind and deaf since birth reveal a wide range of normal behaviors, including laughing, crying, babbling, and pouting, and typical facial expressions of fear, anger, and sadness (Eibl-Eibesfeldt, 1975, 1989). It is highly unlikely that adults teach these behaviors, because smiling and laughing involve a complex sequence of coordinated movements or sounds. Even the possibility that blind and deaf children might learn facial expressions by touching the mother's face and imitating her facial movements was ruled out by a child deaf and blind since birth who was born with no arms. Despite these handicaps, he showed normal facial expressions. Thus, these behaviors have a strong innate component.

Bowlby proposed that early reflexes and signaling behaviors, along with a bias toward looking at faces, leads to an attachment to adults in general and then, usually around 6 to 9 months of age, to one or a few specific adults. Separation from a specific adult may be an innate "cue to danger" that elicits signaling behavior intended to restore proximity.

The infant and adult behaviors eventually become synchronized into an "attachment behavioral system," according to Bowlby. The appearance and behavior of each member elicits certain behaviors in the other. Each member of the system comes to expect that the other will respond to its own behavior in certain ways. Infants' expectations are part of their *internal working models,* discussed in Chapter 3—mental representations of the attachment figures, the self, and the relationship. These models help children interpret and evaluate new situations and then choose a behavior such as playing or seeking the attachment figure for comfort. Between the ages of about 9 and 18 months, an infant's various individual behaviors, especially sucking, clinging, crying, smiling, and following, become incorporated into more complex, self-correcting "control systems."

Bowlby used control-systems theory from engineering as a model of how attachment forms an organizational system. *Control systems* are goal directed and use feedback to regulate the system in order to achieve the goal. A simple control system is a thermostat, which maintains a particular room temperature (the goal) by comparing the actual temperature (the feedback) with the desired temperature. With respect to behavioral systems, Bowlby proposed that genetic action causes the behavioral system to develop but that the developed system is flexible enough to adjust to changes in the environment, within prescribed limits. That is, when infants detect that the adult is too far away (feedback to the system), they correct this state by crying or crawling, which reestablishes contact and re-achieves equilibrium in the system. The limits of acceptable distance vary, depending on internal factors, such as hunger or illness, and external factors, such as the presence of an adult stranger or other cues of danger. The development of a secure attachment expands the distance acceptable by establishing the caretaker as a secure base from which the child can explore.

Bowlby's theory of attachment includes many ideas from ethology. Species-specific reflexes and fixed action patterns, which are the products of evolution, ensure proximity to the mother. Sensitive periods and general and specific learning abilities biologically predispose infants and caretakers to develop a system of synchronized interactions. As in ethological theory, Bowlby observed children (though recent research on attachment stimulated by his theory often is conducted in a laboratory). His colleague, Mary Ainsworth, developed methods for assessing attachment (see below) and provided much of the empirical evidence for attachment theory.

The ethological account of attachment, with its focus on innate behaviors, obviously contrasts with learning theory's (Chapter 6) focus on food or physical contact as reinforcement. Although it seems likely that pleasant interactions have a positive effect on the bond between child and adult, ethologists point out that attachment occurs even when the attachment object physically abuses the infant. Ethological accounts also differ from Freudian theory's focus on the oral drive. Finally, ethology differs from both traditional learning and Freudian theory in stressing an infant's effect on the parent as much as the parent's effect on the infant.

Bowlby later (1980) incorporated into his theory some of the notions of information-processing theory (Chapter 7). He explained unsatisfactory early social relationships, abnormally strong repression, and thinking disorders in part by general principles of selective attention and selective forgetting. For example, if young children's attachment behavior is continually aroused but not responded to, they eventually exclude from awareness the sights, thoughts, or feelings that normally would activate attachment behavior.

Bowlby continually applied his ideas about attachment to his clinical work. Interestingly, his final book (1991), a biography of Darwin, traced Darwin's chronically poor health back to his failure to fully mourn his mother's death when he was 8 years old.

Adults' Responsiveness to Infants ▸ Ethology contributed the important idea that adults, as well as infants, are biologically predisposed to develop attachment. A caretaker typically begins to form an emotional bond to a child in the first few hours or days of life, which encourages caretaking and thus enhances the infant's survival. Babies elicit adult attachment behavior with signaling behaviors such as smiling, looking at the mother's face, and babbling, or by their babyish appearance.

The words of a 1926 popular song were: "Baby face, you've got the cutest little baby face" (music by Harry Akst, lyrics by Benny Davis). An infant's babyish appearance may elicit caretaking. The infants of many species, especially mammals, share certain physical characteristics depicted in Figure 5.1—a head that is large in relation to the body, a forehead that is large in relation to the rest of the face, limbs that are relatively short and heavy, large eyes at or below the midline of the head, and round, prominent cheeks—in a word, cuteness (Lorenz, 1943). This babyishness is exaggerated in baby dolls for children and in young animals in the Disney cartoon films. Interestingly, as Mickey Mouse became more lovable and well behaved over the years, his physical appearance became more babyish—a larger head with softer, more rounded features and larger eyes (Gould, 1980).

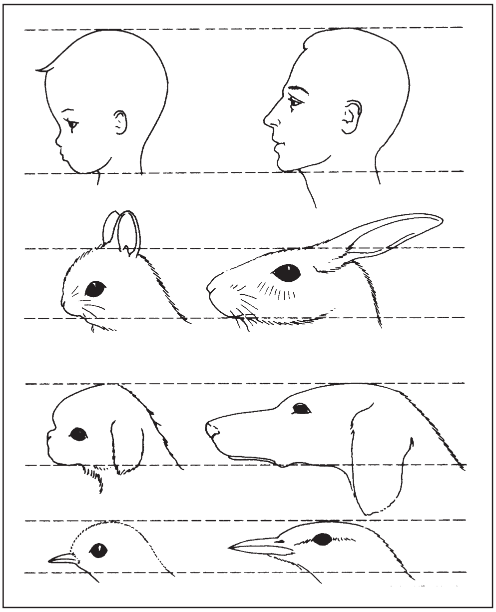

FIGURE 5.1

Characteristics of babyishness or cuteness common to several species.

[From "Die angeborenen Formen möglicher Erfahrung," by Konrad Lorenz, in *Zeitschrift für Tierpsychologie*, 1943, 5, 235–409. Reproduced by permission of Verlag Paul Parey, John Wiley & Sons.]

Infants' smiles also may be powerful elicitors of adults' attention. The adaptive significance of an infant's smile may be to make a tired, busy mother of a young infant feel that those difficult first months are worthwhile (Robson, 1967).

The Developmental Course of Attachment ▸ Very young infants are predisposed toward attachment. For example, they prefer looking at people's faces, and they vocalize in response to human voices. They also are biased toward looking at biological motion rather than random movements (Bardi, Regolin, & Simion, 2014). Early on, infants learn to discriminate their mother's odor from that of others. Two-week-old breast-fed infants turned toward a pad that had been worn in their mother's underarm area rather than a pad worn by another lactating female (Cernoch & Porter, 1985). Likewise, mothers quickly learn to recognize their infant's distinctive smell. Six hours after giving birth, and after only a single exposure to their babies, blindfolded mothers could pick out, by smell alone, their own baby from a set of three babies (Russell, Mendelson, & Peeke, 1983).

Attachment furthers infants' learning about their environment, because parents serve as a "secure base" for exploration in the first year or two of life. Children venture away to explore the next room but return from time to time for "emotional refueling" (Mahler, 1968). If, however, a parent's responses to children's signals are inappropriate (unpredictable, slow, abusive, or not matched to the child's needs), children feel insecure and are less likely to use the mother as a base for exploring a strange environment (Ainsworth, Blehar, Waters, & Walls, 1978). Because the appropriateness of the adult's responses is more important than the total amount of interaction, infants become attached to parents who work full time, if they respond appropriately to the child's signals.

Ainsworth (e.g., Ainsworth et al., 1978) devised the "Strange Situation" procedure, which lasts about 22 minutes, to assess babies' patterns of attachment to their mothers. The infant, a parent, and a stranger in a laboratory setting proceed through a sequence of episodes, gradually moving from low stress (infant with parent) to high stress (infant alone with stranger). Based on their reactions to these events, children are classified into four categories. *Securely attached infants* (the majority of typical middle-class samples) cry when their mother leaves and greet her happily, for comforting, when she returns. *Insecure–avoidant babies* show little emotion when the mother leaves or returns. *Insecure–resistant* babies are difficult to comfort on the mother's return and show either anger or desperate neediness toward her. Infants who do not fit into any of these categories (e.g., no consistent way of dealing with stress; contradictory behaviors) are called *disorganized* or *disoriented* (Main & Solomon, 1990). These infants sometimes have abusive parents.

A large literature (e.g., Cassidy & Shaver, 2008) shows that a dyad's type of attachment depends on many factors, including parents' sensitivity to the child's needs, stresses on the family, parental psychopathology, and child characteristics such as Down syndrome or a difficult temperament. Universally, secure attachment is the most common pattern, maternal sensitivity influences infant attachment patterns, and secure infant attachment leads to later social and cognitive competencies (Van IJzendoorn & Sagi-Schwartz, 2008). However, the percentage in each category shows some variability across countries. For example, in one study (Van IJzendoorn & Sagi, 1999), U.S. and Western European groups showed more avoidant infants than did groups from other regions. One reason for the great interest in attachment type is that the categories predict later social competence. In general, secure attachment predicts effective social functioning during childhood and adolescence, and even later, whereas insecure attachment is associated with various sorts of later psychopathology, as discussed in the chapter on psychoanalytic theory. The initial attachment pattern sets in motion particular styles of thinking, feeling, and relating to others that continue to influence the way children negotiate their environments throughout development. Also, work on young children at developmental risk, such as children with Down syndrome, cerebral palsy, or autism spectrum disorder, promises to broaden our understanding of the variety of social attachments and the complex interweaving of genetic and environmental forces (Vondra & Barnett, 1999). Today, attachment is seen as a lifelong process of forming affectionate bonds with various people, including romantic partners. In fact, assessments of adult attachment styles have been developed and related to various kinds of social relationships, including parenting (Frias, Shaver, & Mikulincer, 2015).

From a contemporary evolutionary perspective, attachment styles are different solutions to the problems in the environment faced by a child after birth. The particular style is an infant's attempt to adapt to her parents' behaviors and the resources available in the environment. For example, parents differ in their pattern of investment in their offspring in terms of time, effort, and resources. Infants increase their chances of survival if they can adapt to their particular caregiving condition (Bugental, Corpuz, & Beaulieu, 2015). If parents are heavily invested in their children and thus are sensitive and responsive, environmental risk decreases and children can explore more freely from their safe base. If, because of environmental pressures such as scarce food, parents are unable or unwilling to invest heavily in caring for their children, resistant or avoidant attachment may be more adaptive. In resistant attachment, clinging to the caregiver could elicit whatever meager resources are available. In avoidant attachment, a more independent infant can try to obtain resources from other adults.

Issues about the attachment categories include the following (Cassidy & Shaver, 2008): How stable over time is an infant's attachment classification? Should attachment be measured as categories or as a continuum? How broad is the effect of the early attachment category on later social relationships and cognitive abilities? What is the child's active contribution (for example, temperament) to the attachment relationship? How, if at all, do child-care arrangements affect type of attachment? What accounts for the variability in a child's attachment behavior across situations? What specific effects does parental physical abuse of an infant have on attachment type?

Peer Interaction

Ethologists argue that children are innately predisposed toward interacting with other people in adaptive ways. Ethological studies of animals' dominance hierarchies, aggression, play, altruistic behavior, and nonverbal communication have provided a powerful framework for observing and interpreting these behaviors in children in natural settings (Blurton-Jones, 1972; McGrew, 1972).

A basic feature of the organization of nonhuman primate groups is the *dominance hierarchy*—the ranking of members of the group according to their power, especially regarding access to resources such as food or mates (Hinde, 1974). This hierarchy indicates who can control whom. It is adaptive because, once established, it lessens conflicts within the group. These dominance hierarchies also construct the social environment into which an infant is born. For example, in rhesus monkeys, which form large and complex social groups, the matrilineal (mothers') dominance hierarchies affect the rank of the infant. All members of the highest-ranking matriline, even infants, outrank lower matrilines. Thus, a newborn "inherits" the status of the mother and outranks even adults of lower-ranking matrilines. Dominance hierarchies even affect how mothers treat their infants. High-ranking mothers are more "laissez-faire" in their supervision of their young than are low-ranking mothers. The latter are more limited in the social situations from which they can rescue their infants, so they are reluctant to let them explore much (Sameroff & Suomi, 1996).

In humans, even 15-month-old infants can infer a social dominance hierarchy from a series of videos showing pairs of adults in which one person was dominant over the other (Mascaro & Csibra, 2014). These hierarchies can be seen in preschoolers' groups (e.g., Hawley & Geldhof, 2012) and in adolescent groups, in which popular peers are looked at more (Lansu, Cillessen, & Karremans, 2014). Within this structure, children learn how to use both prosocial and coercive behaviors to negotiate status and gain access to resources (Hawley, 2014). In particular, when children enter elementary school, they learn that they must express dominance in more subtle ways in order to obtain resources—what Hawley (1999) calls "competing with finesse." Prosocial strategies, such as persuasion, cooperation, and helping, enable children to access resources such as toys or friends in ways that foster acceptance and maintain group harmony. Thus, aggression, or the threat of aggression, which usually is considered a negative behavior, actually may be a positive adaptation for a group and also provide opportunities to acquire the skills needed later during adulthood. Similarly, boys' rough-and-tumble group play may enhance their ability to compete and permit them to evaluate each other's relative strengths, which is one basis for dominance hierarchies. Such observations of children's groups demonstrate several characteristics of ethological research. Researchers observe children's adaptive behaviors, typically in natural settings, and compare them with that of other primates. In response to conflicts, such as a struggle over a toy, a child could, for example, submit, seek help, counterattack, give up the object or position, or make no response. The child who wins in these encounters is considered to be the more dominant. These categories of initiated conflict and response to the conflict are quite similar to those used to study dominance in nonhuman primate groups.

Individual differences in peer interaction might be explained in terms of social defense systems that have evolved for coping with negative peer behaviors and protecting oneself from interpersonal threat (Martin, Davies, & MacNeill, 2014). Children select a relevant strategy from a large repertoire of defense strategies for defusing threats from peers. A dominant child can threaten aggression. In contrast, a low-status child may run away, use subordination behaviors to deflect harm and social exclusion, or warily watch the dominant group members. These behaviors calm down the dominant members and avoid rejection from the group. The heightened arousal, need to be vigilant for potential violence, and frequent activation of the social defense system, may deplete the less dominant child's resources that could have been devoted to other systems, such as exploring or caregiving. More secure, dominant members of the group do not have this high cost.

The ethological approach to children's aggression clearly contrasts with social learning theory's focus on how a behavior (for example, aggression) in individual children is affected by reinforcement, punishment, imitation, and self-efficacy. And, unlike Freud, ethologists focus on interpersonal processes of aggression more than individual psychological processes. Finally, Vygotsky's theory gives more attention to cultural contributions to aggression than does ethology.

Evolutionary psychology has addressed gender differences in social behaviors, especially mating strategies and parenting behaviors. Other behaviors for which evolutionary arguments have been made are male competition and violence; gender differences in play, risk taking, and the ability to inhibit behaviors; and parental investment in their children, with applications to child abuse.

Problem Solving

I gather firewood
As if I had been at it
For a million years

—*William Charlesworth, One Year of Haiku, 1978*

The human brain is designed to solve daily problems in the human-typical environment in which the species has evolved. This view of intelligence differs greatly from other approaches to studying this topic. The intelligence-testing approach views intelligence as a trait on which people differ and assesses it on tests administered by an adult, usually in an unfamiliar setting. Laboratory studies of problem solving (see information-processing theory in Chapter 7) examine children's thinking about novel tasks, out of context, usually in a laboratory. Ethology lies closest to Vygotsky's theory of cognition, among the various theories, in that both address the fit between children and their social environment.

Although even Darwin (1890) studied the "mental power" of earthworms, most of the research on cognition falls within the more recent evolutionary psychology framework. Evolutionary psychologists suggest that cognitive mechanisms may be the missing link between evolution and human behavior; that is, evolution may have led to changes in the brain, which changed thinking, which in turn changed behavior (Tooby & Cosmides, 2005). Complex cognitive skills must have evolved to solve problems such as finding a mate, hunting for food, recognizing group members, communicating with others, warding off enemies, raising offspring, and cooperating to obtain resources. People had to attend to, encode, process, store, and retrieve relevant information, such as remembering specific individuals and figuring out the costs and benefits of interacting with an individual, especially whether to risk one's life to help the person. In this way, evolution selects for the neurological mechanisms that underlie adaptive social and cognitive behaviors.

Tooby and Cosmides (2005), two main voices of evolutionary psychology, have identified *Darwinian algorithms*—evolved cognitive mechanisms specific to particular domains. The mind is like a Swiss army knife, with different tools for performing tasks well in different domains. Examples of these "core domains" are face recognition, language acquisition, certain characteristics of objects, and certain types of processing of social information. The brain consists of modules that process information in these domains with little effort. Infants are programmed to acquire and store certain sorts of information needed for solving certain sorts of problems. Their behaviors generated by Darwinian algorithms bear some relation to fixed action patterns but are more flexible, less tightly wired to particular stimuli.

It is important to note that these cognitive skills enhanced adaptation for our ancestral hunters and gatherers: "Our psyche is not built for the present. It resonates to the vibrations of 200,000 generations ago" (Thiessen, 1996, p. 159). We do not do much hunting and gathering these days. Thus, the cognitive skills underlying these activities may not lead to survival and reproductive fitness in today's urban habitats. Still, we do have these ancestral ways of thinking that continue to influence our development and behavior in a world of shopping malls and computers, and the task of an evolutionary psychologist is to reveal how they are expressed in modern environments. One interesting hypothesis concerning the "modernization" of an ancestral cognitive module is that a module acquired to process information in one domain, such as the acoustical properties of the human voice, may be applied today to another domain, such as music. Music itself may not be essential for survival, but it may come from a module that is (Sperber, 1994).

One modification of the Tooby and Cosmides model is Geary's (2005) model, in which modules within a domain are organized hierarchically. Lower-level modules process less complex information, which is integrated to form higher-level, more complex, and flexible modules. For example, infants have biases that orient them to important social stimuli and lead them to imitate others. Information obtained from these lower-level modules combines with more flexible higher-level social-cognitive mechanisms, to help children develop an understanding of themselves and other people, and thus adapt to various social and physical environments (Bjorklund & Ellis, 2014). Similarly, in concepts of the physical world, infants' surprisingly sophisticated understanding of objects and the ability to use tools is integrated into more advanced and flexible understanding later.

Mechanisms of Development

Ethologists emphasize biological processes as mechanisms of development. Physical maturation, including hormonal changes, motor development, and increased efficiency of the nervous system, underlies the emergence of sensitive periods or of fixed action patterns at appropriate times. For example, nest-building behavior surfaces when a bird matures to the point where reproduction is possible. All of the biological mechanisms of behavior interact with experience, of course. In addition, innate general and specific learning abilities built into the nervous system allow the organism to profit from its experience.

Position on Developmental Issues

Human Nature

Human nature is just one hodgepodge out of many conceivable.

—*Wilson, 1978, p. 23*

Humans are social animals with certain species-specific characteristics. Human intelligence, language, social attachment, and perhaps even aggression and altruism are part of human nature because they serve or once served a purpose in the struggle of the species to survive. However, humans select from their evolutionary heritage the behaviors that best help them adapt to local circumstances—supportive or harsh caretaking, a resource-rich environment or poverty: " 'Human nature,' then, is in part decided by the context within which we find ourselves (Hawley, 2014, p. 5).

Identifying the theory's worldview highlights the differences among ethological theorists. Lorenz stressed the mechanistic, automatic, elicited nature of behaviors, such as reflexes and sign stimuli that elicit fixed action patterns. This stimulus–response model is based on early views of how the nervous system operates. In contrast, Bowlby and many modern ethology theorists are more organismic and draw on systems approaches. Humans spontaneously act to meet the demands of their environment by actively searching for the parent or playmates or by exploring. In Bowlby's control-systems approach, an infant seeks to maintain a certain state, for example, an acceptable degree of proximity to the caretaker. Finally, the theory is contextual in its focus on links between a species' evolutionary history and the present, and on the immediate physical and social setting, to which an organism must adapt.

Qualitative Versus Quantitative Development ▸ Ethology allows for both qualitative and quantitative change. It is not a stage theory and therefore does not posit large-scale qualitative changes in development. Qualitative change occurs when biological maturation reaches the point where a sign stimulus triggers a new fixed action pattern. In this way, a new behavior appears in a more or less discontinuous fashion. Qualitative change also occurs when a system is expressed in different behaviors as a child develops. One such instance is attachment, the desire for which is expressed at first by crying or smiling and later by crawling toward the mother or talking to her. The underlying attachment, however, may be changing quantitatively, usually toward increased organization and efficiency.

Nature Versus Nurture ▶ Like Piaget, ethology was concerned with how an organism adapts to its environment. Both identified biological predispositions toward learning, for example, the assimilation–accommodation process (Piaget) and specialized learning abilities (ethology). Although ethologists focus on the biological basis of behavior, they are quite aware that heredity and environment are intertwined throughout the lifespan. Indeed, any evolved behavior requires some environmental input for its activation. A particular experience has more impact if it occurs during a relevant sensitive period rather than at another time. Moreover, a given genotype may be expressed differently in different environments. Also, one way to think about the importance of the environment is that it selects for or against genetic mutations that occur.

It is the fit between the genes and a particular environment that is adaptive, not just the genes themselves. The set of human genes evolved within a particular environment, so it is adaptive for the "expectable" environment into which most members of the species are born. This environment, typical for the species, provides the relevant experiences for expressing predispositions.

What Develops ▶ The most important behaviors to develop are species-specific behaviors that are essential for survival. These include such behaviors as social attachment, dominance–submission, eating, mating, social cognition, and infant care. Both general abilities to learn or process information and specific behaviors such as fixed action patterns or domain-specific cognitive algorithms are applied to the environment at hand. The theory seeks to explain similarities in what behaviors are acquired and how they develop in all humans and in both humans and other animals. Like for Piaget, the focus has been on what is universal for a particular species. Biology constrains the range of possible differences between cultures or within a culture.

Applications

Ethological work on attachment has had the most impact on real-life topics such as orphanages, adoption, day care, prolonged separation from the mother, and early contact between mother and child. A popular current parenting approach, "attachment parenting," encourages parents to keep their babies close and to respond promptly and appropriately when babies signal their needs. For a securely attached child, a parent serves as a safe base from which to explore the environment and establish independence. Parents should be sensitive to their children's emotional needs during separation caused by hospitalization or other traumatic events.

Bowlby found pathological behaviors in children when they did not receive adequate attention from a caretaker early in life. A more recent project (Nelson, Zeanah, & Fox, 2007) has shown that early social deprivation in the institutional rearing of infants abandoned at birth in Bucharest, Romania, had serious negative effects on brain behavior and nearly all aspects of development. For example, almost half of the children appeared to suffer from one or several forms of psychopathology. However, subsequent adoption into normal families reversed some of these adverse effects, especially if adoption occurred early on. A variety of interventions for infants at risk for not developing secure attachment, as well as children and adolescents with attachment issues, have proven successful (Cassidy, Jones, & Shaver, 2013). Researchers also have applied attachment theory to policy concerning families with working parents, or a parent in the military or in prison (Cassidy et al., 2013).

Evaluation of the Theory

Strengths ▸ Both realized and potential contributions of ethology to developmental psychology are explored in three areas: theory, method, and content.

Theoretical Contributions ▸ Ethology broadens our perspective on what constitutes an explanation of development. We can fully understand children's behavior only if we expand our vision to include a larger space (the larger social context) and a larger time span (the history of the species). Tinbergen (1973) identified four types of questions about the causes of behavior that developmentalists should try to answer about their topic of study. The questions are based in part on the time span involved, which varies from seconds to centuries. These "four whys" pertain to causes that are immediate, ontogenetic, functional, and phylogenetic.

1 *Immediate* causes are the external or internal events that occur directly before the behavior. They provide clues as to the causal mechanism. An infant smiles after viewing a human face or cries as a result of hunger pangs.

2 *Ontogenetic* causes encompass a longer time span—the genotype and the environment interact to produce changes in behavior over an individual's lifetime. In this process, earlier events contribute to later events, as when a secure attachment may cascade to later positive relationships and social competence.

3 *Functional* causes involve the immediate adaptive value of a behavior. An ethologist asks, "What is this behavior trying to achieve?" Children behave in certain ways because they want to obtain food, protection, desired resources, and social support.

4 *Phylogenetic* causes lie in the earlier forms of the behavior as it was shaped over generations as a result of the food supply, types of predators, mating patterns, and so on. Thus, human social cognition may have evolved because of the need for hunting and gathering together.

Most developmental research has examined immediate causes or ontogenetic causes rather than functional or phylogenetic ones, but the latter two are needed as well for an adequate account of development. Knowing the function of a behavior helps the investigator relate a child's behavior to its natural context. For example, the way that investigators think about children's aggressive behavior changes if they discover that one of its functions is to increase the overall stability and cohesiveness of the group. The focus changes from a problem in the child to a feature of human groups. As for phylogenetic causes, among the theorists in this book, only the ethologists and Gibson (see Chapter 8) take an evolutionary perspective. Piaget was concerned with adaptation to the environment but paid little attention to evolutionary processes.

Few human behaviors today are a matter of life and death, such as avoiding predators, and children with mental disabilities, poor health, or physical disabilities are protected, so they may survive and reproduce. Thus, survival of the fittest is much less apparent as an evolutionary force. Developmentalists may find it most useful to draw on the concept of adaptation for understanding how a society may produce *optimal adaptation* (rather than biological survival). Optimal adaptation might include happiness, a feeling of competence at play, success at school, and efficient use of tools such as eating utensils, scissors, and computers.

Thinking about how a child's behavior might be adaptive also can suggest new hypotheses about development. For example, behaviors that seem maladaptive actually may confer advantages in certain developmental niches. For instance, children with a strong tendency to approach novel but potentially dangerous situations tend to develop disruptive behaviors (e.g., Davies, Cicchetti, & Hentges, 2015). However, this risky behavior may be adaptive in adverse environments by making it more likely that children will find new, resource-rich, settings (Gatzke-Kopp 2011). Thus, ethology offers a more balanced perspective by considering both the costs and benefits of any developmental pathway, even when the behaviors are considered psychopathological (Martin et al., 2014).

Methodological Contributions ▸ What can we learn from scientists who spend hours staring at crabs and birds? Regarding developmental psychology's focus on laboratory research rather than naturalistic observation, Bronfenbrenner characterized the discipline as the "science of the strange behavior of children in strange situations with strange adults for the briefest possible periods of time" (1977, p. 513). Moreover, developmentalists rely too heavily on the questioning of children. As Charlesworth commented, "As soon as a research subject has the appropriate Piagetian operations and can talk, researchers stop observing and start asking. It's less strenuous that way" (1988, p. 298).

Laboratory studies tell us what *can* happen during the attentional process. Ethological observation in natural settings tells us what in fact usually *does* happen and what function the behavior has. Ethology provides *theoretically based* observational methods that can fruitfully be combined with traditional developmental laboratory methods. As an illustration, consider what ethologically oriented observational studies might contribute to the understanding of the development of attention, typically examined in the laboratory. Lab research assesses infants' preferences for attending to one of two stimuli placed in front of them or older children's attention to physical attributes, such as shape, color, or size. A child looks preferentially at one object rather than another, sorts the objects, or tries to remember them. An ethologist, in contrast, would shift the focus of such research by asking the following questions: What types of objects or events do children look at or listen to at home and at school? Do children mainly look at people or nonsocial objects and events? What events distract young children? Does efficient attention lead to efficient problem solving or other adaptive behaviors? Does playful, exploratory attention resemble that observed in other primates, humans of other ages, and other cultures? Such observational studies would suggest new variables to be examined in depth in the laboratory. In a similar way, ethological methods could be applied fruitfully to the other theories examined in this volume. We know little about when and how often children engage in problem solving (Piaget and information processing), displaced aggression (Freud), or collaborative learning (Vygotsky).

Content Contributions ▸ Ethology has influenced developmental psychology by showing the importance of behaviors such as attachment and the structure of peer groups. A rich set of data about attachment provided a foundation for the neuroscience and genetic research on the long-term impact of poor early parenting described later in this chapter. Similarly, the information about human phylogenetic change from ethology and evolutionary psychology provided a backdrop for current developmentally oriented evolutionary approaches (e.g., Bjorklund & Ellis, 2014; Tomasello, 2014). More generally, observations of the social behavior of other primates, especially their apparent "mindreading" of their peers (e.g., Kaminski, Call, & Tomasello, 2008) has stimulated similar topics in children.

Weaknesses ▸ The following are critical shortcomings in theoretical, methodological, and substantive areas that must be addressed by ethological theory if it is to fulfill its promise as a theory of development. Some of these shortcomings merely reflect a lack of developmental research in certain areas; others are more serious because they reflect the incompleteness of the theory itself.

Theoretical Limitations ▸ Many of the ethological notions that are most useful to developmental psychology require further elaboration if they are to serve as specific explanations of development. For example, by what processes do sensitive periods begin, have their effect, and end? Are the effects of contact between mothers and their young infants due to biological, social, or cognitive variables or all these variables in interaction? What makes infants predisposed to attend to particular stimuli? The neuroscience and genetic approaches described later are beginning to identify the mechanisms that could answer these questions. Similarly, the cognitive foundation for adaptive behaviors is not well worked out. For example, by what cognitive processes do children detect and understand a dominance hierarchy in their peer group and their own place in it? How do children interpret social cues that could provide this information? The development of transitive reasoning ($A > B > C \ldots$) may be necessary for perceiving a dominance hierarchy (Edelman & Omark, 1973).

More specificity also is needed for theory-based predictions: What specific aspects of a secure or insecure attachment predict specific future social competencies? As Thompson noted, "It is as important to determine what a secure attachment does *not* predict to, and why, as it is to understand its network of predictable consequences" (1998, p. 48). If the various attachment patterns are adaptive for different environmental situations, then the expected long-term outcomes of each attachment type are not so obvious.

Another problem concerns identifying the function of a behavior. The evolution of anatomical structures can be gleaned from fossils, but we have no fossils of human behavior. At best, we can examine other primates, contemporary hunter–gatherers, skulls, DNA, and archeological data such as diseases, housing, cultural artifacts, age distributions, and tools. We can speculate about how an upright stance, enlarged brain area, and increasingly sophisticated tools reflect changes in human behavior in our history. We can hypothesize what sorts of cognitive demands were made on early hunters and gatherers and the extent to which these demands are similar to or differ from those in modern human environments. What was adaptive generations ago may not be adaptive today, however. For example, a preference for fats and sugars was adaptive in our early history, but not now, and in fact leads to obesity and Type 2 diabetes. As another example, attention-deficit/hyperactivity disorder (ADHD) may consist of tendencies that were adaptive in early humans (Jensen et al., 1997). Rapid scanning, quick responses, and high motor activity work better for monitoring threats and escaping from enemies than for reading and concentrating on homework. Moreover, the function of a behavior may be far from obvious. "Morning sickness" and the food aversions associated with it during early pregnancy may protect the fetus from toxic foods at a time when it is most vulnerable (Profet, 1992). Food aversions are most common for foods high in toxins.

Methodological Limitations ▸ One obvious limitation to applying ethological methods to humans is that the most critical experiments are unethical. We cannot perform experiments such as preventing an infant from seeing a human smile for the first few weeks of life in order to see if the social smile is innate. In an early, misguided experiment, Frederick II (1194–1250) raised babies in silence and near isolation to find out if there is a "natural" human language. The babies, not surprisingly, died before the outcome was clear (Wallbank & Taylor, 1960). Instead of experiments, we must rely on naturally occurring atypical situations, such as infants born blind or deaf, institutionalized infants, or infants of mothers who are hospitalized and thus absent for a long period.

A limitation to naturalistic observation is that it is not clear what constitutes a "natural environment" for children in a highly technological society. Should we study children running through a meadow, sitting in a classroom, or playing electronic games? Moreover, developing a comprehensive ethogram of human infants would be a time-intensive, expensive undertaking. As Charlesworth noted, "Unlike most tests, which throw out a small net with a small mesh, the present method throws out a big net with a small mesh and thereby catches many small fish. Herein, of course, lies a big problem of effort and cost. The net gets awfully heavy very quickly" (1979, p. 522). It also is not always clear what behaviors are relevant. An observer unfamiliar with Bowlby's work might well record that the infant crawled to the door of the adjoining room but would probably not record the distance between the mother and the infant.

Content Limitations ▸ Certain psychological phenomena that are not consistently reflected in spontaneous overt behavior may be difficult to study from the ethological perspective. Cognition is a good example. A researcher might be limited to studying overt behaviors, such as removing a physical barrier blocking a desired object. Since cognition and motivation become more complex with increasing age, ethological observations may in general be more informative in infants and toddlers than in older children.

Contemporary Research

The influences of ethological and evolutionary theory on developmental psychology can be seen most clearly in three contemporary topics—attachment, the evolution of human cognition in social groups, and adaptation during development.

Attachment ▸ Research on attachment categories was presented earlier in this chapter, and work on internal working models appeared in the Freud section of this book. Most contemporary research on attachment focuses less on categories of attachment and more on psychological and biological processes involved in both child attachment and relevant parenting behaviors. The focus is on the process of forming a socioemotional relationship between parent and child, with attention given not only to parent effects on children but also how child factors, such as temperament, affect the parent (Laible, Thompson, & Froimson, 2015).

A typical model of the development of attachment is the following (Cassidy et al., 2013): Children develop an attachment behavioral system, which is an organized system of behaviors with the goal of establishing proximity with the parent in order to obtain protection. The parent's state of mind regarding attachment contributes to both their caregiving behavior and their child's attachment. The child's attachment consists of two-way interactions between an internal working model and physiological processes. The child's attachment then contributes to her developmental trajectory—either successful psychosocial functioning or psychopathology.

Much of the recent research identifies correlates between parenting quality and infant attachment, or between attachment categories and later child behaviors (e.g., empathy, compassion, altruism, internalizing or externalizing symptoms) and adulthood functioning (e.g., romantic relationships; parenting behaviors). Particularly of interest are the mechanisms underlying these links. Recent breakthroughs in genetics and neuroscience have provided additional levels of explanation of the process of attachment. For example, researchers have identified genotypes associated with the various attachment styles, particularly disorganized attachment (Spangler, Johann, Ronai, & Zimmermann, 2009). Contemporary neuroscience models of attachment generally propose that the brain systems underlying attachment involve sensitivity to threat in the environment and regulation of attachment-related behaviors and emotions (Gillath, 2015). Brain imaging is clarifying the child and parent neural correlates of attachment categories, such as underlying brain networks or brain volume. For example, mothers showed different brain responses when viewing their own 3- to 6-month-old infant's face, compared to the face of another infant (Esposito, Valenzi, Islam, Mash, & Bornstein, 2015). Thus, today attachment is viewed as a process involving genetics, physiology, cognition, emotion, and behavior.

New directions in attachment research include the role of attachment style in constructing enduring patterns of response to stress, relations between attachment and health and immune function, school readiness, and culture (Cassidy, Jones, & Shaver, 2013; Rholes & Simpson, 2015). For example, insecure attachment during childhood and adulthood is related to altered stress responses, which affect the immune system and lead to poor health outcomes (Pietromonaco & Powers, 2015). Researchers also have added biological measures. Of particular interest is the role of the neurohormone oxytocin in promoting social bonding. For example, over the first three years of life, parents' oxytocin levels predict their children's oxytocin levels (Feldman, Gordon, Influs, Gutbir, & Ebstein, 2013). The child's social reciprocity with a friend was correlated with the child's oxytocin levels, the mother's oxytocin-related genes and hormones, and mother–child reciprocity. One important unanswered question concerns the mechanisms underlying the intergenerational transmission of attachment—how a child's attachment category links to her adulthood attachment category, and how the latter, through the adult's state of mind regarding attachment, affects her parenting behaviors and thus her child's attachment. In other words, what are the relations between the caretaking system and the attachment system (Cassidy et al., 2013; Jones, Cassidy, & Shaver, 2015)? Another important question concerns whether the findings largely based on maternal behavior apply to fathers as well.

Evolution of Human Cognition in Social Groups ▸ The five species of great apes (gorillas, orangutans, chimpanzees, bonobos, humans) share a common ancestor from approximately 15 million years ago, and the last three share a common ancestor from about 6 million years ago (Tomasello & Herrmann, 2010). What is unique about human cognition? The great apes have considerable genetic similarity: Chimpanzees and modern humans, for example, share approximately 95 percent to 99 percent of their genetic material, a proportion similar to that of lions and tigers or rats and mice (King & Wilson, 1975). The other great apes clearly have certain humanlike cognitive and social skills and, in fact, are surprisingly sophisticated cognitively (Call & Tomasello, 2008). They understand the physical world much like humans do. They can count, communicate, recognize themselves in a mirror, and understand object permanence. They also can deceive others of their species so that they are misled as to the location of food, engage in pretense, and predict others' behavior on the basis of their emotional states and direction of locomotion. Chimpanzees have been observed pretending to pull an imaginary pull toy and even carefully disentangling the imaginary string (Hayes, 1951). They understand kinship and dominance relations, and they will select an appropriate ally, such as someone dominant over their opponent. Great apes even understand certain mental states. Chimpanzees, in a within-species competitive game, showed that they know whether their competitor knows or does not know something, though they did not understand false belief (Kaminski et al., 2008). Thus, "chimpanzees know what others know, but not what they believe" (p. 224).

Human thought is unique mainly in the ability to engage in joint attention and cooperative communication, and thus coordinate efforts and collaborate (Tomasello, 2014). These cognitive skills are possible because humans can think about others' perspectives, reflect on their own thinking, and think about others' thinking and one's own in a recursive way ("He's thinking that I'm thinking that. . . ."). That is, humans can represent others' thinking (including false beliefs), interpret their perspectives, and monitor their own thoughts. These skills evolved when ancestral humans faced problems presented by attempts to collaborate and communicate with others. Specifically, early humans' small social units required them to hunt collaboratively to acquire enough food. In order to collaborate, they had to be able to recognize others, communicate at least nonverbally, and form long-term social relationships. Collaboration also encouraged members to help each other so they would be available for future collaboration. Later, when societies became so large that members could not know all group members, humans came to rely on information about who belonged in their group. These ideas have generated research with children. Infants start helping others around 12 to 18 months (Warneken, 2015). By age 3½, they act prosocially toward their collaborative partners, and by age 5, both collaborating with others and belonging to the same group (even if the assignment to a group was arbitrary—a green group and a yellow group) led children to prefer, help, and trust their collaborative partners (Plötner, Over, Carpenter, & Tomasello, 2015). More generally, young children tend toward an in-group bias of liking, acting positively to, and feeling obligations to their own group, and a bias toward viewing out-groups negatively (Rhodes, 2013).

The economic necessity for larger groups with coordinated roles and perspectives, shared understanding that permitted communicating through language, and collective intentions, also led to the development of culture—norms and institutions (Tomasello, 2014). Humans' social-cognitive skills permitted them to engage in cultural learning and pool their cognitive resources. Humans can work together to create new knowledge about objects, quantities, tools, and social relations that cannot be created by a single individual. Cultural artifacts, such as language and other social tools or systems of belief, were developed in each generation and taught to the next. Although young chimpanzees can communicate and learn how to use tools from adult chimpanzees around them, only humans show *cultural transmission*—an evolved biological mechanism that enables children to take advantage of the knowledge and skills acquired over generations by the species. Children grow up surrounded by the very best tools and symbols that the species has developed. A simple example, based on evidence from physical artifacts, is that during human evolution hammers changed from simple stones to stones tied to sticks to modern metal hammers and mechanical hammers

(Basalla, 1988). Humans were able to improve the tool because they understood what the purpose of the tool was (that is, what people *intended to do* with the hammer); they could go beyond simple imitation of someone using a particular type of hammer.

As a result of this evolutionary heritage, young infants can develop the knowledge that other humans are like themselves, with intentional and mental properties. The mirror neuron system discussed in Chapter 6—brain activation that is similar to that of the person observed performing some behavior (e.g., Keysers, Thioux, & Gazzola, 2013)—may facilitate young children's understanding of the psychological causes of another's behavior. Tomasello refers to the "9-month social-cognitive revolution" in which infants begin to understand others as intentional beings. They see others as similarly motivated by goals and thus begin to share attention, as well as intentions, with other people, toward objects and events. Once this social cognitive skill evolved, humans could "imagine themselves 'in the mental shoes' of some other person, so that they can learn not just *from* the other but *through* the other" (Tomasello 1999, p. 6). In this way, infants understand *why* others are using a tool or symbol—what the person intends to do with it. With this understanding, children can engage in cultural learning and become full participants in various cultural rituals and games. Language obviously is particularly important, for example, to ensure that children engage in complex interactions with others that demand negotiation.

Adaptation During Development ▸ Many species have adapted to their environments by evolving specific innate behaviors. In contrast, humans have adapted by evolving plasticity—flexibility in the hormonal system, the expression of genes (see later), and, especially, the brain. Thus, in humans, adaptation is a developmental phenomenon, as the young learn about their environment and adapt to their particular local conditions.

The young brain exhibits flexibility, but this decreases as brain regions becomes specialized to respond mainly to certain kinds of stimuli, such as faces or moving bodies. This plasticity is adaptive because it keeps the brain open to learning about the specific features of the child's particular environment (Bjorklund, 2007; Bjorklund & Ellis, 2014; Bugental et al., 2015). Moreover, understanding the complex human social structure requires a big brain, which necessitates an extended infancy and childhood. This extended period for maturity is a risky strategy for the human species, because infants cannot obtain food or flee from enemies on their own. Moreover, it takes a lot of cognitive resources to constantly scan and evaluate environments.

Early childhood is a sensitive period during which children learn about positive (e.g., resources) and negative (e.g., violence) aspects of their environment and use this information to adapt by calibrating their developmental trajectory (Bugental et al., 2015). Specifically, they learn what physical and social resources are available in the environment, how predictable these resources are, how trustworthy other people are, whether close relationships are likely to last, and what threats exist. For example, early experience with "growing up in poverty, exposures to violence, harsh childrearing practices . . . shifts resource allocations toward more risky and aggressive behavior, earlier pubertal timing and sexual debut, enhanced early fertility, less stable pair bonding, more offspring, and less parental investment per child" (Bjorklund & Ellis, 2014, p. 237). In earlier evolutionary times, this strategy would have maximized people's reproductive success (Bugental et al., 2015). It may be that the predictability of the environment is key. Having an unpredictable, rapidly changing environment (e.g., moving a lot, parents changing jobs frequently, divorce) from birth to age 5 is the best predictor of this fast-track developmental trajectory (Simpson, Griskevicius, Kuo, Sung, & Collins, 2012). Moreover, this early adaptive strategy of impulsivity and risk taking developed in uncertain environments affects later behaviors during adulthood; how adults respond to indicators of current resource scarcity (impulsive and risky decisions) depends on their childhood socioeconomic status not their current one (Griskevicius et al., 2013).

Adaptation during development is constrained by many factors, such as species-specific genes, the child's developmental level (e.g., how much information about the environment can be processed), the nature of developmental mechanisms (e.g., small rather than large leaps in cognitive change), and characteristics of the environment (e.g., available resources). Thus, children inherit the ability to modify their own development so that it is maximally adaptive to local conditions, but within limits, and with the possibility of making wrong choices. Still, this imperfect evolutionary strategy may be the best balance between wired-in behaviors and total plasticity.

Bjorklund (Bjorklund, 2007; Bjorklund & Ellis, 2014) argues that although some of children's behaviors were selected for and are developing because they will lead to an adapted adult, some may have evolved because they serve an adaptive function only at a particular time in childhood. Certain reflexes, such as the grasping reflex, are present in newborns but then disappear several months later after they have served their purpose of aiding survival during that particular period. Also, the cognitive immaturity that goes along with brain plasticity during childhood allows time for play, which may provide a sense of mastery and self-efficacy that encourages children to try out new activities and roles. These activities and roles provide opportunities for learning new skills. Even behaviors that seem maladaptive actually may be adaptive. For example, toddlers' limited working-memory capacity may be adaptive for language learning. The reason is that restricting how much language information can be processed simplifies the language corpus that is analyzed, and this in turn simplifies the process of acquiring language. Children first may acquire single syllables and then gradually deal with more information and increasingly complex information. If children could initially process more linguistic information, they might be overwhelmed by the amount of information and not be able to extract anything useful. In this case, less is more (Newport, 1991).

An example of immature, but advantageous, cognitive skills from the preschool period is children's poor awareness of their cognitive performance, for example, their vastly overestimating how well they perform, even after feedback that they have performed poorly (see Chapter 7). Until approximately age 7, children unrealistically think of themselves as "one of the smartest kids in my class" (Stipek, 1984). This seemingly nonadaptive characteristic may in fact be quite adaptive. This Pollyanna attitude may encourage them to keep trying to do activities that are beyond their current ability level. In this way, they obtain valuable experiences that strengthen their skills. Because they do not expect to fail, they may not be afraid to try out a variety of new activities. This optimism and disregarding negative feedback also may be seen when children continue to use a good, new strategy that does not yet help them (Miller & Seier, 1994; see Chapter 7). This attitude keeps them using and thus strengthening the new strategy until it can help them. Another adaptive cognitive immaturity may be Piaget's notion of egocentrism. Children's bias toward perceiving and conceptualizing in terms of their own perspective obviously limits social understanding and interaction, but it may help them in other ways. Given that people tend to remember better when they relate the information to themselves (e.g., Pratkanis & Greenwald, 1985), egocentrism actually may help young children's recall. Thus, although we tend to see young children's apparent limitations as evidence that they are less advanced than older children and adults, they may be quite well adapted to the demands of their particular developmental period.

In sum, ethology and evolutionary psychology have made significant contributions to developmental psychology. They provide a larger temporal context in which to view development. The focus on the function of molar behaviors complements the focus of most current biologically oriented developmental work on cells and the brain. We now turn to two main contemporary biological perspectives on development—developmental neuroscience and genetics.

Developmental Neuroscience

The human brain has evolved relatively recently:

> If we compressed the 4.5 billion year history of the Earth into a 24-hour period, the first single-cell organisms would have emerged around 18 hours ago, the first simple nervous systems separating animals from plants would have emerged around 3.75 hours ago, the first brain would have emerged about 2 hours and 40 minutes ago, the first hominid brain would have emerged less than 2.5 minutes ago, and the current version of the human brain would have emerged less than 3 seconds ago.
>
> *(Cacioppo & Cacioppo, 2013, p. 667)*

The boom in research exploring the human brain began in the 1990s, designated the "decade of the brain." This exciting new work was stimulated by new technologies of brain imaging that generate maps of brain activity. Here are some of the more common techniques: Several measure currents produced by electrical activity of brain neurons—for example, electroencephalography (EEG; sensor electrodes placed on the scalp) and magnetoencephalography (MEG). Others measure brain activity indirectly, by assessing blood flow and oxygenation as an indicator of increased neural activity—for example, functional magnetic resonance imaging (fMRI) and near-infrared spectroscopy (NIRS). MRI uses a magnetic field and pulses of radio wave energy. DTI (diffusion tensor imaging)—a variant of MRI that detects the movement of water—can be used to infer information about the pathways of brain white matter (brain tissue containing nerve fibers). PET (positron emission tomography) uses radioactive tracers in a dye injected into the bloodstream.

Each of these technologies has strengths and weaknesses for describing the structure and functioning (changes in activity) of the brain (see de Haan, 2015). For example, some tell us more about spatial patterns of brain activity, and others tell us more about the time course of this activity. Techniques vary in their spatial resolution and their temporal resolution of a moving image. Some (e.g., EEG) can be used with very young children but are limited because they do not probe deeply into the brain. PET cannot ethically be used with children because of the radioactive tracers. Moreover, there obviously are challenges with doing neuroimaging with squirmy young children, but researchers are developing creative ways to do this. Thus, the choice of a technique depends on the research question and the person's age.

Neuroimaging methods reveal brain functioning when, for example, a picture or sound is presented. Thus, one could compare the patterns of brain activity in children of different ages or ability levels working on the same task, to infer developmental differences in cognitive processing. Or children of the same age might engage in different sorts of tasks thought to activate different cognitive skills, such as numerical and spatial reasoning. This approach provides information about the relations among brain regions (and among concepts). The patterns of brain activity associated with the two tasks might show both commonalities and domain-specific activity, thus addressing the issue of whether children's thinking forms a general stage or domain-specific areas of knowledge.

Neuroimaging initially focused on identifying the particular region of the brain primarily associated with particular cognitive activities, emotions, or behaviors. More recently, models depict neural networks that may involve several regions of the brain. Also, measures have expanded beyond detecting brain activity to include anatomical measures, such as thickness of the cerebral cortex, that might show significant developmental changes.

In addition to providing information about the brain correlates of behavior, neuroimaging makes several contributions to assessment of abilities. Some imaging techniques can be used with infants, which is an important methodological contribution to developmental psychology, given that infants have few behaviors that can be used for assessment. Another methodological contribution is that imaging sometimes provides more sensitive assessments of social or cognitive skills that are not yet detected by behavioral measures. For example, after an eight-month exercise program, obese children showed brain changes in their fMRI's consistent with improved executive function—a change that was not detected on standard behavioral assessments (Krafft et al., 2014).

A few words about brain anatomy and functioning can set the stage for a discussion of brain development by showing the enormity and complexity of the brain: "The brain is rather like a large, very wrinkled walnut" Karmiloff-Smith (2012, p. 3). If all the surface of the brain were laid out flat, it would be about the size of a football field. The fibers in white matter, laid into a line, would stretch 100,000 miles, enough to circle the earth four times. There are approximately 100 billion neurons in the brain. Each neuron might connect to approximately 1,000 neurons.

The cerebral cortex, which is critical for humans' advanced cognition, language, and perception, accounts for 80 percent of the brain's volume. For the purposes of this chapter, it is most important to know that the frontal lobes, at the front of the brain, involve activities of great interest to psychologists, such as thinking, intentionality, voluntary movement, personality, and attention. As for brain functioning, this occurs at various levels. At the cellular level, chemical substances such as neurotransmitters (e.g., dopamine and serotonin) transmit signals across a *synapse* (connection between neurons) to another nerve, muscle, or gland. At the brain level, activated neural networks across various regions collaborate to produce thought, feeling, or behavior. Finally, any one region of the brain carries out many functions, though it may be more responsible for particular functions.

The following section describes some of the main themes of brain development and its links with behavior. It provides an overview, rather than a detailed technical account, in order to focus on models of developmental neuroscience. These themes are derived mainly from several recent key sources in this area (e.g., Johnson & de Haan, 2015; Stiles, Brown, Haist, & Jernigan, 2015).

Brain Development

1 **Early anatomical changes** Important structural changes in the brain occur in the first few weeks and months of life: For example, the rapid increase in *myelin* (insulation around the nerve fibers) increases the speed and efficiency of the transmission of neural signals and thus enhances information processing (see Chapter 7). As discussed in the neo-Piagetian section of Chapter 2, being able to think about, and manipulate, larger amounts of information is necessary for moving to the next cognitive level. Although this anatomical change is most rapid in the first few years of life, the efficiency of information processing continues to improve until late adolescence or early adulthood.

2 **Strengthening or pruning of connections between neurons** A major task for the brain, especially in the first two years of life, is to form connections between neurons as a result of environmental stimulation. These neural networks, which typically involve numerous neurons, become increasingly refined through late adolescence and continue to change throughout the lifespan. Infants have many more neurons and synapses than end up actually being used. This is one reason why the human infant brain has so much plasticity for adapting to local conditions. Neural pathways that are not used are pruned away—a

sort of "neural Darwinism" (Edelman, 1987)—while others strengthen. The complex relations between biology and experience can be seen in this biologically driven overproduction of synapses early in development, coupled with the pruning away of certain ones because they are not stimulated by experience. An example is infants' perception of phonemes. Infants are born with the ability to discriminate the sounds of all human languages, but the particular subset of these phonemes that they still can discriminate by late infancy depends on the language or languages to which they were exposed during early infancy. Through pruning, they lose the ability to discriminate the phonemes of languages that they do not hear.

The brain seems to have major periods of growth and then pruning during the toddler years and adolescence. These periods of rapid neural growth might indicate that some developmental change is qualitative, especially if it involves brain reorganization, thus addressing the issue of qualitative versus quantitative development.

3 **Increased specialization** At first, most areas of the cerebral cortex are capable of performing a variety of functions. However, the cortex becomes increasingly lateralized, with the left hemisphere typically becoming more dominant. Moreover, with increasing age, brain regions and networks become more specialized, committed to particular activities. In general, a particular task elicits a larger, more diffuse area of brain activity in children than in adults. That is, the engagement of neural networks becomes more specific during development. The outcome is that brain plasticity decreases as brain regions commit to particular tasks. This can be seen, for example, in the fact that late second-language learners do not achieve the level of proficiency of earlier second-language learners. Late second-language learners may even process the second language differently from native speakers. These findings suggest that the brain organization associated with the first language has to be used to learn the second language later. Similarly, the greater ease of discriminating faces from one's own race than faces from other races, when babies primarily have seen faces of their own race, is reflected in different patterns of brain activity when comparing two same-race versus two different-race faces, showing brain specialization for same-race faces (Vizioli, Rousselet, & Caldara, 2010). The experienced brain cannot go back to its less differentiated past.

4 **Effects of environmental stimulation** Normal brain development is dependent on environmental stimulation. Without the stimulation that a typical human environment would have, for which the brain evolved, the brain develops differently. Most children, because

they are physically normal and are raised in an environment typical for the species, have more or less the same sorts of experiences at about the same time. Thus, the pruning proceeds along similar lines for most children. However, what about atypical situations, such as children who are deaf or blind and thus do not receive auditory or visual stimulation? In deaf children, certain areas of the brain that normally would be devoted to auditory processing if the brain received both auditory and visual stimulation instead gradually become devoted to visual processing (Neville, 1995). Conversely, in blind children, areas normally devoted to visual processing when receiving both auditory and visual stimulation instead are devoted over time to auditory processing. Thus, when an area of the brain does not receive its normally expected input, it can be used for other purposes. The brain is preset to rapidly guide children along certain developmental paths, but it is also flexible enough to deal with atypical circumstances. Thus, cognitive neuroscience research is about brain plasticity as much as brain determinism of behavior.

The social environment is as important as the physical environment. For example, infants of mothers experiencing high stress due to social isolation have an altered development of brain inhibitory systems (Huggenberger, Suter, Blumenthal, & Schachinger, 2013). The mothers' mental–emotional state likely decreased their verbal and nonverbal interaction with their infants, which prevented typical pathways from developing and instead set in motion other pathways. Recall also the atypical developmental timetable or pathways set in motion by adverse or unpredictable local conditions, described earlier in this chapter.

5 **Constraints on brain development** These constraints are genetic, environmental, and developmental (the current developmental level of the child). Genetic constraints that impact the structure and function of the brain are discussed in the genetics section of this chapter. The environment sets limits on ways that the brain might develop; it presents options, but not all possible options. Developmental constraints, such as the current organization of the brain system, influence subsequent brain development.

6 **Brain areas develop at different rates** Subcortical brain areas, associated with emotion and sensitivity to reward (e.g., the amygdala and striatum) mature rather quickly. In contrast, prefrontal areas (the front part of the frontal lobes), which support higher-level cognition, especially control over one's thoughts and behaviors, develop more gradually over a longer period of time, continuing even through early adulthood. Thus, young adolescents have an imbalance between

early maturing subcortical structures that increasingly draw them into risky, rewarding behaviors, and later maturing structures for cognitive and emotional control that could put the brakes on these behaviors. This asynchrony presents an interesting theoretical model to explain normal young adolescents' tendencies to engage in risky behaviors, followed by decreases in risk taking in later adolescence as prefrontal areas continue to develop (e.g., Steinberg, 2011). Given these neural findings, along with the significant social and hormonal changes during adolescence, it is not surprising that adolescence seems to be a time of increased vulnerability for psychopathology (Powers & Casey, 2015).

7 **Lifespan changes** Brain changes, including strengthening and weakening of synapses, continue throughout the lifespan. The brain is always a work in progress. During aging, the brain does, for example, becomes smaller and there is a reduction in neurotransmitters. However, certain experiences, such as exercise, can cause changes in the brain that improve brain functioning during the aging years. Contrary to prior belief, recent research shows that new neurons are created throughout our lifetimes, even during old age. This finding questions some of the theories of aging that focus on cognitive loss.

From these themes, the most important point may be that neuroscience research shows the impact of environmental influences on the brain as much as brain influences on behavior. The next section describes contributions of neuroscience to developmental theoretical issues, including interactions of nature and nurture.

Theoretical Issues

What can a neuroscience perspective contribute to our theoretical understanding of development? A main contribution is that neuroscience increases our understanding of how nature and nurture collaborate in complex ways to drive development. The research findings reported above show how environmental inputs to a plastic, yet constrained, brain start a journey down a particular developmental path. Moreover, as described later in this chapter, the brain often is the mediator between genes and behavior, as genes affect behavior and behavior affects gene expression.

Neuroscience findings bolster theories emphasizing the evolution of humans within social groups (e.g., Tomasello, 2014) and identifying the importance of early social experience. A main function of the brain is to recognize and interpret social information. Even in infancy, "babies' brains are adapted to tap into the richest source of new information in their early environment: other human beings" (Johnson, 2013, p. 8). As

Grossmann (2015, p. 1266) notes, "Humans are such intensely social creatures that already as young children they outperform their closest living primate relatives (the great apes) in terms of their social-cognitive skills, while showing very similar skills as great apes when dealing with the physical world." For example, even a rather subtle emotional response such as empathy can be tracked in terms of its changes in brain activity during childhood. These changes, measured by EEG, indicate a gradual decrease with age in emotional arousal and an increase in cognitive evaluation of the situation (Cheng, Chen, & Decety, 2014). More generally, there seems to be a network of specific brain areas focused on the processing of social information that is somewhat independent from other forms of cognition.

Developing brains are sensitive to both positive and negative social environments. On the positive side, neuroimaging documents competent mothering. For example, competent mothering of children at age 12 predicted brain changes (seen in MRIs) thought to indicate positive development at age 16 (Whittle et al., 2014). On the negative side, stresses from maltreatment (Bruce et al., 2013), low socioeconomic status (Muscatell et al., 2012), and institutionalized rearing (Mehta et al., 2010) are associated with brain functioning in children and adolescents that differs from that of children reared in more typical environments. Even mild stressors affect brain activity. In one study (Graham, Fisher, & Pfeifer, 2013), mothers' reports of higher conflict between parents was associated with infants' greater neural responses to very angry speech, compared to neutral speech, across several brain regions known to be involved in emotion and reactions to stress.

Some neuroscience models have addressed explicitly the continual interplay of biological and environmental influences and the causes of diverse developmental pathways. As described in Chapter 2, neuroconstructivism posits slight initial brain constraints or biases such that, for a particular task and situation, some neural pathways are more easily activated or more easily connect to certain outputs. Examples are infants' biases toward looking at faces or analyzing language sounds. Infants seek out these stimuli, which further strengthens and specializes these pathways. Thus, infants may be slightly biased to look at particular types of stimuli, but the small biases become further amplified through specialized activity. The outcome is specialization of brain pathways, because the infant does not use the other pathways that initially could have been used. Slight individual differences in brain structure or function initially also could cascade into larger differences later that are considered neurodevelopmental disorders.

As for other theoretical issues, neuroscience can address the issue of quantitative versus qualitative development. Imaging reveals qualitative changes in the changing organization of neural networks during development and quantitative change in the strength of activation of each neural network. Neuroscience findings also can inform the issue of the extent to which cognition is general versus domain specific. The increasing specialization of areas of the brain during development suggests that cognition becomes more domain specific during development.

Another contribution to theorizing is that cognitive neuroscience research can test some of the claims of theories presented in this book. For example, the fact that cognitive tasks activate both cognitive-control and motor areas of the brain (Diamond, 2000) suggests close connections between action and thought. This could be taken as support for Piaget's claim that motor actions play a key role in cognitive development. Relevant to Piaget's claims about stages, if engaging in two tasks believed to tap the same knowledge system in fact activate the same neural networks, this would suggest that the two cognitive skills involved are part of the same cognitive structure rather than two domain-specific ones. Also relevant to Piaget, seeing how different neural networks interact at various ages can provide clues to age differences in cognitive organization. Another issue relevant to Piaget is whether the unexpected competence of infants described in Chapter 2 indicates the same level of knowledge as that of older children at the age when Piaget thought they develop that concept. The fact that EEG and NIRS measures of infants' face and eye gaze processing, joint attention, and understanding of human action detect precursors of later networks for social cognition (Grossmann & Johnson, 2014) could suggest that social understanding at these two ages is related but not identical. A final example is that the observed heightened self-consciousness of adolescents, described by Piaget and Erikson, has been supported by fMRI measures. When research participants thought that a peer was actively watching them, adolescents showed higher physiological arousal compared to other ages, as well as engagement of brain regions thought to be involved in the processing of socioaffective information (Somerville et al., 2013).

Applications

The neuroscience approach has led to a number of interesting applications. An important one is the insights into atypical development due to brain injury, atypical environments, or neurodevelopmental disorders.

This information about brain functioning in such children both clarifies typical development and suggests interventions for children developing atypically. For example, 3- and 4-year-old children with autism spectrum disorder (ASD) showed an atypical pattern of brain activity when viewing photos of an unfamiliar woman with a neutral or a fearful expression (Dawson, Webb, Carver, Panagiotides, & McPartland, 2004). Given that the ability to accurately identify emotional states in other people is critical for using emotions to explain behavior, children with ASD clearly are disadvantaged in this way. One goal is to detect brain patterns during infancy that predict the later development of ASD so that interventions can begin early.

Another important application has been to legal issues, an area called "neurolaw." Evidence about adolescents' asynchronous brain development, with emotions running ahead of the development of inhibition, contributed to the Supreme Court decision to end sentences of life without parole for crimes committed by minors. The reasoning was that adolescents' neurobiological immaturity makes them less responsible for their actions than are adults. Still another application is called "educational neuroscience." The idea is to use information about children's brain development to design instruction.

Summary

Neuroscience findings and theoretical models have generated a great deal of excitement in developmental psychology for three reasons. First, neuroscience provides additional levels of analysis for understanding development. This information about the biological processes involved in behavior has become increasingly important as developmental theorizing has moved more and more to a focus on development as a changing system, with interacting levels from cells to society (see Chapter 9). The brain is one important part of this organized, interactive system. Second, neuroscience has revealed the importance of experience and learning, as much as the brain, when explaining behavior. In this way, neuroscience strengthens the long history of developmental research on the influences of the environment. One sees brain plasticity throughout life in the strengthening or weakening of synapses and the formation of new neurons and new synapses as the contexts of development change. Development involves continual interplay among brain development, behavior, and environmental resources. Third, neuroscience findings serve as a bridge to clarify the relations between genes and the environment. As described in the next section, the brain often is the mediator between the expression of genes into thinking, feeling, and behavior, and between environmental conditions and the expression of genes. Still, it should be noted that some developmentalists are concerned that the focus of developmental psychology has shifted so much toward neuroscience perspectives that the field is out of balance empirically and theoretically as well as in resources such as grant funding, employment, and university investment in research.

Genetics

Genetics has had a presence in developmental psychology for decades, particularly in discussions of the nature–nurture issue—how genetic predispositions come together with environmental factors to contribute to behavioral outcomes. However, recently the conversation has shifted. Historically, behavioral geneticists could ask "*How much of the variation in this trait* (e.g., IQ) is due to genetic differences among individuals *in this population* and how much is due to environmental differences?" The question was about sources of individual differences in a group. Researchers often looked at how the known degree of genetic relatedness in the group correlated with similarities in a trait. Thus, they studied families, twins, and adopted children. For example, studies have compared adult identical twins, separated early in life, to estimate the relative contributions of genetic and environmental influences. This approach continues today and is clarifying some of the nuances of heritability. For example, the siblings of individuals with schizophrenia have impaired functioning in several areas of cognition compared to normal control families, even when these siblings do not develop schizophrenia (Barch, Cohen, & Csernansky, 2014).

A newer approach in developmental psychology draws on *molecular genetics* to ask a different question. It asks how the meshing of genes and environment *in an individual* causes a trait. What is the causal pathway from genes to cells to tissues to organs to behaviors, and vice versa? This question could not have been studied before technologies for assessing genetic makeup were developed. Geneticists' drive to map the genome, in the Human Genome Project, basically completed in 2003, provided techniques to determine the order of DNA building blocks in an individual's genetic code (see the beginning of this chapter). Psychologists then used these techniques to try to map the gene–environment connections throughout development. That is, they correlated genetic variations with variations in behavior. In part because genetic analyses now are accessible and cost effective, research in this area has boomed in psychology.

Molecular genetics has generated a great deal of excitement in developmental psychology because it provides the genetic component for new theoretical models of the developmental unfolding of brain and behavior as influenced by genes and the environment together. This contemporary approach involves Gene X Environment interactions (G X E) and epigenetics (when the environment causes chemical changes affecting regulation of the genes). We now look at each of these.

Models of Gene X Environment Interactions

Mapping the human genome did not lead to the dramatic breakthrough in understanding physical and mental illness that geneticists expected. A likely reason is that genes are only part of the equation for human physiology and behavior. Genes are simply potentials that may or may not be expressed in particular environments, so in a sense we need to map the human environment as well as the human genome. G X E interactions show that the environment moderates the association between a particular gene variant and an outcome. For example, the known association between a particular gene variant and depression might be strongest in people who experience stressful major life events. Thus, genes may or may not be expressed, depending on a child's developmental contexts. Similarly, a person's genotype moderates the effect of an environmental factor on outcomes, such as traits, behaviors, mental health, and cognition. For example, highly stressful life events might be more likely to lead to depression if a person has a particular pattern of genes. Thus, due to the contributions of the environment, a given *genotype* (genetic makeup) can result in different *phenotypes* (outcomes—traits, behaviors, etc.) in different children, and a given phenotype can reflect different genotypes in different children.

To understand G X E interactions, it first is necessary to review a few basic genetic concepts. Humans have 23 pairs of chromosomes in each cell, and each chromosome is composed of thousands of genes. Genes are short segments along a long chemical spiraling chain of two strands of DNA (see Figure 5.2). The basic chemical building blocks of each gene's DNA provide an information code (for example, the code at the beginning of this chapter) for making proteins. These proteins contribute to the development and regulation of the organism. This code involves particular sequences of these chemical building blocks. An *allele* is one of two or more possible versions of a gene; these are called

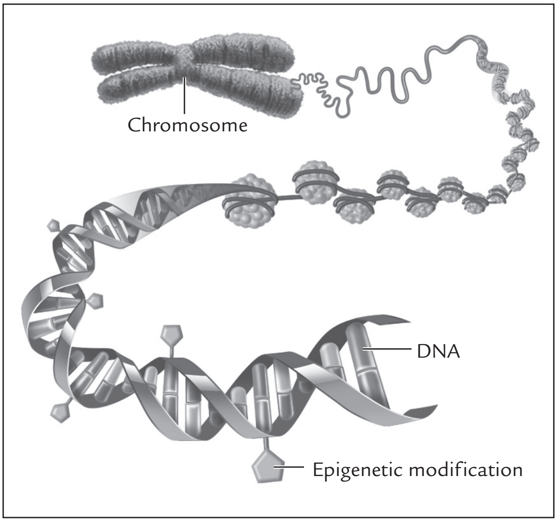

FIGURE 5.2
Chromosome structure, including epigenetic changes.
[Patricia Miller]

genetic polymorphisms—variants of a particular DNA sequence. Polymorphisms most commonly involve different versions of a single base pair (one of the four pairs of the genetic code presented at the beginning of this chapter) but instead can involve long stretches of DNA. A single gene may have many polymorphic regions and polymorphisms. An individual has two alleles for a gene pair—one from each parent. The two alleles in a gene pair can be the same or different versions, which affects which phenotype (e.g., eye color, blood type) a person has. This is a main source of genetic variation among individuals that could affect how much an environmental event or substance (e.g., an environmental toxin) affects them.

It is exceedingly complex to study G X E interactions because the genetic landscape is huge: A person's genome has 20,000 to 25,000 genes, which sounds like a lot, but is barely more than the number for the miniscule roundworm, and much less than the 32,000 for an ear of corn (Schnable et al., 2009). The genome has more than 3 billion bits of information. Thus, the search for the genes relevant to the behavior or trait of interest may seem like a search for a needle in a haystack. Still, the search takes place with the knowledge that the genomes of any two humans are more than 99 percent the same. Importantly, this one percent of variation can provide valuable clues to the nature–nurture issue.

Genes can be analyzed from a small amount of blood or saliva. One analytic technique is to examine variations across individuals in a very small region of a gene that, based on prior research, is a prime suspect for the outcome of interest. This is called the *candidate gene* approach. The initial results were exciting, but subsequently they were not replicated for the most part, perhaps because the gene–outcome link depends on the environment, as shown in the G X E findings above. Subsequently, researchers turned to a newer technique, called "Genome

Wide Association Studies" (GWAS), which examines much of the whole genome of a very large number of individuals (usually thousands) to detect genetic variations that are correlated with a particular mental or physical disorder. Particular genetic patterns tend to co-occur with schizophrenia, autism spectrum disorder, substance-use disorders, and bipolar disorder (e.g., Horga, Kaur, & Peterson, 2014). Typically the genetic pattern identified involves numerous genes, because few if any outcomes of interest to psychologists are due to a single gene. In fact, mental disorders likely are influenced by thousands of genetic polymorphisms (Hindorff et al., 2009). One finding of great surprise to geneticists is that about 98 percent of genetic variations are not even in the coding portions of genes but somehow help regulate genes' functioning. Little is known about how these noncoding variants (formerly considered "junk" DNA) influence outcomes. Another complication to tracking gene–behavior links is the discovery that what a gene can do can depend on nearby genes; genes can interact, such that one gene can suppress another one.

In general, the amount of variation in outcomes associated with genetic variations from these analyses has been disappointingly small. Thus, geneticists have moved to larger and larger samples to capture small correlations between genetic polymorphisms and behavior. Again, one reason that geneticists have found only small direct effects may be that the association is large only in particular environments, which reflects a G X E interaction. That is, the correlation may vary from one environment to another, for example, under conditions of parental support versus neglect. Thus, G X E interactions show that mapping the genome is not enough. At this point, psychologists have studied G X E interactions for a variety of outcomes (e.g., depression, drug abuse, psychopathology) in a variety of environments (e.g., high stress or trauma, neglectful parenting, poor nutrition, and low physical activity).

In Chapter 1, the discussion of the issue of how nature and nurture interact to direct development included examples of G X E interactions. A study was described (Brody et al., 2009) in which improving parenting skills provided a protective factor for adolescent boys who had a genetic predisposition for engaging in high-risk behaviors, such that the predisposition was less likely to be expressed. Thus, good parenting is like an insurance policy. If children do happen to be genetically predisposed to certain disorders that could be expressed under adverse circumstances, then the effects of good parenting and social supports may provide a buffer against gene expression and the resulting negative outcomes. Such findings are exciting to developmental psychologists, because they show that when children have both high-risk genes and a high-risk environment it is possible to create an environmental buffer to genetic tendencies. Complicating the choice of interventions, however, is the fact that the effects of an experience, such as a psychological intervention, depend partly on a person's genetic makeup.

The overall model of G X E interactions is that having, or not having, particular adverse experiences can "turn on" or "turn off" genes that predispose children to psychological or health problems later. This model obviously is of great interest to developmentalists, who want to know how genes are expressed during development in particular environments, which may differ from one developmental point to another. To understand how the environment can be a trigger or a silencer for relevant genes, it helps to liken a person's DNA to a large, organized library:

> Asking what DNA does is like asking what a book in this library does. Books sit on a shelf waiting to be read. Once read, the information in those books can have limitless consequences and can perhaps even lead to the reading of more books, but that refers to the book's potential. Likewise, DNA sits in our cells and waits to be read. The reading or so called "expression" of DNA can, like the books in our library, have limitless consequences. However, without the active process that triggers "expression," this potential may never be realized.
>
> *(Champagne, 2009, p. 27)*

Just as certain books are blocked and others are easily reached, both the environment and regions that regulate DNA can block DNA or make it accessible, thus affecting how easily DNA is expressed. The environment provides, or does not provide, the trigger. Ineffective parenting, high stress, or poor nutrition are examples of triggers. In this way, experience affects the expression of genes. The result is that each cell turns on only a fraction of its genes. Developmental psychology takes center stage in this work because turning on particular genes is timed to particular phases of development, as seen, for example, in puberty changes in adolescence. Similarly, whether a particular experience is a trigger often depends on the child's age and developmental history (for example, poor prenatal nutrition or lack of cuddling during infancy).

A fuller picture of the pathway between a genetic liability and an outcome comes from a recent study (Davies et al., 2015) illustrating the G X E approach. It shows that genetic variation affects the sensitivity of low-socioeconomic, predominantly minority toddlers to particular experiences, specifically, mothers' unresponsive caretaking. For children with a genetic pattern known to put them at risk for poor self-regulation, this poor parenting was linked to an increase in disruptive behaviors two years later. Children in the sample without that genotype did not show these disruptive behaviors. Thus, a given environmental variable, unresponsive mothering, may negatively impact only children with a particular genetic makeup; some children are more vulnerable than others to adverse family situations. The likely pathway was that prolonged unresponsive caretaking triggered the expression of the high-susceptibility genetic variant, which caused decreased dopamine activity in brain circuits involved in reward seeking. This in turn led to an uninhibited temperament, with sensation seeking and risk taking, which escalated into disruptive behaviors.

Epigenetic Models

One groundbreaking and startling finding is that one way that environments can affect gene expression (a G X E interaction) is through *epigenetics*—the modification of gene activity without actually changing the gene. These chemical changes to or near the genes affect which genes are turned on and which are turned off, and this change can continue into the future. In effect, these chemical tags serve as enhancers and repressors that reprogram the gene's activity. It is as if little red or green flags are attached to certain gene regions (see Figure 5.2). Epigenetic changes can be caused by poor prenatal nutrition, parental maltreatment, extreme stress, social isolation, and exposure to pollutants, as well as many other events. Various outcomes have been observed, including depression, schizophrenia, abnormal responses to stress, and decreased learning and memory. Every individual has numerous epigenetic changes during development.

The actual mechanism of epigenetics sometimes involves attaching certain chemical compounds to segments of DNA in genes, thereby affecting access to them and governing the gene's activity by suppressing or enhancing it. That is, the compound "turns on" or silences the gene. For example, in one study (Romens, McDonald, Svaren, & Pollak, 2015), high stress from parents' physical maltreatment of their children (ages 11 to 14) caused an epigenetic change affecting a gene involved in stress regulation. The disrupted hormonal system for regulating stress led to "cascades of downstream changes in biology and behavior" (p. 303) known to lead to later health and psychological problems. It often is the combination of genetic risk and environmental risk that can push children into a maladaptive developmental pathway. What is particularly important about epigenetics is that it potentially can be a permanent change that continues to affect development in the future.

Developmental science is at the heart of epigenetics because genes are expressed during development as experiences accumulate. At any developmental point, our epigenome (all our epigenetic changes) is the sum of the environmental signals it has received thus far. Thus, for example, the epigenetic effects of child maltreatment can accumulate and only at some point trigger a genetic region. Also, new experiences later in life can cause new epigenetic changes. Epigenetics is a lifelong process, and each change in our epigenetic makeup affects how we react to future environmental events. Also, developmental timing is everything. A particular environmental event might cause an epigenetic change in one developmental period but not another. Complicating the picture of environmental influences on gene activity even further, to some extent children create their own environments. For example, children with a genetically predisposed temperament to engage with adults may then evoke cognitively stimulating experiences from their environments, which then enriches their environment and affects what epigenetic changes might occur.

One of the most surprising findings is that epigenetic changes sometimes are passed on to future generations. For instance, maternal abuse and neglect can cause epigenetic changes resulting in abnormal reactivity to stress, which continues into the next generation (Champagne et al., 2006). This finding helps explain the observed cycle of abuse and its negative effects across generations. The impact of environmental effects on the next generation seems to contradict classical genetics principles taught in high school—that experience does not alter genes. However, it is not the genes themselves that are modified; rather, it is the "cellular memory" of the altered gene expression profile that somehow is transmitted.

It still is uncertain how abnormal gene regulation conditions are passed on. It may involve the transmission of the chemically changed context of the gene that altered its expression; the epigenetic signature is passed on. Or, the transmission may occur prenatally, affecting the development of the fetus. Suggesting prenatal processes, the newborns of depressed mothers also have the chemical changes associated with this gene expression in the blood of their umbilical cords (Oberlander et al., 2008).

Finally, an important, and intriguing, index of environmental influences on the genome is the length of *telomeres*—the tail-like regions protecting the ends of chromosomes. Telomeres are thought to be a molecular clock for biological aging in that eroded (and thus shortened) telomeres can indicate that factors such as smoking, obesity, or chronic stress have caused physiological wear and tear on the body (e.g., the cardiovascular system) and thus physical aging. Short telomeres are associated with chronic diseases of aging and early death. In a longitudinal study, children who experienced two or more forms of violence—domestic violence, bullying, or physical maltreatment by an adult—showed significant telomere erosion between ages 5 and 10, even after controlling for socioeconomic status (Shalev et al., 2013). Similar effects were shown in young adults, with high levels of stress at age 17 associated with nonsupportive parenting and predicting shorter telomere length five years later (Brody, Yu, Beach, & Philibert, 2015). Specifically, chronic activation of the body's stress response damages the body.

Theoretical Issues

In a sense, epigenetic findings even destroy the dichotomy between nature and nurture, because nurture changes the regulation of genes. In light of G X E interactions and epigenetics, perhaps the most accurate way to think about nature and nurture is that humans inherit resources for development rather than specific gene-based characteristics (Lickliter & Honeycutt, 2015). The meeting of genetic and environmental processes is exceedingly complex—more complex than ever imagined. An individual is constructed over the lifespan from a dynamic developmental system consisting of various levels from genes to environments, with causality in both directions. Moreover, genetics research shows the importance of the timing of a particular experience, consistent with ethologists' notion of sensitive periods. For example, the study described above on depression was conducted on adolescents because that is a time when a number of major psychiatric disorders appear, suggesting that adolescence may be a time of particular vulnerability to epigenetic changes. The fact that epigenetic effects can be cumulative and permanent provides an explanation for how adverse early experiences can cause problems years later.

One important theoretical advance is the *differential susceptibility hypothesis*, the theory that some children are especially affected by environments—both positive and negative ones—whereas other children are much less affected (Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2011). Some children are like dandelions, who seem to be rather impervious to environmental input and can grow in a variety of environmental circumstances; others are like orchids, highly reactive and very influenced by both harsh and highly nurturing environments. This concept may help solve certain mysteries from research on environmental influences. For example, some children show remarkable resilience in a childhood of poverty, abuse, and high stress and manage to stay on a positive developmental pathway. These children may have genetic polymorphisms making them less susceptible to environmental influences.

G X E and epigenetics research provide another level of explanation to the other theories in this book. Each theory identifies particular types of experience important for development, which potentially could affect gene expression. For instance, Piaget focused on active interaction with one's physical world, Freud and ethologists emphasized early mothering and attachment, Erikson emphasized culture-based socialization, and Vygotsky thought early language interactions were important. The genetic approach suggests pathways between these experiential histories and psychological outcomes, namely, pathways involving turning genes off or on and perhaps permanently altering the regulation of genes. Epigenetics research also spotlights the physiological and behavioral route between the environmental triggering of a gene and the positive or negative behavioral outcome.

Genetics research also adds to our understanding, in each theory, of individual differences in children's responses to events and environments. Polymorphisms affect the impact of the experiences and environmental influences emphasized by various theories. For example, different children may respond differently to disequilibrium (Piaget's theory) or guidance in the zone of proximal development (sociocultural theory) or aggressive models (social learning theory, Chapter 6).

Genetics research points to the need for theories to identify specific critical aspects of experience. For instance, in a longitudinal study (Murphy, Slavich, Rohleder, & Miller, 2013), adolescent females at risk for developing major depression showed more epigenetic markers for depression at testing sessions only when one specific type of rejection, "targeted rejection" (intentional rejection of a person), recently had occurred. This effect was especially strong for females who perceived themselves as high in social status in their peer group. This suggested that targeted rejection set in motion a neurohormonal chain of events that led to the inflammation of body systems, which is the body's protective response to damage or harmful stimuli, including stress. Chronic inflammation is a change associated with mental and physical illnesses. These findings suggest new hypotheses about possible different effects of different kinds of environmental stressors. The study also suggests that perceptions of the environment (accurate or inaccurate), not just the environments themselves, influence the impact of environments on susceptibility genes.

Cultural developmental theories (Chapter 4) suggest the importance of attending to human diversity in G X E and epigenetics research. Human cultures differ in their DNA profiles. It matters who is studied. Most genetic research has been conducted on people of European descent, but various genetic polymorphisms occur at different frequencies in different populations. The NIH 1000 Genomes Project is an international public–private consortium attempting to build a detailed catalog of the main genetic variations between populations in Europe, Africa, and East Asia. The goal is to identify the contribution of genetic variation to illness. A main step is to show which genes indicate the most variability in their responses to particular aspects of the environment. However, cultural theories would argue that attending to genetic diversity is only part of the story. Cultural diversity also may contribute to G X E and epigenetic outcomes. For example, what constitutes a supportive parental environment or what kinds of events are stressful may show cultural differences.

The focus of genetics research on mental and physical diseases has prompted developmentalists to construct new models of links between experience, psychological development, and health. The impact of stress on health, and on telomere length as an indicator of overall health, for example, was described earlier. The growing awareness of connections among genes, the environment, and health can be seen in a current NIH initiative aimed at understanding effects of different environments on genes. The Environmental Genome Project identifies "susceptibility genes," which have polymorphisms that make individuals particularly sensitive or insensitive to radiation and natural and human-made chemicals, including environmental pollutants.

Some of the current theoretical controversies in genetics are quite relevant to development. One concerns the extent to which epigenetic changes and the resulting bodily changes can be reversed. Another concerns the fact that much of the genetic variation among people now appears to come from outside of the coding genes, the basis for the mapped human genome. Another controversy has to do with the fact that most of the research thus far has focused on negative outcomes, such as mental disorders or atypical development. Are the identified genetic and epigenetic processes the same for normal development, including positive developments or traits such as language acquisition, prosocial behavior, and musical talent? Is there a critical difference between typical environments and very enriched environments?

Several important questions about development likely will be addressed in future research. Are there sensitive periods for specific environments measured in G X E interactions? In fact, it has been suggested that researchers should be developing G X E X D (Development) models (Hyde, 2015). Early childhood and adolescence are good candidates for sensitive periods because of significant neural, behavioral, and environmental changes at those times. For example, peer relations (e.g., affiliation and support versus rejection) may be a particularly strong mediator of gene-brain-behavior links during adolescence. Another question concerns the range of environmental triggers in children's lives. Much of the genetic-oriented work thus far has looked at mothering, which, though important, is only one of many important environmental influences, particularly fathers.

Applications

These genetic and epigenetic breakthroughs have important applications. Having more information about their children's genetic makeup, or their own, and the probability of susceptibility genes being expressed, can help people make decisions related to physical and mental health (e.g., susceptibility to depression, recommendations about lifestyle, such as exercise). Eventually, newborn screening involving whole-genome analysis may be routine. One goal of knowing the genetic composition and environmental stressors of various racial, ethnic, and socioeconomic groups is to help tailor interventions to these groups in an attempt to eliminate health disparities. This is similar to "personalized medicine" in the medical field. An intervention that reduces stress on children or improves parenting early on can deter the expression of susceptibility genes into negative outcomes. Along with these applications, however, come a host of ethical and legal issues. Do you want to know your genetic makeup, given that it may alert you to dangers that might never materialize? Would information about your child's genetic makeup affect how you treat him or her? Should doctors tell patients about a genetic risk for a disorder with no known preventive treatment, such as early dementia?

Summary

G X E and epigenetic research provides complex new developmental models of genetic and environmental influences. In fact, such research has documented the importance of the environment as much as that of genes. Genes mediate the impact of the environment, and the environment affects the expression of genes. Sometimes, through epigenetics, experience even chemically alters gene regulation in ways that are transmitted to the next generation in some cases. Children differ in their particular genetic vulnerabilities and even in how sensitive they are to the environment in general. Environments vary in their degree of support for positive developmental pathways despite genetic vulnerabilities.

Integrated, Multilevel Biological Theoretical Perspectives

The various biological approaches in this chapter have developed models of the pathways between biological processes and behavior, making it clear that genes, brain, and experience form a complex system in which each influences, either directly or indirectly, each of the others. This system is particularly complex because their interactions are developmentally sensitive. For example, a particular environmental event might cause an epigenetic change during early infancy but not if it occurs later. Also adding to the complexity is the fact that interactions occur at multiple levels, from cells to society. The following examples of these complex models give a flavor of this interrelated system.

Because the brain often is the pathway through which genes are expressed and thus influence behavior, a new field called *developmental neurogenetics* has emerged recently (Hyde, 2015). This approach develops models in which genetic polymorphisms are associated with particular neural variability. In other words, the goal is to determine which genetic polymorphisms predict particular variations in brain neurochemistry, architecture, or functioning, which in turn result in variations in behavior. This approach typically uses the imaging techniques discussed earlier to assess brain outcomes. An example of a neurogenetic finding is that a particular genetic variant increases amygdala reactivity during adolescents' response to stress (i.e., angry faces) (Battaglia et al., 2012). Specifically, such a pattern typically indicates a gene (or genes) sending signals to the brain that affect the pathways of neurotransmitters. Another example is that genetic polymorphisms that affect dopamine production in certain brain areas are associated with low inhibition of behavior, for instance, sensation seeking and impulsivity (Caylak, 2012). One variation of this approach that can advance our understanding of development is to study these correlations in specific subgroups of people. For example, one might describe the neural and genetic profiles of individuals who are resilient despite their developmental history of harsh, and thus risky, environments (Hyde, 2015).

The developmental aspect of neurogenetics is that the gene-brain-behavior associations often change as a function of age, not only during brain development but also throughout the lifespan as individuals engage in new experiences. A main question is the mechanisms by which these connections occur. The end result of correlating genetic, neural, and behavioral variability is a probabilistic model of development. For example, a model might present the probability of a child developing depression in a particular environment (e.g., high social support vs. maltreatment), based on information about the child's genetic vulnerabilities and particular brain structure and functioning. Development is central because, for example, an initial genetic variant with very small effects can cascade (see Chapter 1), as one thing leads to another, into large effects on behavior over time.

Neurogenetics is beginning to be applied to models of the development of psychopathology (Hyde, 2015). There are known correlations between particular brain patterns and particular psychopathologies. A neurogenetics model would link such correlations to particular genetic polymorphisms. In other words, the goal is to link genetic variation to brain variation to behavior variation, including pathological behaviors. Because brain chemistry and functioning are a phenotype that is at a level closer to the genotype than are the more distant behaviors used to classify different kinds of psychopathology, gene-brain links may be easier to identify than gene-behavior links.

A recent model (Hyde, 2015) expands developmental neurogenetics by adding measures of environmental variability. Thus, this model adds G X E interactions to neurogenetics, such that associations of brain variability with both genetic and environmental variability are included. Genes, brain, and behavior are all in an environmental context, and the brain is a mechanism linking G X E interactions to development. For example, a strong brain reaction to stress might occur with a particular genetic variant in a child developing in a harsh, stressful environment but not in a child developing in a more supportive environment.

Another model that nicely ties together the perspectives of this chapter addresses the relations between the body's response to stress and later outcomes. Experiencing chronic violence during childhood, such as mistreatment by adults, bullying, or domestic violence, often has adverse effects inside a child's body that put the child's physical, psychological, and cognitive health at risk later, even decades later. The main mechanism appears to be the stress response, which can lead to the epigenetic, telomere, and inflammatory changes described earlier. These changes are associated with increased risk for health problems such as heart disease, stroke, immune diseases, dementia, and metabolic diseases (Moffitt et al., 2013). Moreover, altered brain functioning, as seen in neuroimaging, is expressed in behavioral and learning problems, as well as in depression and anxiety. The hormone cortisol, part of the stress response, appears to be particularly important (e.g.,Wadsworth, 2015). Some models of the stress response emphasize environmental conditions such as poverty and racial discrimination. For instance, preadolescent African-American preadolescents in the rural South who developed psychosocial competence despite the developmental risks posed by their family's low socioeconomic status, paid a price in harmful physiological changes in response to the high stress, evident by age 19 (Brody et al., 2013). Moreover, the negative effects of family instability and maternal unresponsiveness during the preschool years result in lower cognitive functioning by age 4 (Suor, Sturge-Apple, Davies, Cicchetti, & Manning, 2015). Finally, maternal prenatal stress can affect development during infancy and later. Mothers who experience chronic stress during pregnancy have newborns with elevated levels of cortisol in their bodies (Pluess & Belsky, 2011).

Ethology and evolutionary psychology also are part of the study of this complex system, as reflected for example in new fields, such as neuroethology and evolutionary cognitive neuroscience. Regarding connections between genetics and evolution, genetic variation and plasticity in gene expression (as seen in epigenetics) contribute to the survival of the species during evolution; when the environment changes, some genetic polymorphisms may be better adapted than others to the new environment. The growing evidence of both plasticity in gene expression and brain plasticity (in the effects of the environment and behavior on brain networks) shows that humans are uniquely equipped to adapt to changing environments. Altered gene regulation and neural connections can, for instance, help us adapt to harsh social or physical environments. For example, dangerous and unpredictable environments tend to lead to a chronic stress response, which is negative from a health perspective, but by encouraging constant vigilance may help children survive, adapt, and develop within that environment (Wadsworth, 2015). In one study, children with stressful childhoods showed improved detection, learning, and memory on tasks involving stimuli of importance to them, such as those having to do with dangers (Frankenhuis & de Weerth, 2013). These systems have evolved and, in turn, potentially change the course of evolution through, for example, the transmission of epigenetic changes across generations. In fact, some of any individual's inherited epigenetic makeup may have been created by conditions hundreds of years ago and transmitted through subsequent generations.

Another way to think about relations between genetics and ethology is that, given that the environments in which humans develop cause epigenetic changes that affect whether a gene is expressed, some genetically possible behaviors never are expressed and thus cannot enter into the process of natural selection by increasing or decreasing survival. Thus, evolution involves not only genetic changes, but also epigenetic changes.

What can we conclude, regarding theory, from this account of neuroscience and genetics? The predominant contemporary theoretical model of gene-environment connections is that there is a dynamic interplay at various levels, including genetic, epigenetic, neuronal, hormonal, emotional, cognitive, behavioral, and environmental levels (e.g., Lickliter & Honeycutt, 2015). In this developmental system (see also Chapter 9), each level affects and is affected by each of the other levels: "All adaptations, regardless of when they appear, have their roots in earlier experiences, shaped by the bidirectional interaction between all levels of an organism and its environment (both *macroenvironments*, such as the family and one's culture, and *microenvironments*, such as neurotransmitters and chemicals affecting the functioning of DNA molecules)" (Bjorklund & Ellis, 2014, p. 247). Note that genes do not hold a privileged controlling position but are just one component that must interact with other components in the system to function. Moreover, the nature of this system changes from one developmental point to another, and early events can cascade through later development. We already knew that development is exceedingly complex; neuroscience and genetics, along with contemporary ethological and evolutionary psychology perspectives, are providing additional mechanisms to explain this complexity.

SUMMARY

The biological terrain of development has many players—ethology, evolutionary psychology, developmental neuroscience, genetics, epigenetics, and many more. Each of these perspectives has made important contributions to developmental theorizing. Each approach has revealed both biological and environmental influences on development, and has proposed models of how they interact. Environmental influences "get under the skin" and become biologically embedded to impact development, as when chronic stress in adverse environments can trigger susceptibility genes, cause epigenetic changes, and modify brain functioning. These new findings basically destroy the nature–nurture dichotomy.

Ethology, along with other evolutionary perspectives, is one of zoology's main contributions to developmental psychology. Thousands of hours spent observing animals, especially nonhuman primates, have helped us understand human behavior and its development. Each species, including humans, has a set of innate behaviors, specific to that species. These behaviors have evolved phylogenetically because they have increased that species' chances of surviving in its particular environment. Some of the most important behaviors are social, such as imprinting and dominance behaviors. Of particular interest are fixed-action patterns elicited by sign stimuli. Even learned behaviors have a strong genetic component, because each species has particular learning predispositions in the form of sensitive periods or general and specific learning abilities. Ethologists study behaviors by conducting both observations in natural settings and experimental studies in laboratories.

The ethological point of view has most influenced developmental psychology by stimulating work on attachment. Very young infants and adults are pretuned to respond to each other. Current attachment research examines long-term effects of each pattern of attachment, adult attachment styles, correlates between parenting quality and infant attachment, links between attachment quality and an infant's stress response, and biological processes involved in developing attachment. Observation of dominance hierarchies in primates and other animals has led to similar studies of human peer groups, especially in preschool settings. Investigators also have asked what cognitive skills might have evolved in natural settings. With respect to developmental issues, ethologists see humans as a species that has evolved in order to survive within a particular environmental niche. Behavior changes both quantitatively and qualitatively as innate and environmental factors interact during development. The result is an organism that can operate efficiently within its environment.

Ethology has several strengths to offer the current field of developmental psychology. With respect to theory, it provides a broad evolutionary perspective on behavior that has encouraged investigators to look at the function of children's behaviors. Ethologists advocate more observational studies of children in natural settings in order to determine the function of particular behaviors. A final contribution is the identification of several content areas as particularly important in development, such as dominance hierarchies, attachment, and cognition. Ethology has certain weaknesses, however, that limit its usefulness for developmental psychology. Its theoretical notions, such as sensitive periods, have not yet reached an explanatory level. With respect to methodology, the observational method poses many challenges. Finally, ethologists find it difficult to study certain aspects of development, such as language and abstract thought in older children. Main examples of contemporary ethological and evolutionary research on development are attachment, the evolution of human cognition in social groups, and adaptation during development.

Ethology and evolutionary psychology are a fruitful source of working hypotheses about what behaviors are important and why they are acquired. An ethological attitude opens the investigator's eyes to a broad context that spans space and time and various levels of analysis. In particular, ethologically based observations in the early phases of a research project can give the "big picture" of the behavior that will later be studied in a controlled laboratory setting.

Neuroscience perspectives have produced models of brain development, as cause of and effect of, children engaged in their environments. Anatomical changes, such as increased myelination, make new learning possible. An initial overproduction of neurons in early infancy is modified by experience. Humans have a lifetime of strengthening certain neural pathways, developing new pathways, and pruning away unused pathways. An initially highly plastic brain becomes less plastic as specialization of brain areas and pathways gradually occurs during development. Brain areas develop at different rates, resulting in important asynchronies at certain developmental points, as seen in adolescents' difficulties controlling their risk-taking behaviors. Finally, brain development takes place over the lifespan, subject to constraints from genes, the environment, and development. Neuroscience has revealed important mechanisms related to the nature–nurture issue and has provided evidence for both qualitative and quantitative development. In applications, neuroscience has improved our understanding of developmental disorders, such as autism, and has informed the design of educational programs.

The human genome is an amazingly complex blueprint for development. Just as a blueprint may never become a house, a genome may never be fully translated into behaviors. Genes may be expressed similarly in most environments, expressed more in some environments than others, or not expressed at all in certain environments. The two main approaches are Gene X Environment models and epigenetics. G X E interactions show that a person's genotype moderates the effect of an environmental factor on outcomes, such as traits, behaviors, mental health, and cognition. For example, highly stressful life events might be more likely to lead to depression if a person has a particular pattern of genes. Similarly, the environment moderates the association between a particular gene polymorphism and an outcome. Positive, close relationships, especially with parents, can buffer the negative effects of certain genes. Epigenetics provides the molecular mechanism by which G X E interactions affect cell biology and consequently behavior. Through epigenetics, certain aspects of the environment affect whether a genetic predisposition is expressed in behavior, which can result in permanent changes in gene regulation. Moreover, epigenetic changes can be transmitted to the next generation. G X E interactions and epigenetics during the course of development influence degrees of risk for developing a problem, given vulnerable gene polymorphisms. Bringing together neuroscience and genetics, recent models have correlated genetic variations and specific patterns of brain activity. Such information clarifies how the brain is a mediator between genes and behavior. Variations in environments also should be added to these models.

Current models of the dynamic interplay among genes, brain, behavior, and the environment favor a systems approach, to capture the complexity and co-influences of these components. Development emerges from these interactions among multiple levels of influence.

SUGGESTED READINGS

The following readings survey evolutionary, including ethological, research on humans and animals:

Bjorklund, D. F., & Ellis, B. J. (2014). Children, childhood, and development in evolutionary perspective. *Developmental Review, 34*(3), 225–264.

Narvaez, D., Panksepp, J., Schore, A. N., & Gleason, T. R. (Eds.). (2013). *Evolution, early experience and human development: From research to practice*. New York, NY: Oxford University Press.

Lorenz delights us with this account of his life with animals:

Lorenz, K. Z. (1952). *King Solomon's ring*. New York: Crowell.

Cognitive developmental neuroscience:

Johnson, M. H., & de Haan, M. (2015). *Developmental cognitive neuroscience: An introduction.* New York: Wiley-Blackwell. A clear overview of the field—a good place to start.

Genetics:

NIH has worked with several scientific organizations to create websites with genetics tutorials for scientists and students in the social sciences.

As of this writing, the following one with the National Coalition for Health Profession Education in Genetics is especially useful: http://www.nchpeg.org/bssr/

Hyde, L. W. (2015). Developmental psychopathology in an era of molecular genetics and neuroimaging: A developmental neurogenetics approach. *Development and Psychopathology, 27,* 587–613.

Meaney, M. J. (2010). Epigenetics and the biological definition of Gene X Environment interactions. *Child Development, 81*, 41–79. This article provides background on epigenetics and Gene X Environment interaction.

This page intentionally left blank

CHAPTER 6

Social Learning Theory

Subjects were tested for the amount of imitative learning. . . . Three measures of imitation were obtained: Imitation of physical aggression: This category included acts of striking the Bobo doll with the mallet, sitting on the doll and punching it in the nose, kicking the doll, and tossing it in the air. Imitative verbal aggression: Subject repeats the phrases, "Sock him," "Hit him down," "Throw him in the air," or "Pow." Imitative nonaggressive verbal responses: Subject repeats, "He keeps coming back for more," or "He sure is a tough fella."

—Bandura, Ross, & Ross, 1961, p. 33

Dialogue between an interviewer (I) and a mother (M) about her adolescent son:
I: Have you ever encouraged Earl to stand up for himself?
M: Yes, I've taught young Earl, and his Dad has. I feel he should stand up for his rights, so you can get along in this world.
I: How have you encouraged him?
M: I've told him to look after himself and don't let anybody shove him around or anything like that, but not to look for trouble. I don't want him to be a sissy.
I: Have you ever encouraged Earl to use his fists to defend himself?
M: Oh yes. Oh yes. He knows how to fight.

—Bandura & Walters, 1959, p. 115

These lessons were learned well. One of the boys interviewed mentioned his pride in his prowess at "stomping"—fighting with his feet: "Like my Dad, he said, 'If you know how to fight with your feet, then it's in your hands, you've got it made,' or something like that. 'You never need to be afraid of anybody.'"

—Bandura & Walters, 1959, p. 122

Mark Twain once remarked, "Training is everything. The peach was once a bitter almond; cauliflower is nothing but cabbage with a college education." This optimistic view of learning captures learning theorists' belief that development comes primarily from experience. Children acquire new behaviors and modify old behaviors as they encounter their social and physical world. As specific learning experiences accumulate, children develop, but not in the stagelike way described by Freud and Piaget. The learning approach is at the opposite end of the continuum from the biological approaches of the previous chapter.

It is important to know about learning theories because they brought scientific respectability to developmental psychology. The approach's rigorous research methods made laboratory studies of children possible in the 1950s and early 1960s, developmental psychology's formative years. In this chapter, we see the expansion and transformation of early learning theory into social learning theory. The focus is on social learning theory, the most influential learning theory within developmental psychology. The chapter will also present some contemporary approaches to learning as it is defined today.

Learning theory is the most truly American theory. Most of the theories in this book arose in Europe and only later influenced North American psychology. Although early learning studies in Europe can be found in Russian work on reflexes and conditioning and Ebbinghaus's verbal-learning studies in Germany, learning theory blossomed and had most of its influence on U.S. soil. Learning theory has become part of our culture and has entered our language as "behaviorism," "rat psychology," "behavior modification," "Skinner box," and "reinforcement." It probably is no accident that learning theory's emphasis on the role of the environment fits so well with American egalitarian ideals. If the environment offers equal opportunity for all, then all humans can achieve their potential.

In order to understand the assumptions and goals of social learning theory, we start with its heritage in "classical" learning theory. After that, sections include a general orientation to social learning theory, examples of developmental research, and an overview of mechanisms of development. Final topics include the theory's position on developmental issues, its applications, its strengths and weaknesses, and contemporary research. The coverage of social learning theory focuses on work stimulated by Albert Bandura, the figure most associated with the theory. Although Bandura now prefers the term "social cognitive theory," that term will not be used because it causes confusion with other areas of developmental psychology typically labeled as "social cognition." Also, the term "social learning theory" still is commonly used by developmental psychologists when referring to Bandura's theory.

History of the Theory

Classical learning theory raised many of the issues to which social learning theory responded. As Henri Bergson (1911, p. 11) noted, "The present contains nothing more than the past, and what is found in the effect was already in the cause."

Learning Theory

In the early 1900s, psychologists' attempts to examine systematically the structure of the mind and the nature of consciousness relied on introspection—verbalizing one's own thoughts or feelings. This unsatisfactory state of affairs led to John Watson's "declaration of behaviorism" in 1913. In this strongly worded statement, he asserted that the goal of psychology should be to predict and control overt behavior, not to describe and explain conscious states. Just as physical scientists could observe physical events, psychologists could now point to physical events (behaviors) as the content of their science and measure them objectively. Rats press bars, children push buttons, and adults say words.

Learning theorists' belief in the influence of the environment is expressed in a famous quote from Watson:

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant, chief, and yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.
>
> *(1924, p. 104)*

Watson did, however, go on to say: "I am going beyond my facts, and I admit it, but so have the advocates of the contrary and they have been doing it for many thousands of years."

Although there are many definitions of *learning*, a common one is "a more or less permanent change in behavior which occurs as a result of practice" (Kimble, 1961, p. 2). Learning theorists' *reductionist* strategy for understanding complex behavior is to break it down into simple units, study the units, and then put the behavior back together again.

The simplest units are *associations* between a stimulus and a response—the atoms of psychology. The research strategy, then, is to study simple associations, then chains of *S–R* (*stimulus–response*) associations, and perhaps even hierarchies of chains, in order to explain complex behavior. Metaphorically, many simple units of Tinkertoy sticks and joiners are combined to form a larger structure. During development, *S–R* associations can be strengthened, weakened, or chained with other associations.

Traditionally, learning has been divided into two types: *classical conditioning* and *operant conditioning*. Classical conditioning begins with a reflex—an innate connection between a stimulus and a response. Examples of reflexes that can be classically conditioned include salivating when food is placed in the mouth, sucking when a nipple is placed in an infant's mouth, and constricting the pupil when a light is shone into the eye. An unconditioned stimulus (nipple placed in the mouth) elicits the unconditioned response (sucking). A conditioned stimulus (sight of the bottle) occurs just before the bottle is given. After repeated pairing of the bottle and sucking, simply showing a bottle produces sucking. Sucking has become a conditioned response. More exotic examples are asthmatic attacks triggered by stimuli such as elevators, children's choirs, bicycle races, political speeches, and the national anthem (Dekker & Groen, 1956).

The most famous case of classical conditioning in children is Watson's "Little Albert" experiment. Watson was awarded the grand sum of $100 in 1917 to do this research. He and Rosalie Rayner (Watson & Rayner, 1920) classically conditioned a fear response in 11-month-old Albert. They placed a white rat in front of the toddler. As he reached for it, they struck a steel bar behind him with a hammer, producing a noxious, painful sound. Albert jerked in alarm and cried. After several repetitions of this pairing of the rat and the sound, Albert cried and crawled away when the rat alone was presented. Albert's fear was a conditioned response to the conditioned stimulus, the white rat. The initial reflex was that the noxious sound (unconditioned stimulus) produced pain (unconditioned response). The conditioned response generalized to objects such as a rabbit, a fur coat, and a Santa Claus mask. As it turned out, his mother removed him from the experiment before Watson had a chance to decondition him. This study has become controversial in recent years (Griggs, 2014). In addition to ethical issues, questions have been raised about Albert's identity, whether he might have been born with neurological problems, and whether the conditioning was as successful as is commonly believed. Over the years, textbook writers have "improved" the results. In addition, there were methodological problems that muddy any interpretation of the results.

At a later time, one of Watson's students, Mary Cover Jones (1924), found that a naturally acquired fear of animals in a 2-year-old child, Peter, could be eliminated by extinguishing this fear response, which presumably was a conditioned response. Peter was seated in a highchair and given a snack, which produced a positive response. As he ate, a white rabbit in a cage was brought closer and closer. The conditioned stimulus (the white rabbit) was not allowed to become powerful enough to evoke the response of fear by, for example, suddenly being brought too near. As the stimulus occurred without the related fear response, this association was weakened. At the same time, eating, the positive response, was replacing the negative fear response to the rabbit. The procedure was quite successful. By the end of the study, Peter was stroking the rabbit and letting it nibble at his fingers. This treatment obviously requires a skillful experimenter who does not inadvertently teach the child to associate eating with fear!

There is an interesting footnote to this research. Peter had to enter a hospital for treatment of scarlet fever. As Peter was leaving the hospital, an unfortunate incident occurred. A large dog lunged at him, frightening him terribly. When Jones then retested Peter, he had reacquired his fear response to animals and had to be deconditioned again.

This deconditioning technique for overcoming fears contrasts with Freud's psychoanalytic study of Little Hans's fear of horses. Whereas Freud was concerned with the deep-seated, underlying anxieties, learning theorists simply try to change the behavior. If Hans would very gradually approach horses and at the same time establish some positive response to horses, his conditioned fear response should weaken. Freud's view would be that these procedures treat only the symptoms, not the underlying psychological cause of the problem. If one symptom is removed, another may appear in its place.

It is difficult to extinguish phobias without intervention because they are self-perpetuating. By avoiding the feared situation, people reduce the rising anxiety. Thus, the phobia is reinforced. In addition, they have no opportunity to extinguish the fear because they do not allow the feared stimulus to be present. There is an old joke about a man who is asked why he always holds a banana in his ear. His answer is that it keeps the lions away. When told there are no lions around, he replies, "See? It works!"

Watson (1924) considered children "lumps of clay" to be shaped by their environment. He carried his ideas to parents in his child-care manual:

> There is a sensible way of treating children. Treat them as though they were young adults. Dress them, bathe them with care and circumspection. Let your behavior always be objective and kindly firm. Never hug and kiss them, never let them sit in your lap. If you must, kiss them once on the forehead when they say goodnight. Shake hands with them in the morning. Give them a pat on the head if they have made an extraordinary good job of a difficult task. Try it out. In a week's time you will find how easy it is to be perfectly objective with your child and at the same time kindly. You will be utterly ashamed of the mawkish, sentimental way you have been handling it.
>
> *(1928, pp. 81–82)*

It speaks well for the wisdom and common sense of parents that they did not adopt his philosophy wholeheartedly. By the 1920s, Watson had left academia and had become an advertising executive.

The other main kind of learning, *operant conditioning*, was championed by B. F. Skinner—one of the most well-known psychologists in history. Unlike classical conditioning, which begins with a reflex, operant conditioning begins with a behavior that a child spontaneously produces. Children learn that if they produce a certain behavior, such as smiling at a parent, they will receive a reinforcement (the delighted parent will pick them up and play with them). If this sequence occurs a number of times, smiling can be said to be operantly conditioned as it becomes more frequent.

The environment changes not only the frequency of behavior by strengthening and weakening associations but also its form—through *shaping*. Pigeons do not naturally play table tennis. However, by beginning with the table-tennis-related behaviors they do have, it is possible to slowly modify these behaviors into a chain of movements appropriate to table tennis. The experimenter "ups the ante" (raises the requirement for obtaining reinforcement) as the behavior gradually comes to approximate the desired behavior. Early in training, moving toward the ball might be sufficient to receive reinforcement, but later on it may be necessary to make the ball drop onto the opponent's side in order to receive reinforcement. Two of Skinner's students, Keller and Marian Breland, used shaping to train animals to perform acts for advertising and in their "IQ Zoo" (Joyce & Baker, 2008). Popgun Pete, a trained chicken, could pull a string to fire a cannon, and a rabbit could ride a fire engine and put out a fire. In one exhibit, "Bird Brain," visitors could play tic-tac-toe against a chicken, who usually won.

Skinner described his first attempt to use shaping on a human:

> I soon tried the procedure on a human subject—our 9-month-old daughter. I was holding her on my lap one evening when I turned on a table lamp beside the chair. She looked up and smiled, and I decided to see whether I could use the light as a reinforcer. I waited for a slight movement of her left hand and turned on the light for a moment. Almost immediately, she moved her hand again, and again I reinforced. I began to wait for bigger movements, and within a short time, she was lifting her arm in a wide arc—"to turn on the light."
>
> *(1980, p. 196)*

Thousands of behaviors can be operantly conditioned, ranging from rats increasingly pressing a bar to children's diminished drooling (Johnston, Sloane, & Bijou, 1966) to pigeons' guiding missiles to their targets in Skinner's Project Pigeon during World War II. Skinner (1967) even kept a cumulative record of his writing output, for self-reinforcement. In a novel, *Walden Two* (1948), Skinner proposed that children in his utopian society be raised by behavioral engineers, specialists in operant conditioning. Desirable behaviors such as self-control and independence would be fostered by reinforcement, whereas undesirable behaviors such as jealousy and poor work habits would be extinguished by lack of reinforcement.

Skinner's research goal of defining and controlling the environment led to the development of certain apparatuses, such as the Skinner box. This cage-box, with a lever that the animal presses, delivered a food pellet to the tray below. Skinner also created a controlled environment for one of his own infants—a completely enclosed, temperature-controlled, soundproof "baby tender." This device has been called a "baby box" and even an "heir conditioner" (Bradley, 1989). However, it was not, as many people believed, a Skinner box for conditioning babies.

In the 1960s, laboratory research showed that a wide variety of behaviors in infants and children could become more frequent if they were reinforced. Developmentalists were particularly interested to find that (a) social reinforcers, such as attention, smiles, and praise from other people, are especially potent, and (b) the principles of operant conditioning could be applied successfully to undesirable behaviors in natural settings. So-called *behavior modification* thus was applied to problematic behaviors such as temper tantrums, avoidance of social interaction, and, with autism spectrum disorders, the lack of spoken language. A behavior modifier changes the reinforcement contingencies so that desirable behavior is reinforced and thereby maintained while undesirable behavior is ignored and thereby weakened. In other words, you try to catch the child doing something right and reinforce it. Harris, Wolf, and Baer (1967) observed an extremely withdrawn boy who spent 80 percent of the time at preschool playing alone. Their observations revealed that the teachers had unintentionally reinforced this behavior by talking to him and comforting him when he was alone. They ignored the child when he played with others. The behavior modification program reversed these contingencies. The teachers attended to the boy when he joined a group and ignored him when he withdrew. He soon spent 60 percent of his time playing with other children. Behavior modification thus showed that a common set of learning principles underlies both normal and abnormal behavior in children.

As the above account shows, learning studies with children were simply translations of paradigms used with animals. Children even wandered through mazes seeking prizes (rather than cheese) at the end (Hicks & Carr, 1912). It should come as no surprise that children learned faster than rats but more slowly than college sophomores. The laws of learning were considered the same in children and other populations. For learning theorists in the 1950s and 1960s, development involves the accumulation of operantly and classically conditioned responses: "The developing child may be adequately regarded, in conceptual terms, as a cluster of interrelated responses interacting with stimuli" (Bijou & Baer, 1961, p. 15). Learning changes behavior, and thereby causes development.

However, children soon showed that they were unlike rats in many ways. As learning theorists used slightly more complex tasks in the 1950s and 1960s, they came to view children as "rats with language." Children could label attributes of objects, such as their color or size, and use the labels to help them learn which attribute always led to reinforcement. Learning began to look cognitive: Attending to relevant information, forming hypotheses about the correct answer, and generating strategies for gathering information increased children's speed of learning. In fact, these cognitive skills struck developmentalists as much more important and interesting than learning per se—the somewhat trivial behavior of detecting which stimulus was arbitrarily linked to reinforcement in that particular task. Thus, psychologists began to study language, attention, memory, and strategies instead. The active, strategic, hypothesis-forming child seen in learning tasks resembled children described by Piaget, whose work was beginning to attract attention in the U.S. in the early 1960s. Furthermore, learning researchers had used abstract, meaningless stimuli—often colored, geometric shapes—because they wanted to measure "pure" basic processes of learning, uncontaminated by previous learning. It is ironic, then, that the most interesting findings from learning research involved children's use of their previously acquired cognitive, linguistic, and social abilities as they attempted to make sense of the simple, meaningless task put before them. The "contamination" was interesting indeed.

Discontent with learning theory came from other quarters as well. Some of the doubts came from within; hundreds of studies of verbal learning had not led to a satisfactory account of memory or learning. In addition, new evidence suggested that biological predispositions limit or modify the laws of learning. For a given species, some kinds of learning are easier than others. For example, rats learn to associate nausea with a certain taste but not with a light or a sound (Garcia & Koelling, 1966). At the same time, learning theory faced external challenges. Noam Chomsky's (1959) attack on B. F. Skinner's account of language acquisition was a serious blow because it showed that learning approaches could not explain the acquisition of a skill as complex as language. In addition, alternative conceptions of learning were developing. Information processing (see Chapter 7), Chomsky's transformational grammar, and Piaget's cognitive theory provided attractive alternative, more cognitive, explanations of behavior: They characterized learning as a change in knowledge rather than as a change in the probability of response. With the entrance of cognitive psychology, psychology began what Hebb (1960) called its "second American revolution," the first being the elimination of any psychology based on introspection.

However, learning theory served a need of the young discipline of psychology at a critical point in its history. Researchers adopted William James's (1892, p. 146) attitude: "I wished, by treating psychology like a natural science, to help her become one." Learning theory adopted the physical sciences as its model, an emphasis that has been called "physics envy." Learning theorists asked questions that could be answered and provided a fruitful methodology for examining those questions, usually tightly controlled laboratory experiments. In Sheldon White's words, learning theories were so influential

> because they found for Psychology a reasonable species of psychological reality, and because they then laid down a paradigm of cooperative research procedures which might search that reality with a hope of significant findings. . . . one could stop the hair-splitting and throat-clearing and one could move into intensive scientific development.
>
> *(1970, p. 662)*

This phase in the history of developmental psychology, from the early 1960s to the early 1970s, was an exciting and fruitful time. A new wave of productive and enthusiastic researchers developed clever experimental tasks adapted to children. There was confidence that developmental psychology was progressing. Developmentalists conducted hundreds of laboratory studies, usually with children easily available—bright, upper-middle-class children in university towns. (Some 4-year-olds even greeted experimenters with "What reinforcement do I get this time?")

Social Learning Theory

Against this backdrop, social learning theorists emerged. They took learning theory and made it social. Social learning theory was born in the 1930s at Yale University, perhaps when Clark Hull offered a graduate seminar on relating learning theory to psychoanalysis. Many of those attending would become pioneers in social learning theory—O. H. Mowrer, Neal Miller, John Dollard, Robert Sears, Leonard Doob, and John Whiting. One of the seminar topics led to the group's first major publication, *Frustration and Aggression* (Dollard, Doob, Miller, Mowrer, & Sears, 1939), which explored the causes of aggression.

The young group of scholars, trained in learning theory by Hull but also inspired by Freud, combined these two traditions. In fact, one of their publications, *Personality and Psychotherapy* (Dollard & Miller, 1950), was dedicated to both Freud and Pavlov. Social learning theorists took interesting and important content from Freudian theory, such as the concepts of dependency, aggression, identification, conscience formation, and defense mechanisms, but sought explanations for behavior in principles of stimulus-response learning, which could be observed, rather than the unconscious, which could not. In Dollard and Miller's words, "The ultimate goal is to combine the vitality of psychoanalysis, the rigor of the natural-science laboratory, and the facts of culture" (1950, p. 3). The guiding belief of social learning theorists was that personality is learned:

> If neurotic behavior is learned, it should be unlearned by some combination of the same principles by which it is taught. . . . We view the therapist as a kind of teacher and the patient as a learner. In the same way and by the same principles that bad tennis habits can be corrected by a good coach, so bad mental and emotional habits can be corrected by a psychotherapist. There is this difference, however. Whereas only a few people want to play tennis, all the world wants a clear, free, efficient mind.
>
> *(Dollard & Miller, 1950, pp. 7–8)*

Social learning theorists explored much territory in the 1940s and 1950s: imitation, neuroses, cross-cultural influences on personality, identification, dependency, and child-rearing practices. Their work focused on socialization, the process by which society attempts to teach children to behave like the ideal adults of that society. As Dollard and Miller observed, "A system of child training built on the laws of learning might have the same powerful effect on the neurotic misery of our time as Pasteur's work had on infectious diseases" (1950, p. 8). Research examined correlations between characteristics of parents (for example, high control and low warmth) or their child-rearing practices (e.g., early toilet training—Freudianism was still hovering) and the child's later personality. In a prototypic study (Sears, Rau, & Alpert, 1965), a child was placed in a roomful of attractive toys and asked to watch a hamster, which was in a box with no lid. The experimenter left the room to finish making the lid for the box. When the temptation to take a closer look at the toys became too great and the child's attention left the hamster for a moment, the hamster silently disappeared through a false floor in the box. Measures of conscience, specifically guilt, included the length of time before deviating, the child's emotional reaction to the deviation, whether the child confessed, and whether the child accepted blame for the disappearance.

At first, social learning theorists kept Freud's focus on drives, whose reduction is reinforcing. Later, in a major theoretical shift, Miller and Dollard (1941) turned to imitation as a powerful learning process for socialization. They proposed that children learn a general tendency to imitate because various imitative behaviors are reinforced. This reinforcement of imitation may start very early, as illustrated by this 11-month-old:

> Shamini (11 months), noticing great-grandmother snoring with open mouth, makes a face with jaws open wide but mouth pulled down to form a small "o" as an imitation of what was an extreme facial gesture. This causes enormous though slightly embarrassed hilarity in [the] rest of [the] family. Shamini responds directly to the laughing others, looking at their faces, laughing, and repeats her "face" with great amusement several times.
>
> *(Reddy, 1991, p. 145)*

Social learning theory provided a new perspective on Freud's important concept of identification with the same-sex parent. Rather than "incorporate" the parent and thus acquire a superego, children observe parents and imitate their behaviors, reflecting their moral values. Children also control their own behavior by repeating to themselves their parents' approving (reinforcement) or disapproving (punishment) statements. Moreover, adults may praise a boy for being "just like his father." Children tend to imitate models, such as parents or siblings, who have been rewarding in the past.

Bandura and Walters (1963) then carried the concept of modeling one step further by showing that children acquire new behaviors simply by watching a model who is reinforced. (This cannot have been a stunning discovery to any parent!) Children who see a hard-working classmate praised by the teacher learn to try that behavior. And, on the side of evil, children who get away with a naughty behavior are quickly imitated as well. Bandura and Walters called this process *vicarious reinforcement*. Thus, learning occurs without overt behavior—"no-trial learning," in Bandura's words. This was an important advance over traditional learning theory, because operant conditioning can gradually produce relatively new behaviors by shaping but cannot explain how complex new behaviors emerge suddenly after a child watches peers play a new game or views the antics of superheroes on television.

Bandura and Walters' imitation theory greatly influenced developmental psychology in the 1960s and early 1970s. It guided most studies of aggression, sex typing, and resistance to temptation. There was great interest in discovering which characteristics of models, such as warmth, power, and similarity to the observer, encouraged imitation. In addition, the list of social reinforcers was broadened to include peers.

Bandura continued to develop social learning theory and made it even more cognitive, and thus coined the term *social cognitive theory* (Bandura, 2012). Social learning theory was able to continue to thrive, despite the demise of learning theory more generally, because Bandura brought cognition into social learning theory early on in plausible and interesting ways. He rejected what he called the radical behaviorist "cognitive bypass operation" (Evans, 1989, p. 83). He was less concerned with the literal duplication of behavior (imitation) than with *observational learning* as a more general process of acquiring information from other people, books, and electronic media. Observational learning may lead to imitation when there is a model to imitate, but it need not lead to imitation.

After children acquire new behaviors by observing various models, they can combine and cognitively organize these behaviors to form more complex behaviors. A girl may become gender typed as female by observing behaviors of her mother, older sister, female teachers, and females on television. Learning to play basketball requires integrating a number of simpler subskills, such as dribbling, guarding, and shooting baskets. Children sometimes can learn whole complex behaviors all at once. A young child may learn to play Monopoly after watching peers play one game.

Because of his groundbreaking work, Bandura is listed as the 20th century's fourth most eminent psychologist, right after Skinner, Piaget, and Freud (Haggbloom et al., 2002). He won several top awards, including the American Psychological Association's Distinguished Scientific Contribution award "for masterful modeling as researcher, teacher, and theoretician" (*American Psychologist*, 1981, p. 27). He was elected to the National Academy of Sciences, is a Fellow of the American Academy of Arts and Sciences, and served as president of the American Psychological Association.

General Orientation to the Theory

The main characteristics of social learning theory are the centrality of observational learning, a causal model that involves an environment–person–behavior system, cognitive contributions to learning, and self-efficacy and agency.

Observational Learning

Both Vygotskian–sociocultural theory and social learning theory emphasize environmental, nonbiological influences on behavior and the importance of learning from watching other people in this environment. Both view development as embedded within pervasive cultural belief systems, which are acquired by children in part by participating in activities with other people. However, social learning theorists focus on children as individuals acquiring competencies and skills, whereas sociocultural theories emphasize children's culturally saturated social contexts.

Observational learning provides one answer to one of the big mysteries of development—how children quickly learn complex new behaviors. Observational learning accounts for most new behaviors. Toddlers learn an average of one to two new behaviors every day simply by watching and listening to others (Barr & Hayne, 2003). Observational learning is particularly useful for explaining how novel, complex behaviors are acquired during development, which is especially important in those areas where mistakes are costly or life threatening. There cannot be much trial-and-error learning in avoiding playing in the street, learning to drive a car, or conducting brain surgery.

How observational learning occurs can be illustrated by a real-life example and a laboratory study. One skill acquired by many boys and girls today is playing soccer. This skill includes a complex set of conceptual and perceptual motor skills. It is doubtful that this skill could be taught simply by telling children how to play the game (just try, through words only, explaining to a child how to do a "header"—deflecting the ball with one's head). Children learn from observing models playing—older children, parents, coaches, and professional soccer players on television. These models are particularly likely to be imitated because they are perceived as having high status, competence, and power (Bandura, 1986; Wood, Kendal, & Flynn, 2013). Books on how to play soccer also provide symbolic models. These various types of models demonstrate how to travel with the ball, pass, attempt goals, make corner kicks, and express elation appropriately after scoring a goal.

To a great extent, children learn the game through what Bandura calls *abstract modeling*—abstracting a general rule from observing specific behaviors. Children gradually extract general concepts of group action in the game: team defensive strategy, predicting where one's teammates will be at a particular moment, and strategies concerning how to play one's position.

Children often receive feedback regarding how closely their behavior matches the model's. The coach may praise a skillful pass. An attempt to score that misses the goal gives immediate feedback, and players may adjust the angle of their kick next time or seek further verbal instruction or demonstration from others. This reinforcement or nonreinforcement is a source of information to children concerning their behavior and also provides an incentive for further participation. Still, reinforcement or punishment to the model or the child is not *necessary* for observational learning to occur: "After the capacity for observational learning has fully developed, one cannot keep people from learning what they have seen" (Bandura, 1977, p. 38).

Of the numerous laboratory studies of observational learning, an excerpt from the famous "Bobo doll" experiment by Bandura, Ross, and Ross (1961) appears at the beginning of this chapter. Preschool children saw an aggressive adult model punch a large, inflated Bobo doll and hit it on the head with a hammer, saying, "Sock him in the nose" and "Pow." In a comparison group, the model played nonaggressively with toys, and a control group had no model. Later, the children played in a room containing a variety of aggressive toys (Bobo doll, dart guns, tetherball with a face painted on it) and nonaggressive toys (tea set, teddy bears, trucks), including the toys the adult model had used aggressively. The children who had observed the aggressive model were more aggressive than the children who had seen a nonaggressive model or no model. Some of children's aggression matched novel behaviors shown by the model, such as hitting a Bobo doll over the head with a hammer. However, seeing an aggressive model also seemed to generally disinhibit other aggressive behaviors, not shown by the model, that the children already had but typically kept under control. Examples were firing imaginary shots at objects and saying "Stupid ball" and "Knock over people." This point is important because it indicates that seeing even mild aggression might elicit a great deal of aggression of various kinds.

This study attracted much interest because it suggested that watching violence on TV or in movies would increase aggression. It was debated, however, whether the children were expressing "aggression" or simply playing vigorously in a setting in which doing so seemed to be approved by adults. Also, they just may have been aroused emotionally and thus more active.

It is clear that Bandura and Freud give us opposite predictions concerning the effects of watching aggression in other people. Freud would see such an activity as a way of reducing aggressive tensions, thus lessening subsequent aggression. In contrast, Bandura would predict that viewing aggression, especially if the aggression is not punished, is likely to cause imitation, thereby increasing aggression. And that is what was found. Ethology offers yet another perspective on the effect of watching aggression. Watching who successfully aggresses against whom provides information for learning the dominance hierarchy of one's group.

A further result in this study is noteworthy. Although the boys were physically more aggressive than girls, from other studies we know that girls *learn* as much aggression from the model as do boys (e.g., Bandura, 1965). That is, girls can produce the aggressive behaviors when asked to or rewarded for doing so but typically do not *produce* as much physical aggression, perhaps because adults are more likely to prohibit this behavior in girls than boys. Thus, one must make a distinction between learning and performance. The finding that children learn and remember what they observe even if it is not reproduced immediately raises the concern that viewed violence on television may not have obvious immediate effects but may be stored in memory for future use.

Researchers have used the basic paradigm of Bandura's study to show that observational learning of a variety of behaviors (prosocial behavior, styles of information processing, conservation of number) is widespread throughout childhood through a variety of models (filmed, symbolic, real). Observational learning continues during adolescence. For example, adolescents with high exposure to smoking in movies were about three times as likely to try smoking or become smokers (Heatherton & Sargent, 2009), even after controlling for a variety of demographic and personality factors, as well as parenting style.

Can social learning explain cultural differences in social behaviors and personality? Many of the behaviors pervasive within a culture reflect the fact that children in the culture are exposed to the same or similar models. For example, cultures vary in teaching about aggression. The Dugum Dani, a warrior society in the New Guinea highlands, has a training program that brings boys closer and closer to real warfare (Gardner & Heider, 1969). War games include skewering the enemy (berry seeds) on a sharp stick, spearing a hoop tossed by the opposition, battling with grass "spears," and watching real battles from a distance. In contrast, the Polynesians of the Society Islands actively discourage aggression and rarely provide aggressive models (Levy, 1969). They teach their children that spirits punish aggression with illness and injury.

Observational learning not only is a process of normal socialization but also can be a therapy for problem behaviors. For example, observational learning can help children overcome fears. In one study (Bandura, 1967), preschool children who were afraid of dogs watched a child happily approach a dog gradually and play with it. After the therapy and even one month later, most of the previously fearful children would hand-feed a dog and even climb into a playpen with it. Even just showing the modeling sequence on film also reduced their fears.

Causal Model Includes Environment–Person–Behavior System

Bandura's model of learning includes three components: biological and psychological characteristics of the person (*P*), the person's behavior (*B*), and the environment (*E*). In *triadic reciprocal causation*, these three factors are highly interdependent, and each factor influences, and is influenced by, each of the others. Consider a situation in which a girl observes a boy giving some of his pennies to help poor children. Several characteristics of the observing child influence whether she will imitate this behavior ($P \longrightarrow B$). Is she cognitively and socially developed enough to understand what it means to be poor? What are her standards of fairness or social justice? Has she observed her parents contributing to charities in the past? The environmental factors might include the social status of the model, whether the model was praised after he gave, the salience of the model in that situation, and other social influences ($E \longrightarrow P$, $E \longrightarrow B$). If the girl feels pleased with herself after sharing, the behavioral act of sharing affects her psychologically ($B \longrightarrow P$). Cognition is important in this process; children symbolically represent the relationships among the situation, their behavior, and the outcome.

Bandura (1997) describes three types of environments: imposed, selected, and created. They vary in the child's active contribution. An *imposed environment* is thrust on people. They cannot control its presence, but they have some control over how they construe it and react to it. For example, children must attend school, but if they do not like it at first, they can try to find aspects they like. A *selected environment* is the part of the potential environment that people actually experience. Only the parts of the environment that children select and activate can affect them. A high school student chooses certain school courses but not others. A student may take advantage of extracurricular activities and engage in rewarding leadership experiences or become entangled in peer pressure to engage in risky behaviors such as heavy drinking. *Created environments* are those that children construct through their behavior ($B \rightarrow E$, $P \rightarrow E$). Children who choose to watch television a great deal expose themselves to a set of models that differs from that of children who usually play with friends instead. Or children may perfect a skill, such as drawing or ballet dancing, which creates an environment of social reinforcement in the form of praise from others. In the sharing situation described above, children who have habitually shared in the past and thereby elicited warmth and gratitude from others have created a positive, supportive milieu for themselves. In contrast, aggressive children may create a hostile environment for themselves wherever they go, causing others to react negatively toward them. Thus, children actively contribute to their own development.

Evidence that children's behavior can change their social environment comes from a study by Brunk and Henngeler (1984). Two 10-year-old child actors exhibited either anxious–withdrawn or aggressively noncompliant behavior in a setting in which mothers (not their own) attempted to engage each boy in a game of checkers. The mothers used more helping and rewards with the anxious–withdrawn child and more ignoring, commands, and discipline with the aggressively noncompliant boy. Thus, the boys "created" two different social environments.

One striking example that personal factors lead people to select particular environments, even where to live, comes from a study in Finland (Jokela, Elovainio, Kivimäki, & Keltikangas-Järvinen, 2008). Major temperament traits, such as sociability, emotionality, and activity predicted migration patterns. Highly sociable people tended to migrate to urban areas and longer distances; high activity people generally tended to migrate, and highly emotional people tended to leave home but not move far away.

Cognitive Contributions to Learning

What is Matter? —Never mind.

What is Mind? —No matter.

—*Punch, 1855*

Figure 6.1 presents Bandura's (1986) outline of the cognitive processes underlying observational learning and, to provide a context, the other component processes involved as well. This model advanced research on observational learning because it provided a detailed, careful analysis of the specific processes involved in such learning. Because each of these processes undergoes development, the model provided a map for studying processes of social development. Children select and process information, apply general rules or principles, weigh information, and make a decision—processes described by information-processing theory (see Chapter 7). Cognitive factors influence what is observed, how that person or event is perceived, how this new information is organized for the future, whether the observational learning has a lasting effect, and what this effect is.

To illustrate these processes, consider a young boy watching a TV show in which a character beats up another person. Characteristics of both the model and the boy control the boy's attention. As summarized in Figure 6.1, the boy is more likely to attend to the model if the model is salient (e.g., aggressive) and attractive (e.g., a superhero), if the model's behavior is not too complex for the boy's understanding, if there are many opportunities to see the model fighting (prevalence), and if the model's behavior proved to be effective (functional value). The boy's cognitive level, his ability to attend selectively, and his past experiences influence whether he attends to this particular model. Also, if he has an optimal level of arousal—not tired, in an alert state—he is more likely to attend. His attention also may be affected by his expectations about what the model will do, based on previous viewing of the show. Finally, his interest in violence will increase his attention.

Even if the boy attends to the model's behavior, it will have little influence unless he remembers it later. He must translate the event into symbols—verbally or in visual images—and integrate it into his cognitive organization. He may use *cognitive rehearsal*—visualizing himself fighting like the superhero. Similarly, outstanding athletes sometimes prepare for a competition by mentally visualizing themselves successfully carrying out the desired sequence of activities. The boy may engage in e*nactive rehearsal*—actually practicing the behavior—hopefully with a toy

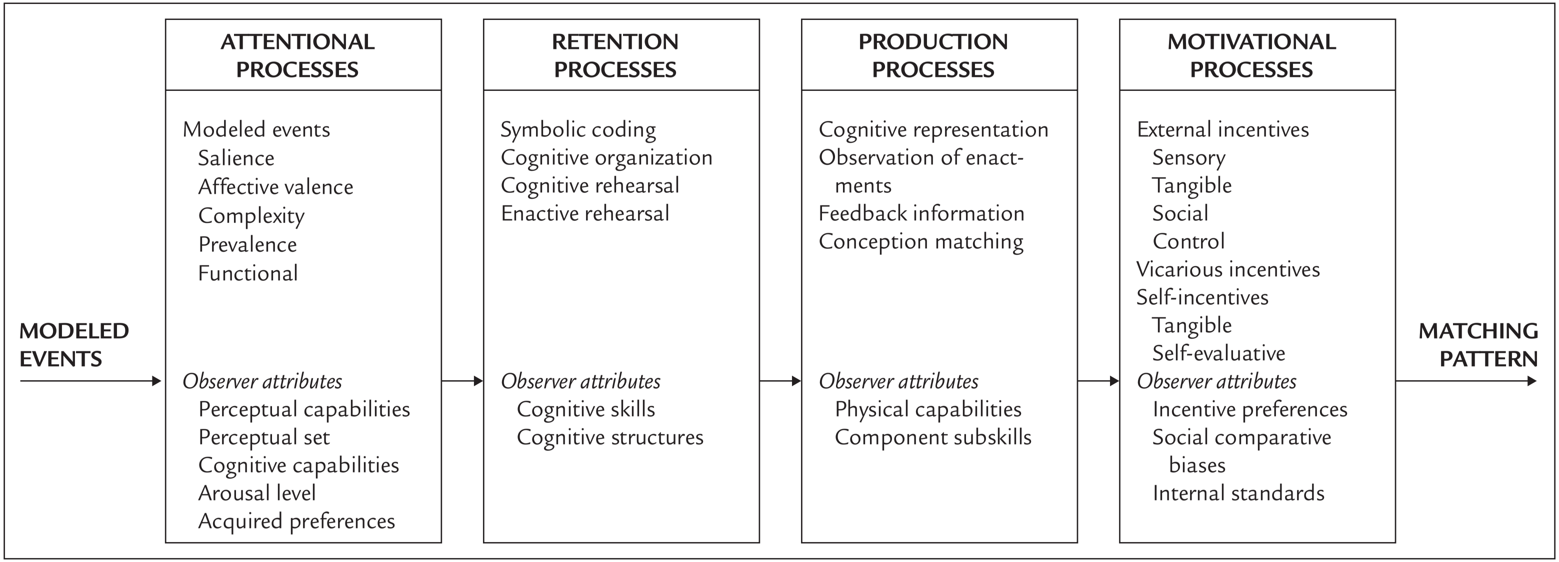

FIGURE 6.1

Subprocesses underlying observational learning, according to Bandura.

[From Albert Bandura, *Social Foundations of Thought and Action,* ©1986. Reprinted by permission of Pearson Education, Inc., and Albert Bandura.]

rather than another child. What he retains in memory does not have to be structurally similar to the model's behavior; it could be a rule, such as "It's OK to beat up bad guys."

The two remaining component processes—production processes and motivational processes—pertain to the child's actual performance of the learned behaviors. When he is pretend-fighting later, he may compare his behaviors with his mental representation of the model's behavior and perhaps modify his behavior ("I have to do a high kick to the chin"). As for motivation, the boy is more likely to reproduce the fighter's behavior if the fighter won the fight and the boy thought it looked like fun. In contrast to Piaget, who examined only the cognitive development making imitation possible, Bandura is interested also in why a child is motivated to imitate only certain actions of certain models at certain times and places.

Abstract modeling, described earlier, is a particularly important developmental advance. Children can formulate an abstract rule by pulling out the relevant elements from a number of specific episodes of observational learning. Abstract modeling is the theory's main mechanism for explaining language learning. As children observe that the past tense is usually formed by adding *-ed*, they abstract this as a general rule and correctly say "walked" and "talked" and incorrectly say "hitted" and "doed." They may even use rules to make very complex incorrect utterances such as "He was disingappeared."

In contrast to Piaget's theory, thinking stays near the surface in Bandura's theory. That is, children detect regularities in the environment and generalize them; for example, "I'm usually good at that sort of game." These external events are translated into a symbolic form and combined with other symbolically represented events or used as information to develop a more general rule; however, the theory does not specify the construction of broad cognitive structures of the type described by Piaget. Bandura's concepts are more like constructed summary statements about the world.

Self-Efficacy and Agency

"I think I can. I think I can. I think I can."

—*Piper,* The Little Engine That Could, *1989/1930. (quoted in Maddux, 1998)*

In recent years, Bandura has emphasized *self-efficacy*—people's perception of their competence in dealing with their environment and exercising influence over events that affect their lives. A more formal definition is "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 31). These courses of action may include behavior, thoughts, and emotions. Self-efficacy affects all types of behavior—academic, social, and recreational. Children may have the necessary skills for mastering a task, but if they do not perceive themselves as capable of actually using their skills effectively, they may fail or, unlike "the little engine that could," may not even attempt the task. For example, when given difficult math problems, children with high math self-efficacy solved more problems, more quickly rejected strategies that did not work, more willingly reworked failed problems, and displayed more positive attitudes toward mathematics than did children with low math self-efficacy (Collins, 1982). This was true even of children with low math ability. This positive reaction to failure among highly efficacious children reflects their attributions of their failure to insufficient effort; they then try harder. In contrast, low-efficacy children attribute their failure to low ability, an attribution that does not encourage them to continue trying.

Thus, high self-efficacy is essential for persisting in the face of rejection. Bandura recounts the many rejections encountered by talented people who persisted:

> James Joyce's *The Dubliners* was rejected by 22 publishers. Gertrude Stein submitted poems to editors for about 20 years before one was finally accepted. Hollywood initially rejected the incomparable Fred Astaire as "a balding, skinny actor who can dance a little." Decca Records turned down a recording contract with the Beatles with the unprophetic evaluation, "We don't like their sound. Groups of guitars are on their way out." . . . Walt Disney's proposed theme park was rejected by the city of Anaheim on the grounds that it would only attract riffraff.
>
> *(1997, p. 73)*

Even infants are developing a sense of personal agency, a sense that they can cause effects in their environment, which is essential for self-efficacy. During development, children gradually construct their self-knowledge about their efficacy in various situations from four main types of information. The most authentic and direct source of information is the success or failure of previous similar attempts. A second source is the vicarious experience of observing others fail or succeed on similar tasks. If children perceive themselves as similar to a model who succeeds, their self-efficacy is enhanced. A third source of information is others persuading children into believing they can achieve their goal. For example, parents praising their child's efforts at age 14 to 38 months predicts children at age 7 to 8 attributing their success to hard work, preferring challenging tasks, and generating strategies for improvement (Gunderson et al., 2013). Finally, information comes from one's physiological and affective states: arousal, anxiety, fatigue, and physical pain. Cognitive development helps children integrate these four sources of information. Acquiring language, becoming more socially aware, and learning to tell one's emotions apart contribute information as well.

Both parental and child self-efficacy is important for positive developmental outcomes. Parents' self-efficacy regarding their parenting skills underlies many of the correlates of parenting quality such as maternal depression, child temperament, social support, and poverty (Coleman & Karraker, 1997). Not surprisingly, parents' feelings of self-efficacy concerning their parenting decrease as their children move from early to middle adolescence, with its new challenges (Glatz & Buchanan, 2015). This drop is less if the adolescent and parents have established good communication. The peer group becomes increasingly important for self-efficacy. Children with low social self-efficacy "exhibit social withdrawal, perceive low acceptance by their peers, and have a low sense of self-worth" (Bandura, 1997, p. 173). Children with high self-efficacy for aggression are quick to use aggression with their peers to obtain goals. Schooling, of course, contributes greatly to children's sense of intellectual efficacy in various areas. An example of schooling's effect on self-efficacy is that children who perceived their classroom environment as more caring, challenging, and mastery oriented had greater math self-efficacy, which in turn predicted math performance (Fast et al., 2010). All of these sources influence children's resulting self-efficacy, which affects how resilient they are to adversity and how vulnerable they are to stress and depression.

Throughout the life span there are changes in which aspects of self-efficacy are most important. For example, adolescence and young adulthood bring new challenges to self-efficacy regarding interpersonal relationships, physical appearance, and occupational competence. During middle age, people may reevaluate their lives, doubt their efficacy concerning physical performance, and seek to achieve efficacy in new areas. A divorce or retooling for a new occupation may be the outcome. Elderly people may face damaged self-efficacy as a result of perceived memory loss, slowed reactions, and lessened self-esteem because they no longer hold a job. A self-fulfilling prophecy can occur: If elderly people are insecure about their efficacy and expect to fail, they may limit their range of activities and invest little effort in any activity, thus ensuring their failure. Bandura argues that true declines due to aging can be offset greatly by real-world knowledge and coping strategies acquired throughout one's lifetime.

Self-efficacy is related to the processing of information outlined in Figure 6.1. Interesting processing biases may be at work. People who tend to attend to and recall the negative features of their performance may underestimate their efficacy. Thus, parents and teachers can enhance children's self-efficacy by drawing attention to the positive aspects of their performance and thereby increasing the salience of those aspects. In fact, the efficacy judgments most conducive to development are slight overestimations, because these motivate children to try moderately challenging tasks that could hone their present skills. Parents across cultures may differ in their response to their child's success and failure. Chinese mothers de-emphasize their children's academic success and emphasize their academic failure, whereas the opposite is true for American mothers (Ng, Pomerantz, & Lam, 2007).

Collective efficacy is a group's shared belief in its ability, through collective action, to produce valued outcomes. For example, high collective family efficacy is associated with adolescents' and parents' satisfaction with their family life, in part because of the open family communication and adolescents' disclosure to parents of their activities outside the home (Bandura, Caprara, Barbaranelli, Regalila, & Scabini, 2011). As for a larger group, efficacious schools have characteristics such as strong academic leadership by administrators, high academic standards and the belief that students can meet them, and instruction that encourages students to exercise control over their performance. Bandura believes that collective political efficacy locally and nationally can bring about social change that addresses social problems such as ineffective schools, illiteracy, poor health practices, risky behaviors, unwanted pregnancies, and the threat of nuclear war. Collective efficacy empowers individuals, who then increase collective efficacy.

Closely related to self-efficacy is *agency*. Children are active rather than passive. If children believe they have the power to produce desired outcomes (self-efficacy), they are motivated to behave in ways to achieve these goals (agency) (Bandura, 2006a). For example, a boy wants to buy a bicycle (sets a goal), plans how he will earn enough money to do so, and persists at mowing neighbors' lawns because he keeps thinking about buying the bicycle. He resists temptation to play with his friends instead (regulates himself) and when he finds he is proceeding toward his goal more slowly than he expected, he reflects on whether he in fact has the necessary motivation to achieve his goal. People reflect on and manage their inner life of emotions and thoughts, as well as their actions: “[P]eople live in a psychic environment largely of their own making” (Bandura, 2006a, p. 165).

Examples of Developmental Research: Moral Judgments and Gender Roles

Two main points of contention between social learning theory and other theories concern two important developmental acquisitions—moral judgments and behavior, and gender-role development.

Moral Judgments and Behavior

An important legal question is “At what age can children understand right from wrong and be responsible for the crimes they commit?” Different theories offer different perspectives on children’s understanding of morality. For Piaget, changes in moral judgments result from general cognitive development. Children move from a focus on amount of damage and degree of punishment to a focus on intentions and extenuating circumstances. For Vygotsky, children internalize the moral belief system of their culture during interaction with adults and peers, such that moral reasoning varies from culture to culture. For Freud, identification with parents, especially a parent of the same sex, brings a set of internalized moral standards to children. Social learning theorists emphasize that children use observed specific behaviors or moral statements to actively construct general standards of conduct—rules, goals, and expectations for their own behavior. These standards are especially effective in regulating behavior because children generalize them to many situations, and use them even when an external authority is not present. Unlike for Freud, the parent of the same sex serves as only one of many models from whom the child learns.

One contribution of social learning theory is to explain why a child’s moral reasoning or behavior would vary from situation to situation and from child to child. A child’s previous history of observational learning and the models in a particular situation influence the child’s behavior. For example, young boys use moral-judgment rules that are similar in form and complexity to those of their mothers (Leon, 1984). Also important are the child’s personal standards, adults’ prohibitions, the expected punishment or reward, and peer influence. Moral judgments involve a complex process of considering and weighing various criteria in a given social situation. Thus, unlike in Piaget's theory, in some situations a child makes a judgment based on intentions and in another situation makes a judgment based on amount of damage.

The tendency of older children to emphasize intentions in moral judgments reflects their greater exposure to models making such judgments. Also, adults have heightened expectations of older children, and older children can more easily infer internal states from situational cues. For example, when disciplining a child, parents are more likely to explain their reasons for doing so if the child is 8 years old rather than 3 years old. The younger child is not impressed with arguments about fairness and equality. Similarly, parents' presentation of legal codes and societal punishment may be reserved for preadolescents and adolescents. Thus, children of different ages tend to see models presenting different sorts of moral judgments.

The main evidence bolstering the social learning account is that children's moral judgments can be altered by a brief social experience in the laboratory. In a prototypic study, Bandura and McDonald (1963) first assessed 5- to 11-year-olds' moral reasoning, based on Piaget's stories depicting moral dilemmas. One actor had good intentions but produced great material damage, whereas the other actor had bad intentions but produced minimal material damage. First the model and then the child made judgments about stories. Then the researchers exposed children to a model whose judgment was opposite that of the child's. In a final test for generalization, a different adult in another room presented new stories that the child judged. As predicted by social learning theory, the children adopted the model's moral standards. The fact that this new moral perspective generalized to new stories in the third phase suggests that the children abstracted a general rule rather than imitated specific responses. A control group with no model did not change. Children maintained these changes for at least a month (Dorr & Fey, 1974).

Bandura proposed an interesting concept, *moral disengagement*, which refers to people justifying their unacceptable behavior. This mental firewall between moral standards and behavior illustrates the important distinction between moral cognitions and behavior. Moral disengagement (e.g., blaming the victim, diffusing responsibility away from oneself to one's social group) is related to both traditional and cyberbullying in young adolescents (Robson & Witenberg, 2013). Online social interaction may particularly encourage bullying, because features of online communication, such as not seeing others' emotional reactions in person, may facilitate aggression (Runions & Bak, 2015).

Gender-Role Development

The development of gender roles is central to much of social development. Almost everything we do is gendered, and almost every aspect of society, from parents to the media, shapes children toward cultural values concerning gender roles. For social learning theory, the developmental processes described above also apply to gender-role development (Bussey, 2011). Gender development flows from the interaction of intrapersonal, behavioral, and social influences operating within societal systems composed of parents, peers, teachers, mass media, and various social institutions. Gender roles develop through the processes of observational learning and self-regulation.

Cognitive development also contributes: Infants and toddlers learn to differentiate between males and females according to their associated appearance and activities. They learn what their gender is, label themselves and others according to gender, and note the styles of behavior of each gender. By age 3 or 4, or even earlier, children disapprove of boys feeding, diapering, and comforting dolls and girls playing with trucks. In fact, in one study (Bussey & Bandura, 1992), when children of this age were confined to a playroom with only toys gender-typed for the other gender, they ignored the toys. One boy even flung the doll across the room and turned his back on it. Some boys tried to transform the feminine toys into masculine ones, for example, by using an eggbeater as a gun or a drill. The boys tried to have the "feminine" toys removed. One boy pointedly told the departing experimenter, "No, I'm finished with those toys," even though he had not played with them at all.

During childhood, children continue to form abstractions about gender based on observations of behaviors and rewards or sanctions. Childhood provides numerous opportunities to observe gendered behavior because children tend to seek out same-sex playmates and, even when both sexes are available, to imitate same-gender models more than other-gender models. Even 3-year-olds copy the preferences of same-sex (over different-sex) child models for novel food, clothes, toys, and games (Frazier, Gelman, Kaciroti, Russell, & Lumeng, 2012). They see people and behaviors repeatedly labeled according to gender and observe that only certain behaviors are sanctioned for each gender and that opportunities are heavily organized by gender (for example, how far away from home one can ride one's bicycle alone, whether wearing jewelry is discouraged). Girls learn that others disapprove of their physical aggression.

Self-efficacy comes into play in many ways, for example, regarding probable success if one enters male-dominated versus female-dominated occupations. This has been particularly true for fields requiring math skills; females tend to underestimate their efficacy in this area. For example, girls whose teachers do not hold stereotypic biases about gender develop greater mathematical self-efficacy and valuing of mathematics (Eccles, 1989), and girls' perceived self-efficacy in various areas affects whether they select careers traditionally associated with females (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001).

Mechanisms of Development

Social learning theorists focus on *processes* of change (as did Vygotsky) in contrast to Piaget and Freud, who were more interested in *structural* change as children go through the stages. According to Bandura, development occurs because of three main factors: physical maturation, experience with the social world, and cognitive development. These three factors cause developmental changes in all of the processes in Bandura's model in Figure 6.1. The first factor, *physical maturation*, holds little interest for social learning theorists. Its main relevance is that young children may not have the physical maturity to reproduce certain motor patterns they observe. The other two factors are much more important.

As already discussed, *experience with the social world* causes development as children engage in observational learning and construct general concepts or rules. As children get older they are exposed to a wider variety of people, behaviors, and media. Moreover, their social environment changes simply because society, ranging from their parents to the legal system, changes its expectations of them. A 4-year-old who cannot add is not a cause for alarm to adults, but a 7-year-old who cannot add faces a social environment in school directed toward learning this concept. A teacher provides much more help with reading to a first-grader than to a third-grader. Older children, by watching the teacher, are expected to learn complex new skills quickly, with a minimum of verbal instruction.

The third factor, *cognitive development*, refers to changes in the cognitive skills in Figure 6.1. Cognitive processes such as attending, remembering, integrating pieces of information, and evaluating feedback pull social development along. The growing ability to translate observations into symbols and to recombine these symbols makes observational learning much more flexible and enduring. Older children can model behavior by reading a description of it or listening to instruction rather than by having to see the behavior. Age differences in cognitive processes can be seen in what children assimilate while watching a movie. Older children have much better comprehension and recall of characters, behaviors, motivations, and outcomes of the behaviors (Newcomb & Collins, 1979). Young children often do not even make a connection between the model's behavior and the consequences of that behavior later on.

Position on Developmental Issues

Human Nature

Learning theories have served as textbook writers' favorite example of a theory with a mechanistic view of human behavior. An infant—"a lively squirming bit of flesh" (Watson, 1928, p. 46)—is material to be fashioned by parents and society. The mechanistic model, however, does not accurately represent modern social learning theory, in which "people are self-organizing, proactive, self-reflective, and self-regulating" (Bussey & Bandura, 1999, p. 691). In triadic reciprocal causation, discussed earlier, people actively operate on the environment, just as the environment acts on them. People filter their experience through their current knowledge and expectations about the world, create their own environment as their own behavior influences the environment, and generate new behavior by reorganizing previously learned behaviors. Thus, one can see some elements of the organismic (e.g., self-organizing) and contextual (e.g., contexts matter) worldviews.

There is a basic difference among theorists concerning the role of interaction. For Piaget and Vygotsky, the interaction or exchange between a child and the physical (Piaget) or social (Vygotsky) environment forms a structure that later becomes an internalized cognitive structure. In contrast, for Bandura the structure of the interchange between the child and the environment is less important than the new information acquired or the increased self-efficacy as a result of this interchange.

One point of comparison among the theorists is the view of humans as rational or irrational. Both Piaget and Vygotsky emphasized the development of rational, logical thought. Although all the theorists consider logical thinking important, both Freud and Bandura studied illogical, irrational thought as well, perhaps because of their focus on motivation. For Bandura, children may think logically or illogically, depending on the types of models they have encountered in problem-solving situations. They acquire styles of processing information from other people.

Qualitative Versus Quantitative Development

Social learning theory views development primarily as a process of quantitative change, in which learning accumulates over time. Development simply involves a multitude of short-term changes. Observational learning may change somewhat qualitatively when symbolic representation of others' behaviors becomes possible, and when changing from one set of rules to different ones. However, we do not find either rapid qualitative changes in movement from one stage to another or massive cognitive reorganization. Bandura considers the search for stages counterproductive because stages draw attention away from individual differences and differences in the way a given child functions in different environments. Furthermore, Bandura notes that a failure to learn may be dismissed as a lack of cognitive readiness, when it actually reflects a poor learning environment. He thinks that an analysis of which subskills are needed to produce a certain behavior or knowledge is much more promising than positing stages.

Nature Versus Nurture

A young branch takes on all the bends that one gives it.

—Chinese proverb

Social learning theorists, like sociocultural theorists, emphasize nurture more than does Freud and much more than does Piaget, the interactionist. However, social learning theorists do not follow the militant environmentalism of traditional learning theory, which viewed the young mind in the way British empiricist John Locke viewed it: a blank slate on which experience writes. Rather, biology, for example, species-specific behaviors, can constrain learning. This was demonstrated dramatically in an attempt to train raccoons to drop tokens into a slot (Breland & Breland, 1961). The animals stopped to "wash" the tokens, as if they were food, even though there was no water around. Bandura's view of the roles of biology and children's active constructors of their experience is captured in his notion of triadic reciprocal causation. The environment, the person (including physical maturation), and the person's behavior are interdependent forces operating in any event. However, the evolutionary, genetic, and neural developmental aspects of the person are given little attention.

What Develops

Because what is developed depends greatly on what the environment has to offer for learning, learning theorists propose few universal behaviors that would be found in every culture. Whereas Piaget claimed that all physically normal children in the world develop concepts of object permanence, causality, and conservation, and Freud assumed a universal concern with sexuality and aggression, social learning theory appears to be almost content-free (as does Vygotsky's theory). Investigators have directed their energy toward process rather than content. One culture may encourage aggressive behavior, whereas another may discourage it. Superstitious behavior may be valued and nurtured in one culture, whereas scientific, analytic thinking may be fostered in another. In other words, there is no universal endpoint to development. Piaget, in contrast, saw development toward a particular way of thinking: formal operations. And Freud saw mature sexuality and freedom from excessive anxiety as the goal of development.

Applications

Social learning theory has addressed a variety of social problems involving children, for example, aggression. Does watching violence on television and in movies, or playing violent video games make children aggressive? Are bullies created by watching others effectively use violence and by successfully bullying other children with no negative consequences? Why do violent adolescent boys sometimes come from "privileged," middle-class families in neighborhoods that support law-abiding behavior? The latter question was examined in a classic study by Bandura and Walters (1959), illustrated in the excerpt at the start of this chapter. Although the parents discouraged their sons' aggression toward them, they actually encouraged them to use aggression to solve their problems with their peers and with adults outside the home.

Social learning theory also has been useful for helping dysfunctional families. Families sometimes unknowingly develop coercive systems (Patterson, 1980; Smith et al., 2014). During hostile interchanges, certain behaviors habitually lead to certain other behaviors through a system of reinforcement. For example, a mother asks her son to clean his room, the child whines, the mother intensifies her command, the child resists, and the conflict rapidly escalates. Patterson noted that "rapid escalation is thought to be an important component in the repertoire of the trained fighter and well practiced coercive children" (1980, p. 7). When the behavior of the child becomes unbearably aversive for the mother, as when the child throws a temper tantrum, the mother gives up and the child stops his aversive behavior. Each person has ended the aversive behavior of the other. The mother has increased the chances that the child will act aversively in the future because his resistance was reinforced by not having to clean his room. Ending the temper tantrum reinforced the mother, which increases the likelihood that she will give in on future occasions. This pattern of reinforcement also increases the likelihood that a rapid escalation of conflict will occur in their future interactions. More generally, parents in functional and problem families differ in their discipline skills. In functional families, the parents set up specific consequences for the child's misbehavior and consistently apply them. In contrast, in coercive dysfunctional families, the child learns that parents may react explosively to misbehavior and make vague punishment threats but will not follow through on these threats.

This negative developmental cascade begins early. Coercive caretaker–child interactions when children are ages 2 through 5 predict later teacher-reported oppositional behavior at school age (Smith et al., 2014). In school, many of the child's coercive interactions and conduct problems are directed toward peers, which often leads to rejection by peers. Thus the child continues to head down a negative developmental pathway toward later behavioral problems. Families assigned to an intervention, in contrast, showed declines in child oppositional and aggressive behavior.

Even the entire family can become a coercive system in which each family member learns to cope with aversive behavior from others, such as hitting, teasing, ignoring, verbal abuse, and requests to do work, by counterattacking, which often ends the aversive behavior. A young girl's teasing of her older brother leads to his hitting her, which in turn leads to punishment from the parents, which finally may even escalate the boy's aggression. Each family member is periodically reinforced for behaving aggressively and coercively when overpowering another family member through negative behaviors. After the psychologist makes the problem family aware of these correlated events, together they try to reduce the amount of aversive behavior with which the child must cope and try to lower the "payoff" for the child's coercive behaviors. If the child is old enough, the family may write a contract that includes the child, specifying what behaviors will be punished by withdrawal of rewards. Thus, they present expectations for behavior and the consequences of disobeying in a clear and consistent way that the aggressive child can easily grasp and represent symbolically.

Bandura has applied his theory on an international scale. He has implemented several programs to improve personal and collective self-efficacy to bring about social change. For example, television and radio programs focused on increasing self-efficacy have been very effective at increasing literacy, safe sex to protect against AIDS infection, and the adoption of family-planning methods in several countries in Africa, Asia, and Latin America. For example, in Mexico, almost one million people took a course to learn how to read after seeing a drama showing people of various ages learning to read and consequently improving their lives (Bandura, 2006b). Other programs have addressed pornography, deterrents to crime, encouragement of healthy behaviors, and moral disengagement regarding violence after terrorist attacks.

Evaluation of the Theory

Social learning theory's strengths are its focus on the situational, social, and emotional influences on behavior and its testability. As in the chapter on psychoanalytic theory, the emphasis is on what the theory *could* contribute to present and future research and theory building in developmental psychology. Two weaknesses are an inadequate account of cognitive development and an inadequate description of development in natural settings.

Strengths

Focus on Situational Influences on Behavior ▸ As mentioned in Chapter 2, one challenge to structural theories, such as Piaget's and Freud's, is that a person's concepts or personality are not expressed in all situations. Social learning theory's focus on situational variables provides a way to explain this domain specificity of knowledge and behaviors. This analysis of situations is sorely needed in current work on children's thinking, remembering, and learning. Looking at characteristics of available models, the child's previous learning history in that situation, and available reinforcers may clarify the child's unevenness of behavior across situations, or even cultures. Cultures differ in what concepts parents and teachers emphasize. As mentioned in Chapter 4, Japanese mothers encourage even very young children to play counting games. A situational analysis also could contribute to an understanding of children's theory of mind. Observing others deceive, manipulate, and comfort people may contribute to this knowledge.

Cognitive theories generally also ignore motivation. In contrast, Bandura addresses "hot" cognition (Zajonc, 1980) as well as the "cold" cognition of other theories. Hot cognition consists of the emotional, motivational aspect of thinking; cold cognition includes the nature of thinking but not its emotional aspects. Examples of hot cognition are children thinking about how to please their parents, experiencing sadness when they fail at a task, and feeling disappointed in themselves when they do not meet their own standards of conduct. Motivation affects whether children apply their knowledge in a particular setting and thus is important to consider during cognitive assessment.

Another potential contribution is to cultural approaches, which, like social learning theory, place importance on children learning by watching the activities of parents, other adults, siblings, and older peers. Social learning theory can specify the motivational, attentional, and cognitive processes involved as well as cultural differences in the extent to which children learn in this way.

Testability ▶ Even those who have attacked learning theories admit that they are among the most testable theories in psychology. Learning researchers have defined terms clearly, stated hypotheses precisely, and kept unobservable, intervening variables to a minimum. Parsimony is highly valued. It is desirable to have a theory that reminds us that we are interested in observable behaviors as well as in thinking and attitudes. Thus, social learning theorists can serve as watchdogs of cognitive psychologists, who sometimes seem to have forgotten about behavior. We must remember that representations, mental operations, and concepts of other people ultimately are related to behavior.

Weaknesses

Inadequate Account of Cognitive Development ▶ It is not clear whether social learning theory is truly a developmental theory. Is developmental change simply short-term change accumulating over a longer period of time? Are the processes of social learning the same at all ages? If development is merely accumulated learning, are there any limits on how much one can speed up development? A truly developmental theory should be able to specify, for example, what differences underlie infants' ability to copy their mother when she sticks out her tongue and 10-year-olds' ability to play a new card game after reading the rules.

Adding a clear and specific account of cognitive development would make the theory more developmental. A child's cognitive level both enables and constrains what she can learn through observation. For example, watching another child share a toy with a friend may be regarded as an isolated behavior by a 4-year-old but may imply a set of meanings concerning fairness and reciprocity for an 8-year-old. The two children differ in what they learn from this observation. As another example, 48-month-olds were able to sort visually identical objects according to weight after watching an adult do this and could even transfer this observational learning to novel objects, but 36-month-olds could not (Wang, Meltzoff, & Williamson, 2015). The younger children did not have the cognitive readiness needed in order to imitate this behavior.

Bandura posited some simple cognitive organization and restructuring during development. He also proposed that as children develop cognitively, perceptually, and motorically, their observational learning becomes more efficient and abstract. However, he devoted little attention to exactly which developing cognitive skills contribute to observational learning. From a contemporary perspective, several good candidates to be studied include perspective taking, monitoring reactions to the model's behavior, considering contexts, evaluating a model's testimony, understanding knowledge states, and calibrating multiple pieces of information or cues (Wood et al., 2013).

Inadequate Description in Natural Settings ▶ A strength of ethology is its method of observing organisms in their natural settings. In contrast, from learning theory, we know much more about the variables that *can* affect the learning of social behaviors than about what variables *actually* operate in the lives of children or what behaviors actually occur at various ages. We know how variables operate to produce short-term changes in the laboratory but less about how they operate in natural environments. We do not know the ecology in which children learn aggression, sex typing, or dependency. Similarly, laboratory studies have identified many processes, such as imitation, abstract modeling, reinforcement, self-efficacy, and concept formation, that mold gender-role behaviors. Which processes, in fact, are most important in particular natural settings at different ages? We need a taxonomy of the various learning situations in which children typically find themselves in each developmental period. The theory's contribution would be much greater if investigators would examine the models and reinforcement contingencies usually found in the typical environments of each phase of development. One recent study (Flynn & Whiten, 2012) shows how research in natural settings can be informative about observational learning from dominant and prestigious models. In a preschool setting, children were more likely to watch another child play with a novel puzzle-box if the observed child was older, more popular, or more dominant than other children.

Moreover, observational learning and patterns of reinforcement need to be tied systematically to social–ecological variables, such as both parents working outside the home, diversity in what constitutes a family, urbanization, racial discrimination, and changing gender roles. A complete account of social learning must also consider demographic variables, such as socioeconomic level, race, gender, and geographic location. For instance, we need a description of developmental changes in aggression that takes into account the type of peer models in the neighborhood that are seen by children in various subgroups of the population, the type of day care the child has, and the father's involvement in child rearing.

Contemporary Research

Social learning theory peaked in its influence on developmental psychology in the 1960s and 1970s. Although today it still is included in most standard accounts of development, relatively few studies with children are directly stimulated by the theory. The recent work on agency and self-efficacy, for example, has focused on adolescents and adults. In a more general sense, however, social learning theory is indirectly responsible for much of the current research on children's social development: aggression (Eisner & Malti, 2015), gender development (Hines, 2015), moral behavior (Killen & Smetana, 2015), peer interaction (Rubin, Bukowski, & Bowker, 2015), and influences of the media (Calvert, 2015). Work on aggression, for example, has expanded in interesting ways to include bullying, relational aggression (e.g., gossip, social exclusion), and the genetic and neural foundations of aggression. Today, important social learning theory concepts such as observational learning, self-efficacy, and the importance of adults' and peers' reactions to a child's behavior are simply assumed because of social learning theory. We now turn to three current active areas of research related to learning theory: cognitive approaches to learning, imitation, and selective social learning from others.

Cognitive Approaches to Learning

Developmentalists recently have shown a renewed interest in learning, in the sense of acquiring new knowledge and skills. Today, learning is virtually indistinguishable from cognitive change over short periods of time. Interestingly, many of these more cognitive approaches draw on the idea from traditional learning theory of the strengthening or weakening of associations. Even infants are adept at detecting regularities in their environment—which events or stimuli tend to occur together and may be causally related. These detected regularities are used to form mental models of the world and neural networks (see Chapter 7). For example, a toddler hears the word "dog" when a small animal with four legs, a panting tongue, a barking sound, and other characteristics is present in various contexts. These features tend to co-occur. Despite some differences in these specific dogs, they are included in the toddler's new concept of dog. These approaches, to be discussed in Chapters 7 and 9, go by several labels, such as probabilistic models, statistical learning, computational models, Bayesian networks, and connectionist models. More generally, a new field—*learning sciences*—has emerged. This interdisciplinary endeavor draws on fields such as cognitive science, machine learning, computer science, and educational psychology. The goal is to understand learning processes and to apply them to effective instruction.

Imitation

There is considerable interest in imitation itself—how early it appears, how it develops, and how it helps development. The ability to imitate is present early on, perhaps even at a few days of age (Meltzoff & Moore, 1989; Nagy, Pilling, Orvos, & Molnar, 2013). Even as early as 6 months, infants imitated, after 24 hours, what they saw on television, and did so as often as for live models (Barr, Muentener, & Amaya, 2007). Anecdotally, parents can attest to their toddler imitating in great detail their own idiosyncratic mannerisms or the dance moves of a rock star the toddler has seen on television.

Young children's imitation presents a paradox. On the one hand, their imitation often is selective. They extract the important features of another person's behavior, infer his intentions, and abstract a rule that they can see the other person is using (e.g., Williamson, Jaswal, & Meltzoff, 2010). On the other hand, they sometimes imitate exactly and even show *overimitation*—imitating everything the person does, relevant or not, and even when they know that they are imitating irrelevancies. A current controversy is over why children do this. It may be that when a child can easily understand the other person's behavior she imitates selectively, but when the behavior is new and complex, and she is not sure which aspects are important, she may imitate everything and fine-tune later (Nielsen, Mushin, Tomaselli, & Whiten, 2014). This may be adaptive in a complex, rich culture with many artifacts that children have to learn how to use. Or, children may overimitate when they want to be like the model, or want to demonstrate shared intentions with the model and communicate affiliation (Over & Carpenter, 2013). Children also may perceive that sometimes models show cultural conventions or rituals, which should be imitated closely, and sometimes models are providing opportunities to develop new skills, which permit some variability in the child's modeling (Legare, Wen, Herrmann, & Whitehouse, 2015).

Imitation plays an important role in the evolution of human societies and in cultural learning during childhood. Chapter 4 described how culture is transmitted through watching and listening to others and engaging in the activities observed. Imitation also seems to be a part of belonging to a social group. People are more likely to imitate others in their own social groups—their in-groups—than in their out-groups (Howard, Henderson, Carrazza, & Woodward, 2015). Interestingly, infants prefer adults who imitate them (Meltzoff, 2007) and show differences in brain activity when adults do or do not imitate them (Saby, Marshall, & Meltzoff, 2012). Children with autism spectrum disorders imitate less than typically developing children (Vivanti, Trembath, & Dissanayake, 2014) and even show less "contagious yawning"—yawning when someone else nearby yawns (Helt, Eigsti, Snyder, & Fein, 2010). This tendency not to imitate may partially account for their poor social learning.

One reason for the recent interest in imitation is neuroscientists' discovery of *action mirroring*, including a possible underlying mechanism—the *mirror neuron system* (Fogassi & Rizzolatti, 2013; Rizzolatti & Craighero, 2004): When people watch someone else perform an action, such as reaching for an object, the pattern of brain activity is virtually the same as when people themselves perform the action. This phenomenon suggests that performed and observed actions are coded in a common cognitive and neural network that may enable even infants to imitate others and understand their intentions and goal-directed behaviors, and thus learn from them. For example, when 7-month-olds see a failed behavior, such as an adult's unsuccessful attempt to reach for an object, they imitate the intended behavior (successfully reaching for the object) rather than the failed one (Hamlin, Hallinan, & Woodward, 2008). This may be a case of "filling in," during imitation, what one knows based on one's prior similar actions. Further evidence that infants apply knowledge about their own actions to those of others comes from studies in which infants are taught a new goal-directed behavior. Ten-month-old infants were trained to pull a cane to retrieve a toy. Subsequently, they could detect the goal-directed nature of another person's cane-pulling actions (Sommerville, Hildebrand, & Crane, 2008).

The larger important message of this line of research is that mind and body are not separated; action and thought are one. The controversies are: Is the neural mirroring system present at birth? How does it change developmentally? How is it modified by experience? What does this system contribute to the understanding of others' behavior? Does this meaning shared between two people also provide a foundation for language development and communication? Can a poorly functioning mirror neuron system explain the apparent deficits in imitation in children with autism spectrum disorders? Finally, some researchers doubt that mirror neurons exist in humans.

Selective Social Learning from Others

Children trust, and therefore imitate or accept information from, only certain people (e.g., Mills, 2013). Preschoolers judge the accuracy and trustworthiness of people's information from cues such as speakers' past accuracy (e.g., Koenig, Clément, & Harris, 2004) and their perceived positive or negative intent (e.g., Mascaro & Sperber, 2009). Moreover, it has been argued (Csibra & Gergely, 2009) that children have an innate tendency to imitate people who indicate, through cues such as pointing, verbal instructions, or eye contact, that they are trying to teach them something. This research adds to early social learning work on the characteristics of the model that affect children's observational learning by showing that the model's mental state and previous competence are important. In this way, children's cognitive development (ability to evaluate others' intent and quality of information) contributes to their observational learning.

SUMMARY

Social learning theory retains the spirit of the behaviorist movement: the experimentally rigorous study of basic learning processes. The spotlight, however, has switched from a hungry rat pressing a bar to a child interacting with other people. Children learn new behaviors by observing others. Moreover, the effect of environmental influences is cognitively mediated, as seen in children's use of language and strategies during problem solving.

Bandura contributed three key concepts:

1. *Observational learning can be much broader than mimicking another person's behavior*. Children can symbolically construct new, complex behaviors by listening to another person or watching a movie. Furthermore, overt behavior is not even necessary in order for learning to occur. As Bandura summarized the influences of models, they "can serve as instructors, motivators, inhibitors, disinhibitors, social facilitators, and emotion arousers" (1989, p. 17).

2. *Children are self-regulatory*. Although reinforcement is not necessary for learning, it is helpful for self-regulation, in part by providing feedback. Children observe which behaviors lead to reinforcement and punishment and use these observations as sources of information to help them abstract rules, evaluate their efficacy, develop standards of conduct, set goals, and decide in which situations to use the observed behavior.

3. *Triadic reciprocal causation provides a model of behavior change*. Three sources of influence—the person, his behavior, and the environment—interact and thus influence each other. The most novel features of this three-pronged model are that children actively select certain environments, and their behavior even helps shape their environment, which in turn acts on them.

Children develop five skills that are very important for social learning: symbolization, vicarious learning, self-regulation, self-efficacy, and the ability to see the future consequences of present behaviors (Perry, 1989). During development, children become more skilled at the four component processes of observational learning: attention, retention, production, and motivation. In particular, the growing ability to use visual and verbal symbols boosts children's observational learning. Much of social development results from the accumulation and integration of episodes of observational learning. Social learning theory has examined a wide variety of developmentally important behaviors, such as aggression, concept formation, language, gender-related behaviors, and moral development.

Learning theories have become less mechanistic over the years and increasingly acknowledge biological contributions, though still focus on nurture. Development mainly is quantitative. Social learning theory has been applied to interventions for dysfunctional families.

Bandura's theory is testable. It also is integrative in that it brings together information processing and socialization processes. Social learning theory could correct several shortcomings of cognitive approaches, providing a way to conceptualize why the child's behavior or demonstrated knowledge might vary from situation to situation. There are two needed directions for further developing social learning theory. First, the interface between cognitive development and observational learning must be worked out in greater detail before the theory can be considered a truly developmental theory. Second, the theory could become much more powerful in predicting and exploring behavior if it acquired a broader ecological database. The theory has shown us that processes of social learning can guide development; the next step is to discover how these processes are involved in the environments typically found at various points in development, in various types of families, and in various socioeconomic and ethnic niches. Contemporary research has expanded many topics emphasized by learning theories, including aggression and environmental influences such as the media. Topics of current interest include cognitive learning, including applications to instruction; the development of imitation itself and a mirror neuron system that might contribute to it; and selective social learning.

SUGGESTED READINGS

Bandura, A. (in press). *Moral disengagement: How good people can act inhumanly and feel good about it.* New York: Worth.

Bandura, A. (2012). Social cognitive theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.). *Handbook of theories of social psychology* (Vol. 1, pp. 349–373). Thousand Oaks, CA: Sage Publications Ltd.

Bandura, A. (2009). Social cognitive theory goes global. *The Psychologist, 22*(6), 504–506.

Forgatch, M. S., Patterson, G. R., & Gewirtz, A. H. (2013). Looking forward: The promise of widespread implementation of parent training programs. *Perspectives on Psychological Science, 8*(6), 682–694.

Meltzoff, A. N., & Williamson, R. A. (2013). Imitation: Social, cognitive, and theoretical perspectives. In P. D. Zelazo (Ed.), *The Oxford handbook of developmental psychology. Vol 1: Body and mind*. New York, NY: Oxford University Press.

CHAPTER 7

Information-Processing Theory

An experimenter (E) questions a child, Lauren (L), about an addition problem:
E: How much is 6 + 3?
L: (Long pause) Nine.
E: OK, how did you know that?
L: I think I said . . . I think I said . . . oops, um . . . I think he said . . . 8 was 1 and . . . um . . . I mean 7 was 1, 8 was 2, 9 was 3.
E: OK.
L: Six and three are nine.
E: How did you know to do that? Why didn't you count "1, 2, 3, 4, 5, 6, 7, 8, 9"? How come you did "6, 7, 8, 9"?
L: Cause then you have to count all those numbers.
E: OK, well how did you know you didn't have to count all of those numbers?
L: Why didn't . . . well I don't have to if I don't want to.

—*SIEGLER & JENKINS, 1989, p. 66*

A part of a connectionist model:
The hidden layer activities, $\vec{Y}^1(t)$ *and* $\vec{Y}^2(t)$*, resulted from*
$\vec{Y}^k(t) = s(V^k\vec{X}^k(t) + U^k\vec{Y}^k(t-1))$,
where $k \in \{1, 2\}$, V^k *and* U^k *are weight matrices and s is the sigmoid:*
$s(x) = (1 + e^{-x})^{-1}$.
The output, $\vec{Z}(t)$*, is calculated accordingly:*
$\vec{Z}(t) = s(W^1\vec{Y}^1(t) + W^2\vec{Y}^2(t))$,
with the W^k *being weight matrices to the output layer.*

—*FRANZ & TRIESCH, 2010, p. 650*

This is the information age. With our various electronic devices, we have constant, fast access to information from friends, family, work colleagues, and websites around the world. In our information-heavy world, almost every aspect of play and work involves decision-making about what information to select, store, and use. It is not surprising, then, that at least one developmental theory would use a technology metaphor and focus on how children deal with information.

In the last five decades, the information-processing approach, on the wave of the cognitive revolution, spread quietly through the field of cognitive development. It is said that the approach "was never born; it gradually coalesced" (Kendler, 1987, p. 364). Information processing arrived with little fanfare and, surprisingly, with only moderate clashes with Piagetian theory. The approach attracted psychologists seeking a more rigorous experimental approach than Piaget's and a more cognitive approach than learning theory. To a great extent, information processing defines the study of cognitive development as it exists today. However, as with Piaget's theory, the influence has so permeated the field that its presence is almost invisible. Many developmental psychologists who study memory, mental representation, and problem solving—major topics of information processing—are not aware that they have accepted certain assumptions and methods of that approach. They feel they are simply performing empirical, atheoretical studies of various aspects of thinking. This chapter makes explicit this implicit agreement about what thinking involves, what aspects of thought change during development, what questions are worth asking, and how those questions should be studied. The information-processing approach continues to change with the advent of another new technology—neuroimaging. Developmental cognitive neuroscience is providing another level of explanation of changes in information processing.

This chapter begins with a brief description of the information-processing approach and then continues with a historical sketch, a general orientation, descriptions of major developmental approaches, and an account of mechanisms of development. Later sections address the theory's position on developmental issues, applications, the theory's strengths and weaknesses, and contemporary research.

Information processing is not a single theory but, rather, a framework characterizing a large number of research programs. Information-processing investigators study the flow of information through the cognitive system. This flow begins with some *input*, such as a written passage, a problem to be solved, or an event, into the human information-processing system. The flow ends with an *output*, which can be information stored in long-term memory, motor behavior, speech, or a decision. Mental operations occur between input and output during real time. For example, the information may be attended to, transformed into some type of mental representation, compared with information already in long-term memory, assigned meaning, and used to formulate a response. These mental processes are similar in some ways to computer programs that accept information, perform certain operations on it, and store it. More generally, both humans and computers manipulate representations and transform input into output. Both computers and humans are limited in the amount of information that can be attended to simultaneously and in the speed with which this information can be processed. The correspondence is, of course, only partial. The circuitry of a computer or the design of a computer program is quite unlike the anatomy and functioning of the brain. However, as we shall see later, the computer metaphor served as a valuable heuristic for developing the field of information processing.

To illustrate this description of the information-processing approach, consider what happens when a young child first encounters the Dr. Dolittle story with the pushmi-pullyu, a horselike creature with a head at each end. The delighted child attends to the picture of the creature while ignoring other objects on the page and encodes it visually, as an image, or verbally, as a "pushmi-pullyu" or "horse with a head on each end." He processes this visual or verbal representation further as he compares it with previously stored information about horses or fantastic creatures such as unicorns. Furthermore, the child may derive certain implications about having two heads ("How does it know if it's coming or going?"), store the new information in a way that allows him to recognize pushmi-pullyus on future occasions, and finally laugh, ask his father to reread the page, or look ahead in the book for more pictures of the pushmi-pullyu.

Thus, the child transforms information over a period of time. Information-processing psychologists (who specialize in concepts of pushmi-pullyus) might ask the following questions: Did the child process the input superficially, noting only its physical characteristics, or deeply, relating it to a system of meaning? How fast did he process the information? Did he process the pushmi-pullyu's features simultaneously or successively? What limited how much information he could analyze during the time he could see the picture? Did he use a strategy of rehearsing the label "pushmi-pullyu," by saying it several times? How is the pushmi-pullyu as it is finally stored in long-term memory different from the input, the physical stimulus? If the child is shown another picture of a pushmi-pullyu, how does he retrieve the relevant information from memory and recognize the picture? If investigators can answer these questions, they can develop a theoretical model describing how the child processes information.

As this example illustrates, information-processing psychologists look at what mental processes children apply to the information and, as a result, how they transform, manipulate, and use that information. In other words, they are primarily interested in exactly how the processing system actually operates in real time in a particular situation—how the system changes external objects or events into a cognitively useful form, perhaps according to certain rules. They examine both how changes in processing occur during development and the constraints on these changes. They try to explain "both how children of given ages have come as far as they have and why they have not gone further" (Siegler & Alibali, 2005, p. 66). Information processing was attractive to developmentalists because it presented a set of specific cognitive processes to guide research on children's thinking and complemented Piaget's structural approach.

Although the pushmi-pullyu example illustrates the "style" of information-processing psychologists, it masks the diversity of approaches within the field. There are two main categories of approaches: *computational models* (typically computer simulations of children's thinking) and empirical studies of various aspects of processing information such as attention, memory, problem solving, and executive control of cognitive processes. The latter is much more common in developmental psychology, and thus will be the focus of this chapter.

History of the Theory

Once developmentalists entered the domain of experimental psychology en masse in the early 1960s, they felt reverberations from every significant event in adult experimental psychology. Information processing was the first major theory of adult cognition to arise since developmental psychology had become an experimental science. The cognitive revolution within adult experimental psychology changed the prevailing view of children's thinking. The attraction of information-processing theory for developmentalists can be understood only by tracing the chain of events within adult experimental psychology that led from neobehaviorist learning approaches to the information-processing approach.

Two movements in the 1940s through the 1960s transformed adult, then developmental, experimental psychology. First, as described in Chapter 6, a crisis of confidence occurred within learning theory, which led psychologists to seek a more satisfactory approach. For example, typical research on learning an arbitrary association between nonsense syllables, for example "GAV-HIG," seemed to be of limited use for our understanding of human thinking. Also, a young linguist named Noam Chomsky had convincingly argued that learning theory's account of language was wrong because it focused on language output and reinforcement of this output. Chomsky proposed that the essence of language is a set of underlying abstract rules that generate sentences. Thus, the important part of language is unobservable and must be inferred from the relations between language input and output.

The second influential development was the exposure of psychologists to conceptions of information implicit in new technology. Psychologists were drawn out of the laboratory to work on improving the human operation of wartime equipment and weapons during World War II and the Korean War. They began to think of humans as information transmitters and decision makers when they examined how military personnel divided their attention between a plane's controls and instructions from a radio, detected blips on a radar screen, and interpreted a plane's instrument readings. A human and a machine (plane or weapon) operate together as a unit. It is desirable that this unit operate efficiently to avoid unfortunate errors, such as plunging into the ocean.

Another technological influence came from communication engineering and information theory, which introduced concepts such as "limited-capacity channels," "serial" (successive) and "parallel" (simultaneous) processing, "coding information" into large units, and "uncertainty" (ambiguous information). Thus, psychologists were not only willing to talk about the mind (in contrast to the behaviorists) but also had a language for doing so. Later, computer scientists' work on more sophisticated computers, robots, and other symbol-manipulating systems suggested to psychologists that people might also be considered symbol-manipulating systems. Newell and Simon (1961), in particular, argued convincingly that the logical capabilities of people could be simulated by appropriate computer programs. The cognitive revolution in psychology had begun!

The late 1980s and 1990s brought computational models—computer models of learning and development, as described below. Whereas these models aimed to mimic the way people actually think, the emerging field of *artificial intelligence* tried to develop maximally efficient and intelligent systems. The latter approach produces robots, computer programs, or other devices that can play chess or other games, translate texts, serve drinks, and keep track of a store's inventory. These devices often surpass average mental skills, as anyone who has been humiliated by a computer in a chess game can attest. For example, even an early computer chess whiz, "Deep Thought," beat nearly all of its human opponents (Lindsay, 1991), and "Deep Blue" even beat the chess expert Garry Kasparov. This work eventually led to today's field of developmental robotics, discussed later. Both information-processing and artificial-intelligence approaches are part of the contemporary field of *cognitive science*—an amalgamation of cognitive psychology, computer science, philosophy, neuroscience, and linguistics.

By the late 1960s, developmental psychologists were beginning to recognize the potential of information processing for studying children's thinking. They were beginning to have doubts about Piaget's theory, as described in Chapter 2, and thought that information processing might offer an attractive alternative. The information-processing approach also was appealing because it permitted controlled experimental studies, as had learning theory, but it also supplied a fruitful new methodology, language, and metaphor for studying the development of thought. In addition, there already was interest in some of the topics studied by information-processing psychologists, particularly memory, attention, and language. There was a sense of excitement about the future of developmental psychology.

As a result of all of these factors, information processing became a major force in the field of developmental psychology. Most of the early information-processing studies were simply direct translations of the adult research, using children as subjects. For example, researchers gave children simpler versions of the memory and attention tasks they gave to adults. Eventually, as happened in learning theory earlier, developmental research began to go beyond these simple translations and to look at specifically developmental issues. Numerous studies have examined children's information processing in recent decades. In addition, recent computational modeling approaches have caused another surge of interest in information processing and, because they emphasize learning, have rejuvenated learning as a topic of study.

General Orientation to the Theory

How do we recognize an "information-processing cognitive developmental psychologist" when we see one? This species has distinctive markings that help "psychologist watchers" identify it. The following field guide describes several characteristics: viewing humans as information-processing systems, conceptualizing development as self-modification, conducting task analyses, and using information-processing methodology. All of these address two main characteristics of human thought: "[O]ur thinking is limited in both speed of processing and the amount we can attend to at any one time, and our thinking is flexible, to get around these limitations and to adapt cognitively to both internal changes such as changed plans and external changes such as a new task" (Siegler & Alibali, 2005, p. 68).

Humans as Information-Processing Systems

There are striking correspondences in how people and computers manipulate input according to certain rules and store the results of these operations. We can compare perceiving with "input," thinking with a "computer program," storage capacity with the number of "GB," forgetting with hitting the "delete" key, recall with "search," strategies with "tools," and a decision with "output." The structure of the cognitive system sometimes is called *cognitive architecture*. An information-processing psychologist asks, "How are humans programmed to make sense out of the complex world around them?" and "What would an information-processing system require in order to exhibit the same behavior as a child?" (Klahr & Wallace, 1976, p. 5). Information-processing psychologists make a step-by-step analysis of what a person does to the information. How this new orientation breaks with the past is illustrated in its language. For example, "input–output" connotes a different sort of thinker than does "stimulus–response" or "assimilation–accommodation." The input to the information-processing device is information, which can come in many forms. It might be a word, a paragraph, a mathematical or logical symbol, a blip on a radar screen, or a mental image. The device performs certain operations on this information, such as comparing it with previously stored information or transforming it into a representation (*encoding*), for example, by transforming a written word into a mental image.

The adult mind can efficiently organize millions of pieces of information. How is such a remarkable device developed? Information-processing psychologists view children at various ages or cognitive levels as being in different knowledge states. They infer each knowledge state from the relationship between the input and the output. Thus, each developmental level is characterized by a particular input–output relationship, and developmental change involves going from one such relationship to another. A simple example would be a study in which two groups of children receive different input—either a set of pictures or a list of words for those pictures. The researcher would compare the children's output—their recall of these items. By looking at the relationship between different inputs (visual–pictorial or visual–verbal) and their outputs (types of errors, order in which the objects were recalled, speed of recall), they would try to infer what mental processes the children in the two groups applied over time to the input. These processes might include verbal rehearsal, organizing the objects into categories, or constructing visual representations. Developmental changes are apparent in nearly every phase of processing—from attention through encoding to recall and decision-making.

Theorists develop specific models of the flow of information through the human information-processing device. Information processing has been called the "psychology of boxes and arrows," because psychologists construct flow diagrams, sometimes called "models," such as the one in Figure 7.1. A model is a theory about the structure, or "blueprint," of the mind, as well as how it functions. The information "goes" in and out of boxes or may be "lost" at any point.

Baddeley's (2000) influential model, simplified in Figure 7.1, provides an example. It focuses on the role of *working memory*, a limited capacity workspace that actively keeps information alive temporarily so that this information can be used for thinking and learning. This information may be new information or may be information called up from the long-term memory system. The four components of working memory are a central executive and three limited capacity subsystems—a visuospatial sketchpad, a phonological loop, and an episodic buffer. The *central executive*, like a boss, regulates and coordinates the activities of working memory by allocating resources, manipulating information, and generally controlling the flow of information. For example, it might inhibit attention to some compelling but irrelevant feature of the environment such as a flashing light and direct attention instead to something more relevant such as words. Like computer software, it directs the activities of the memory system, keeps track of what is going on in all parts of the system, and makes sure the entire system is working in harmony. In this way, the central executive helps humans overcome structural limitations on how much information can be handled.

The *visuospatial sketchpad* specializes in processing and retaining visual and spatial information. The *phonological loop* processes and retains speech sounds, much like playing a very short (1–2 second) audio clip repeatedly. The phonological loop constitutes children's *memory span*,

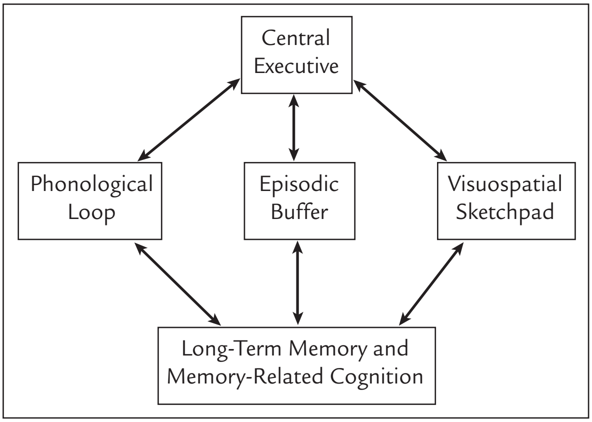

FIGURE 7.1

A flow diagram of the memory system.

[Information from "The episodic buffer: A new component of working memory?" by Alan Baddeley, in *Trends in Cognitive Sciences*, 2000, 4, p. 418, and "Development of working memory in childhood" by Nelson Cowan and Tracy Alloway in *The development of infancy and childhood*, edited by Mary Courage and Nelson Cowan, 2009, Hove and New York: Psychology.]

how many numbers or words a child can repeat back. Both the sketchpad and the loop decay very rapidly unless something is done to keep refreshing the material, such as verbally rehearsing a phone number.

The *episodic buffer* provides a more general type of memory storage and serves as a temporary interface between the phonological loop and the visuospatial sketchpad, on the one hand, and long-term memory on the other hand. It can do this by storing information in a multi-dimensional code. Children's central executive accesses the episodic buffer and controls its functions by attending to particular parts of working memory or to long-term memory. The episodic buffer is particularly important because it not only forms representations that are both visuospatial and auditory but also can construct new, more abstract, representations from these two systems and long-term memory. These new representations then can be stored in long-term memory. The buffer is called episodic because, in a sense, it constructs episodes. *Episodic memory*—memory of a particular episode such as what happened yesterday—is an important aspect of long-term memory.

Long-term memory includes not only episodic memory but also other knowledge about the world—definitions, how to add and subtract, how to ride a bicycle, and so on. Long-term memory has a large capacity and retains information indefinitely within a complex mental organization. During retrieval, information is summoned out of long-term memory and can be operated on further in working memory. When we watch a movie, for example, working memory analyzes the visual images and words and integrates this information somewhat, but long-term memory makes sense of the plot by relating the information to what we already know about the world.

With respect to development, both description and explanation (see Chapter 1) questions could be raised about the stages of processing outlined in the flow diagram. First, in what way, if any, do the stages of processing differ at various ages? Do they differ quantitatively (e.g., more storage room) or qualitatively (e.g., different processing rules)? Second, what causes a child to progress from one state to the next? Are changes in how a child solves a problem due to an increase in the capacity of working memory, the more efficient retrieval of a relevant rule from the long-term store, or both? We know that working memory increases during development and contributes to a variety of important cognitive skills, such as reading and math (Kroesbergen, van't Noordende, & Kolkman, 2014; Nevo & Breznitz, 2013). Some of the most impressive developmental changes occur in the executive processes, as children gain better control over their cognitive skills (Best & Miller, 2010). Also, the phonological loop obviously becomes much more important when language develops. As language continues to develop, children can say words more quickly (Hitch & Towse, 1995), which increases the memory span, and also learn to rehearse items to keep the information alive in the phonological loop. The developments of working memory and long-term memory thus are closely linked; each facilitates the development of the other. Increased memory span makes it possible for long-term memory to work with more information, and as children develop cognitively and construct systems of related concepts in long-term memory, the words they need to keep alive in the phonological loop become increasingly familiar and thus easier to rehearse and remember.

Development as Self-Modification

A theory cannot be a satisfactory developmental theory unless it includes processes for bringing about change. In order to simulate development, including children's active role in their own development, information-processing psychologists had to develop models of a system that could modify itself as a result of experience. For example, as children try out various strategies and see which one they like best, they begin to use some increasingly often and others less often. They learn how to select the most promising routes to solving a problem. If children reject useless methods and retain helpful ones, they gradually become more efficient information processors.

An important breakthrough in computational modeling was the development of self-correcting, self-modifying models that change in light of their processing history. That is, learning is stored so that new learning can build on previous learning. A model can ruthlessly reject procedures that turn out not to be useful, reorganize units already available, and increase or decrease the number of situations in which a particular operation will be used. These self-modifications, then, propel the model from state to state, or from one developmental level to another.

Task Analysis

One hallmark of the information-processing approach is the careful, almost compulsive, analysis of the experimental or real-life task facing a child or adult. The investigator asks, "What cognitive skills and capacities does a child have to have in order to do this task well?" This concern with the specific features of a particular task follows naturally from the approach's focus on the information available in the task setting, the limits to the person's processing capacity, the goals of the task, and the person's processing skills. The unique goals and demands of each particular task elicit a different set of processing activities. For example, children may verbally rehearse conceptually unrelated objects or categorize related objects into "kitchen objects" and "living-room objects" and then only briefly rehearse them, depending on the task. The task demands also may lead to different cognitive activities in children of different ages because of young children's limitations in information processing. Young children may understand the goal and know the appropriate rule but cannot handle all the information in order to apply the rule. Thus the child's knowledge is underestimated. For example, a child may be able to use a balance scale to order blocks according to weight if there are four blocks but not if there are seven.

Piaget and Vygotsky had little interest in task analysis, but the neo-Piagetians did. Recall, for example, that they raised the issue of domain-specific versus domain-general knowledge. Information-processing investigators tend to propose that a child acquires a set of rules or strategies that is specific to a particular domain, such as addition. Both information-process and social learning approaches break down tasks or behavior into their simple components and then posit ways that children learn to integrate these skills into an organized, well-functioning system. As mentioned in Chapter 6, Bandura drew on the information-processing approach to account for the cognitive processing of information during observational learning.

Methodology

Information-processing psychologists typically use rigorous experimental methods to conduct a fine-grained analysis of the time course of problem solving. The experiments can be microscopic when they involve very brief events, such as flashing an image briefly and asking a person to decide whether it is a spatial rotation of an image seen earlier. The studies often examine such temporal variables as the amount of time, in milliseconds, the stimulus is exposed, and take temporal measures, such as reaction time (how long it takes the person to decide whether the design was rotated). It is assumed that any mental activity takes a certain amount of time. Thus, it might be assumed that if two tasks are identical except that one additional cognitive operation is required for one of the tasks, the difference in the time required to perform the two tasks provides a measure of the time needed to perform the additional operation. Long reaction times can also indicate slower processing of information, for example, in younger children than older, in low-IQ children than in average-IQ children, and poor readers than good readers. Researchers' concern with time is not surprising, given their focus on the flow of information over time.

Another powerful method is the *rule-assessment* approach based on error analysis. A task is cleverly designed so that the pattern of correct and incorrect answers over various types of trials reveals the rule or rules the child is using to solve the problem. A classic example is Siegler's (1978) work with the balance-scale task, described later. Although Piaget also made considerable use of children's errors, he did not analyze them in the elegant, systematic way often found in information-processing work. Still another assessment is eye-movement analysis. An eye tracker mounted on a child's head allows the child to move around naturally, thus showing what the child looks at, for how long, and in what order. This information provides clues to processes of attention and encoding.

Information-processing psychologists, particularly Robert Siegler, also have adopted the *microgenetic method* advocated by Vygotsky (see Chapter 4). In this method, children are given a large number of trials on the same general type of problem (Siegler, 2006). There can be multiple sessions spread over weeks or months. This design reveals moment-to-moment changes in a child's cognitive performance in each session, for example, changes in which strategies are used. The microgenetic method permits investigators to observe change directly, while it is happening. They can see moments of sudden change, or cognitive insight—"cognitive moments," as it were. For instance, children sometimes show "hemming and hawing" behaviors on the trial just before the one on which they use a new strategy (Siegler & Jenkins, 1989), as illustrated by the vignette of the child solving an addition problem at the start of this chapter. A child may suddenly fall silent before giving the answer, sometimes as long as a minute or more! These odd behaviors may indicate increased cognitive activity associated with the discovery of a new strategy. The pattern of change over trials also can reveal whether children differ in the developmental route they take to the same end point or their speed of reaching that point. In short, the microgenetic method brings the magnifying glass in very close to the child's behavior. Again, the information-processing approach focuses on specific changes over small time periods.

Information-processing psychologists also have developed models that attempt to simulate thinking and development. One type of model is a *flow diagram*, described earlier, which visually depicts cognitive architecture and processing. Computational models, mentioned earlier, are attempts to write a program or set of computations that is specific enough, accurate enough, and complete enough to generate, from input, an output (behavior) similar to that of humans. Thus, they provide a way to test theories of human thought. The question is: What would an information-processing system have to be like in order to behave as a child does? The computer program and the child should make the same errors and succeed on the same problems. The closer the correspondence, the better the simulation.

Designing a computational model, as described later, can be a long and arduous task, requiring considerable technical and theoretical skills. Modelers start by drawing on what is known about a particular behavior, such as infant reaching, and its neural foundations, and construct a model as their best guess about the capacity of the cognitive system, the representation of information, and the nature of cognitive processes. If modelers have left out some steps in the rules they wrote into the program, if their instructions are logically inconsistent, or if they have incorrectly inferred a rule or other representation from the child's behavior, the program will give an output that does not correspond to the child's. Psychologists then try to correct the program and run it again. Often, this cycle must be repeated many times. Or, as mentioned above, models can learn, and thus modify themselves. This process continues until the model can take input thought to be similar to the input that children receive and produce output similar to that of children of several ages.

Major Developmental Approaches

The study of children's information processing is a diverse, multifaceted enterprise. The next section offers a sampling of research areas: memory, rules for problem solving, mathematical understanding, and computational models. Information-processing psychologists obviously study topics that are somewhat different from those studied by Piaget or Vygotsky.

Memory

Memory is a net; one finds it full of fish when he takes it from the brook; but a dozen miles of water have run through it without sticking.

—Oliver Wendell Holmes

I can't forget but I don't remember what.

—Leonard Cohen (Song, "I Can't Forget")

Children's memory is a fascinating phenomenon, in part because it is fraught with contradictions. On the one hand, it is widely believed that young children have poor memories. On memory subscales of IQ tests or on laboratory memory tasks, they perform poorly compared with adults, and in more natural settings, young children find it difficult to memorize their phone number and street address. Yet parents or teachers who read stories to preschoolers know that children often memorize a story word for word after only a few readings. In fact, children become quite indignant if the reader inadvertently (or because it is past bedtime) leaves out a word or two.

Children's memory has been the topic most often studied by information-processing developmental psychologists and in fact has been one of the largest research areas in developmental psychology. This investment of psychologists' time and energy has paid off handsomely in knowledge not only about children's memory but also, as a bonus, about the development of learning, conceptual development, and self.

Memory involves three main steps. First, children encode information, either verbatim or the gist of the event, either the exact words of a conversation or the essence of its meaning (Brainerd & Reyna, 2014). Next comes the storage of the information, and later, children retrieve the information. Developmental changes occur in each step, as the following research examples indicate. Still, even very young infants appear to be able to encode, store, and retrieve within limits. In one demonstration of this that draws on operant conditioning in a clever way, a ribbon connected to a mobile is tied to an infant's ankle (Rovee-Collier & Gerhardstein, 1997). The infant quickly learns, to her delight, that kicking her feet makes the mobile move. A week later, when she again is placed in the crib, she sees the mobile and again kicks in anticipation of the dancing mobile, even though the ribbon is no longer attached to her ankle. She has remembered what she discovered at the first event. Two-month-olds remember for as long as two weeks, and older infants can remember for longer periods and, during the test of recall, require fewer cues from the original learning situation. This ability to recognize a situation and retrieve a very simple event is, of course, a very rudimentary sort of memory, and there is much still to develop. In general, implicit memory, illustrated by this research and by later memory such as how to ride a bike, matures early and is present in infants. In contrast, explicit memory, which involves not just recognition but also retrieval of facts and events, clearly continues to mature for many years.

Although people generally do not remember events from the first two or three years of their lives, by the preschool years, children clearly have *autobiographical memory*—long-term memory for specific events involving themselves. Autobiographical memory typically is studied by observing mothers and their children talk about an earlier event, such as a birthday party or a trip to the zoo. This memory develops not only because of improved memory per se but also because of the development of a sense of self (Howe, 2014), which becomes stable around age 2. It appears that "it's all about me" at that age because "things that happen to me" serve to organize events in memory. Subsequent developments in language, social cognition, and social relationships enrich this basic self-based organization of memory, and these memories become more coherent, detailed, and evaluative (Fivush, 2014). From these autobiographical memories, adolescents begin to construct a "life narrative," which gives meaning to their lives, shapes their sense of self, and even affects their thinking about the future.

Children differ in their memories. During the preschool years, some children's autobiographical memories are more complex and coherent than other children's. These better-formed memories are more likely if the mother's reminiscing with the child is complex, elaborate, and evaluative, and if she asks open-ended questions rather than questions that can be answered with a simple yes or no (Fivush, 2014).

From preschool until adolescence, five main influences on memory development have been examined—strategies, knowledge, metamemory, capacity, and social-cultural factors. A sixth influence, brain development, has been studied more recently and will be discussed in the contemporary research section.

Strategies ▸ Some memory activities are effortless and seemingly automatic: a baby recognizes her father's face, a boy relates to his friend the plot of his favorite television show seen the night before, an adult hums "White Christmas" while Christmas shopping. The person is not conscious of trying to remember and does not make an effort to remember. These acts of memory "just happen." There is little change in these types of memory during development. Simple recognition memory (indicating that an object or a picture has been seen before) is good even in infants, as mentioned above. By the end of the preschool years, children recall coherent, comprehensible stories or past experiences that are of interest to them. This memory is a by-product of a meaningful activity or event.

When the material to be recalled is *not* part of a context that is meaningful to a child and memory itself must become the primary goal, then there *is* striking improvement in memory during development. Remembering phone numbers, a group of unrelated objects, and the order in which pictures of toys were presented all fall into this category. Much of the information-processing research on children's memory addresses these sorts of remembering.

Children of different ages do different things when they are trying to remember. Older children know that in order to store unrelated information, they must do something special to the material. This "something special" is a strategy. Defined more formally, *strategies* are "mentally effortful, goal-directed processes that are adopted to enhance memory performance" (Bjorklund, Dukes, & Brown, 2009, p. 145). For example, if people want to remember what to buy at the store, they could say the items over and over again to themselves or put the items into categories such as "dairy products" and "vegetables." Or they could make up a silly story about the items ("The carrot swam through the sea of milk on the back of a tuna . . ."), mark the location of the items on their mental image of the layout of the supermarket, or, best of all, simply store a list on an electronic device. These strategies are tools that humans have devised in their constant struggle to overcome their processing limitations.

An early breakthrough study found that although preschoolers appear not to be able to use strategies, they actually can produce them if asked to do so (e.g., to verbally rehearse the items), and these strategies help their recall (Keeney, Cannizzo, & Flavell, 1967). Thus, young children's problem lies in not spontaneously producing the strategy. This *production deficiency* was an exciting finding because it showed that young children have the cognitive ability to use appropriate strategies but simply are deficient in knowing when, where, and how to use (produce) them effectively. This was a new way of thinking about young children's abilities. Researchers then documented a production deficiency with many other memory tasks and many types of strategies.

The next big question was "Are there simple strategies of some sort that preschoolers or even toddlers might produce?" For example, toddlers age 18 to 24 months watched an adult hide a Big Bird stuffed animal (DeLoache, Cassidy, & Brown, 1985). They were told to remember Big Bird's location so that they could find him later. Even though the experimenter then distracted them with attractive toys for several minutes, they frequently stopped playing to talk about Big Bird or his hiding place (the "Big Bird chair"), look at or point to the hiding place, hover near it, or try to get Big Bird. These strategy-like behaviors were much less frequent in control conditions, such as when the adult rather than the child was to remember the location.

Children continue to acquire and fine-tune their strategies. By the preteen years, they typically can pick a strategy that fits the particular task and carry out the strategy spontaneously, quickly, and efficiently. Certain strategies, however, continue to develop during adolescence. An example is "elaboration," or constructing an image out of the materials to be remembered.

It is impossible to remember everything. Thus, one important strategy for remembering is to select only relevant information. Learning what *not* to attend to is as important as learning what to attend to during encoding. In selective memory studies (for example, Miller, 1990), a child sits in front of a box with doors, as shown in Figure 7.2. On half of the doors is a drawing of a cage, which indicates a drawing of an animal concealed behind the door; on the other doors is a drawing of a house, indicating a household object behind the door. The researcher tells half of the children to remember where each animal is located (the other half of the children are told to remember household objects instead). During a 30-second study period, the children can open whatever doors they wish. Typically, preschoolers jump right in and open each door, row by row. Although their door opening is not random, it also is not strategic or efficient, for they are wasting their precious working-memory space viewing irrelevant household objects as well as relevant animals. In contrast, older children open only the relevant (e.g., animal) doors.

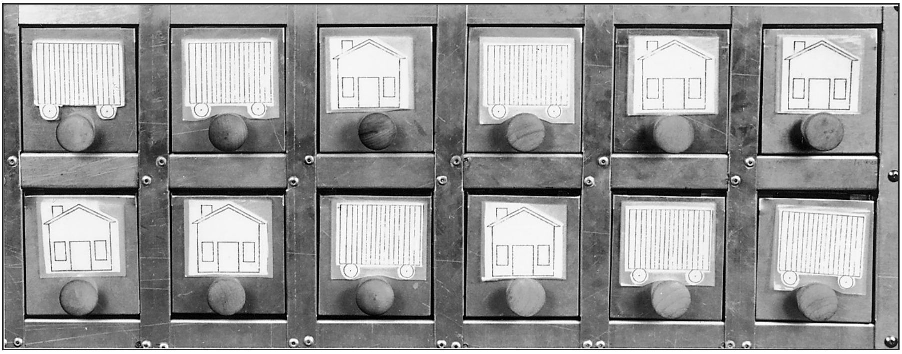

FIGURE 7.2
Apparatus for Miller's selective-memory door-opening task.
[Photo supplied by Patricia Miller.]

In an interesting transitional phase, children are partially selective; some begin by using the selective strategy but then seem unable to sustain it and lapse back to opening all of the doors.

Children's use of strategies for remembering has turned out to be quite complicated. First, children sometimes produce good strategies that, surprisingly, do not help their recall, or they provide less help for younger than for older children (Clerc & Miller, 2013; Miller & Seier, 1994). This is called a strategy *utilization deficiency*. It is puzzling why children would continue to use a strategy that provides little or no help. Eventually the strategy helps recall. Second, children often use several strategies together when trying to remember something, rather than just one (Coyle & Bjorklund, 1997). Third, they tend to change their strategies from trial to trial, even dropping a successful strategy in favor of another one (Siegler, 1996). Fourth, strategy development appears to benefit from the development of knowledge, metamemory, capacity, and social interaction, described below.

Recently, longitudinal studies (e.g., Schneider, 2014) have advanced our theoretical understanding of strategies. Issues include the extent and stability of individual differences in strategy use and memory, the gradual or abrupt development of strategies, the developmental trajectories of various types of strategies, developmental changes in how many different strategies children tend to use on a task, and the prevalence of strategy utilization deficiencies.

Knowledge ▸ Memory is not a mental process separate from the rest of cognition. It is intermeshed in a broad system of thought. In fact, memory has been called "applied cognition" (Flavell, 1971a) because the cognitive system is simply directed to a particular set of problems, namely, storage and retrieval. There are three implications for development. First, children are more likely to remember material that they know about and understand, such as a child-oriented movie or familiar words. Second, children often extract the "gist"—the essence of the material—and construct "fuzzy" memory representations rather than memorize a story or paragraph verbatim (Brainerd & Reyna, 2014). Third, during development as children become "world-wise" and acquire a growing store of knowledge about objects, events, and people in the world, their recall improves.

Numerous studies show that knowledge helps recall (Haden, 2014). When children become experts in a particular domain, they demonstrate good memory in that domain. In a classic study, children who were skilled chess players had better recall of the locations of chess pieces on a chessboard, positioned as if in the middle of a game, than did adults who knew less about chess (Chi, 1978). Thus, children's greater knowledge in a particular domain can outweigh adults' other cognitive advantages. Knowing about chess permits child experts to "chunk" the chess pieces into significant units (for example, an attack), whereas novices must memorize individual pieces and locations by rote. Similarly, on other kinds of memory tasks, learning about categories of items permits children to use the strategy of chunking items to be learned into categories such as clothing, transportation items, and food.

Another influential study showing that knowledge facilitates memory involved a 4-year-old who was obsessed with dinosaur lore (Chi & Koeske, 1983). He knew the names of 40 different dinosaurs, understood the differences between a pachycephalosaur and a rhamphorhyncus, and persuaded his patient mother to spend an average of three hours a week reading his dinosaur books to him. The boy could remember more of his better-known (to him) than his lesser-known dinosaurs. An analysis of what dinosaurs and traits were highly associated showed that the better-known dinosaurs had many links to other dinosaurs and were better organized according to their characteristics.

Although knowledge often helps recall, it also can make it less accurate. As Barbara Kingsolver noted in *Animal Dreams*, "Memory is a complicated thing, a relative to truth, but not its twin." As children increase their store of knowledge, they tend to make inferences that go beyond the information given. Hebb (1949) likened this feature of remembering to the way a paleontologist reconstructs a prehistoric creature. Similar to the way a paleontologist generates a complete dinosaur from lone fragments and his general knowledge about the anatomy of dinosaurs, a person reconstructs an event by filling in among remembered fragments. Sometimes greater knowledge leads to poorer recall. For instance, increasing age is associated not only with increased later recognition of items that actually were seen but also of items that are conceptually related to these items (Brainerd & Reyna, 2014). An example would be falsely recognizing “sleep” when only words such as “bed,” “rest,” “awake,” and “tired” had been presented. Older children with more categorical knowledge spontaneously make a reasonable inference from the information they have been given.

Children’s social knowledge, such as social beliefs, attitudes, and expectations, also affects memory. For example, school-age children with the most stereotyped views of gender-appropriate behavior recalled more pictures of traditional (for example, female secretary) than nontraditional (for example, male secretary) activities (Signorella & Liben, 1984). In addition, they sometimes even reconstructed the pictures, for example, recalling that a secretary was female when in fact the person was a male. Racial stereotypes have a similar biasing effect on European-American children’s recall of the personal characteristics of African-American and European-American children in stories (Bigler & Liben, 1993). Children had trouble accurately recalling the characteristics that ran counter to their racial stereotypes. Thus, memory does not simply copy the world. Children actively “construct” a memory from inferences based on their knowledge. In short, “creative memory” is a by-product of cognitive development.

One cognitive change in knowledge that affects memory is the development of *scripts*—generalized, coherent mental representations of a series of events that occur in a consistent temporal order in everyday life (Nelson, 1986, 1996). These scripts describe “what’s supposed to happen” in certain situations, and they lead children to expect that certain events will occur in a particular order. If this order is violated, children may become confused. For example, a 2-year-old who once was given a bath before dinner, rather than after, became very upset because she thought she would not be fed that evening (Hudson, 1990). Scripts also allow children to understand and remember events. Even young children develop scripts for familiar situations, such as eating at a fast-food hamburger restaurant:

> I walk in there and I, I, I ask my daddy and then the daddy ask the lady and the lady gets it. One small coke, one cheeseburger. . . . They want to eat here so they don’t need a tray. Then we go find a table. I eat it all up. All. And throw the . . . paper . . . the cheeseburgers in the garbage can. . . . Goodbye. Goodbye. Jump in the car. . . . Vroom! Vroom! Goodbye.
>
> *(Nelson, 1978, p. 260)*

The foundation for scripts may start when babies remember the temporal order of simple events. For example, they can later repeat a sequence of events such as putting a ball into a cup, inverting a smaller cup on top of the larger one, and shaking the cups (Lukowski & Bauer, 2014). Scripts involve the social world of people and events and seem to correspond to the way children represent complex events of their day-to-day lives. Notably, scripts both help and hinder memory. They help a child "fill in" details when recalling an event. However, scripts also hinder the recall of one specific event because, for example, the various trips to the restaurant blend together into the script and the child recalls what usually happens at restaurants rather than what happened on one particular visit.

A final observation about the relationship between knowledge and recall is that since children's interests and knowledge differ from those of adults, their most salient memories may differ from those of adults. One 5-year-old, when asked if he remembered the place he had moved from two years earlier, answered: "I remember lots about Michigan. I remember you left a piece of cheese at the back of the refrigerator and it got green stuff all over it."

Metamemory ▶

"The horror of that moment," the King went on, "I shall never, never forget!" "You will, though," the Queen said, "if you don't make a memorandum of it."

—Lewis Carroll

The production deficiency studies mentioned earlier showed that children's difficulties with strategies lay in knowing where, when, and how to produce them. This led to studies of this sort of knowledge about memory. *Metamemory* is knowledge about memory and is a special case of *metacognition*, which is knowledge about any aspect of human thought. Taking notes while listening to a lecture, underlining key points in a textbook on developmental theories, writing a shopping list before leaving for the supermarket, leaving one's completed homework by the front door the night before school, and mentally walking through the previous day in order to recall where a jacket might have been left all reflect metamemory. During development, we acquire an understanding that sometimes it is necessary to make an extra effort or do something special in order to remember and that certain factors facilitate or hinder memory. These factors can include person, task, or strategy variables (Flavell & Wellman, 1977). Examples are knowing that there are limits to how much can be remembered (person variable), that recognition is easier than recall (task variable), and that verbal rehearsal aids recall (strategy variable). Thus, children become amateur psychologists.

Preschoolers have limited knowledge about memory. For instance, they claim superhuman memory abilities, such as when they predict that they can remember 10 items even though they can remember only three or four (Flavell, Friedrichs, & Hoyt, 1970). In a classic study, Kreutzer, Leonard, and Flavell (1975) asked children whether it mattered if, after being told a phone number, they made the call immediately or got a drink of water first. Approximately 40 percent of the kindergartners but more than 75 percent of the fifth-graders thought it would be better to phone first. Presumably, children become increasingly aware that short-term memory fades rapidly. This study also provides an example of increasing knowledge about strategies. When given a retrieval problem in which a boy is trying to remember at which Christmas he received his dog, nearly half of the kindergartners were unable to suggest a way to recall the correct Christmas but all of the fifth-graders could. They thought of aids such as taking a mental trip back to each Christmas and recalling the gifts received or trying to recall other things that happened when the dog was received in the hope that doing so would cue their recall.

Children's thinking about strategies can become rather complex, as the following exchange with a third-grader demonstrates:

> Say the number is 633-8854. Then what I'd do is—say that my number is 633, so I won't have to remember that, really. And then I would think, now I've got to remember 88. Now I'm 8 years old, so I can remember, say, my age two times. And then I say how old my brother is, and how old he was last year. And that's how I'd usually remember that phone number. (Is that how you would most often remember a phone number?) Well, usually I write it down.
>
> *(Kreutzer et al., 1975, p. 11)*

Children not only learn about the nature of memory and the variables that affect it but also learn to monitor their memory performance and the strategies they use to help it. For example, they notice whether a strategy is helping recall and decide whether to switch to another strategy or add a second one. The development of metamemory also is important for distinguishing between one's true and false memories, such as real versus imagined events, and between stronger and weaker memories (Ghetti, Lyons, Lazzarin, & Cornoldi, 2008). Dramatic changes in metamemory through childhood or later demonstrate that teaching children to use strategies effectively must include a metacognitive component as well as just teaching them new strategies.

An important theoretical question is whether metamemory actually helps memory, for example, by knowing that strategies help and actually producing strategies. The results are not consistent, but several longitudinal studies (Grammer, Purtell, Coffman, & Ornstein, 2011; Schneider, 2014) suggest that the two are related. Earlier metamemory was linked to the later use of strategies, and links among metamemory, strategy use, and recall became stronger with age. Moreover, in a study of children drawn from grades K to 4, metamemory not only was associated with greater use of strategies but also affected how much these strategies helped recall (DeMarie, Miller, Ferron, & Cunningham, 2004).

Capacity ▶ A main constraint on children's memory is their limited processing capacity. For example, with increasing age, children can repeat back, in order, a longer string of numbers (e.g., 3281734). Or, regarding working memory, more manipulation of this information becomes possible, for example, repeating these numbers in reverse. This capacity view connotes a container metaphor in which children have small boxes in their heads and adults have larger boxes (Schneider & Weinert, 1989) or a weight-lifter metaphor in which older children have greater "raw mental muscle power" (Flavell, Miller, & Miller, 2002). A commonsense explanation of improved capacity would be that the brain matures physically. Although that is one contributor, the full story is more complicated. When cognitive skills are practiced, they become more automatic and thus less capacity-demanding. For example, as children become more skilled readers, they can recognize words more quickly; they process the information faster. The faster children can process information, the more information they can deal with at any one time. Thus, after practice, a given amount of capacity goes much further. Also, increased knowledge probably helps children use what they have more efficiently because new information can be packaged into preexisting categories and structures. Consequently, some of the developmental increase in capacity reflects children's improved efficiency in using a constant amount of capacity.

Improved capacity has important consequences, such as facilitating children's use of strategies, which are effortful. The high effort of strategies when they are first acquired may account for young children's utilization deficiencies, described earlier, in which children produce a good strategy but it does not help their recall at first. After producing an effortful strategy, young children have less remaining capacity to devote to memorizing per se than do older children for whom the strategy itself requires less effort (Miller & Seier, 1994).

Social–cultural Context ▶ Children talk to other people about the past—what happened a moment ago, yesterday, or months ago. Here is one such exchange, in which a mother (M) and her 5-year-old child (C) are recalling a visit to a natural history museum:

> M: What other kinds of dinosaurs were in there?
> C: Uh, Tyrannosaurus rex.
> M: . . . and they made 'em move, didn't they? Didn't they move?
> C: No.
> M: They did too move (laughing).
> C: No he did not. It did not have his skin on.
> M: Oh that's right, one of them was just bones.
> C: That was Tyrannosaurus rex.
> M: Tyrannosaurus rex was just his bones. Okay.
>
> *(Nelson & Fivush, 2004, p. 502)*

As discussed in the earlier chapter on cultural approaches, memory is socially embedded. Social factors influence memory, as when parents and teachers scaffold children's attempts to remember. Moreover, remembering is put to social uses, as in this example. Recalling shared experiences strengthens relationships and connects children to their families and communities.

Culture also shapes the content of memory: "We are what we remember, and in turn, what we remember is determined by who we are" (Wang, 2014, p. 606). European-American children's memories are more elaborate and self-focused than those of Asian children (Wang, 2014). Also, European-American children often spontaneously offer new information about the event, while Asian children are more passive, mainly responding to their mothers' questions. Like their mothers, European-American children engage in self-expression, often talking about their personal opinions, preferences, and interests. In contrast, Asian children are more likely to talk about other people, rules, and discipline. European-American mothers also elaborate more about emotions in these conversations than do Asian mothers (Fivush, 2009). These differences reflect cultural differences in beliefs about the importance of the self, autonomy, and individual mental states versus relatedness and collectivism. Given the close ties between development of self and autobiographical memory in early development, this cultural difference may contribute to cultural differences in the age of one's earliest memories. For example, Canadian children aged 8, 11, and 14 had an earlier age of first memory, and produced more early memories overall, than did Chinese children (Peterson, Wang, & Hou, 2009).

Perhaps the most compelling evidence of this cultural construction of self comes from studies of bilingual children who were interviewed in either Chinese or English (Wang, Shao, & Li, 2010). The results mirrored those above. Children interviewed in English talked more about their personal experiences and their own roles and perspectives, and indicated higher agreement with Western-independent values, than did children interviewed in Chinese.

Information processing is social not only in terms of the importance of social influences but also in terms of processing social information. Research on *social information processing* shows that cognitive beliefs and expectations can bias how children process information—what they attend to in their social environments, the intentions they attribute to others, what information they recall, and how they respond to others' behaviors. For example, highly aggressive boys tend to interpret an ambiguous event, such as being hit by a ball on the playground, as intentional, whereas less aggressive boys do not. An intervention begun in elementary school decreased adolescent antisocial behavior by changing children's processing of social information (Dodge, Godwin, et al., 2013). Specifically, the intervention reduced the bias to attribute hostile intentions to others, increased children's generation of competent responses to social problems, and devalued aggression. Early family experiences can contribute to processing biases. For example, children who have been neglected and physically abused tend to attribute hostility to others and respond with aggression (Keil & Price, 2009). The information that children store about their previous social interactions biases their current information processing and behavior.

Mathematical Understanding

Researchers recently have had great interest in how children use information about numbers to construct an understanding of mathematics. The earlier theoretical push was Piaget's seminal work on this topic. The practical push is awareness of how poorly U.S. children perform on mathematics tests compared to other modern nations and the concern that it might be because of the way math is taught in school. We cannot design effective math instruction until we have a detailed picture of children's understanding of math at each age, and of the developmental mechanisms for moving from earlier understanding to later understanding. Work on mathematical understanding from an information-processing perspective is represented below by Robert Siegler's work—first on strategies for addition and more recently on developmental changes in the understanding of magnitude.

Children use strategies not only for remembering, as described above, but also for other sorts of cognitive work, including mathematical thinking. Siegler (e.g., 2006) used the microgenetic method described earlier to study how children develop new addition strategies over several problems and sessions and select from their toolbox of current strategies. In the slice of laboratory life at the start of this chapter, a young girl is trying to solve an addition problem. She worked on a large set of addition problems, and Siegler observed her pattern of errors and correct answers, recorded her strategies, and asked her about her strategies. He found that at any age a child uses a variety of strategies to solve addition problems. To solve 4 + 3, a child might put up four fingers on one hand and three fingers on the other hand and then count all the fingers. Or she might put up her fingers and recognize their number without counting. Or she might start with the larger of the two numbers and count on from that point (4, 5, 6, 7).

In this experiment and others, children show the following interesting behaviors: At any age, a child typically uses several different strategies from one problem to the next on the same sorts of problems or even the same problem a short time later. Children often use six strategies or more on a set of addition problems (Siegler & Jenkins, 1989). Sometimes the variation is quite sensible: On easy problems with small numbers, children use the simple recognition strategy because they can easily detect the number of fingers or even just give a correct answer that they have memorized. On other problems that are easy because one number is small, such as 8 + 2, they can use the strategy of counting up from 8. On harder problems, they may have to use the harder strategy of counting all of the fingers. This seems smart. They are using a fast, low-effort strategy on easy problems, where it is likely to be accurate, and slower, more effortful strategies on harder problems to insure a correct answer. Over time they increase their use of the most efficient strategies, decrease their use of the less efficient strategies, and discover new strategies. However, children sometimes seem to act in irrational or surprising ways. They may construct a new strategy right after using an existing one successfully. They may successfully use a new, more efficient strategy but then abandon it for a while and go back to an earlier strategy. Still, these seemingly inefficient temporary rejections of successful strategies are useful, because they help children keep old strategies available while discovering new ones.

Although children sometimes are taught strategies or learn them by watching others, they at times invent a new strategy by themselves during the course of problem solving. Some children show a great deal of insight into their discovery. Others do not and, during questioning, even claim, for example, not to have counted at all, even though videotapes clearly showed that they had used a new counting strategy (Siegler & Jenkins, 1989). In fact, children's new strategies often seem to stay unconscious for a while. Siegler and Stern (1998) found that almost 90 percent of their second-graders discovered a new strategy but could not yet report it.

Thus, the contemporary view of children's strategies emphasizes variability more than consistency, and, on a single problem, multiple-strategy use more than single-strategy use. Strategy variability seems to be the rule rather than the exception during development. That is, Siegler sees all of development as a transition period; children are always thinking in multiple ways, rather than in just one. This going back and forth among various strategies appears in areas as diverse as motor behaviors in infants (Adolph & Robinson, 2015), conceptual understanding in school-age children (Karmiloff-Smith, 1992), and scientific reasoning in adolescents and adults (Schauble, 1996).

More recently, Siegler's work has turned to children's understanding of numerical magnitudes (e.g., Siegler & Lortie-Forgues, 2014). Much of his research focuses on fractions, one of the most difficult concepts for elementary school-aged children to master; even some adults have trouble with this concept. In Siegler's view, the keys to number development are understanding numerical magnitude and broadening the range and types of numbers whose magnitudes are well understood. First, children need to be able to encode and represent numbers accurately. For example, if shown an array of 20 or so black dots and white dots, can they judge whether there are more black dots or white dots? Even 6-month-old infants can do this well if there are twice as many black dots as white dots, but even some adults struggle if the ratio is 11 to 10. Infants' estimations are based on nonsymbolic representations of number (e.g., perception of which category has more). This early ability is of interest because it predicts children's symbolic ("1, 2, 3 . . .") mathematical understanding years later. Thus, nonsymbolic representations of number might be the foundation for understanding at least small symbolic number sets, which then leads to later more conceptual math understanding.

This translation from nonsymbolic to symbolic number is surprisingly slow. For example, when 3- and 4-year-olds who can count to 10 are asked to pick up *N* objects, some children can give the correct number of objects for only the number 1; others for only the numbers 1 and 2; others only the numbers 1, 2, and 3; and others only the numbers 1, 2, 3, and 4 (Le Corre, Van de Walle, Brannon, & Carey, 2006). Thus, several years after they showed understanding of relative magnitude, they still have trouble with symbolic numbers, even with small numbers. Later, even after they understand the magnitudes of numbers 1 to 10, they continue to have trouble understanding the magnitudes of even larger numbers. Also, when they place the numbers 1 to 10 on a physical number line, they place small numbers, such as 2 and 3, much farther apart than they do large numbers (e.g., 7 and 8), indicating an incomplete understanding of number. This pattern of very slow transfer from small to large numbers repeats itself in each successive new numerical concept throughout childhood. And again, understanding number magnitude in early elementary school predicts later understanding of more complex math concepts, such as fractions in middle school (Bailey, Siegler, & Geary, 2014), suggesting that understanding number magnitude is central to the development of mathematical understanding.

In this line of research, consistent with the information-processing approach, careful attention is given to the specifics of the task (e.g., number of items) and the systematic manipulation of task characteristics (i.e., varying the ratio). Also, the amount of time it takes to solve the magnitude problem is taken to indicate the difficulty of the task, and microgenetic change in strategy informs developmental theory. Finally, Siegler finds interesting, illuminating developmental patterns in children's variability of performance in similar versions of a task.

Rules for Problem Solving

Another main line of information-processing research involves detecting which rule a child uses on a problem-solving task (Siegler, 1978). Consider a task (see Figure 7.3) in which children have to predict which side of a

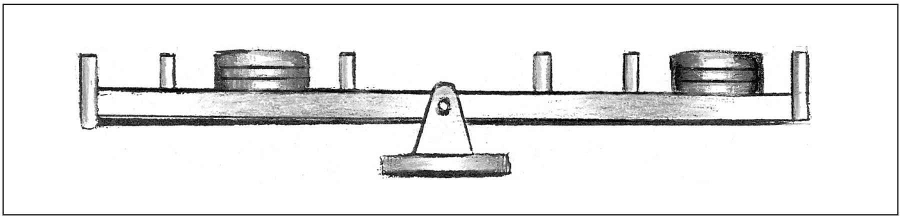

FIGURE 7.3

Example of a trial on Siegler's balance-scale task.

[Information from *Developmental Differences in Rule Learning: A Microgenetic Analysis* by Robert S. Siegler and Zhe Chen published in Cognitive Psychology, Volume 36, Issue 3, (1998). Republished with permission of Elsevier; permission conveyed through Copyright Clearance Center, Inc.]

balance scale (like a seesaw or a teeter-totter) will go down. The relevant information is the number of weights (all of equal weight) on each arm of the scale and how far they are from the middle of the scale. On each arm of the scale are four equally spaced pegs on which weights can be placed. The arms are locked into place until after the child predicts which side, if either, will go down. A young child, for example, might use a simple rule "If the weights on each side of the scale are unequal, then the side with more weight will go down," thus ignoring the weights' distance from the center of the scale. With increasing age, children consider more and more information until they develop a rule that assesses the exact contribution of both number of weights and distance by multiplying the number of weights on each peg by that peg's ordinal distance from the fulcrum. (The ordinal position can be used because the pegs are an equal distance apart. The fourth peg from the midpoint is four times as far away as the first one.) By comparing the outcome of this computation for the two sides, children can predict which side will go down.

Using an elegant design, Siegler systematically varied the number of weights and their distance in a series of problems. Each rule would lead to a characteristic pattern of correct and incorrect predictions over the series of problems. This study is an example of the rule-assessment approach based on error analysis described in the section on methods. Consider, for example, a "conflict–weight problem," in which there is more weight on one side but the weights are more distant on the other side. The configuration is such that the side with more weights goes down. Children using the rule based on number of weight would be correct because they consider only the number of weights. Children using a more advanced rule that considers both number of weights and distance from the fulcrum, however, are correct only part of the time because they simply guess. They know that both distance and number of weights are important but cannot determine the exact contribution of each. Children using the most advanced rule are always correct because they can calculate the contribution of both variables. Notice that the children's errors are as informative as their correct answers. Similar analyses have assessed age differences in rule use on many other tasks as well, including conservation, projection of shadows, probability, speed, and mathematical calculations.

What children bring to this task—their age, initial rule, and initial encoding of the task—affects what they can learn during the task. In one study (Siegler & Chen, 1998), 83 percent of the 4-year-olds failed to encode the distance of the weights from the fulcrum and thus were unable to learn that this feature might be related to the problem. Although they saw 12 problems on which the weights were equal and the side with weights farther from the fulcrum went down, and each time they were asked "Why do you think that side went down?" they never seemed to notice the dimension of distance.

The way that information-processing psychologists study the balance–scale task contrasts with Piaget's approach to the same task. Although both were interested in how children reached their answer, Piaget used the task to diagnose whether children have underlying mental operations. Siegler, in contrast, inferred what specific rules the child used for the task at each step en route to developing an understanding of balancing weights. He thus identified partial knowledge and made a more detailed analysis of the relation between the child's actions and, because he had done a task analysis, the stimulus characteristics of the task—the number of objects and their distance from the fulcrum. He also could see the process of learning because he used a microgenetic design.

Computational Modeling

In the general information-processing approach described thus far, the computer serves as a loose metaphor to help researchers think about the processes a person uses to represent, store, and solve problems about words, pictures, objects, or events. These researchers adopt the informal, but not the formal, language of computer science. They talk about "information," "capacity," and "rules" but do not translate cognitive processes into a formal computer language in a computer program. At most they might develop flow diagrams of the flow of information through the cognitive architecture (see Figure 7.1). The computation modeling approach, in contrast, might try to design a computer model with a system of rules or cognitive processes that generate these input-output relations. These models not only generate behaviors similar to those of children of various ages but also include learning mechanisms that lead to changes, thus simulating developmental changes. Two kinds of computational models are described next—production systems and the more recent connectionist models.

Production Systems ▶ Production systems models of development usually involve a set of rules, expressed in symbolic representations. These rules generate behavior on complex problem-solving tasks, which can be compared with what children actually do on these tasks. An influential production system (Klahr & Siegler, 1978) modeled children's rules on the balance scale described above. An example of a symbolic representational rule is "If *X* is present, then do *Y*." These models were called *production systems*, because the rules specified the conditions (the "if") that produce each behavior (the "then"). A rule might be "*If* the weights on each side of the scale are unequal, *then* the side with more weight will go down," and the child picks the side with more weights. This production system models not only the behavior of children of different ages but also learning during a session. Over trials on the task, feedback on applying the if-then rule(s) leads to more advanced rules. Thus, learning involves acquiring, and sometimes changing, production rules. Sometimes rules conflict, as when one predicts on the basis of number of weights and one on the basis of distance from the fulcrum, and lead to different decisions. This conflict may lead to a new, more complex rule. This production system model successfully predicted children's decisions and described movement from one kind of rule to another one, thus modeling development.

There are numerous types of computational models today. Rather than focus on children's use of rules during problem solving, they address the question "How do children somehow turn a vast amount of sensory stimulation, much of it ambiguous or irrelevant ("noise"), into something meaningful?" Children manage to form categories and abstract representations, detect cause and effect, and predict events. Next is a description of the most common type of computational model today—connectionist models.

Connectionist Models ▶ *Connectionist models,* also called *neural network models*, involve a network of nodes and connections between these nodes, analogous to brain networks of neurons and synapses (see Figure 7.4 for a very simple model). In fact, these models are constructed so as to be consistent with what is known about brain structure, function, and development. The current interest in cognitive neuroscience may be one reason for the attractiveness of connectionist models. This network of artificial neurons forms the underlying microstructure of basic cognitive processes. In contrast to production systems models, which involve symbolic language-like representations of rules and the

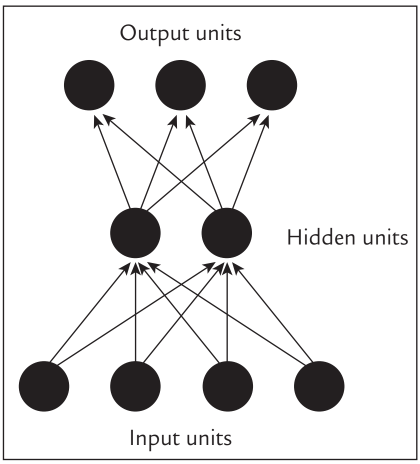

FIGURE 7.4

A simple connectionist model.

manipulation of symbols, connectionist models represent the likelihood of activation of each connection. Another difference is that connectionist models involve *parallel distributed processing*, in which a large amount of input is analyzed simultaneously, in contrast to the serial, sequential processing of production systems. Thus, connectionist models depict thinking as a pattern of activation in neural-like networks. If Descartes had been a connectionist, he would have declared, "I have a pattern of activation in a neural-like network, therefore I am."

More specifically, each neuron-like information processing *unit* has a numerical value, usually the probability that it will be activated. Connectionist models posit several layers or levels of units (see Figure 7.4). The input provided by the modeler might include, for instance, a series of words or pictures, to represent children's experience. For example, there are some extensive databases of young children's language environments that facilitate creating the input for connectionist models of language learning. At the input level, processing units encode the input provided by the modeler and sometimes signals from other networks. At the next level, so-called hidden systems, or internal representations, use information from the input level to compute more complex relations. A final complex level produces output such as decisions, words, or thoughts. The model might represent learning a new word by adjusting weights between units; the child's saying a word would be represented by the activation of an output unit that stands for that word. The modeler tries to bring the neural network to a state in which it can take a given input and produce the same output as a child. Designers have developed models with a variety of architectures (see Yermolayeva & Rakison, 2014). Recent models are much more complex than the one in Figure 7.4, with more levels, more sets of hidden units, and even subnetworks.

Not surprisingly, in connectionist models the connections are all-important. Each unit is connected to units in different layers and sometimes in the same layer as well. Each unit can excite or inhibit other units. As in the brain, the strength of any given connection depends on the frequency of "firings" between the two elements of the connection. That is, with experience, certain units are consistently fired and thus become highly associated (heavily weighted), while other units do not. A helpful analogy is a traffic map showing the most heavily traveled routes in red. In a connectionist model, as in the brain, a unit fires if the total amount of activation it receives from other units exceeds a certain threshold.

In this connectionist world, a piece of knowledge does not reside in a single place in the system. Rather, knowledge is a distributed pattern of activation over many connections. It is a pattern of connections with various weights. And any one unit may take part in representing many different pieces of knowledge if it is part of several patterns of activation. Each network of activation overlaps heavily with other distributed patterns of activation. The goal is to show that different distributions of connections—patterns of connectivity—correspond to different knowledge levels in children of different ages. These models capture the complexity of the cognitive system (and of the brain, as well) because the activation in any unit or system of units is affected by the activity of other units or systems of units.

A model is constructed in the following way: Based on empirical data with children, the modeler sets the starting weights of connections, the pattern of the connections among units, unit activation or inhibition, and the mathematical function for how each unit's total input is transformed into an output. The modeler also sets several rules that govern the flow of activation from input to output. For example, an integration rule calculates the total input each unit receives from other units due to the outputs of those units and the weights on the connections. Because some units activate other units and some units inhibit other units, this rule usually involves calculating the weighted sums of the excitatory and the inhibitory inputs. After all these parameters are set, the modeler provides carefully selected input. Based on the rules, input activates certain units and each of these units passes on its output to certain other units with whom it connects. In complex models, this may continue for several levels. As a result, the pattern of weights changes, which constitutes learning. In this way, the model produces short-term change, and short-term change can add up to long-term change. In short, the model takes input and mathematically generates a set of data (outputs).

Note that learning, or cognitive development, occurs when the pattern of connections changes or the relative strength of the connections changes after each set of inputs. That is, the model may respond to feedback as to whether the output was accurate or inaccurate. If the match is poor, the model or the model-maker may adjust the strengths of the various connections in a way that would minimize error on later trials. In some models, new units are added as a result of experience. The system typically learns by example (actually, a large number of examples). For instance, if a model is learning names of objects, an object (the input) may activate a unit representing a word. If that word is incorrect, the model may be informed which word should have been activated and the weights of the connections are changed so that it is more likely that next time the correct word will be activated.

Let us now consider two simple connectionist models. One model (Gureckis & Love, 2004) simulates infants' category learning about types of imaginary animals. The input to the model was a series of imaginary animals that differed in terms of three attributes: type of body (giraffe, cow, elephant), feet (webbed, club, and hoofed), and tail (fluffy, feathered, and horse). Each item for the model consisted of a set of three attributes, such as giraffe, feathered tail, and webbed feet, that corresponded to a drawing of this animal that had been shown to infants. A series of these three-attribute lists made up the input (experience). The lists were constructed so that the attributes were perfectly correlated. For instance, a giraffe always had a feathered tail and webbed feet; a cow always had a fluffy tail and club feet. Over trials, the model looked for correlations (co-occurrences) among the attributes (e.g., giraffes always have feathered tails) to form several clusters of animals, with similar looking animals in each cluster. The weights of various connections were changed accordingly. After this learning, when a novel animal was presented, the cluster that was activated the most formed the output—the (hopefully) correct category for the animal.

Another example is a model that describes how German children learn which of the six forms of the German definite article "the" go with which nouns (MacWhinney, Leinbach, Taraban, & McDonald, 1989). The appropriate article in German is determined by the noun's gender (masculine, feminine, neuter), number (singular or plural), and role in the sentence (for example, subject, direct object). The input level consisted of 35 units that analyzed these features of nouns. Two levels of hidden units consisted of units formed by combinations of the input-level features, such as the gender and number of the noun, and six output units represent the six possible German articles.

Much like the experience of very young German children who are surrounded by spoken German, the input to this connectionist model was repeated experience with a set of common German nouns and their correct article. This experience led to changes in the strengths of connections between particular articles and particular nouns in the model. Some pathways fired many times and became stronger because of the frequency with which a particular article occurs with particular nouns in German. Some pathways never or rarely fired and remained weak because certain articles never or rarely occur with certain nouns. With more experience, the model became more accurate as correlations between nodes began to approximate correlations between particular articles and nouns in the real world of German language. In this process, the model compared its answer with the correct answer; a match strengthened the rule, whereas a mismatch did not. Once the model constructed a set of rules for which articles go with which sorts of nouns in which contexts, it was tested with unfamiliar nouns. The model was fairly successful at choosing the correct article, much like children generalize the associations or rules of language they have acquired. Other evidence that the model was a good simulation of language development is that during learning, the model made some of the same sorts of errors that young German children do, such as overusing the article that is used most often in German. And the same article–noun combinations that are most difficult for children were also the most difficult for the model. Thus, this connectionist model is a self-modifying system that is consistent with what is known about language development.

Although both production and connectionist models can simulate change and thus serve as examples of the self-modifying systems described earlier, this is especially true of connectionist models, which focus on cognitive change. After the model builder specifies the architecture of the network and learning algorithms and provides a series of inputs, the model itself does the rest of the work of learning. A strength of self-modifying computational models is that they can identify and test theories about mechanisms of development. To simulate longer-term development, model builders sometimes change the parameters of the model in ways known to occur in development, such as changes in neural processing or changes in experiences (input) (Yermolayeva & Rakison, 2014). For example, they might introduce an increased working-memory capacity into the model or provide more pictures or more time per picture in the input to simulate the greater capacity and experience of older children. The beauty of these complex models is that they can show how introducing this small change into the model can eventually lead to a significant change in the system. In fact, some kinds of abnormal cognitive functioning may be caused by a very small initial atypical variation at the perceptual level of functioning that gets magnified in its effects as one thing leads to another over time and experience. For example, in one model, a small initial disturbance in processing phonemes plus exposure to 40,000 sentences led to specific language impairment (SLI)—deficits in syntactical (grammatical) processing (Joanisse & Seidenberg, 2003).

Connectionist models have contributed to theory building not only by simulating children's development but also by providing a new theoretical perspective on some of the mysteries of development. One example is toddler's language spurt (McMurray, Horst, & Samuelson, 2012), often attributed to a qualitative change in cognition or the brain, specific to language. In contrast, this spurt can be explained by connectionist general principles of learning described above, such as slow associative learning, parallel learning, and competition among networks. A connectionist model also provided a new explanation of Piaget's observation that babies continue to reach for an object in location A, where it was first hidden and they had found it, even after they have seen the object moved and hidden in location B. Piaget attributed this error to the lack of an appropriate sensorimotor scheme. In contrast, Munakata's (1998) connectionist model predicted a U-shaped trajectory based on the strength of the tendency to reach to location A, with less reaching to A with very low or very high weighting. When the weights for that bias are weak, in young infants, there should be no reaching for A; as the weights increased, the activation of the A location eventually could persist over a delay (i.e., after the object is hidden in B), thus creating the error of reaching for A. Then, when the weights for reaching for B are strong enough, the infant should no longer have the A bias. Thus, the model provided an alternative explanation—a memory-based developmental mechanism—for the A bias. It also led researchers to study infants younger than those in previous research, infants who have not yet developed the A bias.

Another reason for the excitement about connectionist models is that they have the advantage of requiring researchers to have very precise hypotheses about relevant experience and cognitive processes. These models also have contributed to developmental psychology by providing an alternative view of what is developed—subsymbolic weighted sets of relatedness rather than symbolic rules. These models are complementary to "good old fashioned cognitive psychology" (Oakes, Newcombe, & Plumert, 2009) because they can examine mechanisms that cannot feasibly be studied with behavioral methods (Schlesinger & McMurray, 2012). For example, they can introduce deprivation or cause atypical development, which cannot be done with children. Finally, connectionism is considered a unifying theory, because it should be possible to use it to study all kinds of knowledge and behavior. However, one negative is that connectionist models may be quite complex and technical, and thus not easily used by nonspecialists.

Connectionists have constructed developmental models on numerous topics, such as language learning, motor behavior, causal reasoning, reading, and categorization (see Yermolayeva & Rakison, 2014, for descriptions). In addition, known developmental changes in brain functioning have been modeled. For example, in one model, after the learning phase (presentation of input) was completed, the connections that had low weights were eliminated (Mayor & Plunkett, 2010). This simulates the synaptic pruning during development described in Chapter 5.

Mechanisms of Development

One novel source of change is variability in behavior. The puzzling observation that children keep changing their strategies rather than staying with a successful one led to a model to try to depict this variability. In Siegler's influential *overlapping-waves model*: "A wave, like children's thinking, never stands still" (Siegler, 1996, p. 239). As applied to strategy development, in Figure 7.5 each wave represents a different strategy. The strategies, like waves, overlap in that a child continues to use an old strategy even after a new strategy begins to develop. Many strategies look like waves because they gradually gather strength, peak, and then crash as

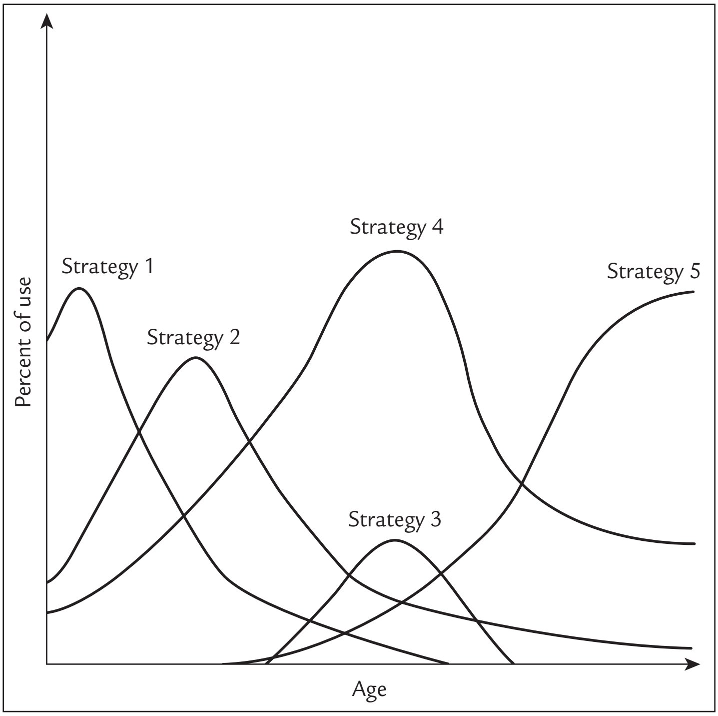

FIGURE 7.5

Siegler's overlapping-waves model of cognitive development.

[Siegler. *Children's Thinking*, in Figure "Siegler's Overlapping Waves of Cognitive Development," Copyright © 1998, Prentice-Hall, Inc. Reproduced by permission of Pearson Education, Inc., p. 98.]

the child discontinues them. We saw in an earlier section that at any age children have several strategies that they could use to solve a problem. In the figure, a child discovers new strategies (3, 4, and 5) and adds them to his repertoire. Some waves never become the most prominent one but still influence the other waves. The wave model of constant change and variability contrasts with the staircase-like stage models, like Piaget's, that depicts development as a series of levels, with brief periods of transition between levels.

Why would children show such variability, especially when it seems to be counterproductive, as when they drop a successful strategy? Siegler draws an analogy to biological evolution. As in evolution, change comes about through variation, competition, and selection. Various strategies compete for dominance. Through experience, a child learns that some strategies are more adaptive (useful, accurate, or efficient) than others and thus retains ("selects") these in the long run. Thus, a process of competition among skills or ideas, in this case, strategies, leads to "survival of the fittest." Moreover, it is adaptive to have multiple strategies because if one strategy fails to solve a problem, the child can go to "plan B." Variability in approaches to a problem also is adaptive because it seems to set the stage for children's ability to profit from new experiences or training. That is, children who show variability seem to be more ready to change their thinking. They may be open to mechanisms of development that move along their thinking. Siegler has used this evolutionary model of cognitive change to account for changes in a variety of areas, such as arithmetic, reading, problem solving, and spelling. Psychologists' past tendency to consider variability a nuisance rather than a phenomenon of interest may have directed attention away from behaviors that could provide important clues to developmental change.

Information-processing theorists have identified at least four specific mechanisms of development: automatization, encoding, generalization, and strategy construction. In *automatization*, processing that used to require conscious awareness becomes more and more automatic. For example, when children count five fingers on one hand many times when learning to count, they eventually can automatically say "five" when holding up one hand with all fingers extended. This releases space in working memory for other cognitive activities, such as constructing a new strategy.

Changes in *encoding* features of the environment can encourage a child to notice, and thus use, different information, as when a child learns to check whether the problem has one large digit (5) and one small one (2), which leads to efficient use of the strategy of counting "5, 6, 7." When information contradicts a person's beliefs, children and even adults can have trouble "seeing," and encoding, what is in front of their very eyes. In one study (Kaiser, McCloskey, & Proffitt, 1986), participants watched a ball released by an electric toy train fall in a curve forward and down to the floor. Most school-age children and many adults encoded the event as the ball falling straight down. Even later, when confronted with the actual curved trajectory of the ball, many still had trouble accepting, and encoding, this information that violated their beliefs. Recall also that some children encoded only number of weights on the balance-scale task. Teaching children what information to encode (both distance from the scale's center and number of weights) enables them to learn from feedback regarding their predictions on the balance scale and subsequently to adopt new rules for problem solving (Siegler, 1978).

A third mechanism of change, *generalization,* operates when a child applies, for example, an adding strategy to new problems with a similar structure. Finally, *strategy construction* occurs when a child has an insight into the problem and tries a new approach. These four mechanisms work together to bring about cognitive change. General cognitive developmental changes, such as increased knowledge and organization of this knowledge, can facilitate the work of these mechanisms.

Researchers have studied change mechanisms with the microgenetic method, which provides a fine-grained description of change that sometimes suggests the cause of the change. Some also study change with self-modifying connectionist models. As a result of input, the model changes the relative strengths of various connections in the system, as described earlier. Change in the overall pattern of associations of various strengths constitutes learning. If the hypothesized change mechanism in the model is correct, it should modify itself and generate a description of change that mimics children's change over time. Although this change is over a short period of time, developmental changes over longer periods of time may involve similar principles.

Position on Developmental Issues

Human Nature

In an update of Newton's view that humans are like machines, humans are now said to resemble computer programs (or laptops, for children?). In this mechanistic view, input is followed by a series of events and finally output. A connectionist model passively waits for input. Flow diagrams seem to portray static structures nudged into activity by intruding arrows. And, robots aside, computers and flow diagrams typically do not move themselves, call a friend, or select a good book to read. Despite these mechanistic features, in many ways the information-processing approach is organismic in its emphasis on dynamic organization, of both children's cognitive system and models; change in both children and models involves active reorganization. Both modify themselves. Children actively interpret new experiences, apply rules and strategies, search for further information in the environment, or even "construct" information as they make inferences based on the input and on previous knowledge. Children become more active cognitively with increasing age as they develop metamemory to enhance their memory by rehearsing, making written reminders, and relating new information to old. Similarly, self-modifying connectionist systems extract patterns from input, develop hypotheses, use input to test these hypotheses, and perhaps create new subnetworks or layers of units and connections. In flow models, executive control processes oversee and actively coordinate the memory system.

Qualitative Versus Quantitative Development

Information-processing theories allow for both qualitative and quantitative development. They do not have the strongly qualitative, stagelike development found in Piagetian and psychoanalytic theory. However, they do have some types of qualitative change: the emergence of new strategies for storage or retrieval, rules for problem solving, changing patterns of activation of nodes and connections, and modes of representation (for example, verbal representation after language is developed). Quantitative development appears in increases in the number of items remembered, in the amount of information in the knowledge base, in the number of strategies in one's repertoire, and in the strength of associations in connectionist systems. There often is interplay between quantitative development and qualitative development, as when children's experience with weighing items leads to a new rule about balance scales, which then becomes more efficiently and consistently applied to a variety of situations. Or, in connectionist systems, a quantitative strengthening of connections can lead to crossing over a threshold, which produces a new behavior that looks qualitatively different from previous behaviors.

Nature Versus Nurture

Nature and nurture interact to produce change. The environment continually brings input to the cognitive system, but neurological development increases the efficiency of the transmission of neuronal impulses. Also, the tendency toward economical, nonredundant, efficient processing may be innate (Klahr & Wallace, 1976), and the processing system may be pretuned to process certain types of stimuli, such as linguistic input. In connectionist models, learning occurs within the constraints of the developing brain: "New structures can emerge at the interface between 'nature' (the initial architecture of the system) and 'nurture' (the input to which that system is exposed)" (Bates & Elman, 1992, p. 15).

What Develops

Stated most generally, cognitive processing develops. It becomes more efficient and organized in its operation and acquires more and more content as the child explores the world. More specifically, children acquire strategies, rules, scripts, patterns of connections, and a broader knowledge base. Another way to describe what develops is: "knowing" (development of knowledge about the world), "knowing about knowing" (metacognition), and "knowing how to know" (development of strategies) (Brown, 1975).

Applications

As mentioned in Chapter 6, cognitive science has generated a new *learning sciences* approach that draws on cognitive science theories and concepts about knowledge and learning to design effective instruction. Information-processing concepts such as adequate working memory, chunking into categories, transfer to related tasks, and problem-solving strategies inform instructional design. Task analysis is critical—breaking reading and mathematics down into their component parts and identifying the cognitive skills necessary in each phase of processing. One poor reader might have problems in the initial phase—encoding—whereas another poor reader might have trouble integrating the meaning of consecutive sentences, which would call for different kinds of instruction. Working memory has emerged as an especially important factor. Having poor working memory is associated with problematic classroom behaviors such as inattention, distractibility, and failure to keep track of what one is doing (Alloway, Gathercole, Kirkwood, & Elliott, 2009). Moreover, a large-scale longitudinal study of children from age 3 through early adulthood showed that working-memory capacity predicts how well children do in reading and spelling (Schneider & Bullock, 2009).

Teachers can help children acquire memory strategies. First- and second-graders whose teachers were told to use memory-relevant language, such as strategy suggestions and metacognitive information, showed more knowledge about strategies and more advanced strategy use on a memory task (Grammer, Coffman, & Ornstein, 2013). In another intervention, focused on "learning how to learn," teachers emphasized choosing a good strategy, self-testing, and planning (e.g., Hacker, Dunlosky, & Graesser, 1998).

Mathematics and science instruction have been of particular interest. In mathematics, one intervention, based on Siegler's research on math understanding described earlier, used board games with a numerical theme with low-income preschoolers to improve their math performance (Siegler & Ramani, 2009). This population is known to be at risk for falling behind in math understanding. In scientific thinking, children and even adults have great difficulty separating hypotheses from evidence. One critical thinking skill is to know how to design unconfounded experiments by changing only one variable while keeping the values of all other factors the same, in order to determine whether that variable caused the experimental outcome. Researchers have developed successful instruction for this concept and documented the importance of teacher guidance over simply learning on one's own (Matlen & Klahr, 2012).

Memory research, using longitudinal studies, has been extended to children at risk. For example, infants born prematurely sometimes show long-term memory deficits (Rose, Feldman, & Jankowski, 2014). In a developmental cascade, premature birth affects less complex abilities such as speed and attention, which then affect more complex abilities such as memory, which in turn affect general cognitive ability. Also, experiencing prenatal metabolic disturbances due to iron deficiency associated with diabetic mothers alters memory circuitry and impairs memory performance through infancy and early childhood (Riggins & Nelson, 2014).

A final important application of memory research is to children's eyewitness testimony in general, but particularly for their own abuse, a situation where they often are the only witnesses. There are several issues: How accurate is young children's testimony in general? Does the highly emotional, traumatic nature of abuse affect children's recall of trauma-related information? How valid are "recovered memories"—older children's or adults' memories of apparently forgotten abuse during early childhood? How suggestible are young children when subjected to repeated questioning by parents, false information provided after the event, or cross-examination in a legal setting? Researchers study children's eyewitness testimony in two main ways. One is to create a live or videotaped event that reproduces some elements of the abuse situation in an ethical way. Children might recall a highly stressful event they saw or events during a Simon Says game in which the child and the experimenter touch parts of each other's bodies (White, Leichtman, & Ceci, 1997). A second approach is to study naturally occurring, mildly traumatic, but nonabusive, experiences, such as going to the dentist or receiving urethral catheterization.

Although there is considerable debate about the answers to the above questions, a wealth of information is emerging (Goodman, Ogle, McWilliams, Narr, & Paz-Alonso, 2014; Howe & Knott, 2015): Although younger children usually do not recall as well as older ones, their errors usually are errors of omission rather than of providing false information. Also, in general, older children are less suggestible than younger ones. However, an exception may be that, with increasing age, children are more likely to incorrectly think they experienced something if it makes sense, that is, if it fits into the "gist" of what they encoded. An example mentioned in the earlier section on knowledge effects on memory, is falsely recognizing "sleep" when only words such as "bed," "rest," "awake," and "tired" were presented (Brainerd & Reyna, 2014). With respect to recall for abuse specifically, most child abuse victims have particularly good recall of stressful events. A major contribution of developmentalists has been to develop standard protocols for interviewing children to elicit accurate testimony (Goodman et al., 2014). Features typically include building rapport with the child, assessing the child's developmental level, discussing the distinction between truth and lies, and explaining interview rules (e.g., acceptable to say "I don't know") before questioning. Then questioning proceeds from free recall and open-ended to more specific questions, to avoid leading the witness. Interestingly, there is reason to doubt that anatomically detailed dolls and other props improve young children's recall accuracy (Salmon, Pipe, Malloy, & Mackay, 2012).

In addition to these general findings, there is evidence of variability among children in the accuracy of their recall for negative events. For example, the type of attachment matters (Chae et al., 2014). Among children with parents high in avoidance (see Chapter 5), higher levels of distress when receiving an inoculation predicted less accurate recall of that event. In contrast, the combination of low parental avoidance–high stress predicted more accurate recall. Also, preschoolers with more positive representations of their parents had more accurate recall. Avoidant parents may not in the past have discussed distressing events with their children or prepared them for coming negative events, resulting in their children's poorly represented and processed memories for such events. Thus, socioemotional factors contribute to recall of distressing events.

The constant use of electronic devices in daily life has raised concerns about multitasking, given children's limited processing capacity, immature attention system, and poorly developed executive functioning. Crossing an intersection while engaged with an electronic device and studying while listening to music raise questions about children's safety and learning. The research indicates that multitasking usually compromises information processing and learning (Courage, Bakhtiar, Fitzpatrick, Kenny, & Brandeau, 2015). However, these negative effects may be avoided by creating certain conditions: giving the child control over the task requirement, making learning platforms developmentally appropriate, and permitting practice.

Evaluation of the Theory

The information-processing approach changed the way developmentalists thought about children's thinking and greatly influenced almost every area of cognitive developmental research. In this section, the focus is on its strengths and weaknesses as a *developmental* theory. The theory's strengths lie in its ability to express the complexity of thought, its precise analysis of performance and change, and its rigorous methodology. Its weaknesses include the shortcomings of models and metaphors, problems with addressing certain developmental issues, and a neglect of the context of behavior.

Strengths

Ability to Express the Complexity of Thought ▶ The information-processing approach, like Piagetian theory, addresses complex thinking. It tries to specify a variety of cognitive processes, ranging from the simple detection of a stimulus to the development of complex rules, strategies, and concepts. Furthermore, it attempts to characterize how perception, attention, memory, language, and abstract mental operations are interrelated. The approach posits an intricate organization of thought in which control processes direct and supervise. For example, children learn to handle large amounts of information by "chunking" it or by relating it to what they already know. Connectionist systems show that a few simple principles of learning (e.g., associations between units, weighting of connections, competition between networks) can account for the detection of complex patterns in the environment and the emergence (sometimes unexpectedly) of complex concepts in children.

Precise Analysis of Performance and Change ▸ Perhaps the greatest strength of information-processing theories is their specificity. They carefully specify the input and children's cognitive architecture. They then make specific predictions about a child's behavior from moment to moment, on the basis of a fine-grained analysis of the task, the current state of the child's cognitive system, and microgenetic changes over numerous trials. Connectionist models are particularly specific because they must identify all assumptions and relevant parameters, decide on calculations for the processing nodes to use, and look at exact changes in strength of particular associations. Psychologists are forced to clear up any muddled theoretical thinking.

The Piagetian and information-processing approaches have much in common. Both attempt to explain how more advanced concepts grow out of earlier, simpler ones—specifically, how a child's current cognitive system both constrains and permits the emergence of new knowledge. However, information-processing investigators attempt to be more explicit about *how* children use their cognitive skills in a given situation. This is a theory of performance, which, as mentioned in Chapter 2, is weakly developed in Piaget's theory. Information-processing theories describe how attention, memory, strategies, representational processes, and logical operations "connect" with tasks. For example, if the task requires that a child decide whether objects on a balance scale will balance, the information-processing approach would specify how the child selects certain information about the objects (for example, number, distance from the fulcrum), encodes it, and applies rules from long-term memory. Piaget's décalages (asynchronies in applying a concept to different but related tasks or content areas) become less mysterious when investigators analyze the information-processing demands of each task. Some tasks make greater demands on working memory than do other tasks. More generally, the information-processing approach emphasizes, more than does Piaget, processing limitations, strategies for overcoming these limitations, domain-specific knowledge about the task at hand, and specific behaviors involved in the process of change on a particular task.

Rigorous Methodology ▸ Related to the theory's specificity is that hypotheses generated by the theory are testable—a trait shared with social learning theory, less so with Piaget's or Vygotsky's theory, and much less so with psychoanalytic theory. Information-processing researchers use stringent and precise experimental methods. As one psychologist commented, "Many of us have become methodological behaviorists in order to become good cognitive psychologists" (Mandler, 1979, p. 281). Laboratory research on basic processing often makes precise measurements of processing time. For developmental research, error analysis and microgenetic designs have proved to be particularly powerful assessment procedures. By cleverly designing different types of problems, researchers have discovered that young children are using simpler, less complete rules, procedures, or strategies than are older children.

Weaknesses

The preceding short section on strengths is followed by a longer section on weaknesses. This imbalance does not reflect an abundance of weaknesses in the theory. Rather, most of the strengths were mentioned earlier in the chapter, whereas weaknesses have been neglected and must now draw our attention.

Shortcomings of Models and Metaphors ▸ A basic problem with flow diagrams and computational models is that these models may adequately describe what the relation between input and output *could* be, but not necessarily what it is. Similarly, it is possible for different models to predict performance equally well. This is one limitation to the generally good testability mentioned earlier. Thus, it can be difficult to judge the psychological validity of a model.

One problem specific to computational models is that constructing these simulations is a time-consuming, technical, often tedious task. Consequently, the majority of researchers studying cognitive development do not use this method. Part of the problem is that in order to be complete and to run successfully, the modeler must be careful not to exclude relevant information. An example of this problem is a college campus computer dating program that contained much information about students' interests and attitudes (Kendler, 1987). The results were not considered successful by a brother and sister who were paired together! No one thought to instruct the computer that siblings should not be paired.

Another problem with computer models is that they often are highly specific, precise models of very limited, specific behaviors. Because they must consider all relevant variables, it is difficult to develop more general models that can run successfully. Still, connectionist models are becoming increasingly successful at self-modifications that eventually lead to more general models.

The metaphors of information processing have been useful. Viewing thinking as bearing some similarities to computer processing and the brain has provided a productive new perspective on thinking and development. However, like all metaphors, information-processing metaphors can be a dangerous tool. As George Eliot, in *Middlemarch*, cautioned: "We all of us, grave or light, get our thoughts entangled in metaphors, and act fatally on the strength of them." One example is that metaphors, and even the more formal models, usually have excess meaning that was not intended. For instance, flow diagrams may make us erroneously think of memory as passive, sequential, and unrelated to other cognitive processes or to emotions. In addition, adopting a particular model may seriously limit our thinking. Once psychologists began to express memory as a series of discrete steps (boxes in a flow diagram), it took several years before a less dichotomous, more gradual, levels-of-processing approach, or parallel processing models, could be seriously proposed. Thus, it must be kept in mind that a model is similar only *in certain ways* to the phenomenon to which it is applied.

Metaphors also can constrain our thinking in that they may overly encourage us to think about cognition in terms of spatial representations. Memory metaphors usually are spatial, implying that we "search" our mental space for objects stored in physical space (Roediger, 1979). There almost seems to be a "homunculus" (little man) who rifles through the files of memory until he finds that necessary paper. In these files or in semantic networks, concepts are stored at different "distances" from each other. Examples of cognitive metaphors in Roediger's list include a workbench, a pushdown stack (of clean plates in a restaurant), an acid bath, a dictionary, and a subway map. In a spoof of memory models, Hintzman (1974) likened memory to a "cow's belly." Information (like food) is transferred from the "short-term stomach" to the "long-term stomach." In this way, we "ruminate" over ideas and "digest" information.

The technology of the times suggests certain metaphors, beginning with Plato's likening memory to the impression of a seal on a wax tablet, which in his time was a method of storing information. Later metaphors were the gramophone, switchboard, tape recorder, computer, and holograph. Today's computer metaphor may evolve as devices become more mobile, social, and varied. Will the Internet become a metaphor for thinking? What metaphor will a post-Internet technology bring? A computer metaphor may eventually seem as naive as Plato's wax tablet.

Problems with Addressing Certain Developmental Issues ▸ The information-processing approach has advanced our understanding of adult cognitive systems. How successfully has it contributed to developmental theory? The approach rates high marks for its careful, refined descriptions of the processing system at various ages or cognitive levels. Its focus on change offers great potential for identifying mechanisms of development, which may be *the* central question about development. What are the main developmental issues still to be resolved?

One issue concerns developmental continuity. Recently, great strides have been made in studying information processing in infants and toddlers, especially working memory and the analysis of linguistic input. What is less clear is how these early competencies are related to the much later, more verbal and complex ones. Connectionist approaches offer mechanisms of change for this continuity in the short term and hopefully will be able to address longer-term changes eventually. Part of the issue is the longstanding question of whether short-term change involves the same mechanisms as long-term change. Does the short-term changing of weights of various connections also characterize the change from age 2 to 7? Can the qualitative change that sometimes emerges from these changing weights explain larger, more general qualitative changes? Does children's change from being "universal novices" (Brown & De Loache, 1978) to experts in an increasing number of domains parallel long-term cognitive change? For example, when older children learn, they bring more to the table due to their considerable experience and understanding than do younger children. This difference suggests that older children's learning may be more likely to involve drawing on previous knowledge, rearranging old knowledge, or simply generalizing to a new domain. That is, the readiness to learn may look somewhat different in a 2-year-old than a 7-year-old. Connectionist models may be more successful at addressing these developmental issues for some kinds of cognitive activities, such as detecting regularities in language, than others, such as metacognition and social cognition.

Neglect of the Context of Behavior ▸ Information-processing theory generally has neglected the context of behavior, such as goals, emotions, and affordances of the physical and social environment. As one critic commented, "Ask not what's inside your head, but what your head is inside of" (Mace, 1977). Another one noted that what a reader would conclude about the mind after reading a 904-page book surveying cognitive science is "Minds talk a lot . . . they move a little, they see a little, but they don't feel much else" (Anderson, 1991, p. 287). Information processing has focused on the processing mechanisms the person brings to a task or setting and on the task parameters more than on the interplay between the demands or possibilities of the larger setting and the needs, goals, and abilities of the person. However, researchers recently have made some progress in addressing how cognition is embodied in motor behaviors, as described in the section on contemporary research. Some research on the social context of cognition was described in the section on memory, and work on the intertwining of emotion and memory is described in the applications section. Also, the possibility of cultural differences in basic cognitive processing was explored in Chapter 4 in work on cultural differences in attentional processes. For example, Mexican-heritage children in the United States more often simultaneously attend to multiple ongoing events than European-American children, who tend to alternate their attention among events (e.g., Correa-Chávez, Rogoff, & Mejía Arauz, 2005). Thus, even basic attention processes are culturally formed; when a culture values children's attending simultaneously to multiple events in the community around them, cultural practices guide children in that direction. Differing contexts related to the socioeconomic status of families contribute to basic information processing as well. For example, young adults who grew up in poverty have poor working memory, which appears to be mediated by the high chronic stress experienced in growing up in such an environment (Evans & Schamberg, 2009). The observed accumulative wear and tear on the body was caused by physiological responses to stress. Finally, the social context affects the sort of learning described in connectionist models. Parents influence which parts of the environment become input into infants' processing systems. Parents direct infants' attention to certain objects and events through shared attention, label certain objects but not others, and give certain types of toys to young children.

Contemporary Research

Some contemporary research was described throughout this chapter. Thus, this section will focus on several areas that recently have become quite active—executive function, cognitive neuroscience, embodied cognition, Bayesian models, statistical learning, and developmental robotics.

Executive Function

One topic of great current interest is *executive function*—cognitive control activities that help children adapt to novel tasks. Executive control is related to the central executive in the Baddeley model described earlier. The core executive functions are thought to be inhibition of impulsive behaviors or decisions, working memory, and cognitive shifting from one framework (e.g., sort by color) to another (sort by shape) (Miyake et al., 2000). An example of inhibition is a task in which children must say "day" when shown a moon and "night" when they see a sun (Montgomery & Koeltzow, 2010). Like an orchestra conductor, executive function coordinates a child's cognitive activities. These skills are very important for effective information processing because they insure focused attention on relevant information, avoidance of distractions, planning, strategies, and cognitive flexibility during problem solving. The prefrontal cortex, the anterior area of the cortex, is heavily involved in executive functioning, and is thought to synchronize neuronal activity widely distributed in the brain. An example of the importance of executive functions is that they are related to school readiness and predict how well children achieve academically (Best, Miller, & Naglieri, 2011; Blair, & Raver, 2015). They also appear to be particularly disrupted in children with autism spectrum disorders or ADHD. Moreover, executive function seems to serve as a protective factor for homeless children: Homeless children with high executive function experience greater academic success (Masten et al., 2012). Executive function also is related to social-cognitive developments, such as theory of mind and social competence (Razza & Blair, 2009). Remarkably, children with better inhibitory control had better physical and mental health and better earnings and were more law abiding 30 years later (Moffitt et al., 2011).

Recent research has identified a number of factors that contribute to executive function. For example, competent parenting (sensitivity and responsiveness) predicts later higher executive function (Blair, Cybele, & Raver, 2014), as do good peer relationships (Holmes, Kim-Spoon, & Deater-Deckard, 2015). Somewhat troubling is the fact that television decreases executive function as well. Watching 10 to 20 minutes of televised fantastical events depleted executive function in young children, when compared to playing or watching other kinds of shows (Lillard, Drell, Richey, Boguszewski, & Smith, 2015). There is recent interest in the possible benefits, for executive functioning, of mindfulness—focusing on in-the-moment thoughts and feelings in a calm and nonjudgmental way. For example, a social and emotional learning program involving mindfulness and caring for others, designed for elementary school students, enhanced cognitive control (Schonert-Reichl et al., 2015). (It also reduced stress, promoted well-being and prosocial behaviors, and produced positive school outcomes.)

Developmental Cognitive Neuroscience

The great interest in developmental cognitive neuroscience research described in Chapter 5 includes information processing. Brain development creates new possibilities for processing, for example, when myelination (insulation of neural impulses) during infancy increases working memory, and later maturation of the prefrontal cortex facilitates the control of attention. Although initial biases direct infants toward certain information to process, such as social information including language, for the most part, brain plasticity makes it possible for infants to analyze information in the particular environments in which they dwell. Experience strengthens certain neural pathways and weakens others. This in turn affects infants' subsequent processing of information. A main question is "What sort of brain architecture and functioning supports each kind of information processing—simultaneous or successive processing, detecting patterns of co-occurrence of environmental features, encoding features in order to construct rules, or generating a script or 'theory' of the world to be tested?" For memory, the question is "how the roughly 1500 grams (3 ½ pounds) of tissue that sits in the bony case atop our shoulders manages to vividly re-create—and even allows us to re-live—events and experiences from the past" (Bauer, 2009, p. 115).

Recent neuroimaging research provides biological support for many of the findings in information processing (e.g., Johnson & DeHaan, 2015; Stiles, Brown, Haist, & Jernigan, 2015). During development, brain regions become increasingly specialized for processing particular kinds of information, though brain networks link activity over multiple regions of the brain. In fact, one theory is that large-scale patterns of brain organization during development emerge from neural activity linking regions of the brain (Johnson, 2011). Significant progress has been made in understanding brain contributions to memory development. When children create a new memory, there is a physical change in the brain. Neural synaptic connections are altered and thus patterns of activation change. Different types of memory are controlled by different neural structures and networks. For example, the development of episodic memory during childhood corresponds closely to the development of certain parts of the hippocampus, located under the cerebral cortex (DeMaster, Pathman, Lee, & Ghetti, 2014). The hippocampus plays an important role in consolidating memories into long-term memory by binding details of an event into a mental representation that integrates these features.

Neuroscience research not only provides another level of explanation of known information-processing development but also contributes to theory building by suggesting new hypotheses. For example, neural activity linking regions controlling higher-level cognition with regions central to motor behavior, emotions, and the processing of social information supports theorizing about embodied cognition (see below) and the intimate role of emotions and social interaction in development (e.g., Grossmann & Johnson, 2014). Both of these areas have been slighted in previous information-processing research. For example, *developmental social cognitive science* is exploring topics such as infants' processing of faces, brain activity during infant–parent shared attention, and the automatic brain processes that occur when we are happy, angry, or empathic. Brain development related to the effects of emotion on memory involves different brain circuitry at different ages (Carver, 2014). Subcortical areas develop relatively early, during infancy, and increase arousal, which facilitates fast responses to emotions. The prefrontal cortex develops quite late—during adolescence—and contributes to cognitive strategies of emotion regulation.

Embodied Cognition

Another trend has been many years in the making. The critique that information-processing approaches ignore the context led to the *embodied cognition* approach in adult cognition (e.g., Glenberg, Witt, & Metcalfe, 2013), and this approach has spread to developmental psychology. Cognition is more than the manipulation of abstract symbols. Rather, cognition is grounded in action; we process information in order to do something. The brain is in an active, moving body that is trying to navigate the physical and social environment. Although Piaget emphasized motoric contributions to infant development, it played little role after that, except as a way to explore the environment. Today, a variety of lines of research have converged on the conclusion that cognition controls actions, and interactions of the body and brain affect cognition. Here is a sampling: Measures of neural activation in sensorimotor areas of the cortex showed that 9-month-old infants recruit their motor system when a situation suggests an impending action (Southgate & Begus, 2013). The crawling ability of 9-month-olds predicted their ability to mentally rotate an object (Schwarzer, Freitag, Buckel, & Lofruthe, 2013). A 14-year longitudinal study found that infants' motor-exploratory competence set in motion a developmental cascade that affected various levels of intellectual function that in turn contributed to academic achievement in adolescence (Bornstein, Hahn, & Suwalsky, 2013). The mirror neuron system discussed in Chapter 5 showed that watching others' actions activates appropriate regions of the brain. Children given conservation training with gestures (even with no objects present!) as well as verbal instruction improved their understanding more than did verbal instruction alone (Ping & Goldin-Meadow, 2008). A main implication is that cognitive developmental research and theorizing should be focused on how a new cognitive skill contributes to the generation of action, and how action facilitates cognitive development.

Bayesian Computational Models

Work on computational models continues. Connectionist models have become increasingly complex in recent years—adding more layers, more sets of hidden units, a working memory (activity in one layer in the model feeds back into itself or into a different layer), repeating loops and mini-networks within the larger network, mechanisms for learning sequences (e.g., predicting what word is likely to come next) and emerging new hidden units over time (Schlesinger & McMurray, 2012). The increasingly complex, interactive, and self-regulating nature of connectionist models has led to integrations with dynamic systems theory, which is discussed in Chapter 9.

Recently, *Bayesian models* have been applied to development. Developmentalists are interested in these models because they address two important questions: How do children make inferences about objects, events, and causality in a world where there is too little usable information because much of it is ambiguous (as when two contiguous events may or may not have a causal relationship)? How can preexisting beliefs and knowledge, known to influence thinking, be modeled such that their influence is represented in everyday thinking, and how are beliefs and knowledge updated as a result of experience? One approach to these questions is to think of children's inferences as probabilistic, given the uncertainty of the meaning of many or most situations. Specifically, Bayesian probabilistic inference is used, or at least approximated. Bayesian models take the connectionist approach of explaining behavior in terms of probabilistically weighted information. Like other computational approaches, they force modelers to be specific about their assumptions, about information in the setting, and about children's prior and present relevant information.

From a Bayesian perspective, what typically happens when young children try to understand their experiences is that they learn from examples, generalizing from these examples. For instance, they see various cats and, through inference, generalize to a category—*cat*—to which they learn to assign a word—"cat." As they encounter new examples, they sometimes are sure that it fits the category (it is definitely a cat), sometimes are sure it does not (it definitely is not a cat; it probably is a dog), and sometimes are not sure (a cat with no tail—a baby lion?). This uncertainty is especially likely in young children who are just beginning to form categories. The idea of Bayesian models is to represent, in a model, this uncertainty, past beliefs, and some learning mechanism that explains how children's categories gradually become more like those of adults.

Basically, the assumption is that children form representations of the probability of their hypotheses being correct: "I kind of think this is a cat (70% probability), but it might be a baby lion (20%) or some other animal (10%)." Children set these probabilities (unconsciously, of course) of each hypothesis based on the category of *cat* they already had and the information provided in the current encounter (Does it meow? Does it have a long tail?). Stated differently, a child has a certain amount of belief to allocate to her various hypotheses about what the creature is. Experience with each new creature just moves around this allocation. As one hypothesis is strengthened, the others are weakened. After learning, based on an exemplar of a cat with a short tail, the child's prevailing belief may be that cats usually have long tails but can have short tails. Another example, from adults, is the way physicians infer a diagnosis. They may have an initial diagnosis (hypothesis) based on a set of symptoms, but additional tests bring new information, leading the physician to shift the probability of each of the several possible diagnoses. A hypothesis about the illness that initially had a low probability could, given enough evidence, become the hypothesis with the highest probability. What both the child and the physician are trying to do is figure out the underlying causal structure—the essence of a cat or the disease—that generates the data that they use to make an inference.

Similarly, children infer from a person's behavior the probable mental state causing the behavior, or infer from a person's spoken language to the underlying generative language system, and so on. In all these examples, given the data observed and the learner's prior knowledge, the learner infers which construct, or causal model, is most likely to have generated the data. In this way, as a result of experience, children change their beliefs. In experiments, a researcher might first assess children's prior beliefs, then present them with a carefully specified set of data, and then examine which hypotheses they endorse. Bayesian models have been developed and tested for various topics, such as language acquisition, perception, concept formation, and motor behavior.

From these examples, it is clear that one reason Bayesian models are attractive is that they seem to describe the uncertainty and messiness of everyday learning. The approach also provides a particularly useful way to think about how young children develop and fine tune their concepts and causal understanding. Moreover, children learn surprisingly quickly. For example, young children somehow pick up new words and their underlying concept after only a few examples. For instance, in a child's first encounter with a new word/concept, such as "sushi," the referent is ambiguous. It could refer to any food in a Japanese restaurant, all circular food, all food that includes rice, just the seaweed wrapping, or even the chopsticks. If three people at the child's table are having three different kinds of "sushi," and two people are having something else, with a different label, the probability of the child's concept of sushi being basically correct becomes very high and the probabilities of her other hypotheses become very low.

Another reason why the Bayesian approach is attractive is that it can incorporate what a child brings to the setting—innate or learned constraints on selecting one hypothesis over another. For example, children have several biases for learning words, such as applying new words to whole objects rather than to parts (e.g., Markman, 1990). Thus, the novice sushi eater above would tend to assume that the word "sushi" refers to the whole piece of sushi, rather than just the seaweed wrapping or just the rice. Still another reason for the attractiveness of Bayesian models is that they have contributed to developmental theory by offering an alternative mechanism of development—shifting probabilities of the likelihood of children's hypotheses about the world.

The Bayesian approach, and the phenomena it explains, is much more complicated than can be communicated here. The many technicalities of constructing Bayesian models are beyond the scope of this chapter (see Perfors, Tenenbaum, Griffiths, & Xu, 2011, for a tutorial, and Gopnik & Wellman, 2012, for applications).

Bayesian models were inspired in part by empirical work showing that children can engage in *statistical learning*. They can detect complex statistical patterns and use them to make causal inferences, and thus could think in ways depicted by Bayesian models. As a very simple example, children automatically process the probability of two items or events occurring together in the input. For example, infants have surprisingly sophisticated language-learning mechanisms for attending to and remembering frequencies of co-occurrence in sounds in language input that may account for their early, rapid acquisition of language. That is, they quickly learn the likelihood of particular syllable sequences—which sounds tend to occur together. In one study (Pelucchi, Hay, & Saffran, 2009), for example, English-learning 8-month-olds could track the probabilities of these co-occurrences of sounds in fluent infant-directed Italian speech. In this way, infants learn to extract words from a continuous stream of sound. Children have plenty of data to draw on in detecting these patterns. They hear approximately 17,000 words a day (Risley & Hart, 1995).

Young children not only detect correlations among data and extract reoccurring patterns, but they also infer abstractions, such as rules of grammar. For example, after children encounter "a boy" and "a girl" many times but never "a boys" and "a girls," they infer a rule about how to form singular and plural nouns. A convincing demonstration that detecting the statistical regularities of language is a powerful mechanism of language learning comes from a line of research showing that infants can learn an artificial language based on knowledge of the statistical regularities of the language (e.g., Saffran & Thiessen, 2007). Young children also draw on statistical learning to construct abstract causal structures. An example is that, from observing patterns of probability among events and noting the effect of their actions on a machine, they can determine what they have to do to make a machine play music (e.g., Fernbach, Macris, & Sobel, 2012).

In a striking demonstration that even infants have expectations about probabilities (and perhaps are even sensitive to sampling patterns), Xu and Garcia (2008) showed 8-month-old infants a box of white and red Ping-Pong balls, in an 80:20 proportion. Then the experimenter took some balls from the box. Infants looked longer when a sample of mostly red balls was taken from a box of mostly white balls (an improbable though not impossible event) than when a sample of mostly white balls was removed. This suggests that infants are even sensitive to sampling patterns.

Statistical-learning approaches have directed researchers' attention to the nature of the information to which children are exposed, for example, language input. In one study, an analysis of the words in books parents commonly read to children showed that this language input had more variation than that of parents' conversations with their children (Montag, Jones, & Smith, 2015). This is important because variety in language input facilitates language development.

Bayesian and statistical learning approaches show that children possess powerful learning skills that help them go well beyond the information given. These approaches are particularly promising for suggesting how automatic processing in infants could partially account for their seemingly precocious cognitive skills described in the chapter on Piaget, as well as their ability to acquire language early and quickly.

Developmental Robotics

A final topic of current interest is d*evelopmental robotics*—the design of autonomous machines that acquire cognitive and behavioral skills through experience (Cangelosi & Schlesinger, 2015). The idea is to develop flexible and adaptive robotic intelligence. The initial architecture, plus exploration of the world and interacting with other people, propels the robot toward greater complexity. The focus of developmental robotics on broad skills contrasts with earlier artificial intelligence systems, which were specialized for a particular task, such as chess. These earlier systems had most of the knowledge they needed built in, so they underwent little or no learning. Today, robots are being designed with developmental principles and findings in mind. The approach is similar to computational modeling, except that the product is an embodied learner, in three-dimensional form, that interacts with the environment, rather than a more abstract learner in a computerized simulation. This modeling can be a tool to test developmental theories or provide insights about development, especially mechanisms of development, including how motor behavior shapes learning and development, and vice versa. Robots, though programmed by a computer, can take many forms: humanoid, wheeled cart or vacuum cleaner, a machine arm, or even doglike or insectlike shapes (Cangelosi & Schlesinger, 2015). For example, iCub approximates the size and shape of a 3-year-old child (Parmigiani et al., 2012). One line of research even involves language learning between two robots—a tutor and a learner (Spranger, 2015). An interesting application has been to develop social-assistive robots for children with autism spectrum disorders or Down syndrome, or hospitalized children (Cangelosi & Schlesinger, 2015).

Thus, contemporary research from an information-processing perspective continues to address longstanding topics such as memory and problem solving, but with new energy from executive function research. In addition, research is expanding into a variety of new and exciting areas.

SUMMARY

The information-processing approach studies how human information detection and manipulation systems work. Investigators take the computer program as a model—either as a metaphoric heuristic device or as a way of simulating and testing their views concerning the nature of human thought. Children change developmentally in how they attend to, represent, store, weight, and combine information in order to reach their goals despite their limited processing capacity. These changes occur at various points in the system, for example, in working memory and long-term memory in some models. Much of development occurs via self-modification, as children formulate rules of decision-making and modify them as a result of feedback, or detect regularities of co-occurrence in the environment. Investigators often begin by performing a task analysis. They then either formulate a computer program simulating how children learn, solve a problem, or store information, or test the efficiency of the child's processing by conducting experiments.

Humans are limited in how much information they can process at a given time and in how fast they can process this information. Much of development involves learning how to overcome these limitations by acquiring strategies and developing executive functions. Research on memory, the most studied area of information-processing development, shows that much of memory development is caused by the acquisition of strategies, the growing store of domain-specific knowledge, increased metamemory, greater functional capacity, and social-cultural influences. There are many levels of influence on memory development. Brain development, practice, exploration, and culture all play some role.

The discovery and selection of various strategies alters the processing of information. There is turning out to be more variability, and less consistency, in children's strategies and performance than once thought. Social influences appear to be quite important. Children develop a series of rules for problem solving and acquire new information that can be expressed in production systems simulations. Connectionist models propose simple principles of learning through the strengthening and weakening of associations in a network. These transparent, precise accounts of development test hypotheses about developmental change and sometimes produce unexpected new findings and new hypotheses.

Mechanisms of development such as encoding, generalization, strategy construction, automaticity, and brain maturation cause more efficient processing. Information-processing theorists view humans as active, organized, self-modifying systems. Development involves both quantitative and qualitative change and both genetic and environmental influences. The essence of development is an increasingly efficient system for controlling the flow of information.

The theory has been applied mainly to educational settings and to issues concerning the reliability of young children's eyewitness testimony. The strengths of the theory are its ability to express the complexity of thought, its precise analysis of performance and change, and its rigorous methodology. Weaknesses involve certain shortcomings of the models and metaphors, problems with addressing certain developmental issues, and a neglect of the context of behavior. Contemporary research areas include executive functions, developmental cognitive neuroscience, embodied cognition, Bayesian computational models (including statistical learning), and developmental robotics.

SUGGESTED READINGS

Bauer, P. J., & Fivush, R. (Eds.). (2014). *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell. This two-volume set covers numerous aspects of memory development.

Brown, D. A., & Lamb, M. E. (2015). Can children be useful witnesses? It depends how they are questioned. *Child Development Perspectives, 9*(4), 250–255.

Cangelosi, A., & Schlesinger, M. (2015). *Developmental robotics: From babies to robots.* Cambridge, MA: MIT Press.

Yermolayeva, Y., & Rakison, D. H. (2014). Connectionist modeling of developmental changes in infancy: Approaches, challenges, and contributions. *Psychological Bulletin, 140*(1), 224–255. This article provides further detail on connectionist models of development.

This page intentionally left blank

CHAPTER 8

Gibson's Ecological Theory of Perceptual Development

We tested 36 infants ranging in age from 6 months to 14 months on the visual cliff. Each child was placed upon the center board, and his mother called him to her from the cliff side and the shallow side successively. All of the 27 infants who moved off the board crawled out on the shallow side at least once; only three of them crept off the brink onto the glass suspended above the pattern on the floor. Many of the infants crawled away from the mother when she called to them from the cliff side; others cried when she stood there, because they could not come to her without crossing an apparent chasm. The experiment thus demonstrated that most human infants can discriminate depth as soon as they can crawl.

—*Gibson & Walk, 1960, p. 64*

On uphill trials [on slopes in a laboratory] infants often attempted hills where they were likely to fall, despite falling on previous trials and in previous sessions. Crawlers usually struggled at the base of impossibly steep slopes for the entire duration of the trial, sometimes getting partway up, then sliding back down. After lengthy frustrated attempts, they tried equally hard moments later at the next impossibly steep slope. Walkers usually adopted a similar strategy, getting a running headstart on two feet and flinging themselves at impossibly steep inclines. Sometimes persistence paid off and infants eventually reached the summit.

—*Adolph & Eppler, 1999, p. 40*

Childhood is a time of perceptual discovery. Children look at and explore the wondrous objects, events, and surfaces in the environment occupied by the human species and thus learn what they can do in the world. They perceive faces to smile at, hills to climb, approaching objects to avoid, words to respond to, seashells to play with, and flowers to sniff. Although such discovery is exciting in itself, it also permits adaptation to this environment. Children are information "hunters and gatherers," trying to survive in an information-heavy world. Eleanor Gibson's focus on the importance of perception for adaptation is a companion piece to the account of ethology and evolution in Chapter 5. Gibson took on a question largely ignored by other theorists we have met: How do we learn about our world through perception? Surely this is a basic task of development. Gibson's answer to this question is that, by moving around, children detect information that specifies objects, events, and layouts in the world that they can use for their daily activities. They "perceive what is going on around them so as to make good use of what the world offers" (Gibson, 1997, p. 42).

The organization of this chapter is as follows: First is a biographical sketch, followed by a general orientation to the theory, and then a description of infant perceptual learning. A section on mechanisms of development is followed by the theory's position on developmental issues, applications of the theory, an evaluation, and contemporary research.

Biographical Sketch

Eleanor J. Gibson's (1910–2002) studies in psychology began when she was a student at Smith College. There she met and married a young faculty member, James Gibson, who also was to become an eminent psychologist. After earning her master's degree with a thesis on learning, she became an instructor at Smith and attended the Gestaltist Kurt Koffka's lectures regularly. Gibson moved on to Yale, hoping to study animal behavior; instead she ended up studying people. At Yale, she obtained a Ph.D. under Clark Hull, the eminent learning theorist. Gibson, however, did not feel intellectually comfortable in the stimulus–response learning climate of Yale. Her husband's relocation for military service during World War II temporarily interrupted her career. When the Gibsons went to Cornell University, Eleanor became an unpaid research associate for 16 years (due to nepotism rules). The Gibsons spent their careers developing an ecological approach to perception—the relation of an organism to its surroundings.

Gibson's early work in the 1950s and 1960s developed the new fields of perceptual learning and perceptual development. At Cornell she studied goats and sheep at the "Behavior Farm." One study, on maternal–infant bonding in goats, was never completed because the baby goats' caretaker gave away some of them (Caudle, 2003). Gibson then studied babies' depth perception on "visual cliffs" and children in reading-related situations in the laboratory. She became a professor at Cornell in 1966. Her book *Principles of Perceptual Learning and Development* (1969), which won the Century psychology prize, was hailed as one of the most influential books on development at that time (Hartup & Yonas, 1971). Her theory provided an alternative to learning theory and Piagetian approaches. Years after her "retirement," she continued to contribute to the field through her research and writing (e.g., Gibson & Pick, 2000). She received many top research awards from the main professional organizations and was awarded the National Medal of Science—the nation's highest scientific honor. She also was elected to the National Academy of Sciences, the American Academy of Arts and Sciences, and the National Academy of Education.

General Orientation to the Theory

Gibson's theory concerns perception, broadly defined. The developmental mystery she wanted to solve is how infants and children learn to perceive and make use of objects, events, and surfaces given the complex, constantly changing array of stimulation in which they are immersed. She asked four questions: What do infants and children perceive? How do they pick up this information? What actions or interactions take place? What are the consequences for knowledge? (Gibson & Pick, 2000) This section examines characteristics of the theory that show how Gibson addressed these questions: the ecological approach, the notion that information for perception is specified in stimulation, the active nature of human perceivers, and ecological methods.

Ecological Approach: Affordances

Like ethologists' focus on the functions of behaviors, Gibson wanted to find out the uses of perception in our daily lives. People need to perceive objects, spatial layouts such as floors or the ground, and temporal events such as approaching objects in order to adapt to the world: to walk around in it, find things in it, play in it, and even survive in it. These stimuli are complex relational units, not simple sensations of light or sound.

Unlike most theories of perception, Gibson's theory stressed what perceivers do in natural environments. Gibson's research and theorizing centered on *affordances*. Affordances are what an environment offers or provides for an organism; they are opportunities for action. Humans' environments "afford" surfaces of support for walking or crawling, objects for grasping, passageways allowing movement, and barriers preventing movement. Even the social environment offers affordances, for example, a smiling or angry face affords positive or negative interactions. Thus, the person and the environment fit together to form a whole, with a meshing of the person's activities and the environment's affordances. The utility of a property of the environment depends on the capacities of the organism. If an infant cannot yet walk, a solid surface does not afford "walking on." Affordances thus involve a relationship between the organism and its surroundings. Gibson claimed that these affordances are perceived directly: "We do not perceive stimuli or retinal images or sensations or even just things; what we perceive are things that we can eat, or write with, or sit down on, or talk to" (1982, p. 60).

As children acquire new motor skills during development, they discover new affordances. Once infants can sit up, this sets in motion a cascade of advances: Sitters do more visual–manual exploring while looking at objects than do nonsitters, which then leads to improved 3-D perception of objects (Soska, Adolph, & Johnson, 2010). When children learn to walk, they learn to perceive whether a surface affords solid support for walking. They look at, feel, and pat an unfamiliar surface to get information about how solid and stable it is. This affordance is irrelevant for, and unknown to, a younger infant. In one experiment illustrating this point (Gibson et al., 1987), infants were placed on a walkway raised 4 feet from the floor. Their smiling mothers stood 6 feet away at the other end of the walkway. The walkway for one condition was a rigid surface (strong plywood covered with a patterned fabric), which affords locomotion for both crawling and walking. In the other condition, the walkway was a patterned fabric on a water bed, which affords crawling but not walking. The infants who could walk looked at and felt the ambiguous water bed surface more than the rigid surface before they either walked on the rigid surface or crawled onto the water bed. Because they already had experience with walking on rigid surfaces, they knew that such surfaces afford walking, but they were not sure about the water bed surface. The infants who could only crawl showed little, if any, differentiation of the two surfaces; they readily moved onto both of them because both were perceived as affording crawling. Thus, infants' locomotion abilities affect what surfaces they perceive to be safe for crossing. There is a fit between what the environment provides and the child's actions, goals, and abilities.

Infants' bodies are constantly increasing in size and in the distribution of weight and, thus, in their biomechanics. Indeed, babies grow by as much as 1.8 centimeters in length per day (Lampl, 1993). Babies show flexible learning as they constantly adapt their changing bodies in an environment with changing affordances—new action possibilities: "Whereas a robot can be programmed to assume a particular body and environment, babies cannot because yesterday's body or environment may no longer hold true today" (Adolph & Robinson, 2015). Fast-growing adolescents and pregnant women face a similar situation. Women in the late months of pregnancy constantly update their perception of affordances, given their enlarging body, and thus can accurately judge whether they can go through passageways that they could formerly (Franchak & Adolph, 2014). Note that in learning about affordances, infants and adults learn about themselves—their own bodies—as well.

Humans have evolved species-specific ways of perceiving the world and learning perceptually. Children's evolutionary heritage provides the perceptual equipment to perceive—or learn to perceive—the affordances of the particular objects, events, and spatial layouts that characterize human settings. We also have hands to detect whether a perceived object can be grasped and manipulated. Similarly, bats are pretuned to use acoustic information (interpreting feedback from sounds) to help them navigate in dark caves. The environment affords food, mates, and places to hide from predators. By exploring and playing, children learn the affordances of objects, events, and surfaces.

The fact that experience creates new affordances explains individual differences in the ability to use potential affordances: "A three-inch-wide beam affords performing backflips for a gymnast, but the affordance is not realizable by others; rock climbers learn to use certain terrains for support that do not appear to others to provide a surface of support" (Gibson & Pick, 2000, p. 17).

Information Is Specified in Stimulation

To begin to understand Gibson's answer to her first question, about what is perceived, one must understand her conception of the role of stimulation in perception. Her description of the active, self-motivated child exploring the stimulus world at first seems quite similar to Piaget's view of children. The theorists part, however, in their conceptions of how children "know" the world through activity. Piagetian children "construct" their knowledge by forming mental schemes based on their motor behaviors with objects. Because perception produces static images, it must be corrected by operational knowledge. Similarly, other cognitive and perceptual approaches see perception as an act of enriching, with knowledge, a sparse, ambiguous, uninformative retinal image. For instance, information-processing approaches describe processes that add meaning to the stimulus by relating it to memories and knowledge in the long-term store. They refer to going beyond the information given by making inferences based on knowledge of the world.

In contrast, Gibson believed that stimulation is a rich source of information that specifies objects, events, and surfaces. The developmental issue, then, is how children learn to extract more and more information from that stimulation. As children perceive, they differentiate information, rather than add to it. Her claim that complex information, including structure, is inherent in stimulation is controversial. It is important, therefore, that we consider this claim carefully.

When we move, the visual stimulation around us appears to be in motion as well, though typically we do not notice that movement. What we have to do is extract patterns, or structure, in the flux of moving stimulation that specifies events, places, and objects. If children can extract this information, they perceive events, places, and objects and understand how the affordances fit with their abilities. They do not perceive a single, discrete "stimulus," such as an object: "There is no shutter on the retina, no such thing as a static image" (1988, p. 5). In other words, stimulation is a field of available information about affordances to be differentiated, and perception is a process of information pickup that happens over time.

Stimulation carries many levels of information. At the simplest and most concrete level, a child tells objects apart by one or several *distinctive features*—critical features that can be used to discriminate between objects. Suppose a boy moves near an ocean and for the first time in his life encounters hundreds of shells. He begins a collection and attempts to identify the shells with the help of a field guide with photographs. Although he is perceptually capable of telling all of the shells apart if he places them side by side, he actually notices only a few distinctive features at first, perhaps only salient differences in color, shape, and size. Only after much playing with the shells and comparing them with each other and with the pictures in the book does he realize that the stimulus class "shells" has a particular set of distinctive features that allows him to determine the appropriate label for each shell. Although size is a salient feature, it seldom is important for differentiating types of shells.

In contrast, slight differences in the shape of the crown at one end of the shell or subtle differences in the colored pattern on the shell are quite important. Although this information was in the light stimulating the boy's eyes from the start, he did not really notice it or abstract it as a defining feature until he had more perceptual experience with the shells.

As another example, imagine that a practical joker mixed up the container labels on the entire stock of ice cream in a 48-flavor ice cream store. An efficient way to tell the flavors apart and group together identical flavors would be to pick out the minimal set of distinctive features that distinguish the types of ice cream. The set might include the following: color, nuts versus no nuts, sherbet versus nonsherbet, flavor (fruit-based, chocolate-based, or other), and smooth versus textured. Faces are another group of objects that can be differentiated by distinctive features. Cartoonists take advantage of striking facial characteristics by exaggerating them in caricatures. A toothy grin or large nose can bring instant recognition. Gibson showed that attending to the distinctive features of letters is part of the process of learning to read (Gibson, Gibson, Pick, & Osser, 1962). Orientation (*M* versus *W*) and curved versus straight (*D* versus *O*) are distinctive features, whereas size and color are not.

A second level of information in an optic array involves *invariants*—relations that remain constant over change. Children extract what is permanent about objects despite changes in their appearance as the objects move toward or away from them. It is clearly more economical to perceive a single, constant mother of a particular size and shape than a succession of different mothers that expand and shrink as their distance changes. In one study (Gibson, Owsley, & Johnston, 1978), Gibson asked whether 5-month-olds could extract the invariant property of rigidity (lack of malleability) when an apparently rigid object underwent various kinds of movements. Babies saw a round, disklike piece of foam rubber move in three ways, for example, rotation in the frontal plane, rotation around the vertical axis, and movement toward or away from them. They watched these rigid movements in succession until they habituated, that is, stopped looking at the object. Then they saw, in succession, a fourth rigid motion, perhaps rotation around the horizontal axis, and then a nonrigid, elastic motion (an experimenter continually squeezed and released the spongy disk). The infants showed little interest in the new rigid motion but much interest in the nonrigid motion. This attention to the novel property of nonrigidity indicates that the infants had extracted the invariant property of rigidity from the stimulus flux of the earlier three movements.

Children can extract a third, larger unit—perceptual *structure*. For example, we abstract a melody from a succession of notes. We recognize this melody as the same melody even if it is transposed to a different key or played at a different tempo or on a saxophone instead of a piano. When we hear a new orchestral work, we have a relatively undifferentiated perception of the work after the first hearing. Only after listening to the work several times are we able to extract melodies and their transformations and grasp the overall structure of the piece. For most people raised in the West, this task is more difficult with Eastern music or modern compositions using the 12-tone scale, which are less familiar, than with the first hearing of yet another Haydn symphony. In this musical example, stimulation has remained the same throughout the repeated hearing. What has changed is what information we have extracted. The pattern is there in stimulation, but we may not have perceived it at first. Our perception became both more specific, as we became aware of subtle musical qualities, and more abstract, as we perceived musical patterns. Thus, Gibson noted that her theory might be called a "seek and ye shall find" theory (1977, p. 157). Our perception improves not by filling in the raw auditory stimulus by adding words or applying schemes, not by cognitively gluing together the notes, but by listening to the music and directing our attention.

Humans as Active Perceivers

Perception does not just happen to a passive perceiver, like a patron waiting for the server to arrive with a meal. Instead, we do things to make perception happen; we sample and select from a buffet of potential information. Perception does not occur only in the brain; it is a whole body activity.

—*Adolph & Robinson, 2015, p. 131*

No parent would be surprised by the claim that children seem to be constantly in motion. Parents might, however, be surprised by the claim that this motion is essential to perceptual development, even in infancy. Children are active organisms that explore in order to learn about the world. They actively extract affordances and use them to discover new affordances. For example, children may perceive the affordances of various types of balls by kicking them, rolling them, and trying to bounce them. Then, by using them in a game for which they are suited, children discover new affordances, such as passing the ball to teammates.

During development, children gain control over their bodies and expand their exploratory potential. They work hard to use each new postural achievement to attend in new ways. Young infants struggle to hold their head and shoulders upright when carried so that they can look about. Later, trying to sit without support while attending to and slapping at a toy requires constant work to maintain balance. Still later, infants just learning to stand suddenly fall to a sitting position when they let go of a chair to attend to and pick up a block on the seat. Children gain more control over their attention, and it becomes more efficient. They can, for example, more efficiently compare two objects by looking systematically back and forth between them.

Humans, as a species, are inherently motivated to explore and learn about their world. There are, however, goals and needs specific to each task or situation. A girl putting together a puzzle attends to shape and color because these attributes are information she needs to achieve her goal of completing the puzzle. A baby learning to walk must be very attentive to the position of her body in space and the distance between furniture. Young soccer players seek a different sort of information. They continually search for and track the ball, perceive the spatial relationship between other players and the ball, and use feedback concerning their attempts to kick the ball (falling down, kicking erratically, and so on). Adult mountain climbers are more attentive to where they place each step than are people taking a leisurely walk (Gibson & Rader, 1979). In these examples, there is a relationship—ideally, a match—between the person's goals and the information actively extracted from the environment.

Methodology

Although Gibson's research, as well as other research stimulated by her theory, followed the experimental procedures of other areas of developmental psychology, it was unusual in one way. It tried to retain ecological validity in the experimental setting. This does not mean that Gibsonians necessarily observe perceptual activities in their natural settings. It does mean that they attempt to simulate (mimic important features of) the stimulation, tasks, and goals of the child's natural environment in the experimental setting: Multimodal stimulation (for example, faces that move and make sounds and objects that can be touched), various kinds of environmental supports for locomotion (for example, solid or nonsolid surfaces), and opportunities for obtaining feedback from exploratory activities (and thus detecting contingencies). This shows the close connection between theory and methods—both stress the ecology.

Early on, Gibson had puzzled over why a newborn goat, when placed on a small, high stand to get it out of the way while its twin was being delivered, knew to stand motionless on this high surface (Caudle, 2003). In a clever experiment to test infants' depth perception, Gibson, along with Walk (1960), constructed a "visual cliff" to simulate a cliff or drop-off in the real world. Gibson also was inspired to create this miniature Grand Canyon after visiting the real Grand Canyon with her young children and pondering, with some concern, their ability to perceive it as a drop-off. The visual cliff is a table with a glass top that looks like a solid surface on one-half of the table; on the other half of the table, the floor is visible through the glass. Thus, the apparatus displays information specifying a drop-off. Some of the results were described at the beginning of this chapter. Infants who can crawl stay on the "cliff" half, refusing to crawl onto the half of the glass that hangs over the apparent "thin air." The visual-cliff experiments demonstrated that crawling infants perceive depth at an edge at least as early as 6 or 7 months. Later research using heart rate indicated that even younger infants differentiate the cliff and noncliff sides (Campos, Langer, & Krowitz, 1970). One method to examine the role of experience is to train perceptual-motor behavior to see whether performance on the cliff improves. In one such study (Dahl et al., 2013), pre-crawling infants received several weeks of experience sitting in a motored cart and controlling its movements with a joy stick. They then showed earlier cliff avoidance than infants with no cart practice.

More recently, Adolph has developed ecologically based variations of the visual cliff that are adjustable, to permit various degrees of cliffs, gaps to reach over, and slopes (see Figure 8.1 for an example, the excerpt at the start of this chapter, and Adolph & Robinson, 2015, for a review). After testing novice and experienced independent sitters, crawlers, and walkers, Adolph concluded that whether babies are willing to enter onto risky surfaces depends on whether they have yet grasped the affordances of the mode of mobility they choose. That is, infants do not have a general fear or wariness of heights. Rather, affordances are driving the behavior; experience in each new mode of mobility is needed to learn about affordances for that mode.

Recent technological advances, especially head-mounted eye trackers, have made it possible to determine what infants and children actually look at as they move around naturally. By using this device, it was possible to learn, for example, that crawling and walking infants have very different views of the world, mainly the floor versus other people near and far (Kretch, Franchak, & Adolph, 2014). Eye trackers also provide detailed descriptions of visual exploration of objects. For instance, when viewing images of animals, 4-month-olds with experience with pets tended to look at the most informative part of animals—their heads—compared to infants with no pet experience (Hurley & Oakes, 2015).

What Infants Learn About

Locomotion is one of infants' greatest achievements. Infants conquer gravity, propel themselves through space, and stay balanced despite encountering novel and variable surfaces. As infants move from crawling to standing to cruising to walking to running (mostly running, it seems to parents), and learn to control these postures, they learn to use information about objects, events, and layouts to exploit their affordances. We look at some important developments during infancy in three areas: communication, interaction with objects, and locomotion in the spatial layout.

Communication

The ecology of the human infant includes other people. Even before babies utter their first word or manipulate objects, they begin learning to participate in the social world. Newborns recognize, and prefer, their mother's voice and face, recognize the overall pattern of people's speech, and discriminate between a foreign language and their own. Young babies learn the affordances of other people's facial expressions, gestures, vocalizations, and actions and learn to respond to them. For example, they can detect the emotional states of other people—an angry facial expression affords bad events, a happy one affords positive events. Babies thus come to anticipate the behaviors of others and to respond to them. Primitive nonlinguistic "conversations" are possible, for infants learn about turn taking and see themselves as able to control their interactions with others. Babies learn that they are agents with particular physical abilities and intentions. Eventually, babies and their parents engage in joint visual attention as they look at and talk about an object or event together. All of this is a perfect context for learning about language and social relationships. The following studies give a flavor of how perception relates to communication.

Infants detect correspondences between faces and voices. For example, 9-month-olds looked longer at a female face when it was accompanied by a female singing voice than when it was accompanied by a male singing voice (Hillairet de Boisferon et al., 2015). In another experiment, using a videotape of a face in the dark with small lights attached, Soken and Pick (1992) showed 7-month-olds patterns of moving lights specifying happy or angry faces. When infants heard a soundtrack of a happy or angry woman, they looked at the appropriate face, even though they could see no details of the face. As a final example, infants use information from their mothers' faces to avoid dangerous situations when perceptual information is inadequate. When trying to decide whether to walk down a slope that they are not sure is safe, 18-month-olds follow their mothers' encouraging or discouraging words, gestures, and facial expressions (Tamis-LeMonda et al., 2008). However, perception trumps maternal wisdom: They ignore encouraging advice to walk down risky slopes and discouraging advice to avoid safe slopes.

Interaction with Objects

Infants make use of whatever motor abilities they currently have to explore their environment. Even very young infants, by moving their head and eyes, can scan the visual layout and discover rudimentary properties of objects and layouts. Later, they can reach for and manipulate objects, thus learning about the properties of objects and their affordances. Consider, for example, a baby lying in her crib and gazing at her stuffed bear on a nearby shelf. She sees a single, solid, three-dimensional object separate from the shelf and from the other toys on the shelf. When her mother bends over the crib and occludes some of the bear, the baby does not think that her mother has bisected the bear. If the bear falls off the shelf, she expects that all parts will fall together but that the shelf and wall will not also fall. If the bear falls toward her, she does not think that it is becoming larger or that it is changing shape as its angle changes. And, finally, she knows that the falling bear may make contact with her face and most certainly will afford cuddling and chewing.

Infants' early perception of the separateness of objects was demonstrated in the following study (Needham & Baillargeon, 1998): Babies at 4½ months of age saw either a cylinder or a tall blue box for several seconds. Then they saw both objects next to each other and watched as a hand appeared and pulled the cylinder. In one case, the hand pulled the cylinder away from the box, and in the other case, the cylinder drew the box with it. Babies looked longer when the objects moved together, an outcome that in infant research is taken to mean that the babies were surprised at this improbable event. The inference is that they had perceived the objects as separate. Remarkably, the results were the same when a 24-hour delay separated the presentation of one object and both objects. This outcome indicates that a very brief visual experience with a single object served to segregate it from an adjacent object, even at a later time. This experiment also serves as an example of the clever methods that have been constructed to assess early competencies. Similar experiments document infants' perception of number, solidity, size and shape constancy, substance, and texture.

One startling perceptual skill concerns babies' detection of the unity of objects and events. For example, 4-month-old infants perceive a long stick protruding on either side of a rectangular object as a single, unbroken, partially occluded stick, rather than two short sticks separated by an object, which is literally what they see. However, they perceive this unity only if they see the stick move back and forth or in depth rather than remain stationary (Kellman & Spelke, 1983). Thus, as Gibson proposed, action—of the object, the infant, or both—is essential for accurate perception. One of the most striking demonstrations of perceived object unity is the perception of a living object in motion. Fox and McDaniel (1982) presented a biological-motion light pattern—a videotape of 10 lights mounted on the joints of the arms, legs, and hips of a figure running in the dark. Another display included the same number of lights, but their movement was random. Infants ages 4 and 6 months tended to look at the running pattern, which indicates both their ability to differentiate an object in biological motion from a random array and their preference for viewing a pattern of moving lights organized into a unitary object.

Different kinds of objects have different kinds of motion paths. Babies use this motion cue to differentiate animate and inanimate objects. In one study (Baker, Pettigrew, & Poulin-Dubois, 2014), babies first were habituated to two events on a computer screen. One event was a dog jumping over a barrier—an appropriate pattern of non-linear motion for an animate object, such as a dog, but not for an inanimate object. The other event was a car (an inanimate object) hitting and rebounding off the barrier—linear movement appropriate for both animate and nonanimate objects. Subsequently, infants looked longer when a different inanimate object, a bus, jumped over the barrier like the dog had (a surprising motion pattern for an inanimate object) rather than rebounded like the car. Infants did not show this differential looking when a different animate object, a cat, jumped over the barrier or hit and rebounded off the barrier, because animate objects can follow either motion path. Thus, by 10 months of age, babies connect certain categories of objects with certain types of movement.

Babies show multimodal object perception. Specifically, they extract the properties of various modalities, such as visual and tactual properties, that go together. For example, infants can tactually recognize an object that they had previously only seen (Streri & Pecheux, 1986). Moreover, even newborns look at a speaker whose mouth movements match the specific sounds they hear rather than the speaker making other sounds (Aldridge, Braga, Walton, & Bower, 1999).

Finally, infants are even sensitive to the sight–sound correspondences of musical events by 7 to 9 months (Pick, Gross, Heinrichs, Love, & Palmer, 1994). Infants heard a soundtrack in synchrony with two displays but specific to only one of the instruments. They appropriately looked at, for example, the musician playing a cello rather than a clarinet and the one playing a trumpet rather than a flute. Thus, experience with various instruments apparently is not necessary for detecting sound–sight correspondences and for differentiating instruments from different families.

Locomotion in the Spatial Layout

As infants learn to roll, creep, crawl, and walk their way around their environments, their attention expands to larger arrays. As J. J. Gibson commented, "The surface is where most of the action is" (1979, p. 127). Infants' perceptions of the layout guides their locomotion around obstacles, through openings, and onto safe, solid surfaces. A toddler crossing a room needs a great deal of affordance information in order to crawl under a table, over rather than around a blanket on the floor, and around rather than over the dog. She constantly has to make decisions. Objects' affordance of being carried seems to fascinate toddlers, who often delight in carrying objects from one place to another. Gibson (1988) noted that this affordance apparently takes a while to be learned completely, for toddlers sometimes try to carry a toy or piece of furniture almost as large as themselves.

Children must constantly tailor their locomotion both to the properties of the terrain and to their own developing abilities. In order to crawl or walk, infants need to find surfaces that afford crawling or walking. Infants' ability to extract affordances for crawling or walking were shown in studies of the visual cliff and other risky surfaces, such as steep slopes, described earlier.

When infants first acquire a new locomotion skill, they seem oblivious to its limitations. An example is Adolph's (1997) longitudinal study of infants encountering upward and downward slopes of various steepness—angles ranging from 0 to 36 degrees (see Figure 8.1). Infants had to decide whether they had the capability to climb or descend in this potentially (though not really) dangerous situation to reach a parent

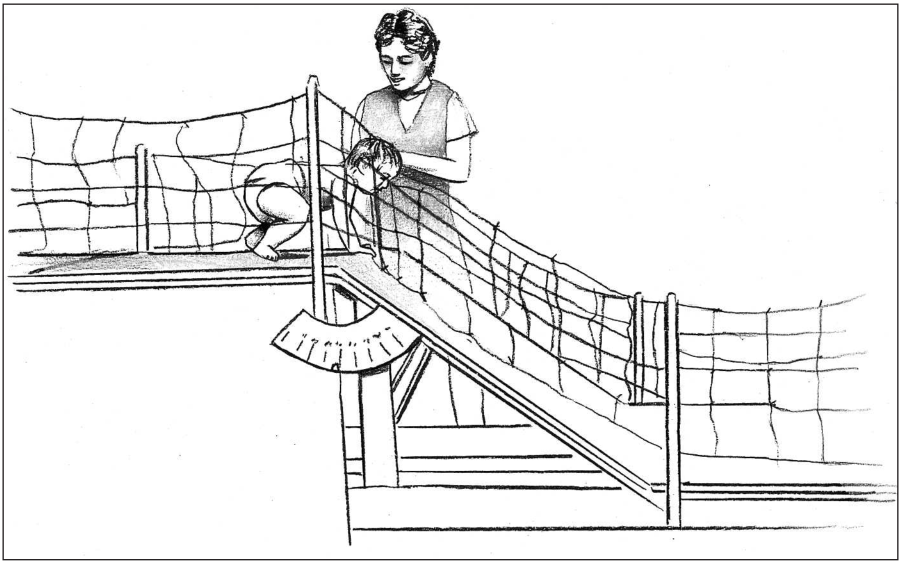

FIGURE 8.1

Adolph's walkway with adjustable slope used to test infants' judgments of whether to descend slopes that vary in steepness. The experimenter followed alongside to ensure the infants' safety.

["Learning in the Development of Infant Locomotion," by Karen Adolph, in *Monographs of the Society for Research in Child Development*, 1997, *62*(3, Serial No. 251). Adapted by permission of the Society for Research in Child Development.]

at the receiving end offering a Cheerio. At first, crawlers showed little caution and often just plunged ahead, even on the steepest slopes, and had to be rescued again and again (see the excerpt at the beginning of this chapter). Over weeks, as the infants' crawling expertise increased, their judgments of affordances improved. The infants tried out a variety of strategies. They sometimes tried various means of traversal down the slope by testing different sliding positions while still on the starting platform. They sat and hung their legs over the slope or changed into a backing position and looked over their shoulders down the slope. The babies eventually crawled on the safe slopes and refused to crawl on the riskier ones. Interestingly, later when they began to walk, they again judged poorly, but they again improved with experience. Thus, with each new postural advance, the infants had to relearn information about affordances relevant to their new ability. The better perceivers more effectively explored the slopes by looking, feeling, and trying out various positions, such as backing down or sliding. The fact that a control group without repeated experience with the slopes in the experiment exhibited the same pattern shows that specific learning on those particular slopes was not important. Rather, practice in maintaining posture and noticing consequences during daily activities transferred to the laboratory situation.

Subsequent experiments also showed that experience with an earlier-developing skill does not transfer automatically to a later-developing one. For example, in a group of 12-month-olds, experienced crawlers refused to crawl over risky drop-offs, but novice walkers stepped repeatedly into the drop-off (Kretch & Adolph, 2013). (Human "spotters" make sure that the infants do not actually fall.) Experienced walkers (18-month-olds), who now know the affordances of walking, would not step off (though did figure out other ways to get down into the lower surface). Thus, perceptual learning is surprisingly specific to a particular postural control system.

Social-cultural factors can influence the development of locomotion. For example, several cultures in Africa, the Caribbean, and India try to promote infant locomotion by strengthening infants' legs and improving their upright balance with massage and special standing and stepping exercises (Adolph, Karasik, & Tamis-LeMonda, 2010). In the United States, when parents are asked to adjust a ramp to create the steepest slopes they will allow their infants to crawl down independently, fathers are more likely than mothers to provide challenges for their toddlers by letting them try slopes beyond their ability (Ishak, Tamis-LeMonda, & Adolph, 2007).

Mechanisms of Development

The sections thus far have described a number of processes for bringing about development. Efficient exploratory activities lead to the economical extraction of information specifying affordances. For a 7-month-old, "fingering explores texture, hand-to-hand transfer and rotation explore shape, and squeezing and banging explore substance" (Gibson & Pick, 2000, p. 150). Children move their eyes to the television, turn their head toward the sound of a distant call, move their hands over sap dripping down a tree, sniff when dinner is being prepared, and cautiously roll a brussels sprout over their tongue. Consequently, children detect features, relations, and higher-order structure that specify affordances of objects, events, and layouts. Children also filter out irrelevant information, as in the "cocktail-party phenomenon" (or "birthday-party phenomenon" in children), in which all background noise is filtered out in order to hear a single voice. Maturation permits new postures and motor skills that lead to new affordances.

Position on Developmental Issues

Human Nature

Gibson's view of human nature is much like Piaget's. In these organismic views, people are inherently motivated creatures who actively explore and try to extract sense from their world. Ideally, this is an organized and efficient process in which the child's needs and goals mesh with the nature of the environment. In Gibson's and Piaget's views, the child has a tremendous capacity to learn from experience and adapt to the environment. Both theorists describe complex organisms that are sensitive to the complex structure of the environment. The theorists differ, however, in the source of this structure. Gibson believed that in stimulation there is structure, which specifies the information available to be perceived. The child learns to detect this structure and the affordances of settings. In contrast, Piaget believed that to a great extent the nature of the interaction between the child and the world constructs the structure.

Qualitative Versus Quantitative Development

Just as perception in adults can gradually improve with practice, so perception in children gradually improves as a result of experience. Perceptual development is not stagelike and thus not mainly qualitative. There may, however, be specific qualitative changes in the exploratory strategies children use. For example, children's systematic visual comparison of two objects may replace their earlier random looking at the two objects. Qualitative change also occurs when the emergence of crawling or walking causes the reorganization of the motor system and a change in the set of affordances for that new skill.

Nature Versus Nurture

Gibson was interested primarily in describing and explaining how children learn from experience and what they learn, especially affordances. However, she thought that nurture and nature are inseparable. They do not just interact; they fit together. What information children extract from the environment depends on their evolved species-specific genetic endowment in addition to their maturational level, immediate goals, and unique set of learning experiences. Babies are innately equipped to find out what the world is like and what it lets them do. Their growing control over their bodies and their awareness of their bodies in space is a big part of the story of perceptual learning and development.

What Develops

Gibson identified four hallmarks of human behavior: agency, prospectivity, the search for order in the world, and flexibility (Gibson & Pick, 2000). *Agency* is "the self in control, the quality of intentionality in behavior" (p. 160). Even infants learn that their actions have effects on the environment and that they can control their own behavior. *Prospectivity* pertains to intentional, anticipatory, planful, future-oriented behaviors. For example, infants open and then begin to close their hand when reaching for an object, in preparation for grasping it. Based on perceived affordances in the setting, children reach, anticipate outcomes, and perceive where they are going in a room. The *search for order* involves children's tendencies to see order, regularity, and pattern and thus make sense of the world. Earlier sections described invariants, higher-order structure in stimulation, and economy of selecting information. Finally, regarding *flexibility*, "perception adjusts to new situations and to changing bodily conditions such as growth, improved motor skill, or a sprained ankle" (Gibson & Pick, 2000, p. 169). Infants face the challenge of a changing body in a variable world.

Applications

Gibson's work on reading showed that perceptual learning about letters, correspondences between letters and sounds, and the structure of sentences is essential for learning to read. In addition, her theory suggests that preschool teachers can provide interesting and varied objects and surfaces and let young children learn perceptually by exploring that world. Perceptual learning also is essential for children's safety and health. Being able to judge the slipperiness of surfaces and the lack of support offered by a rickety bridge railing are essential for avoiding serious accidents. Studies of affordances can inform bicycle safety programs for children. One study looked at how children on bicycles try to judge gaps between cars when entering an intersection with continuous cross traffic (Plumert & Kerney, 2014).

Evaluation of the Theory

Gibson's theory is the most well-known theory of perceptual development. It has inspired a great deal of creative research, especially regarding infants' early perceptual and motor competencies. The evaluation will focus on the potential of Gibson's theory to guide not only perceptual research but also developmental research more generally and to tie perception to other areas of development. The strengths of the theory are its focus on the ecological context of perception and its putting the body back into developmental psychology. The main weakness is the unclear account of cognition.

Strengths

Focus on the Ecological Context of Perception ▸ As Gibson commented, "Only a few hardy perception psychologists still study perception of the real world rather than small displays on computer screens" (1991, p. 607). Gibson asked how perception serves us in our daily lives in a world of complex patterns, objects, and events rather than points of light or brief, static stimuli. In James Gibson's words, she worked on "perception outdoors under the sky instead of perception of points in a darkroom" (1979, p. xii). The perception of the affordances of natural units is essential for adapting to the environment. This ecological orientation has relevance for the current state of cognitive developmental research. Like ethological theory, Gibson's theory could enrich the information-processing approach, for example, by directing it toward (1) larger, more complex properties of the environment to be processed, (2) events rather than static stimuli, and (3) affordances.

First, Gibson criticized the tendency of information-processing researchers to break down the world into objects and properties of objects such as color and shape. In Gibson's words, "Such a conception requires them to invent 'processing mechanisms' to put the world together" (1977, p. 156). In contrast, Gibsonians showed that even young infants can detect structures, such as melodies, and complex and meaningful properties of the world, such as pliability and traversability.

Second, information-processing approaches should take seriously Gibson's concern with the processing of events that occur over time: a rapidly approaching object, a ball rolling across the floor, one object striking another, liquid being poured out of a glass. This change in focus would broaden our understanding of processing based on the typically studied static stimuli, such as pictures, letters, objects, and written words. Most real-life events involve the movement of one or several objects or people—a complex set of information. Some of the social information processing work does address more complex events, such as a negative social interaction.

A third implication is that information-processing work should give more attention to functions: How do children gather, and process, information about the functions of artifacts and natural objects and events in the environment? What do they offer for humans? In fact, Gibson suggested that affordances provide a natural organization for knowledge, for example, a category of "things you can walk on." Learning about the affordances of events, objects, and surfaces may be a first step toward a conceptual understanding of them.

Putting the Body Back into Developmental Psychology ▶ Gibson did not leave the child wrapped in thought (Pick, 1992): Children are doing something in order to achieve some goal in a setting. Thus, she was ahead of her time in her focus on the fit between the body and what the setting offers—what might be called "embodied perception" (Cañal-Bruland & van der Kamp, 2015). Embodied cognition, the influence of the body on cognition (see Chapter 7), may draw on embodied perception—information from affordances learned while moving around, exploring surroundings, and achieving some goal. When we seek information about affordances, we do so because of our physical and psychological needs for moving toward resources, expressing ourselves, interacting with others, obtaining objects to work on, and so on. We explore to obtain information for a particular purpose. If the goal is a social one, knowing the possibilities for action provided by other people may contribute to the understanding of their mental states, which impacts social interaction. If the goal is nonsocial, such as determining the number of objects, knowing the separability and unity of an object may contribute to an understanding of how to count. Our affordance-gathering actions in a particular setting may pave the way for a more abstract understanding of how to make our way around that setting. In these ways, Gibsonian perceptual development can contribute to an embodied cognitive development.

As another example of how Gibson's focus on the role of the body in perceptual development can inform work on other areas of development, consider work on the development of the self. Gibson's emphasis on what children do contrasts with most theories' focus on what children know or what they are like. For example, developmentalists speak of a "self-concept," which connotes a static something that the child has, whereas Gibson speaks of self in terms of "agency," which connotes doing and action. Babies become aware of themselves as one object among many and can link proprioceptive information from their own body to a visual image of their body. Remarkably, Bahrick and Watson (1985) found that 5-month-olds could discriminate between a live video display of their own currently moving legs and that of another identically dressed infant or their own legs videotaped at another time. In the latter two displays, proprioceptive and visual information were not synchronized. Moreover, infants can even tell when the video has reversed their right and left legs! (Morgan & Rochat, 1997). Work on the development of self would be enriched by a consideration of one's body, and what it can do, as well as one's psychological characteristics.

Weaknesses

A weakness of Gibson's theory is her unclear account of cognition. Contemporary psychologists tend to make a distinction between perception and cognition and then address how they interact. Gibson probably was correct that this distinction is misguided; it is artificial to try to separate the two. Still, her placement of many abilities that most psychologists would label as cognitive under the rubric of perception is puzzling to many in the field. The basic problem is that Gibson proposed a theory of the *direct* perception of the environment but then included some behaviors that seem to many psychologists to involve indirect, interpretive cognition. For instance, Gibson's examples of perceptual learning included inferring emotions from a parent's face, reading maps, interpreting X-ray and aerial photographs, and identifying material under a microscope. Others included detecting means–end relations, perceiving causality, learning that events in the world can be contingent on one's own actions, and perceiving conservation as an invariance over time and over an event sequence (Gibson, 1969, pp. 8–9, 388), which sound very Piagetian. Furthermore, children are said to perceive affordances such as swinging (on swings), warmth and light for reading (from a fire), and hiding (behind a screen). These examples seem to involve inference, categorization, and interpretation. In short, the distinction between perception and cognition is blurred.

Contemporary Research

Research on one topic of current interest, infant perceptual learning, was described in the section on that topic. The other main contemporary Gibsonian-inspired research examines infants' perceptually guided motor behaviors, asking intriguing questions such as "Why are toddlers who are able to climb up a slope or stairs unable (or unwilling) to climb back down?" and "Why does it take weeks of experience with a new motor skill such as crawling or walking before it can guide behavior adaptively?" "Why does an experienced crawler's awareness of affordances of surfaces not transfer to beginning to walk on those surfaces?" It may be that some perceptual learning is specific (e.g., steep slopes are dangerous to crawl on) and some is general and can be considered "learning to learn" as when infants "acquire the ability to generate relevant information about novel locomotor problems and their potential solutions" (Adolph, 2008, p. 214). When novice walkers encounter a slope, a shag carpet, or a wobbly railing for the first time, they have to generate information to begin a process of specific learning about the relation between their walking ability and the nature of the layout. There are plenty of opportunities to learn: Twelve- to 19-month-olds average 2,368 steps per hour—the length of 7.7 American football fields (Adolph et al., 2012). Infants are amazingly clever at figuring out solutions. For example, when encountering a wobbly rubber bridge handrail that collapsed to the floor when leaned on, some infants crossed safely by leaning backward as if wind surfing or mountain climbing (Berger, Adolph, & Lobo, 2005).

Another developmental puzzle of current interest is why infants give up an efficient motor behavior that they have mastered, and whose affordances they know, in order to take on a new motor behavior at which they are novices (Adolph & Tamis-LeMonda, 2014). In particular, as soon as children take their first step, they abandon crawling, which served them well for getting around efficiently and safely, in order to go through months of wobbling and falling. In fact, new walkers have about 32 falls per hour (Adolph et al., 2012). At this point, it is better to be a skilled crawler than a bumbling walker. Eventually there will be benefits of walking—faster mobility, a richer visual input, better access to distant objects, and new ways of interacting with other people—though new walkers do not know that yet. Even when new walkers were placed at the top of a steep slope into the crawling position that allowed them to slide safely down such a slope before, about half of them stood up, tried to walk, and fell (Adolph, 1997). So why do they persist? There may be several reasons (Adolph & Tamis-LeMonda, 2014): Even with falling, new walkers can go faster than experienced crawlers, and even experienced crawlers actually fall quite a bit—an average of 17 falls per hour (Adolph et al., 2012). Given that novice walkers walk more than experienced crawlers crawl, overall, even poor walking may be more beneficial than excellent crawling. Plus, even poor walkers can see more, especially distant objects that provide more opportunities for play, and can carry objects to their mothers to try to get their attention.

Finally, neuroimaging is identifying some of the brain correlates of infant perceptual learning. For example, infants' brain organization for identifying objects is both similar to, and different from, that of adults (Wilcox & Biondi, 2015). We now know some of the age-related changes in patterns of neural activation associated with shape and speed information about objects during the first year of life (Wilcox, Hawkins, & Hirshkowitz, & Boas, 2014). Thus, as infants develop sitting, then crawling, then walking, it may be possible to identify, with neuroimaging, how each advance affects infants' perception of shape and speed. Another line of research related to Gibson's theory is that it is known that many tasks activate both cognitive-control and motor areas of the brain (Diamond, 2000), reflecting close connections between action and thought.

SUMMARY

Gibson asked four questions: What is learned? How is this information picked up? What actions (or interactions) take place? What are the consequences for knowledge? Her answers are the following: Children learn to perceive affordances, namely, what it is that the events, objects, and layout in the environment offer that relates to the infant and can be controlled by the infant. An object's affordance is what can be perceived. This relation is a fit between children and their environments. Children extract, from stimulation, information that specifies these places, objects, and events and their affordances for actions. They learn to perceive distinctive features, invariants, and patterns in events, objects, and layouts. As they learn what is invariant in objects and events, children learn about themselves as objects that move about this world of variants and invariants. Infants also learn to participate in a communicative event. Importantly, children learn the consequences of their attempts to use affordances—successful exploration and play versus falling or not reaching a toy.

The ecological context of this learning is important because children learn to perceive information that helps them adapt to this environment. In each setting, children's goals—whether playing or reading or climbing over a fence—guide their pickup of information. In general, the fit between the goal and perception improves during development. As a result of active exploration, infants learn about communication, interaction with objects, and locomotion in spatial layouts.

Regarding developmental issues, Gibson viewed humans as active, self-motivated creatures who develop primarily quantitatively but also sometimes qualitatively. Nature and nurture intertwine to produce an efficient, adaptive perceptual system. The strengths of the theory are its focus on the ecological context of perception and its inclusion of the body in motion during cognition. An area of the theory needing further development concerns the nature of cognitive aspects of perceptual learning. Contemporary Gibsonian-inspired research is addressing puzzling aspects of infants' motor development, so important for their learning about the affordances of their world.

SUGGESTED READINGS

The best sources for Gibson's theory are her own publications:

Gibson, E. J., & Pick, A. D. (2000). *An ecological approach to perceptual learning and development*. New York: Oxford University Press. This is the most up-to-date, comprehensive account of her theory.

Gibson, E. J. (2002). *Perceiving the affordances: A portrait of two psychologists*. Mahwah, NJ: Lawrence Erlbaum. This inspiring autobiography shows the obstacles that women scientists had to overcome in the 20th century.

An interview with Gibson can be found on the website of the Society for Research in Child Development.

The following article puts Gibson's career into a historical perspective and identifies her main contributions:

Pick, H. L., Jr. (1992). Eleanor J. Gibson: Learning to perceive and perceiving to learn. *Developmental Psychology, 28,* 787–794.

CHAPTER 9

Theories Today: Themes and Perspectives

An experimenter shows a 5-year-old a candy box with pictures of candy on it and asks her what she thinks is in it. "Candy," she replies. She then gets to look inside and discovers to her surprise that it actually contains pencils. What would another child who had not yet looked inside think was in it, the experimenter next asks. "Candy," says the child, amused at the deception. The experimenter then tries the same procedure with a 3-year-old. The response to the first question is the expected "candy," but the response to the second is an astonishing and unamused "pencils." More surprising yet, the younger child also claims, in response to further questioning, that he himself had initially thought that pencils would be in the box—and had even said there were.

—*Flavell & Miller, 1998, p. 851*

The preferred states of infants' motor systems in nonreaching movements—their individual intrinsic dynamics—profoundly influenced the nature of the transition to reaching. . . . Two infants, Gabriel and Nathan, had large and vigorous movements; the other two were quieter and generated fewer and slower, less forceful movements. The task for all the babies was the same: To get their hands in the vicinities of the desired objects. But they had different problems to solve to do this: Gabriel and Nathan had to damp down their forceful movements to gain control; Hannah and Justin had to produce more muscle force to extend their arms forward in space and hold them stiffly against gravity.

—*Thelen & Smith, 2006, p. 295*

Developmental theories, like the children they describe, are always in motion, always changing. Each chapter in this book on the "big" approaches also described some of their contemporary relatives that are currently stimulating research, for example, connectionism and modern attachment theories. The sections on contemporary research showed how each theory is alive and well, in some form, today. Where are we now in our theorizing about development? This chapter begins with a description of the principles from the various theories that are so generally accepted that they form the foundation for developmental theorizing and research today. Next is an overview of theories emphasized or deemphasized today. Then the main section provides an account of four themes that currently are driving theorizing and research. In the context of these themes, several prevailing theories are presented.

Generally Accepted Theoretical Principles

One sign that developmental theorizing has advanced over the years is that several theoretical ideas from the various theories in this book are so compelling and supported by research that they are merely assumed today and form part of the current foundation for research and theorizing. First, children are active, not passive. They contribute to their own development by selecting certain contexts and interpreting new experiences in light of their current knowledge and history of social experiences (constructivism). Second, understanding development involves description and explanation from multiple perspectives, from cells to society. Thus, studying development is an interdisciplinary enterprise. The various levels are dynamically intertwined, in constant two-way interaction, such that changes in each level impacts other changing levels as well. Third, there is an underlying continuity to development. Each point in development involves a quantitative or qualitative change, based on a child's previous developmental history, that sets in motion a cascade of short-term and long-term changes. Fourth, it is assumed that a main goal of developmental work is to identify developmental processes that drive development. These processes flow from the inseparable activities of nature and nurture. These four assumptions may not be reflected in every new theory and study, but they form the bigger picture of the enterprise of developmental science.

Overview of Theorizing Today

Let us keep making theories. We may eventually get the right one.

—*Eleanor J. Gibson (2003, p. 295)*

No one theory currently dominates the field. Several have waned in influence, in that research today rarely explicitly tests them—Freud, Erikson, classical Piagetian theory, Vygotsky, social learning, and Gibson. However, all have contributed major theoretical ideas that have been assimilated into the field, as described above, such that their impact is almost invisible. Certain theories currently are influential for specific topics, such as connectionism for language and brain development, information processing for memory development, Bowlby for attachment, evolutionary theory for genetic and brain influences, *dynamic systems theory* (see below) for motor and language development, and Piagetian-inspired *theory theory* and *core knowledge theory* (see below) for conceptual development. Although Vygotsky's theory has little explicit presence today, it is very much present in the considerable interest in the cultural contexts of development. Today, for the most part, instead of building grand theories, developmentalists seem to be constructing small, focused theories that are energizing research in specific areas, such as attachment or theory of mind. An exception is dynamic-systems theory, a very broad theory described below. In terms of salient topics and approaches, the ones that seem most on the rise currently are genetics (especially epigenetics, Gene X Environment interaction), neuroscience, computational models (especially connectionist and Bayesian models), executive function, and dynamic systems. Most of these focus on the two-way interplay between nature and nurture, and between quantitative and qualitative changes. Most were boosted by technological advances—in computer technology, neuroimaging or genetic analyses.

Themes Driving Theorizing and Research Today

Four themes, or questions, seem to capture the current excitement in research and theorizing and highlight the main debates about development: How general are developmental changes? How can complex, dynamic change be captured theoretically? How can theories best depict long-term development? How can theories best depict universal and diverse aspects of development? In the context of these questions, several theoretical approaches will be described: theory theory, core knowledge, and dynamic systems.

1. How general are developmental changes?

As mentioned in the chapter on Piaget, others' research cast doubt on his view that the cognitive structure of a particular stage is reflected in most or all domains. Specifically, children often do not seem to have concepts characteristic of a particular stage that they apply consistently across tasks. And cognitive changes do not seem to change the whole cognitive system. Instead, children seem to have a coherent understanding specific to a particular domain and, for the most part, construct this understanding from experience with that particular domain. For example, mathematical knowledge comes from experience with counting, measuring, and so on. Today, the prevailing approach to understanding conceptual knowledge seems to focus on domain-specific knowledge. The debate centers on how best to characterize this understanding as well as the role of innate factors. Below are the two main positions in this debate: the theory theory and core knowledge. The former is constructivist—in the Piagetian spirit—and the latter emphasizes innate predispositions toward the early acquisition of certain concepts.

The Theory Theory ▸ Suppose a child is told the following story, which the experimenter acts out with dolls (Wimmer & Perner, 1983): A boy puts some chocolate in a blue cupboard and goes out to play. In his absence, his mother moves the chocolate into a green cupboard. After the boy returns for his chocolate, the children are asked where the boy will look for it. Three-year-olds immediately say "the green cupboard," where the chocolate actually is, even though the boy in the story could not possibly know that the chocolate was moved. In contrast, the 4- and 5-year-olds usually say "the blue cupboard," because, unlike the 3-year-olds, they have a theory of mind in which people act on the basis of their beliefs, even when the beliefs are false. This surprising and compelling demonstration of 3-year-olds' belief system, and its relatively rapid change over the next year or two, became the basic paradigm for *theory-of-mind* research. One could say that the 3-year-old and the older child have different theories of mind—different underlying principles about mental states and their connections to behavior and the physical world. The first excerpt at the start of this chapter describes another popular assessment of understanding of false beliefs. Theory of mind, a main topic within the theory theory, is one of the most active research areas in developmental psychology today (Wellman, 2014).

The theory theory proposes that children, and perhaps even infants, have the capacity to construct intuitive, folk, everyday, naïve "theories" that attempt to explain a particular domain. For example, children have theories of biology, physics, and mind. Evidence of these domains being somewhat independent includes a child's uneven knowledge across these domains as well as cognitive deficits specific to one domain in children with disorders believed to be biologically based. An example is the poor understanding of certain aspects of mind in children with autism-spectrum disorders. These theories are called "foundational" in that they address particularly important aspects of daily life, such as the properties of physical objects, and are influential for shaping and constraining other concepts during development.

According to the theory theory, children's thinking progresses much as does scientific discovery and hypothesis testing. Children are little scientists who test their theories. Children are born with a tendency to form naïve, or folk, theories, which help them make sense of the world. Such a theory is an organized representation about a particular domain. These theories entail unobservable causal relationships that underlie observable phenomena. A simple example, from theory of mind, is the knowledge that desires lead to intentions; a child might understand that another child *wants* to find her new game and thus *intends* to look for it. Or, in the cupboard example, 4- and 5-year-olds think that beliefs lead to the behavior of looking for an object in a particular place, even when the belief is false. The claim is that young children and perhaps even infants construct causal theories of mind rather than isolated pieces of knowledge about mind. These theories are somewhat abstract, coherent, and internally consistent, much like Piaget's cognitive structures but on a much smaller scale. Children use these causal-explanatory theories to interpret the world, predict future events, and explain previous events.

Although children test their theories, theories are somewhat resistant to change. Children initially tend to try to ignore disconfirming evidence or perhaps patch up the theory. An implication for education is that children (and even adults) resist giving up their theories, for example, their belief that the world is flat, based on their everyday experience, even when teachers provide evidence that the world is round. Getting children to give up an old theory is as important as providing them with a new theory. The following is an example of a child's resistance when told that flowers turn toward the sun, which contradicted the child's current belief (Opfer & Siegler, 2004, p. 325):

> Child: But they can't turn theirselves! . . . Remember, they can't turn theirselves?
>
> Experimenter: But they can.
>
> C: [shrugs]

E: Why would the yellow flowers turn . . . ?
C: They couldn't! They *can't* turn theirselves.
E: Sure they can.
C: [quietly] They can? [more loudly] Not if the wind blows it.
E: Well, there is no wind.
C: Then how can it turn over? Only a person can turn over, like this [moves arm as flowers were depicted as doing]—or, the wind can blow it over [moves arm to illustrate wind blowing flowers to face the sun].

As counterevidence continues to build, children adjust their theories. Consider a 9-month-old baby who has a simple theory of action (Gopnik & Meltzoff, 1997). He believes that he can influence people's actions by communication (e.g., screeching loudly at a restaurant) and can influence objects' actions by making physical contact with them. This theory about the role of force on physical objects works fairly well much of the time in a 9-month-old's world. However, counterevidence arises when he tries to put a block into a bottle with a narrow neck. He repeatedly but unsuccessfully tries to force it into the bottle but eventually must reconsider his theory, and by 18 months he has a new and better theory that acknowledges that brute force does not always work with physical objects. The new theory in turn has a new set of interpretations, predictions, and explanations that he will test.

The new theory may be a revision of the old theory, as in the above example of physical force. Or the new theory may be quite different from, and incompatible with, the old theory. An example of a new theory is the change from a flat-world to a round-world theory. This radical theory change constitutes a cognitive revolution, similar to the scientific revolution in changing from Newtonian to Einsteinian physics in the history of science.

Experience (evidence and counterevidence) contributes to the specific theory children construct. Consequently, they have different theories for different domains, and a child's theories may evolve at different rates in different domains. Not only would a 6-year-old's theory of biology be very different from her theory of mind, but also one theory could be more advanced than the other.

Many sorts of evidence support the claim that children develop a theory of mind. Infants seem to have some inkling of mental states such as people's intentions; then, during the preschool years, children move from a focus on desires to a focus on true and false beliefs. That is, young preschoolers predict and explain others' behavior in terms of people's desires—what people *want* to do—and older preschoolers also consider what people *believe* about reality. As an example of the latter, 4- and 5-year-olds understand that John looked around the neighborhood for his puppy because he *thought* it had gotten lost and he *wanted* to find it, even though it actually was asleep under the bed. Another theory-of-mind ability is knowing that people can have mental states that differ from their behavior, as when someone is sad but smiles so that others cannot detect the sadness.

Regarding a theory of physics, recent demonstrations of young infants' considerable knowledge about properties of objects, such as their permanence and continuity, and correlations between objects' sights and sounds were described in the chapters on Piaget's and Gibson's theories. Also, the information-processing chapter reported adults' and children's adherence to their theory that objects fall straight down even though they saw evidence to the contrary when watching an object dropped from a moving toy train. An example of young children's changing theory of biology is their awareness of some, but not all, properties that distinguish living from nonliving entities (as in the above flower example). They are puzzled by plants, for example, because plants grow, like animals, but have only passive movement, unlike animals. Other evidence is that young children seem to have some notion of the "essence" of an animal, because they can ignore physical similarity or dissimilarity and detect underlying essences. For example, they consider a realistic-looking mechanical monkey to be more like a hammer than like a real monkey (Carey, 1985). However, some essences are harder for young children to maintain. This was demonstrated when children were told a story about a scientist who operated on a horse to make it look like a zebra (Keil, 1989). The scientist added stripes to the horse, cut off its mane, taught it to live in Africa, and so on. Is it still a horse? Young children had trouble continuing to think of it as a horse, but older children did not.

Some developmentalists question whether infants and young children have knowledge that is abstract, coherent, and consistent enough to be called a "theory." Preschoolers' understanding of mind, for example, may involve a more concrete and limited body of knowledge acquired from interaction with family and peers and from their knowledge of their own desires and intentions. In response, theory-theory theorists have identified the defining qualities of a theory theory (Wellman & Gelman, 1998): First, the theory theory proposes that children divide the world into fundamentally different sorts of "things"—for example, thoughts versus solid physical objects. Second, children understand that each domain involves fundamentally different sorts of causes—for example, in the physical domain, one object collides with another object, causing it to move, but desires and intentions cause human behavior. Third, children refer to distinctive underlying constructs in their understandings—for example, the mind consists of mental representations, but solid objects are composed of physical substances. Fourth, concepts form a larger system. Desires are connected to intentions to perform certain actions, as when a desire for candy leads to the intention of obtaining some, which leads to a trip to the store. In other words, if children have a theory, they should honor distinctions among domains as to the sort of entities they are and use distinctive causal principles when reasoning about various domains. They also should construct theories such that each domain is represented by a distinct set of unobservable and interconnected causal notions. The debate between theory theory and other approaches continues today.

It is clear that the theory theory looks somewhat Piagetian in its claims that knowledge is organized, that children construct new knowledge, that current knowledge constrains what sort of change can occur, and that a period of instability accompanies change. However, the approach differs from Piaget's in that it tends to consider each theory to be domain specific and relatively separate from the others. Also, theories appear much earlier than Piaget thought, and most theory change is more modest than the dramatic changes from one Piagetian stage to another.

Recent theory-of-mind research has focused on several issues: Is infants' apparent understanding of others' mental states (e.g., predicting a person's intention, knowing what a parent is looking at or pointing to) actually a theory? How does it differ from the later, more advanced understanding of intentionality? What factors contribute to theory-of-mind development? Executive function and parents' input have been of particular interest. Do children in all cultures follow the same developmental sequence of acquiring various aspects of theory of mind? There seem to be both similarities and differences. How does theory of mind develop further after the preschool years? What specific aspects of theory of mind are compromised in children with autism-spectrum disorders? What brain networks support theory-of-mind understanding? For example, the brain regions activated when children and adults think about other people's thoughts becomes more specific to people's mental states rather than their appearance or social relationships, with increasing age (Gweon, Dodell-Feder, Bedny, & Saxe, 2012). How is theory of mind related to social interactions (Brink, Lane, & Wellman, 2015)?

How is theory of mind related to other areas of social cognition, such as obligations, norms, and morality?

A recent theoretical advance is to integrate theory theory with the Bayesian models of statistical learning described in the information-processing chapter (Gopnik & Wellman, 2012). Specifically, a main learning mechanism for changing one's theory of mind may be to infer causal structure by drawing on statistical information about regularities in social behavior. During development, children sometimes adjust the probabilities of several possible hypotheses rather than reject one and move to the next one.

Some developmentalists think that the theory theory does not provide a satisfactory explanation of young infants' precocious understanding of the world. They think that it is necessary to assign a significant innate component to explain such abilities. We now turn to this account.

Core Knowledge ▶ *Core knowledge* theories (e.g., Spelke, Bernier, & Skerry, 2013) propose domain-specific knowledge, as does the theory theory. However, core knowledge theories posit that humans have evolved a largely innate set of cognitive skeletal principles—a skeletal explanatory system—that facilitates early, rapid learning in certain domains. This small set of systems is the starting state of human cognition. It requires minimal environmental input to be activated and then constrains how knowledge develops as a result of experience. Various theorists suggest somewhat different sets of domains. One influential theory proposes five somewhat separate, but integrated, core knowledge systems (Spelke et al., 2013): objects (and their motions), agents (and their goal-directed actions), number (and their arithmetic operations), places (that one can navigate to in the spatial layout), and geometrical forms. Each system has a different set of principles, for example, cohesion (objects move as connected wholes), contact (objects interact only when they touch), and continuity (objects move on open paths) (Spelke & Kinzler, 2007). Infants use these principles to perceive object boundaries, represent objects out of view, and predict the movements of objects. Thus, the principles guide representation and reasoning in the domains. Learning in these core knowledge areas proceeds much more quickly than learning in other domains because the core principles guide learning. That is, there is an innate push toward certain kinds of information processing, which accounts for surprisingly early knowledge in some domains.

Evidence for this early core knowledge is found in earlier chapters that presented evidence of surprisingly advanced understanding in newborns and young infants. Young infants expect that objects are whole, even when the whole object cannot be seen, and that one solid object cannot pass through another one. They also differentiate arrays with different numbers of objects and expect longer arrays to have more objects (Huang & Spelke, 2015). Early on, infants recognize familiar faces and categorize faces according to sex, age, and race. Infants are predisposed to imitate others, especially others perceived as like them; to share mental states such as attention and information; to infer others' goals; and to evaluate others' helpful or nonhelpful behaviors (Spelke et al., 2013). Moreover, in studies of infants' responses to animated stimuli, infants seem to expect that members of a social group will act in similar ways—engage in similar actions and make similar choices (Powell & Spelke, 2013). This inference is specific to social stimuli; they do not show these expectations when the same cues are depicted with inanimate figures. Thus, there is an early, rudimentary, domain-specific understanding of social relationships. Infants also differentiate human patterns of movement (a pattern of moving lights indicating a person running) from random motion. Regarding the geometry core system, 2-year-olds can use abstract two-dimensional maps to locate objects in three-dimensional layouts, drawing on both distance and angle information (Winkler-Rhoades, Carey, & Spelke, 2013). As an example of core biological knowledge, 8-month-old infants expect animals to have insides (Setoh, Wu, Baillargeon, & Gelman, 2013). They consider it a violation when a self-propelled, agentive object turns out to be hollow. These five core systems have been found in other cultures and nonhuman primates as well, thus suggesting an evolved conceptual system (Spelke et al., 2013). They exist even in people with little or no formal education and with primitive symbol systems.

These core knowledge systems serve as the foundation for the development of later, more abstract and flexible understanding about these domains. An example is early intuitive preverbal reasoning about approximate numbers and later formal verbal reasoning about numbers (Piazza, 2010). Another example is early use of maps (e.g., distance and angle information) for navigation and later formal understanding of geometry (Huang & Spelke, 2015). Neural networks supporting core knowledge can be considered a "neurocognitive start-up tool" for the eventual transformation of core knowledge, as a result of experience and maturation, into more abstract concepts (Piazza, 2010). The principles of a core knowledge domain guide and constrain this development.

The theory-theory and core-knowledge approaches are similar in their focus on early domain-specific knowledge systems and developmental modifications of these knowledge systems. They differ in that the theory

theory assigns less innate influence, focuses less on infants' apparent precocious knowledge about the physical and social world, and places more importance on theory construction and testing, even during infancy. They both address what constrains human cognitive development, though their answers are different—innate biases (core knowledge) or constructed theories (theory theory).

It should be noted that not all developmentalists who think that children's knowledge is domain specific are theory theorists or core knowledge theorists. An example of other domain-specific approaches is moral domain theory, which focuses on how moral reasoning is distinct from other domains such as reasoning about social conventions (e.g., Helwig & Turiel, 2011). Other examples are certain computational approaches and the neo-Piagetians, especially Kurt Fischer and information-processing approaches focused on knowledge acquisition or problem solving in, for instance, math. In one theory not discussed in this book, Howard Gardner (2011) proposed domain-specific intelligences in several domains, such as linguistic, spatial, logical-mathematical, musical, bodily kinesthetic, intrapersonal (understanding the self), and interpersonal (understanding others). Although some of these forms of intelligence are assessed on IQ tests, some, particularly musical and kinesthetic intelligence, are not. In Gardner's view, professional musicians and dancers, first-rate quarterbacks, plumbers, and car mechanics display high intelligence of nontraditional sorts.

There also are nativist domain-specific approaches other than core knowledge. Modularity approaches argue that the mind consists of a loosely connected set of specialized, encapsulated, innate modules, structures, or constraints shaped by evolution to perform a particular function (Fodor, 1983). Modules are preprogrammed to respond to specific sorts of information, and the number of modules potentially can be large. A module requires little experience in order to be triggered. For example, simply being exposed to language may be sufficient for normal language development; instruction is not necessary. Experience is thought to have little effect other than to provide content that fits into the innate structure; counterevidence cannot overturn the modules. Thus, infant minds in many ways are not that different from adult minds; the modules just have to be expressed.

Finally, although domain-specific approaches characterize much of the theorizing and research today, there also is great interest in identifying specific domain-general mechanisms that contribute to the construction of domain-specific knowledge. Executive functions, especially working memory, are a prime example, as seen in research on the contributions of executive function to the development of theory of mind (Devine & Hughes, 2014). One current goal of theorizing is to integrate domain-specific and domain-general knowledge.

2. How can complex, dynamic change be captured theoretically?

Each theory in this text has added complexity to the picture of development, often by adding another level of analysis or showing the intricate connections among areas of development or among biological and environmental contributions. Moreover, the body in motion in Gibson's theory and embodied cognition (described in Chapter 7) add the notion of a developing child as a body in action. All of this has converged to create great interest in dynamic-systems theory because it captures this complexity, connections, and action, and provides a broad and coherent account of development.

Dynamic-Systems Theory ▸ *Dynamic-systems theory* addresses changes over time in complex, self-organizing, holistic systems. One self-organizing system from an earlier chapter is Piaget's cognitive structures that reorganize themselves in order to maintain equilibrium. Dynamic-systems theory comes from work on complex systems in physics and mathematics, but it fits into models of biology and the organismic tradition in developmental psychology. In dynamic systems' "big-picture" view, one can understand development only by considering "the multiple, mutual, and continuous interaction of all the levels of the developing system, from the molecular to the cultural" and "nested processes that unfold over many time scales from milliseconds to years" (Thelen & Smith, 2006, p. 258). The moving body and the brain are closely connected; thus cognition is embodied. There are two-way interactions among the brain, body, and environment. This inclusiveness makes it the broadest, most encompassing developmental theory and may provide a way to integrate other developmental theories into an overarching developmental theory.

In a dynamic system, a person's behavior depends on all the forces at work in the current moment. The irreducible unit is the organism-in-context. In this way, the approach resembles sociocultural developing-person-in-context approaches and Gibson's theory. A simple example is a person's choice of dinner restaurant, which depends on the interaction of elements such as what kind of food he had for lunch, how hungry he is, what preferences are expressed by his dinner companions, and what kind of restaurants are located nearby. Another simple example, which shows the interdependence of brain, body, and the physical world, is that babies walk quite differently when they are wearing a diaper, especially a bulky cloth diaper, than when they are naked (Cole, Lingeman, & Adolph, 2012). These different forms of walking are due to system-wide changes: A diaper causes spreading of the legs, which makes the infant's gait less mature and leads to more missteps and falls.

A mountain stream serves as a good metaphor for a dynamic system (Thelen & Smith, 2006). At various points down the mountain, the stream is expressed as a fast stream, a small trickle, a waterfall, or a still pool, depending on many factors, such as the rate of flow of the water downstream, the terrain, and weather conditions. Most of the time, this pattern is about the same. After a heavy rain or a drought, however, the configuration of the water changes, though in predictable ways. To understand the current dynamic state of the stream and how it self-organizes, we must consider many time frames, from the ancient geological history of the mountain to the recent rainstorm. We also must consider many levels of "cause," from the terrain of the mountain and gravity to water molecules. The same is true of changes in human dynamic systems. Developing children show patterns, self-organization, and interconnected changes on many levels, ranging from culture to molecules.

To explain a person's behavior, rather than focus on abilities or traits that a person "has," the theory focuses on the assembling or re-creating of a behavior on the spot. That is, a behavior emerges from the pattern of all the variables operating at a particular moment. Any behavior is "softly assembled" in the moment from the interaction of multiple subsystems for the specific task at hand; the behavior is not set in stone and can vary on future occasions or even disappear for a while. For example, it can be difficult to say when an infant "can walk," because walking appears in some situations but not others, and the quality of the walking varies from situation to situation (the diaper example above). Given the overall state of the system in its current setting, a certain behavior comes together.

Dynamic-systems theory asks, "Where do new behaviors come from?" New complex forms or skills emerge from interactions of the parts of a complex system—from the relations among the parts and the self-organizing nature of living organisms. New behaviors can be said to "fall out" of the current status of the system in its present context, just as a new stream falls out of an existing stream after a heavy rain. This concept of emergence of new forms is found in biological systems theories in the development of an embryo from one cell through various more complex organizations or the emergence of a new organ or limb during prenatal development through a predictable set of configurations.

One example of the emergence of a new ability is that babies who do not have the motor skill to perform some desired action try to create a behavior that works. In trying to assemble a new motor behavior on the spot, such as trying to obtain a toy out of reach or walking on a water bed for the first time, infants draw on the motor skills they already have. First they try out several different behaviors in an attempt to find one that works. Then, after seeing which behaviors work, or appear promising, they put together and fine-tune a new behavior, such as pulling on the cloth on which the desired toy rests. Thus, both the nature of the task and the child's current motor skills and motivations determine what develops in a particular situation at a particular time. "Individual speed 'personalities'" (Thelen & Smith, 2006) also play a role, as seen in the second excerpt at the start of this chapter. A more cognitive example of emergence, in older children, is the creation of a new strategy in response to information specifying the task in its physical environment. That is, given children's current strategies and skills, the nature of the task materials, and their goals, they assemble a new strategy. This theoretical account provides a new perspective on strategy variability (described in the information-processing chapter). A child might successfully use a new, good addition strategy on one addition problem but drop it moments later for an older strategy, if the dynamic situation (i.e., all active current forces) has shifted slightly.

Consider a classic dynamic-systems experiment: As mentioned in the ethology/biology chapter, newborns have a stepping reflex. They appear to walk, much like a toddler does, when supported in an upright position with their feet touching the floor. The fact that this reflex disappears around two months of age traditionally has been interpreted as showing that maturing higher brain functions begin to inhibit lower-level reflex behaviors. However, the dynamic-systems approach suggests another explanation (Thelen, Fisher, & Ridley-Johnson, 1984). The fact that babies older than 2 months continue to show this "walking" pattern when lying on their backs argues against the traditional inhibition explanation. Thelen and her colleagues proposed instead that as babies gain weight over their first few months, their legs become too heavy to lift when they are upright. Their evidence was that these older babies, who apparently had lost the walking reflex on the usual measures, suddenly began showing it again when held in a waist-high tank of water that made their legs less heavy. Thus, an infant's behavior depends both on what the infant can do and the affordances of the immediate setting. If you change one element in the dynamic system, you change the interaction of the parts. Recently, the disappearance of the walking reflex has become a mystery again, because another change in the setting—lifting a baby into the air—causes babies who had lost the walking reflex to once again show the walking pattern (Barbu-Roth et al., 2015). This observation casts doubt on the hypothesis that the weight of the legs is the critical variable.

An important notion in the theory is that of an *attractor state*—a preferred state in which the system tends to reside. Stated differently, it is a child's preferred behavior within the set of possible behaviors of the current state of the system. Although behaviors vary, the organism tends to return to this preferred state of relative stability. A 4-year-old tends to walk in a particular way, at a particular speed, but the form of walking changes somewhat when walking very fast or when walking in water or on a rocking boat or a water bed. An 8-year-old tends to use a particular addition strategy but uses others if the numbers get so large or so small that other strategies work better or a less effortful strategy can be used. In large time frames, even stages such as Piaget's can be considered attractor states with periods of instability between them. Indeed, in dynamic-systems theory, the system organizes and reorganizes over time to form a series of dynamically stable attractor states. This notion of an attractor state is useful for capturing both the consistency and variability of children's behavior. Proposing an attractor state "banishes forever the vocabulary of programs, structures, modules, and schemas and supplants these constructs with concepts of complexity, stability, and change. Stability defines the collective states of the system, assessed by its resistance to change" (Thelen & Smith, 2006, p. 274).

One reason why dynamic-systems theory is attractive is that it makes intriguing predictions about development based on several subtle principles of change. One principle is that a small initial difference or effect can have reverberations that culminate in large, dramatic differences or effects later. This idea is expressed in developmental cascades, discussed in earlier chapters: An early event or development sets in motion a series of far-reaching effects over a number of years. One implication is that a researcher may need to look for causes of a new behavior not only in recent events but also in much earlier events. A related prediction is that a small change causes changes throughout the system. Thus, dynamic-systems researchers might look for effects of instruction on tasks other than the ones on which they trained a child. Another principle is that quantitative change can lead to qualitative change as a skill gradually changes until it passes a critical threshold and then seems to emerge as a qualitatively different skill. For example, infants' muscles gradually become stronger to the point that they can—apparently suddenly—sit without support.

It is clear that dynamic-systems and connectionist approaches have much in common, and in fact have been combined fruitfully (Samuelson, Jenkins, & Spencer, 2015). They both emphasize the importance of what is in the initial state and the entire matrix of connections, and show how small initial differences in that initial state result in large changes later. Both also see gradual quantitative change eventually causing a system-wide change and the emergence of a new, qualitatively different new behavior. The brain, on which connectionism is modeled, is a dynamic system in which a change in one part impacts the whole brain system, and there is continual interaction during development among genes, brain, cognition, behavior, and environment.

Given the above principles, it is obvious that methods for studying dynamic systems must examine moment-to-moment changes over time. This characteristic is shared with information-processing approaches. Microgenetic methods (Chapters 4 and 7) and longitudinal designs are the best methods for looking at change. By looking at behavior over a period of time, researchers can identify the preferred state. They also can identify the point of most rapid and significant change when the system is self-organizing to a new developmental level. At this unstable point, a system reveals itself, especially its processes of change. One technique for measuring the dynamic pattern of locomotion and its change is to dress babies in black bodysuits with reflective markers (like baby bikers) at their joints. As the babies learn to move across a surface by creeping, crawling, or scooting, a computer reads the reflections to determine the speed, direction, and pattern of the movements over time (Freedland & Bertenthal,1994). By looking at how each behavior flows from previous behaviors and from the current environment, such as the surface on which the baby crawls, it is possible to hypothesize what variables (for example, body weight, body proportion, perceptual ability) are controlling behavior. Finally, the experimenter tests this hypothesis experimentally; an example is the earlier experiment in which babies walked in water.

Another attraction of the dynamic-systems approach is its inclusion of many aspects of development and many levels of analysis. In principle, one could study any sort of content from a dynamic-systems perspective, a characteristic that distinguishes it from most of the other theories in this book. The approach shares with Piagetian theory a desire to describe the overall organization of behavior and dynamic equilibration. Most of the theories in this book tend to break complex systems into simpler, cause-and-effect relations, thereby limiting their scope. However, the inclusiveness of dynamic-systems theory makes it difficult to conduct research from this perspective. It is difficult to identify and examine all potential causes of a behavior and their complex interactions.

The main topic studied thus far is infants' motor behaviors, such as walking, reaching, and searching for hidden objects, because such behaviors are easily observed and measured. However, the approach also has been applied to more cognitive topics, such as object permanence, naming hierarchical categories, and inferring intent (Samuelson et al., 2015), and to social development topics such as play (Steenbeek & van Geert, 2008), emotion regulation (Lewis & Cook, 2007), personality development (Nowak, Vallacher, & Zochowski, 2005), interpersonal communication (Fogel & Garvey, 2007), and even social deviance (Caprara, Dodge, Pastorelli, & Zelli, 2007). For example, the Caprara et al. study showed that a behavior that initially is only slightly deviant from the norm can cascade over time into serious aggression. A number of variables in the system (child variables, social environmental variables) determine both whether the initial slight deviance does escalate and whether the serious aggression can be brought back to its attractor state. Dynamic systems theory has even been applied to worldwide problems such as violence, poverty, and family crises (Fogel, King, & Shanker, 2008), and extensions to other topics appear regularly.

Dynamic-systems theory is one version of a larger metatheoretical approach called *relational-developmental-systems theory* (Overton & Molenaar, 2015). This larger approach includes the characteristics of dynamic-systems theory, but in particular it breaks down dichotomies in favor of a holistic synthesis of, for example, nature and nurture, and qualitative and quantitative changes, and an understanding of their relations. The approach also focuses on the relations (two-way influence) between individuals and their contexts. The individual and context are fused within the entire relational-developmental system. These relations change throughout a person's lifespan and are embedded in a particular time and place in history. The approach is aligned closely with contextualism (discussed in Chapter 4), embodied cognition (discussed in Chapter 7), and optimal lifespan development.

These first two contemporary themes—breadth of change and dynamic change—are the focus of several identifiable theories, as described above.

In contrast, the last two themes have no current overarching theory. Rather, the themes characterize the focus of numerous lines of research from which major theories may eventually evolve.

3. How can theories best depict long-term development?

Developmental research now has identified, and provided information about, so many influences on development that it now is possible to look at the effects of multiple causes of development over childhood or even longer stretches of the lifespan. The increased availability of huge sets of data, including longitudinal data, with hundreds or thousands of individuals provides opportunities to look at many variables. Moreover, advances in the power of computers for calculations and in statistical models of causal relations among variables over time have made it possible to develop predictive models of complex, long-term development. For example, statistical models can identify the direction of causes, including two-way interactions. They also can detect moderating variables, such as effective parenting, that can serve as a buffer to dampen the effects of child risk factors, such as premature birth or a difficult temperament. In addition, these models can test for mediating variables, such that variable *A* does not affect a child outcome directly but does have an effect through variable *B*. For example, a difficult temperament may elicit angry, ineffective parental reactions, which increase the child's aggression. Temperament does not cause aggression directly but has an effect through parenting variables.

To provide a sense of work that examines long-term changes, developmental cascades, and diverse developmental pathways, we turn to work by Nancy Eisenberg and her colleagues. One study was multimethod, multi-informant, large ($N = 474$) and longitudinal—ages 5–10 at time one, 11–17 at time two, and 12–18 at time three (Wang, Chassin, Eisenberg, & Spinrad, 2015). An aspect of temperament—low effortful control (poor self-regulation)—predicted high aggression later. Having both low effortful control and low impulsivity predicted more depression later or co-occurring aggression and depression. The effect of effortful control on later aggression or co-occurring aggression and depression varied, depending on the child's age and degree of impulsivity. For instance, for older adolescents, lower effortful control predicted more symptoms only for children with average or high impulsivity. This study illustrates the use of statistical models that capture the complex relations among multiple variables, the detection of multiple pathways to depression versus aggression or depression plus aggression, and the identification of age and impulsivity as moderators of the relation between effortful control and later problems. In other words, children who start out at risk because of poor effortful control likely will follow different developmental pathways, depending on their impulsivity. The study also was typical in that it was not generated by a broad, salient theory, though it was related to a theory specific to the effects of temperament. Complex, predictive models such as this one are clarifying the developmental processes involved in both typical and atypical development.

4. How can theories best depict universal and diverse aspects of development?

The chapter on Vygotsky and sociocultural approaches stated that work from these approaches broadened developmental psychology by stimulating theoretical and empirical work on cultural differences between countries and within a country, as well as on cultural processes involved in all aspects of development. A main thrust of current research is to continue this work on diversity and integrate it with what aspects of development seem to be universal. No overarching theory of culture or diversity predominates, but the research has a common purpose—to develop theories of human development based on multiple races, ethnicities, social classes, genders, and other differences. Of particular interest is how these factors might lead to different developmental pathways. Numerous studies in the Vygotsky/sociocultural chapter provide examples of this large enterprise.

Position on Developmental Issues

Regarding worldview, the theory theory and, especially, the dynamic-systems approaches are organismic because they emphasize self-organizing systems. Both approaches include both quantitative and qualitative change and emphasize interactions between nature and nurture. In contrast, core knowledge theory emphasizes the innate origins of thinking. In many ways, dynamic-systems theory breaks down the dichotomies of nature–nurture and qualitative–quantitative because all of these work together to bring about change. Finally, the "what" of development includes new theories, the modification of skeletal core knowledge, and new attractor states (such as new knowledge or abilities). More than any other theory in this book, dynamic-systems theory focuses on change, on processes of development.

SUMMARY

Developmental theories develop. Four themes guide current development work: How general are developmental changes? How can complex, dynamic change be captured theoretically? How can theories best depict long-term development? How can theories best depict universal and diverse aspects of development? Regarding the first theme, theory theory and core knowledge theories propose that children develop coherent, causal-explanatory, domain-specific concepts and that development involves changes in these concepts in light of feedback from testing these theories. Core knowledge theories posit innate skeletal knowledge in several domains; this core knowledge constrains and guides further conceptual development. Regarding the second theme, dynamic-systems theory is a broad theory that tries to encompass all relevant factors operating at a particular developmental moment. This theory focuses on change and on two-way interactions within and between multiple levels and on the emergence of new knowledge and skills as children construct behaviors on the spot.

SUGGESTED READINGS

Spelke, E. S., Bernier, E. P., & Skerry, A. E. (2013). Core social cognition. In M. R. Banaji & S. A. Gelman (Eds.), *Navigating the social world: What infants, children, and other species can teach us* (pp. 11–16). New York: Oxford University Press.

Spencer, J. P., Perone, S., & Buss, A. T. (2011). Twenty years and going strong: A dynamic systems revolution in motor and cognitive development. *Child Development Perspectives, 5*(4), 260–266.

Wellman, H. W. (2014). *Making minds: How theory of mind develops*. New York: Oxford University Press.

CHAPTER 10

Reflections

> *The beginnings and endings of all human undertakings are untidy, the building of a house, the writing of a novel, the demolition of a bridge, and, eminently, the finish of a voyage.*
>
> —*John Galsworthy*

Sergey Nivens/Shutterstock

Although it is tempting to tidy up the assortment of theories presented here by offering an orderly set of conclusions, that aim is not realistic. Developmental psychology is a huge, multifaceted discipline that has produced a diverse group of theories. Some theories are bold and speculative, while others are cautious and precise; some are large scale and rambling, while others are modest and systematic. Furthermore, they ask different questions about development. Consequently, they address different levels of reality, ranging from a gene to an action to a child-in-social context. Any attempt to integrate all the theories would be foolish at best and misleading at worst.

This chapter, then, offers several "untidy" thoughts that linger after this survey of theories. The first section summarizes the theories' positions on the four developmental issues that were raised in each chapter. In the second section, we revisit the issue of mechanisms of development, discussed in each chapter. In the third section, we view the history of developmental theory from two points of view. In the final section, critical psychology provides another perspective on developmental theorizing.

Developmental Issues Revisited

Human Nature

The distinctions among organismic, mechanistic, and contextualist worldviews served as a useful heuristic for understanding and comparing developmental theories, though some theories do not fall neatly into one category. The organismic worldview depicts children as active agents who engage with their social and nonsocial environments and contribute to their own development. Most contemporary versions of the theories have at least some element of this. Children actively assimilate, accommodate, and equilibrate (Piaget); strengthen ego processes (Freud); construct a sense of identity (Erikson); and acquire cultural tools that help them co-construct knowledge and skills with other people (Vygotsky/sociocultural). In addition, children actively develop self-regulatory mechanisms and seek out particular environments (social learning); develop a set of strategies, rules, and procedures for problem solving (information processing); and search and actively adapt to their environment (ethology/evolution). Children also explore environments for their affordances (Gibson), construct and test out intuitive theories (theory theory), use their core knowledge to construct more abstract understanding, and self-organize to produce new behaviors (dynamic systems). Active self-regulation, in particular, is important for social learning theory, Vygotsky, Piaget, Bowlby, information processing (executive control processes), and dynamic systems. Some of the theories also include passive, mechanistic biological- or environmental-based processes. Examples include the push from biological drives (Freud, Erikson, ethology), the expression of innate core knowledge systems (core knowledge), the registering of co-occurring events (some versions of connectionism and neuroscience), reinforcement contingencies (learning theory), and reflexes and the response to sign stimuli (ethology).

Mechanistic and organismic approaches also differ in their focus on antecedent causes of behaviors or inherent causes within a whole structure. Antecedent mechanistic causes are involved in stimulus–response associations (learning theory), fixed action patterns (ethology), and input–output procedures (information processing). Inherent causes are illustrated by cognitive structures with a tendency toward equilibration (Piaget); theories (theory theory); the organization of the id, ego, and superego (Freud); a pattern of distributed activation (some connectionist self-regulating models); intrinsic motivation (Gibson); control systems of behavior (Bowlby's ethological theory); dialectical systems (sociocultural); and the self-organizing tendencies of a system (dynamic systems).

Overall, Piagetian and dynamic-systems theories are the most clearly organismic theories, whereas traditional learning theory is the most clearly mechanistic. Later, social learning theories, especially Bandura's, added some organismic, self-regulatory features to learning theory.

Finally, the contextual worldview is most clearly seen in Vygotskian-sociocultural theories and dynamic systems theory and least seen in social learning theory and information processing. However, almost every contemporary theory is at least beginning to conceptualize the ways in which developing children are embedded in contexts.

In addition to differences in the theories' worldviews, there are striking differences in the theories' overall views of humans as developing into rational, efficient "scientists" or into socioemotional cognitive beings that develop intuitive concepts and "hot" cognition (emotion-laden cognition) and seek the meaning of events in their lives. Piagetian, information-processing, and, for the most part, core knowledge and theory-theory theorists have emphasized the rational; Freud and Erikson emphasized how motives and needs affect thinking. The other theories are more neutral on this issue or have addressed both kinds of thinking. For example, in social learning theory and cultural approaches, the models that children observe may demonstrate either logical or irrational thinking. Genetics and neuroscience approaches can focus on either rational or emotional thoughts and behaviors. Ethologists, evolutionary psychologists, Gibsonians, and core knowledge theorists emphasize the adaptation required for survival or optimal functioning in the particular environment. Rational, scientific thought is most adaptive for some settings, whereas sensitivity to interpersonal relationships and emotions may be more adaptive in other settings.

Our theorists' views of human nature are not a trivial matter because they influence their theorizing. As the biographies of the theorists illustrated, theorists' worldviews are influenced by their backgrounds and cultures. This is not necessarily a negative because it has led to new theories that offer novel perspectives on development. Examples are Piaget's biological background (adaptation of organisms), Freud's medical background (sexual drives and psychopathology), and Vygotsky's political–historical context (improving minds through activity, work, and cultural tools).

Qualitative Versus Quantitative Development

The contemporary view is that dichotomies, such as qualitative versus quantitative and nature versus nurture, are obsolete ways of thinking. Both of these involve intertwined processes that cannot be separated in a developing organism. Still, thinking of the theories' emphases on qualitative or quantitative change as falling along a dimension is a useful way to compare and contrast them. All the theorists see a number of ways in which development increases quantitatively—in amount, frequency, or degree. With increasing age, children strengthen and generalize their cognitive skills (Piaget), increase their ego strength (Freud and Erikson), and develop their skills gradually as they move through the zone of proximal development (Vygotsky). They also imitate more accurately (social learning theory), process information more efficiently (information processing), and increase or decrease the strength of certain neural pathways and develop more specialized brain regions (neuroscience and connectionism). In addition, children detect more affordances (Gibson), refine their theories (theory theory), and use core knowledge to develop abstract concepts (core knowledge).

Although all the theories posit at least minor qualitative change, only dynamic systems and the stage theorists—Piaget, Freud, and Erikson—make qualitative change a central part of their theories. In the other theories, the most common qualitative change is a smaller-scale change, such as a new strategy of learning or problem solving (information processing) or theory change within a particular domain (theory theory). Dynamic-systems and connectionist approaches address how quantitative change, once it crosses a certain threshold, can lead to a qualitative reorganization of a whole system. A major current question is how best to conceptualize the relations between qualitative and quantitative change during development. Thus, the current focus is on process rather than dichotomies.

Nature Versus Nurture

All the theorists agree that development emerges from a complex configuration of innate and experiential influences. However, they vary in what they choose to study. Ethology, evolutionary psychology, neuroscience, genetics, and core knowledge approaches have focused research on nature. Still, their research findings often show the effects of nurture—in attachment, changes in brain organization as a result of experience, epigenetics, and the learning guided by core knowledge systems. Social learning and Vygotskian-sociocultural theories most clearly emphasize nurture, though they acknowledge the contributions of nature. Piagetian, Eriksonian, and theory-theory approaches most clearly are interactionist. Piaget, for example, depicted development as an interaction of two innate factors (physical maturation and equilibration) and two types of experience (social and physical). Erikson also stressed both biological and social changes, showing that as drives change, they mesh (or conflict) with social institutions. Some of the other theories do not focus on this issue but imply interactionism. In information processing, for example, brain development obviously increases the potential efficiency of the information-processing system, and problem-solving experience leads children to adopt new strategies when they receive feedback during attempts at problem solving. Gibson's theory posits the evolution of perceptual learning abilities that permit adaptation to the environment. Connectionist models vary in how much starting-state architecture the modeler includes.

What Develops

The diverse answers to "What develops?" suggest that development can be understood only by looking at various levels of analysis, from cells to society. What develops is how each level is organized within itself and how each level interacts with each other level. An organism, with its genetic, physiological, psychological, and behavioral aspects, is part of a system that includes the environment, with its physical, interpersonal, and cultural aspects. Each level of analysis contributes to our understanding of behavior and has its own set of principles. Behavior can never be reduced to any single level, such as the neurological, and no level is more important than the others. Only a theory with multiple levels of analysis is likely to describe the complex interweaving of innate and environmental forces during development. No theory has accomplished this, though dynamic systems theory has at least offered a general outline of what such a theory might involve.

Some theories aim for a very broad account of development, whereas others focus more narrowly. The stage and dynamic-systems theorists look at stage- or state-defining characteristics and therefore operate at a very general level. In their view, the most important developments are cognitive structures (Piaget), personality structures (Freud and Erikson), or continually self-organizing systems (dynamic systems). Other theorists focus on more specific acquisitions, often limited to certain situations or types of stimulation: rules (information processing and social learning theory), the perception of affordances (Gibson), adaptive behaviors (ethology), intuitive theories (theory theory), and culturally constructed skills (sociocultural). With respect to content, the theories range from stressing social behaviors and personality (Freud, Erikson, social learning theory) to thinking (Piaget, information processing, Vygotsky, theory theory, core knowledge) to perception (Gibson). The sociocultural, dynamic-systems, ethological, genetic, and neuroscience approaches study a variety of behaviors.

Moving Toward Mechanisms of Development

The introductory chapter stated that a developmental theory must *describe* development within one domain and the relationship among simultaneously developing domains and that it must *explain* the course of development that has been described. Then a section of each chapter examined that theory's contributions to our understanding of what moves development along. Among the mechanisms offered were assimilation, accommodation, and the equilibration process (Piaget); biological drives, identification, and ego strengthening (Freud); internalization and dialectical processes (Vygotsky); biological maturation and fixed-action patterns (ethology); gene expression (genetics); brain maturation and experience, reorganization of neural networks, and strengthening and weakening neural pathways (neuroscience); and observational learning (social learning theory). Other mechanisms are automatization, increased working memory, and acquisition of strategies (information processing); changing weights of a distributed pattern of activation (connectionism); statistical learning (Bayesian theory); perceptual learning (Gibson); theory change (theory theory); and self-organization and regulation (dynamic systems; some connectionist models).

A common weakness of developmental theories is that they lack an adequate account of specific mechanisms of development. For example, Piaget, Freud, and Erikson have given us a rich description of development, but their mechanisms of development—equilibration and the invariant functions for Piaget, drives for the psychoanalysts—are vague. We cannot easily observe and study these mechanisms. In contrast, social learning, information processing, ethological, Gibsonian, sociocultural theories, and dynamic-systems theories emphasize processes of change but are weaker at describing what develops. Even these process theories, however, could be improved with more specificity. What we need are precise accounts of moment-to-moment, real-time activities. The field has made some progress in this regard in recent years. The microgenetic method is a step in the right direction. Connectionist, Bayesian, and statistical learning approaches, in particular, are providing precise models of change, including the mechanisms involved. The models depicting two-way connections among genes, brain, and behavior (and maybe contexts), described in Chapter 5, are promising as well. The challenge will be to integrate all of these mechanisms into a larger dynamic system. The next decade likely will be an exciting time for theorists focused on mechanisms of change.

One task for any proposed mechanism of development is to tie together different versions of a similar skill across the lifespan. For example, mechanisms move an infant's understanding that a person is intentionally reaching for an object to a preschooler's fuller understanding of intentions to an adult's mature understanding. Another task is to address the two roles of developmental mechanisms. The first role is to facilitate the acquisition of new skills. Many dynamic systems and connectionist models are focused on explaining how a new skill emerges. The second role of processes is to make these skills readily accessible for daily use. Research suggests that much of development involves children's learning to *use* the skills they have already acquired. Children can think in words long before they spontaneously verbally rehearse a list of items to be remembered. Young children have a rudimentary understanding of number but are easily diverted from using this understanding by distracting stimuli or a large amount of information to process. Adolescents use formal operations in some content areas but not others. Information processing approaches have identified attention, working memory, and retrieval as particularly important for accessing knowledge and skills.

Historical Progress of Developmental Theories

It often seems to me that's all detective work is, wiping out your false starts and beginning again. Yes, it is very true, that. And it is just what some people will not do. They conceive a certain theory, and everything has to fit into that theory. If one little fact will not fit it, they throw it aside. But it is always the facts that will not fit in that are significant.

—*Agatha Christie,* Death on the Nile

A succession of developmental theories has waxed and waned in influence. Are we left with a sense of scientific progress? Has each successive theory been better than the one before it? The traditional view of scientific progress, also the commonsense view, sees the history of a discipline as a cumulative enterprise. Each new discovery or theory builds on previous work and is a refinement of it in the search for truth. Each theory stands until empirical observations cast doubt on its validity.

Clearly, there is continuity and a sense of theory development between Freud and Erikson within the psychoanalytic tradition or between classical learning theory and social learning theory within learning theory. Over a longer period of time, however, the historical progression of theories in this volume does not seem to follow this pattern. One is struck more with discontinuity than with continuity in moving from Freud to learning theory to Piaget to information processing to dynamic systems. Each theory challenged a previous one and proposed an attractive alternative conception of development more than it refined the earlier theory. Often a new theory is accepted because it corrects the excesses of an established theory, as when developmentalists were attracted to sociocultural approaches because they address the social context of thinking, which is relatively ignored by information processing approaches. Similarly, the theory-theory and core knowledge approaches offer a plausible account for the counterevidence regarding Piaget's theory, specifically, early competencies and domain-specific knowledge. A switch of allegiance occurs despite the fact that newer theories are less well worked out than the abandoned theories. The history of developmental psychology suggests that when a theory cannot be modified satisfactorily, the stage is set for change. A discipline seems to have a particular need at some point in history and embraces a new theory that promises a more satisfactory view of that discipline.

Such discontinuities from one theory to another become understandable if one looks at Thomas Kuhn's (1970) account of the growth of scientific knowledge. Kuhn provided an alternative to the traditional account of each theory building on previous ones in a linear fashion. Instead, he saw successive theories as supplanting previous theories. He posited the following historical sequence within any scientific discipline: First is a "preparadigmatic phase," in which no one theory or generally agreed-upon way of studying the discipline's subject matter has emerged. There is debate over fundamental issues within the discipline. Next comes a period of "normal science," in which one paradigm dominates the field or at least an important subarea of the field. A *paradigm* is a generally accepted set of assumptions as to what should be studied, what questions should be asked, how these questions can be studied, and how the results should be conceptualized. For example, the information processing approach emerged from a general agreement among developmental psychologists to study the flow of information through a processing system that resembles the operations of a computer and, furthermore, to ask how that information is stored, not how it is strengthened as a result of reinforcement. An investigator using this paradigm therefore is likely to measure reaction time, types of errors, or number of items correct but probably will not ask about reinforcement schedules. Thus, a paradigm serves as a working model of how to do science.

A paradigm is both an intellectual framework and a sociological phenomenon. Examples of this intellectual framework are the organismic, mechanistic, and contextualist worldviews. One holding a mechanistic worldview, for instance, would be more likely to develop a theory that posits external mechanical rather than internal cognitive causes of behavior. Also, the general-orientation section of each chapter in this book roughly defines the paradigmatic characteristics of each theory. With respect to the sociological aspect of paradigms, Kuhn pointed to a "community" of scholars who share certain assumptions or ground rules. The scholars can make rapid progress during the period of normal science because, instead of questioning the assumptions of the approach, they can concentrate their efforts on gathering data and solving problems identified by the paradigm. It is a time for "mopping-up operations" (Kuhn, 1970) to tidy up the paradigm. Scientists maintain the paradigm by training students to carry on the tradition. The students absorb the conventions for solving problems in the field and thereby "step into the circle" of that paradigm. An old paradigm never dies immediately; it just fades away as students trained in the new paradigm enter the field and believers in the old paradigm are ignored and left behind.

The change from one paradigm to another follows a typical pattern. At some point, a crisis arises. Phenomena may be discovered that cannot be explained by the current paradigm and consequently cause a crisis of confidence in the paradigm. Examples from developmental psychology might be the failure of learning theory to explain language development, young children's belief in nonconservation, and incorrect answers on theory-of-mind tasks (specifically, not understanding false beliefs). If a more promising alternative paradigm appears on the scene, it may win the allegiance of the field and begin its own phase of normal science. Thus, after a first paradigm emerges in a discipline, there is a continual back-and-forth movement between normal science (a time of stability) and scientific revolution (a time of change). The history of a science is cyclic more than continuous, according to Kuhn.

Obvious examples of scientific revolutions are Darwinian theory, Einstein's theory of relativity, and the Copernican revolution, which brought the view that the sun rather than earth is the center of the universe. Each of these paradigms brought a gestalt-like shift in the way scientists looked at facts.

It is interesting that whether a new theory, set of findings, or method influences the field and eventually becomes a paradigm depends on many factors that have nothing to do with the work itself. A good case in point is the fact that Binet, the IQ pioneer, conducted experiments on conservation and other concepts of number before Piaget was even born. In fact, Binet published over 200 books and papers on topics such as children's memory and cognitive styles that had nothing to do with IQ testing. Yet this work was, and still is, ignored for various historical and sociological reasons (Siegler, 1992; Wesley, 1989).

Psychologists disagree about the value of Kuhn's model for the social sciences and about where to locate psychology in this history-of-science model. Is psychology in a preparadigmatic phase, or has it entered the cycle of paradigms and scientific revolutions? There has never been a paradigm that was accepted by the entire field of psychology or even developmental psychology. Today, psychologists still question basic issues about development, such as whether newborns have any innate knowledge, for example, skeletal core knowledge systems. However, a paradigm can be restricted to a subarea within the field. From this perspective, there are several candidates for paradigms in developmental psychology. In fact, each of the theories described in this book has won over a group of scholars who have accepted the assumptions and gone about the business of solving problems defined by these assumptions. One example is the Piagetian group in Geneva. A group of investigators accepted Piaget's intellectual framework and proceeded as though they were working out the details of this framework. Piaget's theory never quite reached this status among American researchers in cognitive development. Other paradigmatic communities can be identified for computer-simulation, particularly connectionist, approaches at several U.S. universities, for ethology in Germany, learning in the early 1960s, and dynamic systems and the theory theory in parts of the United States and Europe.

Regardless of whether future generations will look back on today as a time of preparadigmatic or paradigmatic science, Kuhn's view of science as both continuous (during normal science) and discontinuous (during scientific revolution) seems to have some validity in the history of theories of developmental psychology. Both continuity and discontinuity are apparent in information processing, for example. It built on the precision and analytic posture of learning theory but won followers in part because of dissatisfaction within the ranks of learning researchers, rather than simply because it produced a better version of learning theory. An example of attempts to patch up a faltering paradigm can be seen when learning theory posited verbal mediation (associations involving verbal labels), generalized rules, and complex hierarchies of mental associations to try to incorporate some of the alternative explanations offered by cognitive theories. The observable stimuli and responses went underground, and mental *S–R* chains, expectations, concepts, and rules entered the vocabulary of learning theory. However, this did not halt the declining influence of the theory, because emerging cognitive theories provided a more plausible explanation of anomalies that had appeared in learning experiments.

Critical Psychology: Are Theories of Development Gendered?

A final perspective on the various theories in this book comes from *critical psychology* (e.g., Parker, 2015), which critiques mainstream psychology from a variety of perspectives. In general, it shows how the discipline of psychology and the theories it produces are products of the culture in which they arose and, thus, may entail biases. It questions the traditional view that the evaluation of facts is totally objective, that "there is only one established dogma in science—that scientists do not blindly accept established dogma" (Brush, 1976, p. 68). Thus, critical psychology uncovers culture-based assumptions of psychological research and theory regarding the self, behavior, society, and development. The aim is to produce better science and theorizing.

One influential aspect of culture, for example, is its conception of masculine and feminine gender roles. Feminist theories have critiqued and transformed a wide range of disciplines across the sciences and humanities (e.g., Tong, 2013). For example, in the field of history, adding the activities of women to what is studied changed models of history from a focus on wars, generals, and rulers to the inclusion of everyday family and community life, and social reforms. In recent years, developmentalists have drawn on feminist theories to critique, and provide alternative perspectives on, developmental psychology (Burman, 2008a, 2008b; Miller & Scholnick, 2000; Scholnick & Miller, 2007).

Parallel to the change from cross-cultural psychology to cultural psychology described in Chapter 4, work on gender is changing somewhat from the gender-differences approach that has characterized the field of psychology to a gender-psychology, or feminist-psychology, approach. In the latter view, gender is not just another individual difference—an independent variable that causes differences in thinking and behavior. Rather, like culture (and in fact a main aspect of culture), gender pervades all human situations and is an inextricable part of any event. Also, like cultural beliefs, beliefs about gender are so pervasive and deeply ingrained that they are often invisible to people within a culture. Finally, models of behavior and development arising mainly from one culture or gender may not be universal or appropriate for understanding all behaviors.

Developmentalists and feminist scholars ask some of the same questions—about the process of acquiring knowledge, the effects of social institutions on people, the effects of experience on one's perspective, and the construction of social categories (Miller, 2006). There are a number of feminist theories, such as liberal (positivist), socialist, African American/ethnic, essentialist, existentialist, psychoanalytic, radical, postmodern, and postcolonial theories (Rosser & Miller, 2000). Each offers a framework through which to explore various central issues in developmental psychology. However, despite their differences, these feminist theories have certain commonalities. In particular, they focus on the notion of connections rather than separation, distance, and dichotomy (see examples below). That is, development is as much a process of developing relationships with others and developing an understanding of the complex connections in the social and physical world as it is a process of establishing autonomy, mastery, competition, supposed objectivity, and analysis of reality into objects and properties. Moreover, feminist approaches focus on the cultural, institutionalized organization of social relations according to gender, race, class, and ethnicity (and therefore differences in power). There is no universal child; rather there are individual children of a particular race, ethnicity, gender, nationality, and social class who develop in a culture that has beliefs about all these identities that influence children's development. A satisfactory account of development must start with this diversity rather than bring it in after "normal" or "typical" development is addressed.

The following are several examples of attempts, inspired by feminist theories, to provide a broader conception of development (Miller & Scholnick, 2000). Metaphors can have implicit cultural assumptions. Metaphors may depict development as a process of argument (conflict), survival of the fittest (competition), an arrow (directionality to development), and building or, in contrast, from a feminist perspective, a process of friendship (scaffolding), conversation (collaboration), apprenticeship, and narrative (sense making) (Scholnick, 2000). In other words, one could view a developing child as a solitary, distanced, scientific thinker who develops concepts of isolated objects in the world, focuses on mastery of his environment, and competes with others for resources. In contrast, one could view development as analogous to collaboration and the search for meaning.

Another example of uncovering implicit gender biases in research and theorizing is the study of aggression, which can be physical, as it typically has been studied, or relational, as is the case with gossip (Crick & Rose, 2000). Moreover, thinking can be linear, distanced from the object of study, and reductionist, or it can be contextual–relational, situated, reciprocal, dialogical, connected, co-constructed, experientially based, and diverse (Miller, 2000). Developmentalists have raised other issues, such as these: Who has the authority to author an autobiographical memory; whose voice and memory counts? (Fivush, 2000) Does the world as viewed from the margins (in minority, low-power positions) look different from the world as viewed from the center (of power)? How do children's essentialist concepts of gender and developmentalists' essentialist concepts of children impact development and its study? (Gelman & Taylor, 2000) Feminist approaches clearly have close ties to the sociocultural theories within developmental psychology. The inclusion of feminist theories in developmental psychology is part of a larger movement toward a broader, more diverse, multicultural vision of people and their development.

Conclusions

As Beilin commented, "History makes every theory look deficient in some way" (1985, p. 9). Because no one theory satisfactorily explains development, it is critical that developmentalists be able to draw on the content, methods, and theoretical concepts of many theories. Each theory has something important to say; no theory alone is sufficient. A knowledge of the developmental theories in this volume can serve as a heuristic for developmental researchers and professionals working with children. Shifting from theory to theory provides a flexible perspective on children's behavior.

Suggesting the value of using theories flexibly does not mean, however, that there is no place for developmentalists who operate within a single theory. There is value to pushing a single theory to its limits. As Kuhn noted in his discussion of paradigms, sometimes rapid progress is most likely when investigators do not question the assumptions of their field. Finding out where a theory breaks down can be very informative. As the English logician Augustus De Morgan commented, "Wrong hypotheses rightly worked from have produced more useful results than unguided observation." Given the current level of knowledge in developmental psychology, we need both eclectics and true believers.

> "Where shall I begin?" asked the White Rabbit.
>
> "Begin at the beginning," the King said gravely, "and go on till you come to the end: then stop."
>
> —*Lewis Carroll (Alice in Wonderland)*

REFERENCES

Adolph, K. E. (1997). Learning in the development of infant locomotion. *Monographs of the Society for Research in Child Development, 62*(3, Serial No. 251).

Adolph, K. E. (2008). Learning to move. *Current Directions in Psychological Science, 17*, 213–218.

Adolph, K. E., Cole, W. G., Komati, M., Garciaguirre, J. S., Badaly, D., Lingemen, J. M., . . . Sotsky, R. B. (2012). How do you learn to walk? Thousands of steps and dozens of falls per day. *Psychological Science, 23*, 1287–1394.

Adolph, K. E., & Eppler, M. (1999). Obstacles to understanding: An ecological approach to infant problem solving. In E. Winograd, R. Fivush & W. Hirst (Eds.), *Ecological approaches to cognition: Essays in honor of Ulric Neisser.* Mahwah, NJ: Erlbaum.

Adolph, K. E., Karasik, L. B., & Tamis-LeMonda, C. S. (2010). Motor skills. In M. H. Bornstein (Ed.), *Handbook of cross-cultural development science: Vol. 1. Domains of development across cultures.* Hillsdale, NJ: Erlbaum.

Adolph, K. E., & Robinson, S. R. (2015). Motor development. In R. L. Lerner (Series Ed.) & L. Liben & U. Müller (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 2. Cognitive processes* (7th ed.). New York, NY: Wiley.

Adolph, K. E., Robinson, S. R., Young, J. W., & Gill-Alvarez, F. (2008). What is the shape of developmental change? *Psychological Review*, *115*, 527–543.

Adolph, K. E., & Tamis-LeMonda, C. S. (2014). The costs and benefits of development: The transition from crawling to walking. *Child Development Perspectives, 8*(4),187–192.

Ainsworth, M. D., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment*. Hillsdale, NJ: Erlbaum.

Alderson-Day, B., & Fernyhough, C. (2015). Inner speech: Development, cognitive functions, phenomenology, and neurobiology. *Psychological Bulletin,141*(5), 931–965.

Aldridge, M. A., Braga, E. S., Walton, G. E., & Bower, T. G. R. (1999). The intermodel representation of speech in newborns. *Developmental Science, 2*, 42–46.

Alley, D., Chae, Y., Cordon, I., Kalomiris, A., & Goodman, G. S. (2015). Child maltreatment and autobiographical memory development: Emotion regulation and trauma-related psychopathology. In L. A. Watson & D. Bernsten (Eds.), *Clinical perspectives on autobiographical memory*. New York, NY: Cambridge University Press.

Alloway, T. P., Gathercole, S. E., Kirkwood, H., & Elliott, J. (2009). The cognitive and behavioral characteristics of children with low working memory. *Child Development, 80*, 606–621.

American Psychologist. (1981). Albert Bandura: Award for Distinguished Scientific Contributions: 1980. *American Psychologist, 36,* 27–34.

Anderson, J. (1991). Comments on *Foundations of cognitive science*. *Psychological Science, 2,* 283–287.

Arnett, J. J. (2015a). *Emerging adulthood: The winding road from the late teens through the twenties* (2nd ed.). New York, NY: Oxford University Press.

Arnett, J. J. (2015b). The cultural psychology of emerging adulthood. In L. A. Jensen (Ed.), *The Oxford handbook of human development and culture: An interdisciplinary perspective* (pp. 487–501). New York: Oxford University Press.

Arseth, A. K., Kroger, J., Martinussen, M., & Marcia, J. E. (2009). Meta-analytic studies of identity status and the relational issues of attachment and intimacy. *Identity, 9*, 1–32.

Averill, J. R. (1976). Patterns of psychological thought: A general introduction. In J. R. Averill (Ed.), *Patterns of psychological thought*. Washington, DC: Hemisphere.

Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4,* 417–423.

Bahrick, L. E., & Watson, J. S. (1985). Detection of intermodal proprioceptivevisual contingency as a potential basis of self-perception in infancy. *Developmental Psychology, 21*, 963–973.

Bailey, D. H., Siegler, R. S., & Geary, D. C. (2014). Early predictors of middle school fraction knowledge. *Developmental Science, 17*(5), 775–785.

Baillargeon, R. (1987). Object permanence in 3.5- and 4.5-month-old infants. *Developmental Psychology, 23*, 655–664.

Baker, R. K., Pettigrew, T. L., & Poulin-Dubois, D. (2014). Infants' ability to associate motion paths with object kinds. *Infant Behavior & Development, 37*(1), 119–129.

Banaji, M. R., & Gelman, S. A. (Eds.). (2013). *Navigating the social world: What infants, children, and other species can teach us*. New York: Oxford University Press.

Bandura, A. (1965). Influence of model's reinforcement contingencies on the acquisition of imitative responses. *Journal of Personality and Social Psychology, 1,* 589–595.

Bandura, A. (1967). Behavioral psychotherapy. *Scientific American, 216,* 78–86.

Bandura, A. (1977). *Social learning theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1986). *Social foundations of thought and action.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1989). Social cognitive theory. In R. Vasta (Ed.), *Annals of child development* (Vol. 6). Greenwich, CT: JAI Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Bandura, A. (2006a). Toward a psychology of human agency. *Perspectives on Psychological Science, 1*, 164–180.

Bandura, A. (2006b). Going global with social cognitive theory: From prospect to paydirt. In S. I. Donaldson, D. E. Berger, & K. Pezdek (Eds.), *Applied psychology: New frontiers and rewarding careers*. Mahwah, NJ: Erlbaum.

Bandura, A. (2012). Social cognitive theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.). *Handbook of theories of social psychology* (Vol. 1). Thousand Oaks, CA: Sage Publications Ltd.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development*, *72*, 187–206.

Bandura, A., Caprara, G. V., Barbaranelli, C. Regalila, C., & Scabini, E. (2011). Impact of family efficacy beliefs on quality of family functioning and satisfaction with family life. *Applied Psychology: An International Review, 60*(3), 421–448.

Bandura, A., & McDonald, F. J. (1963). The influence of social reinforcement and the behavior of models in shaping children's moral judgments. *Journal of Abnormal and Social Psychology, 67,* 274–281.

Bandura, A., Ross, D., & Ross, S. A. (1961). Transmission of aggression through imitation of aggressive models. *Journal of Abnormal and Social Psychology, 63,* 575–582.

Bandura, A., & Walters, R. H. (1959). *Adolescent aggression.* New York: Ronald Press.

Bandura, A., & Walters, R. H. (1963). *Social learning and personality development.* New York: Holt.

Barbu-Roth, M., Anderson, D. I., Streeter, R. J., Combrouze, M., Park, J., Schultz, B., . . . Provasi, J. (2015). Why does infant stepping disappear and can it be stimulated by optic flow? *Child Development, 86*(2), 441–455.

Barch, D. M., Cohen, R., & Csernansky, J. G. (2014). Altered cognitive development in the siblings of individuals with schizophrenia. *Clinical Psychological Science, 2*(2), 138–151.

Bardi, L., Regolin, L., & Simion, F. (2014). The first time ever I saw your feet: Inversion effect in newborns' sensitivity to biological motion. *Developmental Psychology, 50*, 986–993.

Barr, R., & Hayne, C. (2003). It's not what you know, it's who you know: Older siblings facilitate imitation during infancy. *International Journal of Early Years Education, 11,* 7–21.

Barr, R., Muentener, P., & Amaya, G. (2007). Age-related changes in deferred imitation from television by 6- to 18-month-olds. *Developmental Science, 10*, 910–921.

Basalla, G. (1988). *The evolution of technology*. Cambridge, England: Cambridge University Press.

Bates, E. A., & Elman, J. L. (1992). *Connectionism and the study of change*. (Tech. Rep. No. 9202). La Jolla, CA: University of California, San Diego.

Battaglia, M., Zanoni, A., Taddei, M., Giorda, R., Bertoletti, E., Lampis, V., . . . Tettamanti, M. (2012). Cerebral responses to emotional expressions and the development of social anxiety disorder: A preliminary longitudinal study. *Depression and Anxiety, 29*, 54–61.

Bauer, P. J. (2009). The cognitive neuroscience of the development of memory. In M. L. Courage & N. Cowan (Eds.), *The development of memory in infancy and childhood*. New York: Psychology Press.

Baumrind, D. (1973). The development of instrumental competence through socialization. In A. D. Pick (Ed.), *Minnesota symposia on child psychology* (Vol. 7). Minneapolis, MN: University of Minnesota Press.

Beilin, H. (1971). The training and acquisition of logical operations. In M. F. Rosskopf, L. P. Steffe, & S. Taback (Eds.), *Piagetian cognitive-developmental research and mathematical education.* Washington, DC: National Council of Teachers of Mathematics.

Beilin, H. (1985). Dispensable and core elements in Piaget's research program. *The Genetic Epistemologist, 13,* 1–16.

Beilin, H., & Fireman, G. (2000). The foundation of Piaget's theories: Mental and physical action. In H. Reese (Ed.), *Advances in child development and behavior* (Vol. 27). New York: Academic Press.

Berger, S. E., Adolph, K. E., & Lobo, S. A. (2005). Out of the toolbox: Toddlers differentiate wobbly and wooden handrails. *Child Development, 76*, 1294–1307.

Bergson, H. (1911). *Creative evolution*. New York: Holt & Company.

Berland, J. C. (1982). *No five fingers are alike: Cognitive amplifiers in social context*. Cambridge, MA: Harvard University Press.

Best, J. R. (2014). Relations between video gaming and children's executive functions. In F. C. Blumberg (Ed.) *Learning by playing: Video gaming in education*. New York, NY: Oxford University Press.

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development, 81,* 1641–1660.

Best, J. R., Miller, P. H., & Naglieri, J. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences, 21*(4), 327–336.

Bhaskar, R. (1983). Beef, structure and place: Notes from a critical naturalist perspective. *Journal for the Theory of Social Behaviour, 13*, 81–97.

Bialystok, E. (2015). Bilingualism and the development of executive function: The role of attention. *Child Development Perspectives, 9*(2), 117–121.

Bigler, R. S., & Liben, L. S. (1993). A cognitive-developmental approach to social stereotyping and reconstructive memory in Euro-American children. *Child Development, 64*, 1507–1518.

Bijou, S. W., & Baer, D. M. (1961). *Child development* (Vol. 1). New York: Appleton-Century-Crofts.

Bjorklund, D. F. (2007). *Why youth is not wasted on the young: Immaturity in human development.* Malden, MA: Blackwell.

Bjorklund, D. F., Dukes, C., & Brown, R. D. (2009). The development of memory strategies. In M. L. Courage & N. Cowan (Eds.), *The development of memory in infancy and childhood.* New York: Psychology Press.

Bjorklund, D. F., & Ellis, B. J. (2014). Children, childhood, and development in evolutionary perspective. *Developmental Review, 34*(3), 225–264.

Blair, C., Cybele, R. C., & Raver, C. C. (2014).Two approaches to estimating the effect of parenting on the development of executive function in early childhood. *Developmental Psychology, 50*(2), 554–565.

Blair, C., & Raver, C. C. (2015). School readiness and self-regulation: A developmental psychobiological approach. *Annual Review of Psychology, 66,* 711–731.

Blurton-Jones, N. (1972). *Ethological studies of child behavior.* Cambridge, England: Cambridge University Press.

Bornstein, M. H., Cote, L. R., Haynes, O. M., Suwalsky, J. T. D., & Bakeman, R. (2012). Modalities of infant–mother interaction in Japanese, Japanese American immigrant, and European American dyads. *Child Development, 83*(6), 2073–2088.

Bornstein, M. H., Hahn, C., & Suwalsky, J. T. D. (2013). Physically developed and exploratory young infants contribute to their own long-term academic achievement. *Psychological Science, 24*(10), 1906–1917.

Bower, T. G. R. (1974). *Development in infancy.* San Francisco: Freeman.

Bowlby, J. (1958). The nature of the child's tie to his mother. *International Journal of Psychoanalysis, 39,* 350–373.

Bowlby, J. (1969). *Attachment and loss: Vol. 1. Attachment*. New York: Basic Books.

Bowlby, J. (1980). *Attachment and loss: Vol. 3. Loss.* New York: Basic Books.

Bowlby, J. (1982). *Attachment and loss: Vol. 1. Attachment* (2nd ed.). New York: Basic Books.

Bowlby, J. (1991). *Charles Darwin: A new biography*. London: Hutchinson.

Bradley, B. S. (1989). *Visions of infancy*. Oxford: Polity/Blackwell.

Brainerd, C. J. (Ed.). (1996). *Psychological Science* celebrates the centennial of Jean Piaget [Special section of journal]. *Psychological Science, 7,* 191–225.

Brainerd, C. J., & Reyna, V. F. (2014). Dual processes in memory development: Fuzzy-trace theory. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Breland, K., & Breland, M. (1961). The misbehavior of organisms. *American Psychologist, 16,* 681–684.

Bremner, J. G., Slater, A. M., & Johnson, S. P. (2014). Perception of object persistence: The origins of object permanence in infancy. *Child Development Perspectives, 9*(1), 7–13.

Bretherton, I., & Munholland, K. A. (1999). Internal working models in attachment relationships: A construct revisited. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment.* New York: Guilford Press.

Bringuier, J. (1980). *Conversations with Jean Piaget.* Chicago: University of Chicago Press.

Brink, K. A., Lane, J. D., & Wellman, H. M. (2015). Developmental pathways for social understanding: Linking social cognition to social contexts. *Frontiers in Psychology, 6:719.*

Brody, G. H., Beach, S. R. H., Philibert, R. A., Chen, Y., & Murry, V. M. (2009). Prevention effects moderate the association of 5-HTTLPR and youth risk behavior initiation: Gene X environment hypotheses tested via a randomized prevention design. *Child Development, 80*, 645–661.

Brody, G. H., Yu, T., Beach, S. R. H., & Philibert, R. A. (2015). Prevention effects ameliorate the prospective association between nonsupportive parenting and diminished telomere length. *Prevention Science, 16*(2), 171–180.

Brody, G. H., Yu, T., Chen, E., Miller, G. E., Kogan, S. M., & Beach, S. R. H. (2013). Is resilience only skin deep? Rural African Americans' socioeconomic status-related risk and competence in preadolescence and psychological adjustment and allostatic load at age 19. *Psychological Science, 24*(7), 1285–1293.

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist, 32*, 513–531.

Bronfenbrenner, U. (1986). Recent advances in research on human development. In R. K. Silbereisen, K. Eyferth, & G. Rudinger (Eds.), *Development as action in context: Problem behavior and normal youth development.* New York: Springer- Verlag.

Bronfenbrenner, U., & Morris, P. A. (2006). The bioecological model of human development. In W. Damon & R. M. Lerner (Series Eds.) & R. M. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1.Theoretical models of human development* (6th ed.). New York: Wiley.

Brown, A. L. (1975). The development of memory: Knowing, knowing about knowing, and knowing how to know. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 10). New York: Academic Press.

Brown, A. L., & DeLoache, J. S. (1978). Skills, plans, and self-regulation. In R. S. Siegler (Ed.), *Children's thinking: What develops?* Hillsdale, NJ: Erlbaum.

Bruce, J., Fisher, P. A., Graham, A. M., Moore, W. E., Peake, S. J., & Mannering, A. M. (2013). Patterns of brain activation in foster children and nonmaltreated children during an inhibitory control task. *Developmental Psychopathology, 25*(4), 931–941.

Brückner, G. H. (1933). Untersuchungen zur Tiersoziologie, insbesondere der Auflösung der Familie. *Zeitschrift für Psychologie, 128,* 1–120.

Bruner, J. S. (1987, December). The artist as analyst [Review of the book *A way of looking at things: Selected papers from 1930 to 1980*]. *The New York Review of Books, 34*, 8–13.

Brunk, M. A., & Henggeler, S. W. (1984). Child influences on adult controls: An experimental investigation. *Developmental Psychology, 6,* 1074–1081.

Brush, S. G. (1976). Fact and fantasy in the history of science. In M. H. Marx & F. E. Goodson (Eds.), *Theories in contemporary psychology* (2nd ed.). New York: Macmillan.

Bryant, P. E. (1986). Theories about the causes of cognitive development. In P. L. C. Van Geert (Ed.), *Theory building in developmental psychology.* Amsterdam: North Holland.

Budak, D., & Chavajay, P. (2012). Cultural variation in the social organization of problem solving among African American and European American siblings. *Cultural Diversity and Ethnic Minority Psychology, 18*(3), 307–311.

Bugental, D. B, Corpuz, R., & Beaulieu, D. A. (2015). An evolutionary approach to socialization. In J. E. Grusec & P. D. Hastings (Eds.), *Handbook of socialization: Theory and research* (2nd ed.). New York, NY: Guilford.

Burman, E. (2008a*). Deconstructing developmental psychology* (2nd ed.). New York: Routledge/Taylor & Francis Group.

Burman, E. (2008b). *Developments: Child, image, nation.* New York: Routledge/Taylor & Francis Group.

Burnham, J. C. (1979). From avant-garde to specialism: Psychoanalysis in America. *Journal of the History of the Behavioral Sciences, 15*, 128–134.

Bussey, K. (2011). Gender identity development. In S. J. Schwartz, K. Luyckx, & V. L. Vignoles (Eds.), *Handbook of gender identity and research* (Vol. 2). New York, NY: Springer Science + Business Media.

Bussey, K., & Bandura, A. (1992). Self-regulatory mechanisms governing gender development. *Child Development, 63*, 1236–1250.

Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review, 106,* 676–713.

Bussey, K., Fitzpatrick, S., & Raman, A. (2015).The role of moral disengagement and self-efficacy in cyber-bullying. *Journal of School Violence, 14*(1), 30–46.

Butler, S. (1878). *Life and habit*. London: Trübner & Company.

Cacioppo, J. T., & Cacioppo, S. (2013). Social neuroscience. *Perspectives on Psychological Science, 8*(6), 667–669.

Cairns, R. B. (1979). *Social development: The origins and plasticity of interchanges*. San Francisco: W. H. Freeman.

Call, J., & Tomasello, M. (2008). Does the chimpanzee have a theory of mind? 30 years later. *Trends in Cognitive Sciences,12*(5),187–192.

Calvert, S. L. (2015). Children and digital media. In R. M. Lerner (Series Ed.) & M. H. Bornstein & T. Leventhal (Vol. Eds.), *Handbook of child psychology and developmental science, Vol. 4: Ecological settings and processes* (7th ed.). New York: Wiley.

Campos, J. J., Langer, A., & Krowitz, A. (1970, October 9). Cardiac responses on the visual cliff in prelocomotor human infants. *Science, 170,* 196–197.

Cañal-Bruland, R., & van der Kamp, J. (2015). Embodied perception: A proposal to reconcile affordance and spatial perception. *i-Perception, 6*(2), 63–66.

Cangelosi, A., & Schlesinger, M. (2015). *Developmental robotics: From babies to robots.* Cambridge, MA: MIT Press.

Caprara, G. V., Dodge, K. A., Pastorelli, C., & Zelli, A. (2007). How marginal deviations sometimes grow into serious aggression. *Perspectives on Child Development, 1*, 33–39.

Carey, S. (1985). *Conceptual change in childhood*. Cambridge, MA: MIT Press.

Carey, S. (2009). *The origin of concepts*. New York: Oxford University Press.

Carraher, T. N., Carraher, D. W., & Schliemann, A. D. (1985). Mathematics in the streets and in schools. *British Journal of Developmental Psychology, 3,* 21–29.

Carver, L. J. (2014). Cognitive neuroscience of emotion and memory development. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Case, R. (1985). *Intellectual development: A systematic reinterpretation.* New York: Academic Press.

Case, R. (1992). *The mind's staircase: Exploring the conceptual underpinnings of children's thought and knowledge.* Hillsdale, NJ: Erlbaum.

Case, R. (1998). The development of conceptual structures. In W. Damon (Series Ed.) & D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (5th ed.). New York: Wiley.

Cassidy, J., Jones, J. D., & Shaver, P. R. (2013). Contributions of attachment theory and research: A framework for future research, translation, and policy. *Development and Psychopathology, 25*(4), 1415–1434.

Cassidy, J., & Shaver, P. R. (Eds.). (2008). *Handbook of attachment: Theory, research and clinical applications* (2nd ed.). New York: Guilford Press.

Cassirer, E. (1951). *The philosophy of the enlightenment*. Boston: Beacon Press.

Caudill, W., & Weinstein, H. (1969). Maternal care and infant behavior in Japan and America. *Psychiatry, 32*, 12–43.

Caudle, F. M. (2003). Eleanor Jack Gibson [Obituary]. *American Psychologist, 58*, 1090–1091.

Caylak, E. (2012). Biochemical and genetic analyses of childhood attention deficit/hyperactivity disorder. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics, 159B*, 613–627.

Cernoch, J. M., & Porter, R. H. (1985). Recognition of maternal axillary odors by infants. *Child Development, 56,* 1593–1598.

Chae, Y., Goodman, G., Larson, R. P., Augusti, E., Alley, D., VanMeenen, K. M., Culver, M., & Coulter, K. P. (2014). Children's memory and suggestibility about a distressing event: The role of children's and parents' attachment. *Journal of Experimental Child Psychology, 123*, 90–111.

Champagne, F. A. (2009). Beyond nature vs. nurture: Philosophical insights from molecular biology. *APS Observer, 22*(3), 27–28.

Champagne, F. A., Weaver, I. C., Diorio, J., Dymov, S., Szyf, M., & Meaney, M. J. (2006). Maternal care associated with methylation of the estrogen receptor-α1b promoter and estrogen receptor-α expression in the medial preoptic area of female offspring. *Endocrinology, 147*, 2909–2915.

Charlesworth, W. R. (1978). *One year of haiku*. Minneapolis, MN: Nodin Press.

Charlesworth, W. R. (1979). Ethology: Understanding the other half of intelligence. In M. von Cranach, K. Foppa, W. Lepenies, & D. Ploog (Eds.), *Human ethology: Claims and limits of a new discipline.* Cambridge, England: Cambridge University Press.

Charlesworth, W. R. (1988). Resources and resource acquisition during ontogeny. In K. B. MacDonald (Ed.), *Sociobiological perspectives on human development.* New York: Springer-Verlag.

Chavajay, P. (2008). Organizational patterns in problem solving among Mayan fathers and children. *Developmental Psychology, 44*, 882–888.

Chen, X. (2015). Exploring the implications of social change for human development: Perspectives, issues and future directions. *International Journal of Psychology, 50*(1), 56–59.

Cheng, Y. Chen, C., & Decety, J. (2014). An EEG/ERP investigation of the development of empathy in early and middle childhood. *Developmental Cognitive Neuroscience, 10*, 160–169.

Chi, M. T. H. (1978). Knowledge structures and memory development. In R. S. Siegler (Ed.), *Children's thinking. What develops?* Hillsdale, NJ: Erlbaum.

Chi, M. T. H., & Koeske, R. D. (1983). Network representation of a child's dinosaur knowledge. *Developmental Psychology, 19,* 29–39.

Chiao, J. Y., Cheon, B. K., Pornpattananangkul, N., Mrazek, A. J., & Blizinsky, K. D. (2014). Cultural neuroscience: Understanding human diversity. In M. Gelfand, C. Chiu, & Y. Hong (Eds.) *Advances in culture and psychology* (Vol. 4). New York, NY: Oxford University Press.

Child Trends Data Bank. (2015.). *Immigrant children: Indicators on children and youth*. Retrieved from Child Trends website: http://www.childtrends.org/?indicators=immigrant-children

Cho, G. E., Sandel, T. L., Miller, P. J., & Wang, S.–H. (2005). What do grandmothers think about self-esteem? American and Taiwanese folk theories revisited. *Social Development, 14,* 701–721.

Chodorow, N. (1978). *The reproduction of mothering: Psychoanalysis and the socialization of gender*. Berkeley, CA: University of California Press.

Chomsky, N. (1959). A review of B. F. Skinner's *Verbal Behavior*. *Language, 35,* 26–58.

Church, R. B., & Goldin-Meadow, S. (1986). The mismatch between gesture and speech as an index of transitional knowledge. *Cognition, 23*, 43–71.

Clerc, J., & Miller, P. H. (2013). Utilization deficiencies and transfer of strategies in preschoolers. *Cognitive Development, 28*(1), 76–93.

Cole, M. (1988). Cross-cultural research in the sociohistorical tradition. *Human Development, 31*, 137–157.

Cole, M. (1992). Culture in development. In M. Bornstein & M. Lamb (Eds.), *Developmental psychology: An advanced textbook* (3rd ed.). Hillsdale, NJ: Erlbaum.

Cole, M., Gay, J., Glick, J. A., & Sharp, D. W. (1971). *The cultural context of learning and thinking.* New York: Basic Books.

Cole, W. G., Lingeman, J. M., & Adolph, K. E. (2012). Go naked: Diapers affect infant walking. *Developmental Science, 15*(6), 783–790.

Cole, M., & Scribner, S. (1978). Introduction. In L. S. Vygotsky (Ed.), *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Coleman, P. K., & Karraker, K. H. (1997). Self-efficacy and parenting quality: Findings and future applications. *Developmental Review, 18*, 47–85.

Collins, J. L. (1982, March). *Self-efficacy and ability in achievement behavior.* Paper presented at the meeting of the American Educational Research Association, New York.

Cooper, C. R. (1999). Multiple selves, multiple worlds: Cultural perspectives on individuality and connectedness in adolescent development. In A. S. Masten (Ed.), *Cultural processes in child development*. Mahwah, NJ: Erlbaum.

Correa-Chávez, M., & Rogoff, B. (2009). Children's attention to interactions directed to others: Guatemalan Mayan and European American patterns. *Developmental Psychology, 45*, 630–641.

Correa-Chávez, M., Rogoff, B., & Mejía Arauz, R. (2005). Cultural patterns in attending to two events at once. *Child Development, 76,* 664–678.

Courage, M. L., Bakhtiar, A., Fitzpatrick, C., Kenny, S., & Brandeau, K. (2015). Growing up multitasking:

The costs and benefits for cognitive development. *Developmental Review, 35*, 5–41.

Coyle, T. R., & Bjorklund, D. F. (1997). Age differences in, and consequences of, multiple and variable strategy use on a multitrial sort-recall task. *Developmental Psychology, 33*, 372–380.

Crick, N. R., & Rose, A. J. (2000). Toward a gender-balanced approach to the study of social-emotional development: A look at relational aggression. In P. H. Miller & E. K. Scholnick (Eds.), *Toward a feminist developmental psychology*. New York: Routledge.

Crosnoe, R., & Fuligni, A. J. (2012). Children from immigrant families: Introduction to the special section. *Child Development, 83*(5), 1471–1476.

Csibra, G., & Gergely, G. (2009). Natural pedagogy. *Trends in Cognitive Sciences, 13*(4),148–153.

Dahl, A., Campos, J. J., Anderson, D. I., Uchiyama, I., Witherington, D. C., Ueno, M., . . . Barbu-Roth, M. (2013). The epigenesist of wariness of heights. *Psychological Science, 24*, 1361–1367.

Darwin, C. (1890). *The formation of vegetable mould, through the action of worms, with observations on their habits*. New York: Appleton.

Davidson, P. (1988). Piaget's category-theoretic interpretation of cognitive development: A neglected contribution. *Human Development, 31*, 225–244.

Davies, P., Cichetti, D., & Hentges, R. F. (2015). Maternal unresponsiveness and child disruptive problems: The interplay of uninhibited temperament and dopamine transporter genes. *Child Development, 86*(1), 63–79.

Dawson, G., Webb, S. J., Carver, L., Panagiotides, H., & McPartland, J. (2004). Young children with autism show atypical brain responses to fearful versus neutral facial expressions of emotion. *Developmental Science, 7*(3), 340–359.

De Haan, M. (2015). Neuroscientific methods with children. In R. M. Lerner (Series Ed.) & W. F. Overton & P. C. M. Molenaar (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 1. Theory and method* (7th ed.). New York, NY: Wiley.

De Marsico, M., Sterbini, A., & Temperini, M. (2013). A strategy to join adaptive and reputation-based social-collaborative E-learning, through the zone of proximal development. *International Journal of Distance Education Technologies, 11*(3), 12–31.

De Vries, P. (1973). *Forever panting.* Boston: Little, Brown.

Dede, C. (2010). Comparing frameworks for 21st century skills. In J. Bellanca & R. Brandt (Eds.), *21st century skills: Rethinking how students learn*. Bloomington IN: Solution Tree Press.

Dekker, E., & Groen, J. (1956). Reproducible psychogenic attacks of asthma: A laboratory study. *Journal of Psychosomatic Research, 1,* 58–67.

DeLoache, J. S., Cassidy, D. J., & Brown, A. L. (1985). Precursors of mnemonic strategies in very young children's memory. *Child Development, 56*, 125–137.

DeLoache, J. S., & LoBue, V. (2009). The narrow fellow in the grass: Human infants associate snakes and fear. *Developmental Science, 12*, 201–207.

DeMarie, D., Miller, P. H., Ferron, J., & Cunningham, W. (2004). Path analysis tests of theoretical models of children's memory performance. *Journal of Cognition and Development, 5*, 461–492.

DeMaster, D., Pathman, T., Lee, J. K., & Ghetti, S. (2014). Structural development of the hippocampus and episodic memory: Developmental differences along the anterior/posterior axis. *Cerebral Cortex, 24*(11), 3036–3045.

Devine, R. T., & Hughes, C. (2014). Relations between false belief understanding and executive function in early childhood: A meta-analysis. *Child Development, 85*(5), 1777–1794.

Diamond, A. (1985). The development of the ability to use recall to guide action, as indicated by infants' performance on A$\bar{B}$. *Child Development, 56,* 868–883.

Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development, 71*, 44–56.

Dodge, K. A., Godwin, J., & The Conduct Problems Prevention Research Group. (2013). Social-information-processing patterns mediate the impact of preventive intervention on adolescent antisocial behavior. *Psychological Science, 24*(4), 456–465.

Dollard, J., Doob, L., Miller, W. N. E., Mowrer, O. H., & Sears, R. R. (1939). *Frustration and aggression.* New Haven, CT: Yale University Press.

Dollard, J., & Miller, N. E. (1950). *Personality and psychotherapy.* New York: McGraw-Hill.

Dornbusch, S. M., Ritter, P. L., Leiderman, P. H., Roberts, D. F., & Fraleigh, M. J. (1987). The relation of parenting style to adolescent school performance. *Child Development*, *58*, 1244–1257.

Dorr, D., & Fey, S. (1974). Relative power of symbolic adult and peer models in the modification of children's moral choice behavior. *Journal of Personality and Social Psychology, 29,* 335–341.

Drake, S. G. (1834). *Biography and history of the Indians of North America.* Boston: Perkins and Hilliard, Gray.

Dugmore, N. (2014). Flexing the frame: Contemplating the use of multiple ports of entry in parent-infant psychotherapy. *Infant Mental Health Journal, 35*(4), 366–375.

Duh, C. J, Paik, J., Miller, P. H., & Gluck, S. (2015, under revised review). *Theory of mind and executive function in Chinese preschool children.*

Dunn, J. (1988). *The beginnings of social understanding.* Oxford, England: Basil Blackwell.

Eccles, J. (1989). Bringing young women to math and science. In M. Crawford & M. Gentry (Eds.), *Gender and thought*. New York: Springer-Verlag.

Edelman, G. M. (1987). *Neural Darwinism: The theory of neuronal group selection*. New York: Basic Books.

Edelman, M. S., & Omark, D. R. (1973, March). *The development of logical operations: An ethological approach.* Paper presented at the meeting of the Society for Research in Child Development, Philadelphia.

Eibl-Eibesfeldt, I. (1975). *Ethology: The biology of behavior* (2nd ed.). New York: Holt, Rinehart & Winston.

Eibl-Eibesfeldt, I. (1989). *Human ethology.* New York: de Gruyter.

Eisner, M. P., & Malti, T. (2015). Aggressive and violent behavior. In R. M. Lerner (Series Ed.) & M. E. Lamb (Vol. Ed.), *Handbook of child psychology and developmental science, Vol. 3: Socioemotional processes* (7th ed.). New York: Wiley.

Elder, G. H. Jr., Shanahan, M. J. & Jennings, J. A. (2015). *Human development in time and place*. In R. M. Lerner (Series Ed.) & M. H. Bornstein, & T. Leventhal (Vol. Eds.), *Handbook of child psychology and developmental science, Vol. 4: Ecological settings and processes* (7th ed.). New York: Wiley.

Elkind, D. (1968, May 26). Giant in the nursery—Jean Piaget. *New York Times Magazine*, p. 25.

Ellis, B. J., Boyce, W. T., Belsky, J., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2011). Differential susceptibility to the environment: An evolutionary–neurodevelopmental theory. *Development and Psychopathology, 23,* 7–28.

Ensor, R., & Hughes, C. (2008). Content or connectedness: Mother–child talk and early social understanding. *Child Development, 79*, 201–216.

Erikson, E. H. (1950). Growth and crises of the healthy personality. In M. J. E. Senn (Ed.), *Symposium on the healthy personality.* New York: Josiah Macy, Jr. Foundation.

Erikson, E. H. (1951). The California loyalty oath: An editorial. *Psychiatry, 14,* 244–245.

Erikson, E. H. (1958). *Young man Luther.* New York: Norton.

Erikson, E. H. (1959). *Identity and the life cycle* (Psychological Issues, Monograph No. 1). New York: International Universities Press.

Erikson, E. H. (1963). *Childhood and society* (2nd ed.). New York: Norton.

Erikson, E. H. (1968). *Identity: Youth and crisis.* New York: Norton.

Erikson, E. H. (1969). *Gandhi's truth.* New York: Norton.

Erikson, E. H. (1973). The wider identity. In K. Erikson (Ed.), *In search of common ground: Conversations with Erik H. Erikson and Huey P. Newton.* New York: Norton.

Erikson, E. H. (1977). *Toys and reasons.* New York: Norton.

Erlich, N., Lipp, O. V., & Slaughter, V. (2013). Of hissing snakes and angry voices: Human infants are differentially responsive to evolutionary fear-relevant sounds. *Developmental Science, 16*(6), 894–904.

Eron, L. D. (1987). The development of aggressive behavior from the perspective of a developing behaviorism. *American Psychologist*, *42*, 435–442.

Esposito, G., Valenzi, S., Islam, T., Mash, C., & Bornstein, M. H. (2015). Immediate and selective maternal brain responses to own infant faces. *Behavioural Brain Research, 278*, 40–43.

Evans, G. W., & Schamberg, M. A. (2009). Childhood poverty, chronic stress, and adult working memory. *Proceedings of the National Academy of Sciences of the United States of America, 106*(16), 6545–6549.

Evans, R. I. (1967). *Dialogue with Erik Erikson.* New York: Harper & Row.

Evans, R. I. (1973). *Jean Piaget: The man and his ideas.* New York: Dutton.

Evans, R. I. (1989). *Albert Bandura: The man and his ideas—A dialogue.* New York: Praeger.

Fast, L. A., Lewis, J. L., Bryant, M. J., Bocian, K. A., Cardullo, R. A., Rettig, M. & Hammond, K. A. (2010). Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance? *Journal of Educational Psychology, 102*(1), 729–740.

Federal Interagency Forum on Child and Family Statistics. (2015). *America's children: Key national indicators of well-being*. Retrieved from ChildStats website: http://www.childstats.gov/americaschildren/demo1.asp

Feldman, R., Gordon, I., Influs, M., Gutbir, T., & Ebstein, R. P. (2013). Parental oxytocin and early caregiving jointly shape children's oxytocin response and social reciprocity. *Neuropsychopharmacology, 38*(7), 1154–1162.

Fernbach, P M., Macris, D. M., & Sobel, D. M. (2012). Which one made it go? The emergence of diagnostic reasoning in preschoolers. *Cognitive Development, 27*(1), 39–53.

Ferrara, R. A., Brown, A. L., & Campione, J. C. (1986). Children's learning and transfer of inductive reasoning rules: Studies of proximal development. *Child Development, 57,* 1087–1099.

Fischer, K. W., & Bidell, T. R. (1998). Dynamic development of psychological structures in action and thought. In W. Damon (Series Ed.) & R. M. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (5th ed.). New York: Wiley.

Fischer, K. W., & Bidell, T. R. (2006). Dynamic development of action and thought. In W. Damon (Series Ed.) & R. M. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1.Theoretical models of human development* (6th ed.). New York: Wiley.

Fischer, K. W., & Hencke, R. W. (1996). Infants' construction of actions in context: Piaget's contributions to research on early development. *Psychological Science, 7,* 204–210.

Fisher, S., & Greenberg, R. P. (1996). *Freud scientifically reappraised: Testing the theories and therapy.* New York: Wiley.

Fivush, R. (2000). Accuracy, authority, and voice: Feminist perspectives on autobiographical memory. In P. H. Miller & E. K. Scholnick (Eds.), *Toward a feminist developmental psychology*. New York: Routledge.

Fivush, R. (2009). Sociocultural perspectives on autobiographical memory. In M. L. Courage & N. Cowan (Eds.), *The development of memory in infancy and childhood*. New York: Psychology Press.

Fivush, R. (2014). Maternal reminiscing style: The sociocultural construction of autobiographical memory across childhood and adolescence. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Fivush, R., & Zaman, W. (2014). Gender, subjective perspective, and autobiographical consciousness. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Fivush, R. & Zaman, W. (2015). Gendered narrative voices: Sociocultural and feminist approaches to emerging identity in childhood and adolescence. In K. McLean & Syed, M. (Eds.), *The Oxford handbook of identity development*. New York, NY: Oxford University Press.

Flavell, J. H. (1963). *The developmental psychology of Jean Piaget.* Princeton, NJ: Van Nostrand.

Flavell, J. H. (1971a). First discussant's comments: What is memory development the development of? *Human Development, 14,* 272–278.

Flavell, J. H. (1971b). Stage-related properties of cognitive development. *Cognitive Psychology, 2,* 421–453.

Flavell, J. H. (1982). On cognitive development. *Child Development, 53,* 1–10.

Flavell, J. H. (1992). Cognitive development. *Developmental Psychology, 28*, 998–1005.

Flavell, J. H. (1996). Piaget's legacy. *Psychological Science, 7*, 200–203.

Flavell, J. H., Friedrichs, A. G., & Hoyt, J. D. (1970). Developmental changes in memorization processes. *Cognitive Psychology, 1*, 324–340.

Flavell, J. H., & Miller, P. H. (1998). Social cognition. In W. Damon (Series Ed.) & D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (5th ed.). New York: Wiley.

Flavell, J. H., Miller, P. H., & Miller, S. A. (2002). *Cognitive development* (4th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Flavell, J. H., & Wellman, H. M. (1977). Metamemory. In R. V. Kail & J. W. Hagen (Eds.), *Perspectives on the development of memory and cognition.* Hillsdale, NJ: Erlbaum.

Flavell, J. H., & Wohlwill, J. F. (1969). Formal and functional aspects of cognitive development. In D. Elkind & J. H. Flavell (Eds.), *Studies in cognitive growth: Essays in honor of Jean Piaget.* New York: Oxford University Press.

Flynn, E., & Whiten, A. (2012). Experimental "micro-cultures" in young children: Identifying biographic, cognitive, and social predictors of information transmission. *Child Development, 83*(3), 911–925.

Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: MIT/Bradford Books.

Fogassi, L., & Rizzolatti, G. (2013). The mirror mechanism as neurophysiological basis for action and intention understanding. In A. Suarez & P. Adams (Eds.), *Is science compatible with free will? Exploring free will and consciousness in the light of quantum physics and neuroscience*. New York, NY: Springer Science + Business Media.

Fogel, A., & Garvey, A. (2007). Alive communication. *Infant Behavior and Development, 30*, 251–257.

Fogel, A., King, B. J., & Shanker, S. G. (Eds.). (2008). *Human development in the twenty-first century: Visionary ideas from systems scientists.* New York: Cambridge University Press.

Fonagy, P, & Campbell, C. (2015). Bad blood revisited: Attachment and psychoanalysis, 2015. *British Journal of Psychotherapy, 31*(2), 229–250.

Fox, R., & McDaniel, C. (1982, October 29). Perception of biological motion by human infants. *Science, 218,* 486–487.

Fraley, R. C., Roisman, G. I., & Haltigan, J. D. (2013). The legacy of early experiences in development: Formalizing alternative models of how early experiences are carried forward over time. *Developmental Psychology, 49*(1), 109–126.

Franchak, J. M., & Adolph, K. E. (2014). Gut estimates: Pregnant women adapt to changing possibilities for squeezing through doorways. *Attention, Perception, & Psychophysics, 76,* 460–470.

Frankenhuis, W. E., & de Weerth, C. (2013). Does early-life exposure to stress shape or impair cognition? *Current Directions in Psychological Science, 22*(5), 407–412.

Frankenhuis, W. E., & Panchanathan, K. (2011). Individual differences in developmental plasticity may result from stochastic sampling. *Perspectives on Psychological Science, 6*(4), 336–347.

Franz, A., & Triesch, J. (2010). A unified computational model of the development of object unity, object permanence, and occluded object trajectory perception. *Infant Behavior & Development, 33*(4), 635–653.

Frazier, B. N., Gelman, S. A., Kaciroti, N., Russell, J. W., & Lumeng, J. C. (2012). I'll have what she's having: The impact of model characteristics on children's food choices. *Developmental Science, 15*(1), 87–98.

Freedland, R. L., & Bertenthal, B. I. (1994). Developmental stages in interlimb coordination: Transition to hands-and-knees crawling. *Psychological Science, 5*, 26–32.

Freud, S. (1953a). The interpretation of dreams. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vols. 4–5). London: Hogarth Press. (Original work published 1900)

Freud, S. (1953b). Fragment of an analysis of a case of hysteria. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 7). London: Hogarth Press. (Original work published 1905)

Freud, S. (1955a). Analysis of a phobia in a five-year-old boy. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol.10). London: Hogarth Press. (Original work published 1909)

Freud, S. (1955b). Notes upon a case of obsessional neurosis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol.10). London: Hogarth Press. (Original work published 1909)

Freud, S. (1955c). Totem and taboo. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 13.). London: Hogarth Press. (Original work published 1913)

Freud, S. (1955d). The Moses of Michelangelo. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 13.). London: Hogarth Press. (Original work published 1914)

Freud, S. (1955e). From the history of an infantile neurosis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol.17). London: Hogarth Press. (Original work published 1918)

Freud, S. (1959). An autobiographical study. In J. Strachey (Ed. & Trans.), *The standard edition of* the complete psychological works of Sigmund Freud* (Vol. 20). London: Hogarth Press. (Original work published 1925)

Freud, S. (1960). The psychopathology of everyday life. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 6). London: Hogarth Press. (Original work published 1901)

Freud, S. (1961a). The ego and the id. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 19). London: Hogarth Press. (Original work published 1923)

Freud, S. (1961b). Some psychical consequences of the anatomical distinction between the sexes. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 19). London: Hogarth Press. (Original work published 1925)

Freud, S. (1961c). The future of an illusion. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 21). London: Hogarth Press. (Original work published 1927)

Freud, S. (1961d). Dostoevsky and parricide. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 21). London: Hogarth Press. (Original work published 1928)

Freud, S. (1961e). Civilization and its discontents. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 21). London: Hogarth Press. (Original work published 1930)

Freud, S. (1963a). Introductory lectures on psycho-analysis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 15). London: Hogarth Press. (Original work published 1916)

Freud, S. (1963b). Introductory lectures on psycho-analysis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 16). London: Hogarth Press. (Original work published 1917)

Freud, S. (1964a). New introductory lectures on psycho-analysis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 22). London: Hogarth Press. (Original work published 1933)

Freud, S. (1964b). Why war? In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 22). London: Hogarth Press. (Original work published 1933)

Freud, S. (1964c). An outline of psycho-analysis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 23). London: Hogarth Press. (Original work published 1940)

Freund, L. S. (1990). Maternal regulation of children's problem-solving behavior and its impact on children's performance. *Child Development, 61,* 113–126.

Frias, M. T., Shaver, P., & Mikulincer, M. (2015). Measures of adult attachment and related constructs. In G. J. Boyle, D. H. Saklofske, & G. Matthews (Eds.), *Measures of personality and social psychology constructs*. San Diego, CA: Elsevier Academic Press.

Fuligni, A. J. (2007). Family obligation, college enrollment, and emerging adulthood in Asian and Latin American families. *Child Development Perspectives, 1*, 96–100.

Garcia, C., Rivera, N., & Greenfield, P. M. (2015). The decline of cooperation, the rise of competition: Developmental effects of long-term social change in Mexico. *International Journal of Psychology, 50,* 6–11.

Garcia, J., & Koelling, R. A. (1966). Relation of cue to consequences in avoidance learning. *Psychonomic Science, 4,* 123–124.

Gardner, H. (2011). The theory of multiple intelligences. In M. A. Gernsbacher, R. W. Pew, L. M. Hough, J. R. Pomerantz, & FABBS Foundation (Eds.), *Psychology and the real world: Essays illustrating fundamental contributions to society.* New York, NY: Worth.

Gardner, R., & Heider, K. G. (1969). *Gardens of war: Life and death in the New Guinea stone age.* New York: Random House.

Gatzke-Kopp, L. M. (2011). The canary in the coalmine: The sensitivity of mesolimbic dopamine to environmental adversity during development. *Neuroscience and Biobehavioral Reviews, 35*(3), 794–803.

Gauvain, M., & Munroe, R. L. (2014). Development of perspective taking in relation to age, education, and the presence of community features associated with industrialization: A four-culture study. *Cross-Cultural Research: The Journal of Comparative Social Science, 48*(1), 32–44.

Gauvain, M., Munroe, R. L., & Beebe, M. (2013). Children's questions in cross-cultural perspective: A four-culture study. *Journal of Cross-Cultural Psychology, 44*(7), 1148–1165.

Gauvain, M., & Perez, S. (2015). Cognitive development and culture. In R. M. Lerner (Series Ed.) & L. S. Liben & U. Müller (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 2. Cognitive processes* (7th ed.). New York, NY: Wiley.

Geary, D. C. (2005). *The origin of mind: Evolution of brain, cognition, and general intelligence*. Washington, DC: American Psychological Association.

Gelman, R. (1969). Conservation acquisition: A problem of learning to attend to relevant attributes. *Journal of Experimental Child Psychology, 7,* 167–187.

Gelman, R. (1972). Logical capacity of very young children: Number invariance rules. *Child Development, 43*, 75–90.

Gelman, R., & Gallistel, C. R. (1978). *The child's understanding of number.* Cambridge, MA: Harvard University Press.

Gelman, S. A., & Taylor, M. G. (2000). Gender essentialism in cognitive development. In P. H. Miller & E. K. Scholnick (Eds.), *Toward a feminist developmental psychology*. New York: Routledge.

Ghetti, S., Lyons, K. E., Lazzarin, F., & Cornoldi, C. (2008). The development of metamemory monitoring during retrieval: The case of memory strength and memory absence. *Journal of Experimental Child Psychology, 99,* 157–181.

Gibson, E. J. (1969). *Principles of perceptual learning and development.* New York: Appleton-Century-Crofts.

Gibson, E. J. (1977). How perception really develops: A view from outside the network. In D. LaBerge & S. J. Samuels (Eds.), *Basic processes in reading: Perception and comprehension.* Hillsdale, NJ: Erlbaum.

Gibson, E. J. (1982). The concept of affordances in development: The renascence of functionalism. In W. A. Collins (Ed.), *The concept of development.* Hillsdale, NJ: Erlbaum.

Gibson, E. J. (1988). Exploratory behavior in the development of perceiving, acting, and the acquiring of knowledge. *Annual Review of Psychology, 39*, 1–42.

Gibson, E. J. (1991). *An odyssey in learning and perception.* Cambridge, MA: Bradford/MIT Press.

Gibson, E. J. (1997). An ecological psychologist's prolegomena for perceptual development: A functional approach. In C. Dent-Read & P. Zukow-Golding (Eds.), *Evolving explanations of development: Ecological approaches to organism–environment systems.* Washington, DC: American Psychological Association.

Gibson, E. J. (2003). What psychology is about: Ruminations of an opinionated aged psychologist. *Ecological Psychology, 15*, 289–295.

Gibson, E. J., Gibson, J. J., Pick, A. D., & Osser, H. (1962). A developmental study of the discrimination of letter-like forms. *Journal of Comparative and Physiological Psychology, 55,* 897–906.

Gibson, E. J., Owsley, C. J., & Johnston, J. (1978). Perception of invariants by five-month-old infants: Differentiation of two types of motion. *Developmental Psychology, 14,* 407–415.

Gibson, E. J., & Pick, A. D. (2000). *An ecological approach to perceptual learning and development*. New York: Oxford University Press.

Gibson, E. J., & Rader, N. (1979). The perceiver as performer. In G. Hale & M. Lewis (Eds.), *Attention and cognitive development.* New York: Plenum Press.

Gibson, E. J., Riccio, A., Schmuckler, M., Stoffregen, T., Rosenberg, D., & Taormina, J. (1987). Detection of the traversability of surfaces by crawling and walking infants. *Journal of Experimental Psychology: Human Perception and Performance, 13,* 533–544.

Gibson, E. J., & Walk, R. D. (1960, April). The "visual cliff." *Scientific American, 202,* 64–71.

Gibson, J. J. (1979). Foreword: A note on E. J. G. by J. J. G. In A. D. Pick (Ed.), *Perception and its development: A tribute to Eleanor J. Gibson.* Hillsdale, NJ: Erlbaum.

Gill, M. M. (1959). The present state of psychoanalytic theory. *Journal of Abnormal and Social Psychology, 58,* 1–8.

Gillath, O. (2015). The neuroscience of attachment: Using new methods to answer old (and new) questions. In J. A. Simpson & W. S. Rholes (Eds.), *Attachment theory and research: New directions and emerging themes*. New York, NY: Guilford.

Glatz, T., & Buchanan, C. M. (2015). Change and predictors of change in parental self-efficacy from early to middle adolescence. *Developmental Psychology, 10*, 1367–1379.

Glenberg, A. M., Witt, J. K., & Metcalfe, J. (2013). From the revolution to embodiment: 25 years of cognitive psychology. *Perspectives on Psychological Science, 8*(5), 573–585.

Goodman, G., Ogle, C. M., McWilliams, K., Narr, R. K., & Paz-Alonso, P. M. (2014). Memory development in the forensic context. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Gopnik, A. (1994). Après le patron. *Cognitive Development, 9,* 131–138.

Gopnik, A., & Meltzoff, A. N. (1997). *Words, thoughts, and theories*. Cambridge, MA: MIT Press.

Gopnik, A., & Wellman, H. M. (2012). Reconstructing constructivism: Causal models, Bayesian learning mechanisms, and the theory theory. *Psychological Bulletin, 138*(6), 1085–1108.

Gottlieb, G. (1979). Comparative psychology and ethology. In E. Hearst (Ed.), *The first century of experimental psychology.* Hillsdale, NJ: Erlbaum.

Gould, S. J. (1980). *The panda's thumb.* New York: Norton.

Graham, A. M., Fisher, P. A., Pfeifer, J. H. (2013). What sleeping babies hear: A functional MRI study of interparental conflict and infants' emotion processing. *Psychological Science, 24*(5), 782–789.

Grammer, J., Coffman, J. L., & Ornstein, P. (2013). The effect of teachers' memory-relevant language on children's strategy use and knowledge. *Child Development, 84*(6),1989–2002.

Grammer, J. K., Purtell, K. M., Coffman, J. L., & Ornstein, P. A. (2011). Relations between children's metamemory and strategic performance: Time-varying covariates in early elementary school. *Journal of Experimental Child Psychology, 108,* 139–155.

Greenfield, P. M. (2009). Linking social change and developmental change: Shifting pathways of human development. *Developmental Psychology, 45*, 401–418.

Greenfield, P. M. (2015). Introduction. Special issue: social change, cultural evolution, and human development. *International Journal of Psychology, 50*(1), 4–5.

Griggs, R. A. (2014). The continuing saga of Little Albert in introductory psychology textbooks. *Teaching of Psychology, 41*(4), 309–317.

Griskevicius, V., Ackerman, J. M., Cantú, S. M., Delton, A. W., Robertson, T. E., Simpson, J. A., Tybur, J. M. (2013). When the economy falters, do people spend or save? Responses to resource scarcity depend on childhood environments. *Psychological Science, 24*(2), 197–205.

Grossmann, T. (2015). The development of social brain functions in infancy. *Psychological Bulletin, 141*(6), 1266–1287.

Grossmann, T., & Johnson, M. H. (2014). The early development of the brain bases for social cognition. In K. N. Ochsner & S. M. Kosslyn (Eds.), *The Oxford handbook of cognitive neuroscience. Vol. 2: The cutting edges.* New York, NY: Oxford University Press.

Gunderson, E. A., Gripshover, S. J., Romero, C., Dweck, C. S., Goldin-Meadow, S., & Levine, S. C. (2013). Parent praise to 1- to 3-year-olds predicts children's motivational frameworks 5 years later. *Child Development, 84*(5), 1526–1541.

Gureckis, T. M., & Love, B. C. (2004). Common mechanisms in infant and adult category learning. *Infancy, 5*(2), 173–198.

Gweon, H., Dodell-Feber, D., Bedny, M., & Saxe, R. (2012). Theory of mind performance in children correlates with functional specialization of a brain region for thinking about thoughts. *Child Development 83*(6), 1853–1868.

Hacker, D. J., Dunlosky, J., & Graesser, A. C. (Eds.). (1998). *Metacognition in educational theory and practice*. Mahwah, NJ: Erlbaum.

Haden, C. A. (2014). Interactions of knowledge and memory in the development of skilled remembering. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Haggbloom, S. J., Warnick, R., Warnick, J. E., Jones, V. K., Yarbrough, G. L., Russell, T. M., . . . Monte, E. (2002). The 100 most eminent psychologists of the 20th century. *Review of General Psychology, 6,* 139–152.

Hall, C. S. (1954). *A primer of Freudian psychology.* New York: World.

Hall, C. S., & Lindzey, G. (1957). *Theories of personality.* New York: Wiley.

Hamlin, J. K. (2013). Moral judgments and actions in preverbal infants and toddlers: Evidence for an innate moral core. *Current Directions in Psychological Science, 22*(3), 186–193.

Hamlin, J. K., Hallinan, E. V., & Woodward, A. L. (2008). Do as I do: 7- month-old infants selectively reproduce others' goals. *Developmental Science, 11*, 487–494.

Hamlin, J. K., Wynn, K., Bloom, P., & Mahajan, N. (2011). How infants and toddlers react to antisocial others. *Proceedings of the National Academies of Science, 108*, 19931–19936.

Harris, F. R., Wolf, M. M., & Baer, D. M. (1967). Effects of adult social reinforcement on child behavior. In W. W. Hartup & N. L. Smothergill (Eds.), *The young child: Reviews of research.* Washington, DC: National Association for the Education of Young Children.

Harris, P. L., & Koenig, M. A. (2006). Trust in testimony: How children learn about science and religion. *Child Development, 77*, 505–524.

Hartmann, H. (1958). *Ego psychology and the problem of adaptation.* New York: International Universities Press.

Hartup, W. W., & Yonas, A. (1971). Developmental psychology. *Annual Review of Psychology, 22,* 337–392.

Hawley, P. H. (1999). The ontogenesis of social dominance: A strategy-based evolutionary perspective. *Developmental Review, 19*, 97–132.

Hawley, P. H., (2014). Ontogeny and social dominance: A developmental view of human power patterns. *Evolutionary Psychology, 12*(1)*,* 318–342.

Hawley, P. H., & Geldhof, G. J. (2012). Preschoolers' social dominance, moral cognition, and moral behavior: An evolutionary perspective. *Journal of Experimental Child Psychology, 112*(1),18–35.

Hayes, C. (1951). *The ape in our house.* New York: Harper.

Heatherton, T. F., & Sargent, J. D. (2009). Does watching smoking in movies promote teenage smoking? *Current Directions in Psychological Science, 18,* 63–67.

Hebb, D. O. (1949). *The organization of behavior.* New York: Wiley.

Hebb, D. O. (1960). The American revolution. *American Psychologist, 15,* 735–745.

Hebb, D. O. (1980). *Essay on mind.* Hillsdale, NJ: Erlbaum.

Helt, M. S., Eigsti, I. Snyder, P. J., & Fein, D. A. (2010). Contagious yawning in autistic and typical development*. Child Development, 81*(5)*,* 1620–1631.

Helwig, C. C., & Turiel, E. (2011). Children's social and moral reasoning. In P. K. Smith & C. H. Hart (Eds.), *The Wiley Blackwell handbook of childhood social development* (2nd ed.). West Sussex, UK: Wiley-Blackwell.

Henrich, J., Heine, S., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences, 33*(2–3), 61–83.

Hess, E. H. (1970). Ethology and developmental psychology. In P. H. Mussen (Ed.), *Carmichael's manual of child psychology* (3rd ed., Vol. 1). New York: Wiley.

Hicks, V. C., & Carr, H. A. (1912). Human reactions in a maze. *Journal of Animal Psychology, 2,* 98–125.

Hill, P. L., & Turiano, N. A. (2014). Purpose in life as a predictor of mortality across adulthood*. Psychological Science, 25*(7), 1482–1486.

Hillairet de Boisferon, A., Dupierrix, E., Quinn, P. C., Loevenbruck, H., Lewkowicz, D. J., Lee, K., & Pascalis, O. (2015). Perception of multisensory gender coherence in 6- and 9-month-old infants. *Infancy*, 20(6), 661-674.

Hinde, R. A. (1974). *Biological bases of human social behavior.* New York: McGraw-Hill.

Hindorff, L. A., Sethupathy, P., Junkins, H. A., Ramos, E. M., Mehta, J. P., Collins, F. S., & Manolio, T. A. (2009). Potential etiologic and functional implications of genome-wide association loci for human diseases and traits. *Proceedings of the National Academy of Sciences,106*(23), 9362–9367.

Hines, M. (2015). Gendered development. In R. M. Lerner (Series Ed.) & M. E. Lamb (Vol. Ed.), *Handbook of child psychology and developmental science, Vol. 3: Socioemotional processes* (7th ed.). New York: Wiley.

Hintzman, D. L. (1974). Psychology and the cow's belly. *Worm Runner's Digest, 16,* 84–85.

Hitch, G. J., & Towse, J. (1995). Working memory: What develops? In F. E. Weinert & S. Schneider (Eds.), *Memory performance and competencies: Issues in growth and development.* Hillsdale, NJ: Erlbaum.

Holmes, C. J., Kim-Spoon, J., & Deater-Deckard, K. (2015). Linking executive function and peer problems from early childhood through middle adolescence. *Journal of Abnormal Child Psychology*. Advance online publication, posted June 23.

Hopkins, J. R. (1995). Erik Homburger Erikson (1902–1994). *American Psychologist, 50*, 796–797.

Horga, G., Kaur, T., & Peterson, B. S. (2014). Annual research review: Current limitations and future directions in MRI studies of child- and adult-onset developmental psychopathologies. *Journal of Child Psychology and Psychiatry, 55*(6), 659–680.

Horney, K. (1967). *Feminine psychology.* New York: Norton.

Howard, L. H., Henderson, A. M., Carrazza, C., & Woodward, A. L. (2015). Infants' and young children's imitation of linguistic in-group and out-group informants. *Child Development, 86*, 259–275.

Howe, M. L. (2014). The co-emergence of the self and autobiographical memory: An adaptive view of early memory. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Howe, M. L., & Knott, L. M. (2015). The fallibility of memory in judicial processes: Lessons from the past and their modern consequences. *Memory, 23*(5), 633–656.

Huang, Y., & Spelke, E. S. (2015). Core knowledge and the emergence of symbols: The case of maps: *Journal of Cognition and Development,16*(1), 81–96.

Hudson, J. A. (1990). The emergence of autobiographical memory in mother–child conversation. In R. Fivush & J. A. Hudson (Eds.), *Knowing and remembering in young children.* Cambridge, England: Cambridge University Press.

Huggenberger, H. J., Suter, S. E., Blumenthal, T. D., & Schachinger, H. (2013). Maternal social stress modulates the development of prepulse inhibition of startle in infants. *Developmental Cognitive Neuroscience, 3*(1), 84–90.

Hurley, K. B., & Oakes, L. M. (2015). Experience and distribution of attention: Pet exposure and infants' scanning of animal images. *Journal of Cognition and Development, 16*(1), 11–30.

Hutchins, E. (1991). The social organization of distributed cognition. In L. A. Resnick, R. Levine, & A. Behrend (Eds.), *Perspectives on socially shared cognition.* Washington, DC: American Psychological Association.

Hutchinson, G. E. (1959). Homage to Santa Rosalia, or why are there so many kinds of animals? *The American Naturalist, 93*(870), 145–159.

Hyde, L. W. (2015). Developmental psychopathology in an era of molecular genetics and neuroimaging: A developmental neurogenetics approach. *Development and Psychopathology, 27*, 587–613.

Iaccino, W. J., & Hogan, J. D. (1994, March). *Plotting the impact of Piaget*. Paper presented at the meeting of the Society for Research in Child Development, Boston.

Inhelder, B., & Piaget, J. (1980). Procedures and structures. In D. R. Olson (Ed.), *The social foundations of language and thought: Essays in honor of Jerome S. Bruner.* New York: Norton.

Inhelder, B., Sinclair, H., & Bovet, M. (1974). *Learning and the development of cognition.* Cambridge, MA: Harvard University Press.

Ishak, S., Tamis-LeMonda, C. S., & Adolph, K. E. (2007). Ensuring safety and providing challenge: Mothers' and fathers' expectations and choices about infant locomotion. *Parenting: Science and Practice, 7*, 57–68.

James, W. (1892). A plea for psychology as a natural science. *Philosophical Review, 1,* 146–153.

Jensen, P. S., Mrazek, D., Knapp, P. K., Steinberg, L., Pfeffer, C., Schowalter, J., & Shapiro, T. (1997). Evolution and revolution in child psychiatry: ADHD as a disorder of adaptation. *Journal of the American Academy of Child and Adolescent Psychiatry, 36(12),* 1672–1681.

Joanisse, M. F., & Seidenberg, M. S. (2003). Phonology and syntax in specific language impairment: Evidence from a connectionist model. *Brain and Language, 86,* 40–56.

Johnson, M. H. (2011). Interactive specialization: A domain-general framework for human functional brain development? *Developmental Cognitive Neuroscience, 1,* 7–21.

Johnson, M. H. (2013). The paradox of the emerging social brain. In M. R. Banaji & S. A. Gelman (Eds.), *Navigating the social world: What infants, children, and other species can teach us.* New York: Oxford University Press.

Johnson, M. H., & De Haan, M. (2015). *Developmental cognitive neuroscience: An introduction.* West Sussex, UK: Wiley-Blackwell.

Johnston, M. K., Sloane, H. N., & Bijou, S. W. (1966). A note on the measurement of drooling in free-ranging young children. *Journal of Experimental Child Psychology, 4,* 292–295.

Jokela, M., Elovainio, M., Kivimäki, M., & Keltikangas-Järvinen, L. (2008). Temperament and migration patterns in Finland. *Psychological Science, 19,* 831–837.

Jones, E. (1953). *The life and work of Sigmund Freud* (Ed. and abridged by L. Trilling & S. Marcus) (Vol. 1). New York: Basic Books.

Jones, E. (1955). *The life and work of Sigmund Freud* (Ed. and abridged by L. Trilling & S. Marcus) (Vol. 2). New York: Basic Books.

Jones, E. (1957). *The life and work of Sigmund Freud* (Ed. and abridged by L. Trilling & S. Marcus) (Vol. 3). New York: Basic Books.

Jones, E. (1961). *The life and work of Sigmund Freud* (Ed. and abridged by L. Trilling & S. Marcus). New York: Basic Books.

Jones, J. D., Cassidy, J., & Shaver, P. R. (2015). Adult attachment style and parenting. In A. Simpson & W. S. Rholes (Eds.), *Attachment theory and research: New directions and emerging themes*. New York: Guilford Press.

Jones, M. C. (1924). A laboratory study of fear: The case of Peter. *Pedagogical Seminary, 31,* 308–315.

Joyce, N., & Baker, D. B. (2008, September). The IQ zoo. *Monitor on Psychology, 39*(8), 24–25.

Juang, L. P., & Cookston, J. T. (2009). A longitudinal study of family obligation and depressive symptoms among Chinese American adolescents. *Journal of Family Psychology, 23*, 396–404.

Juang, L. P., Syed, & Cookston, J. T. (2012). Acculturation-based and everyday parent–adolescent conflict among Chinese American adolescents: Longitudinal trajectories and implications for mental health*. Journal of Family Psychology, 26*(6), 916–926.

Kaiser, M. K., McCloskey, M., & Proffitt, D. R. (1986). Development of intuitive theories of motion: Curvilinear motion in the absence of external forces. *Developmental Psychology, 22*, 67–71.

Kaminski, J., Call, J., & Tomasello, M. (2008). Chimpanzees know what others know, but not what they believe. *Cognition, 109,* 224–234.

Karmiloff-Smith, A. (1992). *Beyond modularity: A developmental perspective on cognitive science.* Cambridge, MA: MIT Press.

Karmiloff-Smith, A. (2012). From constructivism to neuroconstructivism: The activity-dependent structuring of the human brain. In E. Marti & C. Rodriguez (Eds.), *After Piaget*. Piscataway, NJ: Transaction Publishers.

Kawai, M. (1965). Newly acquired pre-cultural behavior of natural troop of Japanese monkeys. *Primates, 6*, 1–30.

Kearins, J. M. (1981). Visual spatial memory in Australian Aboriginal children of desert regions. *Cognitive Psychology, 13*, 434–460.

Keating, D. P. (2012). Cognitive and brain development in adolescence. *Enfance, 64*(3), 267–279.

Keeney, T. J., Cannizzo, S. R., & Flavell, J. H. (1967). Spontaneous and induced verbal rehearsal in a recall task. *Child Development, 38,* 953–966.

Keil, F. C. (1989). *Concepts, kinds, and cognitive development.* Cambridge, MA: MIT Press.

Keil, V., & Price, J. M. (2009). Social information-processing patterns of maltreated children in two social domains. *Journal of Applied Developmental Psychology, 30,* 43–52.

Kellman, P. J., & Spelke, E. (1983). Perception of partly occluded objects in infancy. *Cognitive Psychology, 15*, 483–524.

Kendler, H. H. (1987). *Historical foundations of modern psychology*. Chicago: Dorsey Press.

Keysers, C., Thioux, M., & Gazzola, V. (2013). Mirror neuron system and social cognition. In S. Baron-Cohen, H. Tager-Flusberg, & M. V. Lombardo (Eds*.), Understanding other minds: Perspectives from developmental social neuroscience* (3rd ed.). New York: Oxford University Press.

Killen, M., & Smetana, J. G. (2015). Origins and development of morality. In R. M. Lerner (Series Ed.) & M. E. Lamb (Vol. Ed.), *Handbook of child psychology and developmental science, Vol. 3: Socioemotional processes* (7th ed.). New York: Wiley.

Kimble, G. A. (1961). *Hilgard and Marquis' conditioning and learning* (2nd ed.). New York: Appleton-Century-Crofts.

King, M., & Wilson, A. (1975, April 11). Evolution at two levels in humans and chimpanzees*. Science, 188*, 107–116.

King, R. A., Neubauer, P. B., Abrams, S., & Dowling, A. S. (Eds.). (2007). Celebrating the 150th anniversary of the birth of Sigmund Freud. *The psychoanalytic study of the child* (Vol. *62).* New Haven, CT: Yale University Press.

Klahr, D., & Siegler, R. S. (1978). The representation of children's knowledge. In H. W. Reese & L. P. Lipsitt (Eds.), *Advances in child development and behavior* (Vol. 12). New York: Academic Press.

Klahr, D., & Wallace, J. G. (1976). *Cognitive development: An information-processing view.* Hillsdale, NJ: Erlbaum.

Klein, G. S. (1970). *Perception, motives, and personality.* New York: Knopf.

Klopfer, P. H. (1971). Mother love: What turns it on? *American Scientist, 59,* 404–407.

Kluger, J. (2015). Why you're pretty much unconscious all the time. Retrieved from the TIME website: http://time.com/3937351/consciousness-unconsciousness-brain/

Koenig, M. A., Clément, F., & Harris, P. L. (2004). Trust in testimony: Children's use of true and false statements. *Psychological Science, 15*, 694–698.

Koenig, M. A., & Sabbagh, M. A. (2013). Selective social learning: New perspectives on learning from others. *Developmental Psychology, 49*(3), 399–403.

Koenig, O. (1951). Das Aktionsystem der Bartmeise *(Panurus biarmicus* L.*). Oesterreichische Zoologische Zeitschrift, 1*, 1–82.

Kohlberg, L. (1969). Stage and sequence: The cognitive-developmental approach to socialization. In D. A. Goslin (Ed.), *Handbook of socialization theory and research.* Chicago: Rand-McNally.

Krafft, C. E, Schwarz, N. F., Chi, L., Weinberger, A. L., Schaeffer, D. J., Pierce, J. E, . . . McDowell, J. E. (2014). An 8-month randomized controlled exercise trial alters brain activation during cognitive tasks in overweight children. *Obesity, 22*(1), 232–242.

Kretch, K. S. & Adolph, K. E. (2013). Cliff or step? Posture-specific learning at the edge of a drop-off. *Child Development, 84*, 226–240.

Kretch, K. S., Franchak, J. M., & Adolph, K. E. (2014). Crawling and walking infants see the world differently. *Child Development, 85*, 1503–151.

Kreutzer, M. A., Leonard, C., & Flavell, J. H. (1975). An interview study of children's knowledge about memory. *Monographs of the Society for Research in Child Development, 40*(1, Serial No. 159).

Kroesbergen, E. H., van't Noordende, J. E., & Kolkman, M. E. (2014). Training working memory in kindergarten children: Effects on working memory and early numeracy. *Child Neuropsychology, 20*(1), 23–37.

Kroger, J., & Marcia, J. E. (2013). The identity statuses: Origins, meanings, and interpretations. In S. J. Schwartz, K. Luyckx, & V. L. Vignoles. (Eds.), *Handbook of identity theory and research* (Vol. 1, pp. 31–53). New York, NY: Springer Science + Business Media.

Kroger, J., Martinussen, M., & Marcia, J. E. (2010). Identity status change during adolescence and young adulthood: A meta-analysis. *Journal of Adolescence, 33*(5), 683–698.

Kuhl, P. K. (2010). Brain mechanisms in early language acquisition. *Neuron, 67*, 713–727.

Kuhn, D. (1989). Children and adults as intuitive scientists. *Psychological Review, 96*, 674–689.

Kuhn, D. (2015). Thinking together and alone. *Educational Researcher, 44*(1), 46–53.

Kuhn, T. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago: University of Chicago Press.

Laible, D., Thompson, R. A., & Froimson, J. (2015). Early socialization: The influence of close relationships. In J. E. Grusec & P. D. Hastings (Eds.), *Handbook of socialization: Theory and research* (2nd ed.). New York, NY: Guilford Press.

Lampl, M. (1993). Evidence of salutatory growth in infancy. *American Journal of Human Biology, 5,* 641–652.

Langlois, J. H., Roggman, L. A., Casey, R. J., Ritter, J. M., Rieser-Danner, L. A., & Jenkins, V. Y. (1987). Infant preferences for attractive faces: Rudiments of a stereotype? *Developmental Psychology, 23,* 363–369.

Lansu, T. A. M., Cillessen, A. H. N., & Karremans, J. C. (2014). Adolescents' selective visual attention for high-status peers: The role of perceiver status and gender. *Child Development, 85*(2), 421–428.

Le Corre, M., Van de Walle, G., Brannon, E. M., & Carey, S. (2006). Re-visiting the competence/performance debate in the acquisition of the counting principles. *Cognitive Psychology, 52*(2), 130–169.

Legare, C. H., Wen, N. J., Herrmann, P. A., & Whitehouse, H. (2015). Imitative flexibility and the development of cultural learning. *Cognition, 142,* 351–361.

Leon, M. (1984). Rules mothers and sons use to integrate intent and damage information in their moral judgments. *Child Development, 55,* 2106–2113.

Lerner, R. M. (2006). Developmental science, developmental systems, and contemporary theories of human development. In W. Damon & R. M. Lerner (Series Eds.) & R. M. Lerner (Volume Ed.), *Handbook of child psychology: Vol. 1.Theoretical models of human development* (6th ed.). New York: Wiley.

Lerner, R. M., Lerner, J. V., Bowers, E. P., & Geldhof, G. J. (2015). Positive youth development and relational-developmental-systems. In R. M. Lerner (Series Ed.) & W. F. Overton & P. C. M. Molenaar (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 1. Theory and method* (7th ed.). New York, NY: Wiley

Levy, R. I. (1969). On getting angry in the Society Islands. In W. Caudill & T. Y. Lin (Eds.), *Mental health research in Asia and the Pacific.* Honolulu, HI: East-West Center Press.

Lewis, M. C., & Cook, L. C. (2007). Changing habits of emotion regulation at transition points in infancy: A dynamic systems analysis. *Journal of Developmental Processes, 2*, 67–89.

Liben, L. S., & Bowman, C. R. (2014). The development of memory from a Piagetian perspective. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory* (Vol. 1). West Sussex, UK: Wiley-Blackwell.

Liben, L. S., & Müller, U. (Eds.) (2015). *Handbook of child psychology and developmental science: Vol. 2. Cognitive processes* (7th ed.). New York, NY: Wiley.

Lickliter, R., & Honeycutt, H. (2015). Biology, development, and human systems. In R. M. Lerner (Series Ed.) & W. F. Overton & P. C. M. Molenaar (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 1. Theory and method* (7th ed.). New York, NY: Wiley.

Lillard, A. S., Drell, M. B., Richey, E. M., Boguszewski, K., & Smith, E. D. (2015). Further examination of the immediate impact of television on children's executive function. *Developmental Psychology, 51*(6), 792–805.

Lindsay, R. K. (1991). Symbol-processing theories and the SOAR architecture [Review of the book *Unified theories of cognition*]. *Psychological Science, 5*, 294–302.

Linzarini, A., Houdé, O., & Borst, G. (2015). When Stroop helps Piaget: An inter-task positive priming paradigm in 9-year-old children. *Journal of Experimental Child Psychology, 139*, 71–82.

Looft, W. R., & Svoboda, C. P. (1971). *Structuralism in cognitive developmental psychology: Past, contemporary, and futuristic perspectives.* Unpublished manuscript, Pennsylvania State University, University Park.

Lopez, A., Ruvalcaba, O., & Rogoff, B. (2015). Attentive helping as a cultural practice of Mexican-heritage families. In Y. M. Caldera & E. W. Lindsey (Eds.), *Mexican American children and families: Multidisciplinary perspectives*. New York, NY: Routledge/Taylor & Francis Group.

Lorenz, K. Z. (1931). Beiträge zur Ethologie sozialer Corviden. *Journal für Ornithologie, 79,* 67–127.

Lorenz, K. Z. (1943). Die angeborenen Formen möglicher Erfahrung. *Zeitschrift für Tierpsychologie, 5*, 235–409.

Lorenz, K. Z. (1952). *King Solomon's ring*. New York: Crowell.

Lorenz, K. Z. (1959). Psychologie und Stammesgeschichte. In G. Herberer (Ed.), *Evolution der Organismen*. Stuttgart, Germany: Fischer.

Lorenz, K. Z. (1966). *On aggression.* New York: Harcourt, Brace and World.

Lourenco, O., & Machado, A. (1996). In defense of Piaget's theory: A reply to 10 common criticisms. *Psychological Review, 103*, 143–164.

Lukowski, A. F., & Bauer, P. J. (2014). Long-term memory in infancy and early childhood. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Luria, A. R. (1961). *The role of speech in the regulation of normal and abnormal behavior*. New York: Liveright.

Luria, A. R. (1976). *Cognitive development: Its cultural and social foundations*. Cambridge, MA: Harvard University Press.

Luria, A. R. (1979). *The making of mind: A personal account of Soviet psychology* (M. Cole & S. Cole, Eds.). Cambridge, MA: Harvard University Press.

Mace, W. M. (1977). James J. Gibson's strategy for perceiving: Ask not what's inside your head, but what your head's inside of. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing.* Hillsdale, NJ: Erlbaum.

Macfarlane, A. (1977). *The psychology of childbirth.* Cambridge, MA: Harvard University Press.

MacWhinney, B. J., Leinbach, J., Taraban, R., & McDonald, J. L. (1989). Language learning: Cues or rules? *Journal of Memory and Language, 28*, 255–277.

Maddux, J. E. (1998). Why the little blue engine could: Self-efficacy and the real power of positive thinking [Review of the book *Self-efficacy: The exercise of control*]. *Contemporary Psychology, 43*, 601–602.

Mahalingam, R. (2006). Cultural psychology of immigrants: An introduction. In R. Mahalingam (Ed.), *Cultural psychology of immigrants*. Mahwah, NJ: Erlbaum.

Mahler, M. S. (1968). *On human symbiosis and the vicissitudes of individuation: Vol. 1. Infantile psychosis.* New York: International Universities Press.

Mahler, M. S., Pine, F., & Bergman, A. (1975). *The psychological birth of the human infant.* New York: Basic Books.

Main, M., & Solomon, J. (1990). Procedures for identifying infants as disorganized/disoriented during the Ainsworth Strange Situation. In M. T. Greenberg, D. Cicchetti, & E. M. Cummings (Eds.), *Attachment in the preschool years*. Chicago: University of Chicago Press.

Manago, A. M. (2015). Values for gender roles and relations among high school and non-high school adolescents in a Maya community in Chiapas, Mexico. *International Journal of Psychology, 50*(1), 20–28.

Manago, A., Guan, S. A., & Greenfield, P. M. (2015). New media, social change, and human development from adolescence through the transition to adulthood. In L. A. Jensen (Ed.), *The Oxford handbook of human development and culture: An interdisciplinary perspective.* New York, NY: Oxford University Press.

Mandler, G. (1979). Emotion. In E. Hearst (Ed.), *The first century of experimental psychology*. Hillsdale, NJ: Erlbaum.

Marcia, J. E. (1967). Ego identity status: Relationship to change in self-esteem, "general maladjustment," and authoritarianism. *Journal of Personality, 35*, 118–133.

Marcia, J. E. (2007). Theory and measure: The identity status interview. In M. Watzlawik & A. Born (Eds.), *Capturing identity: Quantitative and qualitative methods* (pp. 1–14). Lanham, MD: University Press of America.

Markman, E. M. (1990). Constraints children place on word meanings. *Cognitive Science, 14*(1), 57–77.

Marks, A., Ejesi, K., & Garcia Coll, C. (2014). Understanding the U.S. immigrant paradox in childhood and adolescence. *Child Development Perspectives, 8*(2), 59–64.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*, 224–253.

Markus, H. R., & Kitayama, S. (2010). Cultures and selves: A cycle of mutual constitution. *Perspectives on Psychological Science, 5*(4), 420–430.

Martin, M. J., Davies, P. T., & MacNeill, L. A. (2014). Social defense: An evolutionary-developmental model of children's strategies for coping with threat in the peer group. *Evolutionary Psychology, 12*(1), 364–385.

Mascaro, O., & Csibra, G. (2014). Human infants' learning of social structures: The case of dominance hierarchy. *Psychological Science, 25*(1), 250–255.

Mascaro, O., & Sperber, D. (2009). The moral, epistemic, and mindreading components of children's vigilance towards deception. *Cognition, 112*, 367–380.

Mascolo, M. F., & Fischer, K. W. (2015). Dynamic development of thinking, feeling, and acting. In R. M. Lerner (Series Ed.) & W. F. Overton & P. C. M. Molenaar (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 1. Theory and method* (7th ed.). New York, NY: Wiley.

Masten, A. S., Herbers, J. E., Desjardins, C. D., Cutuli, J. J., McCormick, C. M., Sapienza, J. K., . . . Zelazo, P. D. (2012). Executive function skills and school success in young children experiencing homelessness. *Educational Researcher, 41*(9), 375–384.

Matlen, B. J., & Klahr, D. (2012). Sequential effects of high and low instructional guidance on children's acquisition of experimentation skills: Is it all in the timing? *Instructional Science, 41*(3), 621–634.

Maynard, A. M., Greenfield, P. M., & Childs, C. P. (2015). Developmental effects of economic and educational change: Cognitive representation in three generations across 43 years in a Maya community. *International Journal of Psychology, 50,*12–19.

Mayor, J., & Plunkett, K. (2010). A neurocomputational account of taxonomic responding and fast mapping in early word learning. *Psychological Review, 117,* 1–31.

McCain, G., & Segal, E. M. (1969). *The game of science*. Belmont, CA: Brooks/Cole.

McGrew, W. C. (1972). *An ethological study of children's behavior*. New York: Academic Press.

McLean, K. C., & Syed, M (Eds.) (2015). *The Oxford handbook of identity development*. New York, NY: Oxford University Press.

McMurray, B., Horst, J. S., & Samuelson, L. K. (2012). Word learning emerges from the interaction of online referent selection and slow associative learning. *Psychological Review, 119*(4), 831–877.

Mehta, M.A., Gore-Langton, E., Golembo, N., Colvert, E., Williams, S. C. R., & Sonuga-Barke, E. (2010). Hyporesponsive reward anticipation in the basal ganglia following severe institutional deprivation early in life. *Journal of Cognitive Neuroscience, 22*(10), 2316–2325.

Mejía-Arauz, R., Rogoff, B., Dexter, A., & Najafi, B. (2007). Cultural variation in children's social organization. *Child Development, 78*, 1001–1014.

Meltzoff, A. N. (2007). "Like me": A foundation for social cognition. *Developmental Science, 10*, 126–134.

Meltzoff, A. N., & Moore, M. K. (1989). Imitation in newborn infants: Exploring the range of gestures imitated and the underlying mechanisms. *Developmental Psychology, 25*, 954–962.

Michaels, C. F., & Carello, C. (1981). *Direct perception*. Englewood Cliffs, NJ: Prentice-Hall.

Miller, N. E., & Dollard, J. (1941). *Social learning and imitation.* New Haven, CT: Yale University Press.

Miller, P. H. (1978). Stimulus variables in conservation: An alternative approach to assessment. *Merrill-Palmer Quarterly, 24,* 141–160.

Miller, P. H. (1990). The development of strategies of selective attention. In D. F. Bjorklund (Ed.), *Children's strategies: Contemporary views of cognitive development*. Hillsdale, NJ: Erlbaum.

Miller, P. H. (2000). The development of interconnected thinking. In P. H. Miller & E. K. Scholnick (Eds.), *Toward a feminist developmental psychology*. New York: Routledge.

Miller, P. H. (2006). Contemporary perspectives from human development: Implications for feminist scholarship. *Signs: Journal of Women in Culture and Society, 31,* 445–469.

Miller, P. J., Fung, H., Lin, S., Chen, E., & Boldt, B. R. (2012). How socialization happens on the ground: Narrative practices as alternate socializing pathways in Taiwanese and European-American families. *Monographs of the Society for Research in Child Development, 77*(1, Serial No. 302).

Miller, P. H., & Scholnick, E. K. (Eds.). (2000). *Toward a feminist developmental psychology*. New York: Routledge.

Miller, P. H., & Seier, W. L. (1994). Strategy utilization deficiencies in children: When, where, and why. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 25). New York: Academic Press.

Miller, S. A. (1976). Nonverbal assessment of Piagetian concepts. *Psychological Bulletin, 83,* 405–430.

Mills, C. M. (2013). Knowing when to doubt: Developing a critical stance when learning from others. *Developmental Psychology, 49,* 404–418.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41,* 49–100.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., . . . Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Science, 108*(7), 2693–2698.

Moffitt, T. E., & The Klaus-Grawe 2012 Think Tank. (2013). Childhood exposure to violence and lifelong health: Clinical intervention science and stress-biology research join forces. *Development and Psychopathology, 25*(4), 1619–1634.

Montag, J. L., Jones, M. N., & Smith, L. B. (2015). The words children hear: Picture books and the statistics for language learning. *Psychological Science, 26*(9), 1489–1496.

Montagu, A. (1973). The new litany of "innate depravity," or original sin revisited. In A. Montagu (Ed.), *Man and aggression.* New York: Oxford University Press.

Montangero, J., & Maurice-Naville, D. (1997). *Piaget, or, the advance of knowledge*. Mahwah, NJ: Erlbaum.

Montgomery, D. E., & Koeltzow, T. E. (2010). A review of the day–night task: The Stroop paradigm and interference control in young children. *Developmental Review, 30*(3), 308–330.

Morelli, G. A., Rogoff, B., Oppenheim, D., & Goldsmith, D. (1992). Cultural variation in infants' sleeping arrangements: Questions of independence. *Developmental Psychology*, *28*, 604–613.

Morgan, R., & Rochat, P. (1997). Intermodal calibration of the body in early infancy. *Ecological Psychology, 9*(1), 1–23.

Morra, S., Gobbo, C., Marini, Z., & Sheese, R. (Eds.). (2008). *Cognitive development: Neo-Piagetian perspectives*. New York: Taylor & Francis Group/Erlbaum.

Morsella, E., Godwin, C. A., Jantz, T. K., Krieger, S. C., & Gazzaley, A. (in press). Homing in on consciousness in the nervous system: An action-based synthesis. *Behavioral and Brain Sciences*, June 22, 1–106.

Müller, U., Carpendale, J. I. M., & Smith, L. (Eds.) (2010). *The Cambridge companion to Piaget*. New York, NY: Cambridge University Press.

Munakata, Y. (1998). Infant perseveration and implications for object permanence theories: A PDP model of the AB task. *Developmental Science, 1*(2),161–184.

Murphy, M. L. M., Slavich, G. M., Rohleder, N., & Miller, G. E. (2013). Targeted rejection triggers differential pro- and anti-inflammatory gene expression in adolescents as a function of social status. *Clinical Psychological Science, 1*(1), 30–40.

Murray, F. B. (1983). Learning and development through social interaction and conflict: A challenge to social learning theory. In L. Liben (Ed.), *Piaget and the foundations of knowledge*. Hillsdale, NJ: Erlbaum.

Muscatell, K., Morelli, S., Falk, E., Way, B., Pfeifer, J. H., Galinsky, A. D., . . . Eisenberger, N. I. (2012). Social status modulates neural activity in the mentalizing network. *Neuroimage, 60*(3), 1771–1777.

Nagy, E., Pilling, K., Orvos, H., & Molnar, P. (2013). Imitation of tongue protrusion in human neonates: Specificity of the response in a large sample. *Developmental Psychology, 49*(9), 1628–1638.

National Center for Education Statistics, Institute of Education Sciences. U. S. Department of Education. (2011). *TIMSS 2011: Mathematics and science achievement of U.S. fourth- and eighth-grade students in an international context.*

Needham, A., & Baillargeon, R. (1998). Effects of prior experience on 4.5-month-old infants' object segregation. *Infant Behavior and Development, 21*, 1–24.

Nelson, C. A., III, Zeanah, C. H., & Fox, N. A. (2007). The effects of early deprivation on brain-behavioral development: The Bucharest Intervention Project. In D. Romer & E. F. Walker (Eds.), *Adolescent psychopathology and the developing brain: Integrating brain and prevention science.* New York: Oxford University Press.

Nelson, K. (1978). How children represent knowledge of their world in and out of language: A preliminary report. In R. S. Siegler (Ed.), *Children's thinking: What develops?* Hillsdale, NJ: Erlbaum.

Nelson, K. (1996). *Language in cognitive development: The emergence of the mediated mind.* New York: Cambridge University Press.

Nelson, K. (Ed.). (1986). *Event knowledge.* Hillsdale, NJ: Erlbaum.

Nelson, K. (2008).Self in time: Emergence within a community of minds. In F. Sani (Ed.), *Self continuity: Individual and collective perspectives.* New York: Psychology Press.

Nelson, K., & Fivush, R. (2004). The emergence of autobiographical memory: A social cultural developmental theory. *Psychological Review, 111*, 486–511.

Neville, H. J. (1995). *Brain plasticity and the acquisition of skill*. Paper presented at the Cognitive Neuroscience and Education Conference, Eugene, OR.

Nevo, E., & Breznitz, Z. (2013).The development of working memory from kindergarten to first grade in children with different decoding skills. *Journal of Experimental Child Psychology, 114*(2), 217–228.

Newcomb, A. F., & Collins, W. A. (1979). Children's comprehension of family role portrayals in televised dramas: Effects of socioeconomic status, ethnicity, and age. *Developmental Psychology, 15,* 417–423.

Newell, A., & Simon, H. A. (1961, December 22). Computer simulation of human thinking. *Science, 134,* 2011–2017.

Newport, E. L. (1991). Constraining concepts of the critical period for language. In S. Carey & R. Gelman (Eds.), *The epigenesis of mind: Essays on biology and cognition*. Hillsdale, NJ: Erlbaum.

Ng, F., & Pomeranatz, E. M, & Lam, S. (2007). European American and Chinese parents' responses to children's success and failure: Implications for children's responses. *Developmental Psychology, 107, 43*(5), 1239–1255.

Nielsen, M., Mushin, I., Tomaselli, K., & Whiten, A. (2014). Where culture takes hold: "Overimitation" and its flexible deployment in Western, Aboriginal, and Bushmen children. *Child Development, 85*(6), 2169–2184.

Nowak, A., Vallacher, R. R., & Zochowski, M. (2005). The emergence of personality: Dynamic foundations of individual variation. *Developmental Review, 25,* 351–385.

Nunes, T., & Bryant, P. (2015). The development of mathematical reasoning. In R. M. Lerner (Series Ed.) & L S. Liben & U. Müller (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 2. Cognitive processes* (7th ed.). New York, NY: Wiley.

Oakes, L. M., Newcombe, N. S., & Plumert, J. M. (2009). Are dynamic systems and connectionist approaches an alternative to Good Old Fashioned Cognitive Development? In J. P. Spencer, M. Thomas, & J. McClelland (Eds.), *Dynamic systems and connectionist approaches to development.* New York: Oxford University Press.

Oberlander, T. F., Weinberg, J., Papsdorf, M., Grunau, R., Misri, S., & Devlin, A. M. (2008). Prenatal exposure to maternal depression, neonatal methylation of human glucocorticoid receptor gene (NR3C1) and infant cortisol stress responses. *Epigenetics, 3*, 97–106.

Opfer, J. E., & Siegler, R. S. (2004). Revisiting preschoolers' living things concept: A microgenetic analysis of conceptual change in basic biology. *Cognitive Psychology, 49*(4), 301–332.

Oudekerk, B. A., Allen, J. P., Hessel, E. & Molloy, L. E. (2015). The cascading development of autonomy and relatedness from adolescence to adulthood. *Child Development, 86*(2), 472–485.

Over, H., & Carpenter, M. (2013). The social side of imitation. *Child Development Perspectives, 7*(1), 6–11.

Overton, W. F. (1984). World views and their influence on psychological theory and research: Kuhn-Lakatos-Laudan. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 18). Orlando, FL: Academic Press.

Overton, W. F., & Molenaar, P. C. M. (2015). Concepts, theory, and method in developmental science: A view of the issues. In R. M. Lerner (Series Ed.) & W. F. Overton & P. C. M. Molenaar (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 1. Theory and method* (7th ed.). New York, NY: Wiley.

Paik, J. H., van Gelderen, L., Gonzales, M., de Jong, P. F., & Hayes, M. (2011). Cultural differences in early math skills among U.S., Taiwanese, Dutch, and Peruvian preschoolers. *International Journal of Early Years Education, 19*(2), 133–143.

Palombo, J., Bendicsen, H. K., & Koch, B. J. (2009). *Guide to psychoanalytic developmental theories*. New York, NY: Springer Science+Business Media.

Papert, S. (1999). The century's greatest minds: Jean Piaget. *TIME, 13*, 74–75 & 78.

Paris, S. G., & Cross, D. R. (1988). The zone of proximal development: Virtues and pitfalls of a metaphorical representation of children's learning. *The Genetic Epistemologist*, *16*, 27–37.

Parke, R. D. (2013). Gender differences and similarities in parental behavior. In W. B.Wilcox & K. Kovner Kline (Eds.), *Gender and parenthood: Biological and social scientific perspectives* (pp. 120–163). New York, NY: Columbia University Press.

Parker, I. (Ed.) (2015). *Handbook of critical psychology*. New York, NY: Routledge.

Parmiggiani, A., Maggliali, M., Natale, L., Nori, F., Schmitz, A., Tsagarakis, N., . . . Metta, G. (2012). The design of the iCub humanoid robot. *International Journal of Humanoid Robotics, 9*(4), 1–24.

Patterson, G. R. (1980). Mothers: The unacknowledged victims. *Monographs of the Society for Research in Child Development, 45*(5, Serial No. 186).

Peace, M. A., & Kuhn, D. (2011). Experimental analysis of the effective components of problem-based learning. *Science Education, 95*(1), 57–86.

Pelucchi, B., Hay, J. F., & Saffran, J. R. (2009). Statistical learning in a natural language by 8-month-olds. *Child Development, 80*, 674–685.

Pepper, S. C. (1934). A contextualistic theory of possibility. *University of California Publications in Philosophy*, *17*, 177–197.

Pepper, S. C. (1942). *World hypotheses: A study in evidence*. Berkeley, CA: University of California Press.

Perez, S. M., & Gauvain, M. (2009). Mother–child planning, child emotional functioning, and children's transition to first grade. *Child Development, 80*, 776–791.

Perfors, A., Tenenbaum, J. B., Griffiths, T. L., & Xu, F. (2011). A tutorial introduction to Bayesian models of cognitive development. *Cognition, 120*(3), 302–321.

Perry, D. G. (1989, April). Social learning theory. In R. Vasta (Chair), *Theories of child development.* Symposium conducted at the meeting of the Society for Research in Child Development, Kansas City, MO.

Peterson, C., Wang, Q., & Hou, Y. (2009). "When I was little": Childhood recollections in Chinese and European Canadian grade school children. *Child Development, 80*, 506–518.

Piaget, J. (1929). *The child's conception of the world*. New York: Harcourt, Brace. (Original work published 1926)

Piaget, J. (1950). *The psychology of intelligence.* New York: Harcourt, Brace. (Original work published 1947)

Piaget, J. (1951). *Play, dreams and imitation in childhood.* New York: Norton. (Original work published 1945)

Piaget, J. (1952a). Autobiography. In E. G. Boring, H. S. Langfeld, H. Werner, & R. M. Yerkes (Eds.), *A history of psychology in autobiography* (Vol. 4). Worcester, MA: Clark University Press.

Piaget, J. (1952b). *The origins of intelligence in children*. New York: International Universities Press. (Original work published 1936)

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books. (Original work published 1937)

Piaget, J. (1964a). Development and learning. In R. E. Ripple & V. N. Rockcastle (Eds.), *Piaget rediscovered.* Ithaca, NY: Cornell University Press.

Piaget, J. (1964b). *The early growth of logic in the child.* New York: Harper & Row.

Piaget, J. (1970). *The child's conception of movement and speed.* London: Routledge & Kegan Paul. (Original work published 1946)

Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. *Human Development, 15*, 1–12.

Piaget, J. (1979). Correspondences and transformations. In F. B. Murray (Ed.), *The impact of Piagetian theory: On education, philosophy, psychiatry, and psychology.* Baltimore: University Park Press.

Piaget, J. (1980). *Experiments in contradiction.* Chicago: University of Chicago Press. (Original work published 1974)

Piaget, J. (1981). *Intelligence and affectivity: Their relationship during child development*. Palo Alto, CA: Annual Reviews. (Original work published 1954)

Piaget, J. (1983). Piaget's theory. In P. H. Mussen (Series Ed.) & W. Kessen (Vol. Ed.), *Handbook of child psychology: Vol. 1. History, theory, and methods* (4th ed.). New York: Wiley.

Piaget, J. (1985). *The equilibration of cognitive structures.* Chicago: University of Chicago Press. (Original work published 1975)

Piaget, J. (1987). *Possibility and necessity* (Vols. 1–2). Minneapolis, MN: University of Minnesota Press. (Original work published 1981)

Piaget, J. (1995). *Sociological studies*. New York: Routledge. (Original work pub- lished 1965)

Piaget, J., & Inhelder, B. (1969). *The psychology of the child.* New York: Basic Books. (Original work published 1968)

Piazza, M. (2010). Neurocognitive start-up tools for symbolic number representations. *Trends in Cognitive Sciences, 14*(12), 542–551.

Pick, A. D., Gross, D., Heinrichs, M., Love, M., & Palmer, C. (1994). Development of perception of the unity of musical events. *Cognitive Development, 9,* 355–375.

Pick, H. L. (1992). Eleanor J. Gibson: Learning to perceive and perceiving to learn. *Developmental Psychology, 28*, 787–794.

Pietromonaco, P. R., & Powers, S. I. (2015). Attachment and health-related physiological stress processes. *Current Opinion in Psychology, 1,* 34–39.

Ping, R. M., & Goldin-Meadow, S. (2008). Hands in the air: Using ungrounded iconic gestures to teach children conservation of quantity. *Developmental Psychology, 44*, 1277–1287.

Plötner, M., Over, H., Carpenter, M., & Tomasello, M. (2015). The effects of collaboration and minimal-group membership on children's prosocial behavior, liking, affiliation, and trust. *Journal of Experimental Child Psychology, 139*, 161–173.

Pluess, M., & Belsky, J. (2011). Prenatal programming of postnatal plasticity? *Development and Psychopathology, 23,* 29–38.

Plumert, J. M., & Kearney, J. K. (2014). How do children perceive and act on dynamic affordances in crossing traffic-filled roads? *Child Development Perspectives, 8*(4), 207–212.

Poincaré, J. H. (1952). *Science and hypothesis*. New York: Dover. (Original work published 1908)

Powell, L. & Spelke, E. S. (2013). Preverbal infants expect members of social groups to act alike. *Proceedings of the National Academy of Sciences, 110*(41), 3965–3972.

Powers, A., & Casey, B. J. (2015). The adolescent brain and the emergence and peak of psychopathology. *Journal of Infant, Child & Adolescent Psychotherapy, 14*(1), 3–15.

Pratkanis, A. R., & Greenwald, A. B. (1985). How shall the self be conceived? *Journal for the Theory of Social Behavior, 15*, 311–328.

Price-Williams, D. R., Gordon, W., & Ramirez, M., III. (1969). Skill and conservation: A study of pottery-making children. *Developmental Psychology, 1,* 769.

Profet, M. (1992). Pregnancy sickness as adaptation: A deterrent to maternal ingestion of teratogens. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adaptive mind: Evolutionary psychology and the generation of culture*. New York: Oxford University Press.

Ramsey, J. L., Langlois, J. H., Hoss, R. A., Rubenstein, A. J., & Griffin, A. M. (2004). Origins of a stereotype: Categorization of facial attractiveness by 6-month-old infants. *Developmental Science, 7,* 201–211.

Rapaport, D. (1960). The structure of psychoanalytic theory: A systemization attempt. *Psychological Issues, 2*(2, Monograph No. 6).

Razza, R. A., & Blair, C. (2009). Associations among false-belief understanding, executive function, and social competence: A longitudinal analysis. *Journal of Applied Developmental Psychology, 30*(3), 332–343.

Reddy, V. (1991). Playing with others' expectations: Teasing and mucking about in the first year. In A. Whiten (Ed.), *Natural theories of mind: Evolution, development and simulation of everyday mindreading*. Oxford, UK: Basil Blackwell.

Reese, E. (2014). Taking the long way: Longitudinal approaches to autobiographical memory development. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Reese, H. W. (1991). Contextualism and developmental psychology. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 23). San Diego, CA: Academic Press.

Reyher, J. (1967). Hypnosis in research on psychopathology. In J. E. Gordon (Ed.), *Handbook of clinical and experimental hypnosis.* New York: Macmillan.

Rhodes, M. (2013). The conceptual structure of social categories: The social allegiance hypothesis. In M. R. Banaji & S. A. Gelman (Eds.), *Navigating the social world: What infants, children, and other species can teach us.* New York: Oxford University Press.

Rholes, W. S., & Simpson, J. A. (2015). Introduction: New directions and emerging themes in attachment theory and research. In J. A. Simpson & W. S. Rholes (Eds.) *Attachment theory and research: New directions and emerging themes.* New York, NY: Guilford.

Riegel, K. (1972). Influence of economic and political ideologies on the development of developmental psychology. *Psychological Bulletin*, *78*, 129–141.

Riggins, T., & Nelson, C. A. (2014). Memory in at-risk populations: Infants and children who experience metabolic disturbances during the prenatal period. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Risley, R. R., & Hart, B. (1995). *Meaningful differences in the everyday experience of young American children.* Baltimore, MD: Paul H Brookes Publishing.

Rivas-Drake, D., Syed, M., Umana-Taylor, A., Markstrom, C., French, S., Schwartz, S. J., Lee, R., & the Ethnic and Racial Identity in the 21st Century Study Group. (2014). Feeling good, happy, and proud: A meta-analysis of positive ethnic-racial affect and adjustment. *Child Development, 85*(1), 77–102.

Rizzolatti, G., & Craighero, L. (2004). The mirror neuron system. *Annual Review of Neuroscience, 27,* 169–192.

Robson, C., & Witenberg, R. T. (2013). The influence of moral disengagement, morally based self-esteem, age, and gender on traditional bullying and cyberbullying. *Journal of School Violence,12*(2), 211–231.

Robson, K. S. (1967). The role of eye-to-eye contact in maternal-infant attachment. *Journal of Child Psychology and Psychiatry, 8,* 13–25.

Rochat, P. (2012). Baby assault on Piaget. In C. Martí & C. Rodriguez (Eds.), *After Piaget*. Piscataway, NJ: Transaction Publishers.

Roediger, H. L. (1979). Implicit and explicit memory models. *Bulletin of the Psychonomic Society, 13,* 339–342.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. New York: Oxford University Press.

Rogoff, B. (2014). Learning by observing and pitching in to family and community endeavors: An orientation. *Human Development, 57*(2–3), 69–81.

Rogoff, B., & Gardner, W. P. (1984). Guidance in cognitive development: An examination of mother–child instruction. In B. Rogoff & J. Lave (Eds.), *Everyday cognition: Its development in social context*. Cambridge, MA: Harvard University Press.

Rogoff, B., & Göncü, A. (1987). Vygotsky and beyond [Review of the book *Vygotsky and the social formation of mind*]. *Contemporary Psychology*, *32*, 22–23.

Rogoff, B., Najafi, B., & Mejia-Arauz, R. (2014). Constellations of cultural practices across generations: Indigenous American heritage and learning by observing and pitching in. *Human Development, 57*, 82–95.

Romens, S. E., McDonald, J., Svaren, J., & Pollak, S. D. (2015). Associations between early life stress and gene methylation in children. *Child Development, 86*(1), 303–309.

Rose, S. A., Feldman, J. F., & Jankowski, J. J. (2014). Memory in at-risk populations: Infants born prior to term. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Rosenberger, N. (2007). Rethinking emerging adulthood in Japan: Perspectives from long-term single women. *Child Development Perspectives, 1*, 92–95.

Rosser, S. V., & Miller, P. H. (2000). Feminist theories: Implications for developmental psychology. In P. H. Miller & E. K. Scholnick (Eds.), *Toward a feminist developmental psychology*. New York: Routledge.

Rovee-Collier, C. K., & Gerhardstein, P. (1997). The development of infant memory. In N. Cowan (Ed.), *The development of memory in childhood*. Hove, East Sussex, UK: Psychology Press.

Rubin, K. H., Bukowski, W. M., & Bowker, J. C. (2015). Children in peer groups. In R. M. Lerner (Series Ed.) & M. H. Bornstein & T. Leventhal (Vol. Eds.), *Handbook of child psychology and developmental science, Vol. 4: Ecological settings and processes* (7th ed.). New York: Wiley.

Ruffman, T. (1999). Children's understanding of logical inconsistency. *Child Development, 70*, 872–886.

Runions, K. C., & Bak, M. (2015). Online moral disengagement, cyberbullying, and cyber-aggression. *Cyberpsychology, Behavior, and Social Networking, 18*(7), 400–405.

Russell, J. (1982). Cognitive conflict, transmission, and justification: Conservation attainment through dyadic interaction. *Journal of Genetic Psychology, 140*, 283–297.

Russell, M. J., Mendelson, T., & Peeke, H. V. S. (1983). Mothers' identification of their infants' odors. *Ethology and Sociobiology, 4,* 29–31.

Saby, J. N., Marshall, P. J., & Meltzoff, A. N. (2012). Neural correlates of being imitated: An EEG study in preverbal infants. *Social Neuroscience, 7*(6), 650–661.

Saffran, J. R., & Thiessen, E. D. (2007). Domain-general learning capacities. In E. Hoff & M. Shatz (Eds.), *Blackwell handbook of language development*. West Sussex, UK: Wiley-Blackwell.

Salmon, K., Pipe, M., Malloy, A., & Mackay, K. (2012). Do non-verbal aids increase the effectiveness of "best practice" verbal interview techniques? An experimental study. *Applied Cognitive Psychology, 26*(3), 370–380.

Sameroff, A. J., & Suomi, S. J. (1996). Primates and persons: A comparative developmental understanding of social organization. In R. B. Cairns, G. H. Elder, & E. J. Costello (Eds.), *Developmental science*. Cambridge, England: Cambridge University Press.

Samuelson, L. K., Jenkins, G. W., & Spencer, J. P. (2015). Grounding cognitive-level in behavior: The view from dynamic systems theory. *Topics in Cognitive Science, 7*(2), 191–205.

Saxe, G. B. (1999). Source of concepts: A cultural-developmental perspective. In E. K. Scholnick, K. Nelson, S. A. Gelman, & P. H. Miller (Eds.), *Conceptual development: Piaget's legacy.* Mahwah, NJ: Erlbaum.

Saxe, G. B. (2012). *Cultural development of mathematical ideas: Papua New Guinea studies.* New York, NY: Cambridge University Press.

Saxe, G. B., Guberman, S. R., & Gearhart, M. (1987). Social processes in early number development. *Monographs of the Society for Research in Child Development, 52*(2, Serial No. 216).

Scarr, S. (1985). Cultural lenses on mothers and children. In L. Friedrich-Cofer (Ed.), *Human nature and public policy*. New York: Praeger.

Schauble, L. (1996). The development of scientific reasoning in knowledge-rich contexts. *Developmental Psychology, 32*, 102–119.

Scheper-Hughes, N. (1987). Culture, scarcity, and maternal thinking: Mother love and child death in Northeast Brazil. In N. Scheper-Hughes (Ed.), *Child survival.* Boston: D. Reidel.

Schlein, S. P. (1987). Editor's preface. In E. H. Erikson (Au.) & S. P. Schlein (Ed.), *A way of looking at things: Selected papers of Erik H. Erikson, 1930–1980*. New York, NY: W. W. Norton & Company.

Schlesinger, M., & McMurray, B. (2012). The past, present, and future of computational models of cognitive development. *Cognitive Development, 27*, 326–348.

Schnable, P. S., Ware, D., Fulton, R. S., Stein, J. C., Wei, F., Pasternak, S., . . . Wilson, R. K. (2009). The B73 maize genome: Complexity, diversity, and dynamics. *Science, 326*(5956), 1112–1115.

Schneider, W. (2014). Individual differences in memory development and educational implications: Cross-sectional and longitudinal evidence. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Schneider, W., & Bullock, M. (2009). *Human development from early childhood to early adulthood: Findings from a 20 year longitudinal study.* New York: Psychology Press.

Schneider, W., & Weinert, F. E. (1989). Memory development: Universal changes and individual differences. In A. de Ribaupierre (Ed.), *Transitional mechanisms in child development: The longitudinal perspective*. Cambridge, England: Cambridge University Press.

Scholnick, E. K. (2000). Engendering development: Metaphors of change. In P. H. Miller & E. K. Scholnick (Eds.), *Toward a feminist developmental psychology*. New York: Routledge.

Scholnick, E. K., & Miller, P. H. (2007). Uncovering the body in conceptual development. In W. Overton & U. Mueller (Eds.), *Developmental perspectives on embodiment and consciousness*. Mahwah, NJ: Erlbaum.

Schonert-Reichl, K. A., Oberle, E., Lawlor, M. S., Abbott, D., Thomson, K., Oberlander, T., & Diamond, A. (2015). Enhancing cognitive and social–emotional development through a simple-to-administer mindfulness-based school program for elementary school children: A randomized controlled trial. *Developmental Psychology, 51*(1), 52–66.

Schore, A. N. (2014). Early interpersonal neurobiological assessment of attachment and autistic spectrum disorders. *Frontiers in Psychology, 5*, 1049.

Schwarzer, G., Freitag, C., Buckel, R., & Lofruthe, A. (2013). Crawling is associated with mental rotation ability by 9-month-old infants. *Infancy, 18*(3), 432–441.

Sears, R. R., Rau, L., & Alpert, R. (1965). *Identification and child rearing*. Stanford, CA: Stanford University Press.

Setoh, P., Wu, D., Baillargeon, R., & Gelman, R. (2013). Young infants have biological expectations about animals. *Proceedings of the National Academy of Sciences, 110*(40), 15937–15942.

Shackman, J. E., & Pollak, S. C. (2014). Impact of physical maltreatment on the regulation of negative affect and aggression. *Development and Psychopathology*, *26*(4), 1021–1033.

Shahaeian, A., Peterson, C. C., Slaughter, V., & Wellman, H. M. (2011). Culture and the sequence of steps in theory of mind development. *Developmental Psychology*, *47*(5),1239–1247.

Shalev, I., Moffitt, T. E., Sugden, K., Williams, B., Houts, R. M., Danes, A., Mill, J., . . . Caspi, A. (2013). Exposure to violence during childhood is associated with telomere erosion from 5 to 10 years of age: A longitudinal study. *Molecular Psychiatry, 18*, 576–581.

Shapley, H., Rapport, S., & Wright, H. (Eds.). (1965). *The new treasury of science*. New York: Harper & Row.

Sherman, L. J., Rice, K., & Cassidy, J. (2015). Infant capacities related to building internal working models of attachment figures: A theoretical and empirical review. *Developmental Review*, *37*, 109–141.

Shweder, R. A., Balle-Jensen, L., & Goldstein, W. (1995). Who sleeps by whom revisited: A method for extracting the moral goods implicit in praxis. In J. J. Goodnow, P. J. Miller, & F. Kessell (Eds.), *Cultural practices as contexts for development: New directions for child development*. San Francisco: Jossey-Bass.

Shweder, R. A., Goodnow, J. J., Hatano, G., LeVine, R. A., Markus, H. R., & Miller, P. J. (2006). The cultural psychology of development: One mind, many mentalities. In W. Damon & R. M. Lerner (Series Eds.) & R. M. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1.Theoretical models of human development* (6th ed.). New York: Wiley.

Siegal, M. (1991). *Knowing children: Experiments in conversation and cognition*. Hillsdale, NJ: Erlbaum.

Siegler, R. S. (1978). The origins of scientific reasoning. In R. S. Siegler (Ed.), *Children's thinking: What develops?* Hillsdale, NJ: Erlbaum.

Siegler, R. S. (1992). The other Alfred Binet. *Developmental Psychology, 28,* 179–190.

Siegler, R. S. (1995). How does change occur: A microgenetic study of number conservation. *Cognitive Psychology, 28*, 225–273.

Siegler, R. S. (1996). *Emerging minds: The process of change in children's thinking*. New York: Oxford University Press.

Siegler, R. S. (1998). *Children's thinking* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Siegler, R. S. (2006). Microgenetic analyses of learning. In W. Damon & R. M. Lerner (Series Eds.) & D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (5th ed.). New York: Wiley.

Siegler, R. S., & Alibali, M. W. (2005). *Children's thinking* (4th ed.). Upper Saddle River, NJ: Prentice-Hall.

Siegler, R. S., & Chen, Z. (1998). Developmental differences in rule learning: A microgenetic analysis. *Cognitive Psychology, 36*, 273–310.

Siegler, R. S., & Jenkins, E. (1989). *How children discover new strategies*. Hillsdale, NJ: Erlbaum.

Siegler, R. S., & Lortie-Forgues, H. (2014). An integrative theory of numerical development. *Child Development Perspectives, 8*(3),144–150.

Siegler, R. S., & Ramani, G. B. (2009). Playing linear number board games—but not circular ones—improves low income preschoolers' numerical understanding. *Journal of Educational Psychology, 101*, 545–560.

Siegler, R. S., & Stern, E. (1998). Conscious and unconscious strategy discoveries: A microgenetic analysis. *Journal of Experimental Psychology: General, 127*, 377–397.

Signorella, M. L., & Liben, L. S. (1984). Recall and reconstruction of gender-related pictures: Effects of attitude, task difficulty, and age. *Child Development, 55,* 393–405.

Simpson, J. A., Griskevicius, V., Kuo, S. I., Sung, S., & Collins, W. A. (2012). Evolution, stress, and sensitive periods: The influence of unpredictability in early versus late childhood on sex and risky behavior. *Psychology, 48*(3), 674–686.

Skinner, B. F. (1948). *Walden two*. New York: Macmillan.

Skinner, B. F. (1967). Autobiography. In E. G. Boring & G. Lindzey (Eds.), *A history of psychology in autobiography* (Vol. 5). Englewood Cliffs, NJ: Prentice-Hall.

Skinner, B. F. (1980). The experimental analysis of operant behavior: A history. In R. W. Rieber & K. Salzinger (Eds.), *Psychology: Theoretical-historical perspectives.* New York: Academic Press.

Sloutsky, V. (2015). Conceptual development. In R. M. Lerner (Series Ed.) & L. S. Liben & U. Müller (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 2. Cognitive processes* (7th ed.). New York, NY: Wiley.

Smith, J. D., Dishion, T. J., Shaw, D. S., Wilson, M. N., Winter, C. C., & Patterson, G. R. (2014). Coercive family process and early-onset conduct problems from age 2 to school entry. *Development and Psychopathology, 26*(4), 917–932.

Soken, N., & Pick, A. (1992). Intermodal perception of happy and angry expressive behaviors by seven-month-old infants. *Child Development, 63*, 787–795.

Somerville, L. H., Jones, R. M., Ruberry, E. J., Dyke, J. P., Glover, G., & Casey, B. J. (2013). The medial prefrontal cortex and the emergence of self-conscious emotion in adolescence. *Psychological Science, 24*(8), 1554–1562.

Sommerville, J. A., Hildebrand, E. A., & Crane, C. C. (2008). Experience matters: The impact of doing versus watching on infants' subsequent perception of tool use events. *Developmental Psychology, 44,* 1249–1256.

Soska, K. C., Adolph, K.E., & Johnson, S. P. (2010). Systems in development: Motor skill acquisition facilitates three-dimensional object completion. *Developmental Psychology, 46,* 129–138.

Southgate, V., & Begus, K. (2013). Motor activation during the prediction of nonexecutable actions in infants. *Psychological Science, 24*(6), 828–835.

Sowell, E. R., Thompson, P. M., Leonard, C. M., Welcome, S. E., Kan, E., & Toga, A. W. (2004). Longitudinal mapping of cortical thickness and brain growth in normal children. *Journal of Neuroscience, 24*, 8223–8231.

Spangler, G., Johann, M., Ronai, Z., & Zimmermann, P. (2009). Genetic and environmental influences on attachment disorganization. *Journal of Child Psychology and Psychiatry*, *50*, 952–961.

Spelke, E. S., Bernier, E. P., & Skerry, A. E. (2013). Core social cognition. In M. R. Banaji & S. A. Gelman (Eds.), *Navigating the social world: What infants, children, and other species can teach us*. New York, NY: Oxford University Press.

Spelke, E. S., & Kinzler, K. D. (2007). Core knowledge. *Developmental Science,10*, 89–96.

Sperber, D. (1994). The organization of lexical knowledge in the brain: Evidence from category- and modality-specific deficits. In L. A. Hirschfeld & S. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture*. New York: Cambridge University Press.

Spiker, C. C. (1966). The concept of development: Relevant and irrelevant issues. *Monographs of the Society for Research in Child Development*, *31*(5, Serial No. 107), 40–54.

Spitz, R. A. (1945). Hospitalism: An inquiry into the genesis of psychiatry conditions in early childhood. *Psychoanalytic Study of the Child, 1,* 53–74.

Spranger, M. (2015, August). *Incremental grounded language learning in robot-robot interactions—examples from spatial language*. Paper presented at the 5th Joint IEEE International Conference on Development and Learning and on Epigenetic Robotics. Providence, RI.

Starr, A., Libertus, M. E., & Brannon, E. M. (2013). Infants show ratio-dependent number discrimination regardless of set size. *Infancy, 18*(6), 927–941.

Steele, H., Steele, M., & Fonagy, P. (1996). Associations among attachment classifications of mothers, fathers, and their infants. *Child Development, 67*, 541–555.

Steenbeek, H., & van Geert, P. (2008). An empirical validation of a dynamic systems model of interaction: Do children of different sociometric statuses differ in their dyadic play? *Developmental Science, 11*, 253–281.

Steinberg, L. (2011). Adolescent risk taking: A social neurobiological perspective. In E. Amsel & J. G. Smetana (Eds.), *Adolescent vulnerabilities and opportunities: Developmental and constructivist perspectives.* New York, NY: Cambridge University Press.

Stern, D. N. (1974). Mother and infant at play: The dyadic interaction involving facial, vocal, and gaze behaviors. In M. Lewis & L. A. Rosenblum (Eds.), *The effect of the infant on its caretaker*. New York: Wiley.

Stern, D. N. (1985). *The interpersonal world of the infant*. New York: Basic Books.

Stern, D. N. (1995). *The motherhood constellation*. New York: Basic Books.

Stevenson, H. W., Lee, S., & Stigler, J. W. (1986). Achievement in mathematics. In H. Stevenson, H. Azuma, & K. Hakuta (Eds.), *Child development and education in Japan*. New York: Freeman.

Stigler, J. W. (1984). "Mental abacus": The effect of abacus training on Chinese children's mental calculation. *Cognitive Psychology, 16*, 145–176.

Stiles, J., Brown, T. T., Haist, F., & Jernigan, T. L. (2015). Brain and cognitive development. In R. L. Lerner (Series Ed.) & L. Liben & U. Müller (Vol. Eds.), *Handbook of child psychology and developmental science: Vol. 2. Cognitive processes* (7th ed.). New York, NY: Wiley.

Stipek, D. (1984).Young children's performance expectations: Logical analysis or wishful thinking? In J. G. Nicholls (Ed.), *Advances in motivation and achievement: Vol. 3.The development of achievement motivation*. Greenwich, CT: JAI Press.

Streri, A., & Pecheux, M. (1986). Vision-to-touch and touch-to-vision transfer of form in 5-month-old infants. *British Journal of Developmental Psychology, 4,* 161–167.

Suor, J. H., Sturge-Apple, M. L., Davies, P. T., Cicchetti, D., & Manning, L. G. (2015). Tracing differential pathways of risk: Associations among family adversity, cortisol, and cognitive functioning in childhood. *Child Development, 86*(4), 1142–1158.

Super, C. M., Harkness, S., Barry, O., & Zeitlin, M. (2011). Think locally, act globally: Contributions of African research to child development. *Child Development Perspectives, 5*(2), 119–125.

Syed, M., & Mitchell, L. (2013). Race, ethnicity, and emerging adulthood: Retrospect and prospects. *Emerging Adulthood, 1*(2), 83–95.

Tamis-LeMonda, C. S., Adolph, K. E., Lobo, S. A., Karasik, L. B., Ishak, S., & Dimitropoulou, K. A. (2008). When infants take mothers' advice: 18-month-olds integrate perceptual and social information to guide motor action. *Developmental Psychology, 44*, 734–746.

Telzer, E. H., Tsai, K., Gonzales, N., & Fuligni, A. (2015). Mexican American adolescents' family obligation values and behaviors: Links to internalizing symptoms across time and context. *Developmental Psychology, 51*(1), 75–86.

Thayer, G. H. (1909). *Concealing coloration in the animal kingdom*. New York: Macmillan.

Thelen, E., Fisher, D. M., & Ridley-Johnson, R. (1984). The relationship between physical growth and a newborn reflex. *Infant Behavior and Development, 7*, 479–493.

Thelen, E., & Smith, L. B. (2006). Dynamic systems theories. In W. Damon & R. M. Lerner (Series Eds.) & R. M. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1.Theoretical models of human development* (6th ed.). New York: Wiley.

Thiessen, D. (1996). *Bittersweet destiny: The stormy evolution of human behavior*. New Brunswick, NJ: Transaction.

Thompson, R. A. (1998). Early sociopersonality development. In W. Damon (Series Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (5th ed.). New York: Wiley.

Thorndike, E. L. (1898). Animal intelligence: An experimental study of the associative processes in animals. *Psychological Review: Series of Monograph Supplements, 2*(4, Whole No. 8).

Tinbergen, N. (1951). *The study of instinct*. London: Oxford University Press.

Tinbergen, N. (1958). *Curious naturalists.* New York: Basic Books.

Tinbergen, N. (1973). *The animal in its world: Explorations of an ethologist 1932–1972* (Vols. 1 & 2). Cambridge, MA: Harvard University Press.

Tobin, J. J., Wu, D. Y. H., & Davidson, D. H. (1989). *Preschool in three cultures*. New Haven, CT: Yale University Press.

Tolman, E. C. (1959). Principles of purposive behavior. In S. Koch (Ed.), *Psychology: A study of a science*. New York: McGraw-Hill.

Tomasello, M. (1999). *The cultural origins of human cognition.* Cambridge, MA: Harvard University Press.

Tomasello, M. (2014). *A natural history of human thinking*. Cambridge, MA: Harvard University Press.

Tomasello, M., & Herrmann, E. (2010). Ape and human cognition: What's the difference? *Current Directions in Psychological Science, 19*(1), 3–8.

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1991). *Cultural learning* (Tech. Rep. No. 21). Atlanta, GA: Emory University, Emory Cognition Project.

Tong, R. P. (2013). *Feminist thought: A more comprehensive introduction* (4th ed.). Boulder, CO: Westview Press.

Tooby, J., & Cosmides, L. (2005). Conceptual foundations of evolutionary psychology. In D. M. Buss (Ed.), *The handbook of evolutionary psychology*. Hoboken, NJ: Wiley.

Toulmin, S. (1978, September 28). The Mozart of psychology. *New York Review of Books, 25,* 51–57.

Tuddenham, R. D. (1966). Jean Piaget and the world of the child. *American Psychologist, 21,* 207–217.

Tulviste, P. (1991). *Cultural-historical development of verbal thinking: A psychological study*. Commack, NY: Nova Science.

Van de Vijver, F. J. R. (2015). Methodological aspects of cross-cultural research. In M. J. Gelfand, C. Chiu, & Y. Hong (Eds.), *Handbook of advances in culture and psychology* (Vol. 5.). New York, NY: Oxford University Press.

van IJzendoorn, M. H., & Sagi, A. (1999). Cross-cultural patterns of attachment: Universal and contextual dimensions. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment theory and research: Theory, research, and clinical application*. New York: Guilford Press.

van IJzendoorn, M. H., & Sagi-Schwartz, A. (2008). Cross-cultural patterns of attachment: Universal and contextual dimensions. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (2nd ed.). New York, NY: Guilford Press.

Vivanti, G., Trembath, D., & Dissanayake, C. (2014). Mechanisms of imitation impairment in autism spectrum disorder. *Journal of Abnormal Child Psychology, 42*(8), 1395–1405.

Vizioli, L., Rousselet, G. A., & Caldara, R. (2010). Neural repetition suppression to identity is abolished by other-race faces. *Proceedings of the National Academy of Sciences of the United States of America, 107*(46), 20081–20086.

Vondra, J. I., & Barnett, D. (Eds.). (1999). Atypical attachment in infancy and early childhood among children at developmental risk. *Monographs of the Society for Research in Child Development, 64*(3, Serial No. 258).

Vuyk, R. (1981). *Overview and critique of Piaget's genetic epistemology, 1965–1980* (Vol. 1). New York: Academic Press.

Vygotsky, L. S. (1956). *Selected psychological investigations*. Moscow: IAPN-SSSR.

Vygotsky, L. S. (1960). *Development of the higher psychical functions*. Moscow: APN.

Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1981). The instrumental method in psychology. In J. V. Wertsch (Ed.), *The concept of activity in Soviet psychology*. Armonk, NY: M. E. Sharpe.

Waddington, C. H. (1957). *The strategy of the genes.* London: Allen & Unwin.

Wadsworth, M. E. (2015). Development of maladaptive coping: A functional adaptation to chronic, uncontrollable stress. *Child Development Perspectives, 9*(2), 96–100.

Wallbank, T. W., & Taylor, A. M. (1960). *Civilization past and present.* Chicago: Scott, Foresman.

Wang, F. L., Chassin, L., Eisenberg, N., & Spinrad, T. L. (2015). Effortful control predicts adolescent antisocial-aggressive behaviors and depressive symptoms: Co-occurrence and moderation by impulsivity. *Child Development,* 86(6), 1812–1829.

Wang, Q. (2014). The cultured self and remembering. In P. J. Bauer & R. Fivush (Eds.), *The Wiley handbook on the development of children's memory*. West Sussex, UK: Wiley-Blackwell.

Wang, Q., Shao, Y., & Li, Y. J. (2010). "My way or Mom's way?" The bilingual and bicultural self in Hong Kong Chinese children and adolescents. *Child Development, 81*(2), 555–567.

Wang, Z., Meltzoff, A. N., & Williamson, R. A. (2015). Social learning promotes understanding of the physical world: Preschool children's imitation of weight sorting. *Journal of Experimental Child Psychology, 136,* 82–91.

Warneken, F. (2015). Precocious prosociality: Why do young children help? *Child Development Perspectives, 9*(1), 1–6.

Wason, P. C., & Johnson-Laird, P. N. (1972). *Psychology of reasoning.* Cambridge, MA: Harvard University Press.

Wass, R., & Golding, C. (2014). Sharpening a tool for teaching: The zone of proximal development. *Teaching in Higher Education, 19*(6), 671–684.

Watson, J. B. (1924). *Behaviorism.* New York: Norton.

Watson, J. B. (1928). *Psychological care of infant and child.* New York: Norton.

Watson, J. B., & Rayner, R. (1920). Conditioned emotional reactions. *Journal of Experimental Psychology, 3,* 1–14.

Weintraub, R. A. (2005). *How one night in a field changed astronomy.* Retrieved from the National Aeronautics and Space Administration website: http://www.nasa.gov/vision/universe/solarsystem/radio_jupiter.html

Wellman, H. M., & Gelman, S. A. (1998). Knowledge acquisition in foundational domains. In W. Damon (Series Ed.) & D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (5th ed.). New York: Wiley.

Wellman, H. W. (2014). *Making minds: How theory of mind develops*. New York, NY: Oxford University Press.

Wertsch, J. V. (1979). From social interaction to higher psychological processes: A clarification and application of Vygotsky's theory. *Human Development, 22*, 1–22.

Wertsch, J. V. (1985). *Vygotsky and the social formation of mind.* Cambridge, MA: Harvard University Press.

Wertsch, J. V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. Cambridge, MA: Harvard University Press.

Wertsch, J. V., & Hickmann, M. (1987). Problem solving in social interactions: A microgenetic analysis. In M. Hickmann (Ed.), *Social and functional approaches to language and thought*. Orlando, FL: Academic Press.

Wesley, F. (1989). Developmental cognition before Piaget: Alfred Binet's pioneering experiments. *Developmental Review, 9*, 58–63.

Westen, D., Gabbard, G. O., & Ortigo, K. M. (2008). Psychoanalytic approaches to personality. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed.). New York: Guilford Press.

White, B. L. (1969). Child development research: An edifice without a foundation. *Merrill-Palmer Quarterly*, *15*, 47–78.

White, R. W. (1963). Ego and reality in psychoanalytic theory: A proposal regarding independent ego energies. *Psychological Issues, 3*(3, Monograph No. 11).

White, S. H. (1970). The learning theory approach. In P. H. Mussen (Ed.), *Carmichael's manual of child psychology* (3rd ed., Vol. 1). New York: Wiley.

White, S. H. (1976). The active organism in theoretical behaviorism. *Human Development, 19*, 99–107.

White, S., & Tharp, R. G. (1988, April). *Questioning and wait-time: A cross-cultural analysis*. Paper presented at the meeting of the American Educational Research Association, New Orleans, LA.

White, T. L., Leichtman, M. D., & Ceci, S. J. (1997). The good, the bad, and the ugly: Accuracy, inaccuracy, and elaboration about preschoolers' reports about a past event. *Applied Cognitive Psychology, 11,* 537–554.

Whittle, S., Simmons, J. G., Dennison, M., Vijayakumar, N., Schwartz, O., Yap, M. B. H., . . . Allen, N. B. (2014.). Positive parenting predicts the development of adolescent brain structure: A longitudinal study. *Developmental Cognitive Neuroscience, 8,* 7–17.

Wilcox, T., & Biondi, M. (2015). Object processing in the infant: Lessons from neuroscience. *Trends in Cognitive Sciences, 19*(7), 406–413.

Wilcox, T., Hawkins, L. B., Hirshkowitz, A., & Boas, D. A. (2014). Cortical activation to object shape and speed of motion during the first year. *NeuroImage, 99,* 129–141.

Williamson, R. A., Jaswal, V. K., & Meltzoff, A. N. (2010). Learning the rules: Observation and imitation of a sorting strategy by 36-month-old children. *Developmental Psychology, 46*(1), 57–65.

Wilson, E. O. (1975). *Sociobiology. The new synthesis.* Cambridge, MA: Belknap Press of Harvard University Press.

Wilson, E. O. (1978). *On human nature.* Cambridge, MA: Harvard University Press.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13,* 103–128.

Winkler-Rhoades, N., Carey, S. C., & Spelke, E. S. (2013), Two-year-old children interpret abstract, purely geometric maps. *Developmental Science, 16*(3), 365–376.

Winnicott, D. W. (1971). *Playing and reality.* New York: Basic Books.

Winsler, A., Fernyhough, C., & Montero, I. (Eds.). (2009). *Private speech, executive functioning, and the development of verbal self-regulation.* New York: Cambridge University Press.

Wober, M. (1972). Culture and the concept of intelligence: A case in Uganda. *Journal of Cross-Cultural Psychology, 3*, 327–328.

Wood, L. A., Kendal, R. L., & Flynn, E. G. (2013). Who do children copy? Model-based biases in learning. *Developmental Review, 33*(4), 341–356.

Xu, F., & Garcia, V. (2008). Intuitive statistics by 8-month-old infants. *Proceedings of the National Academy of Sciences. 105*, 5012–5015.

Yermolayeva, Y., & Rakison, D. H. (2014). Connectionist modeling of developmental changes in infancy: Approaches, challenges, and contributions. *Psychological Bulletin, 140*(1), 224–255.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*, 151–175.

Zeng, R., & Greenfield, P. M. (2015). Cultural evolution over the last 40 years in China: Using the Google Ngram Viewer to study implications of social and political change for cultural values. *International Journal of Psychology, 50,* 47–55.

Zhang, X., Anderson, R. C., Dong, T., Nguyen-Jahel, K., Li, Y., Lin, T., & Miller, B. (2013). Children's moral reasoning: Influence of culture and collaborative discussion. *Journal of Cognition and Culture,13*(5), 503–522.

This page intentionally left blank

NAME INDEX

Note: Page numbers in italic represent figures and tables.

Abrams, S., 120
Adler, A., 98, 99
Adolph, K. E., 19, 343, 377, 380, 381, 384, 386, 390, *391*, 392, 398, 413
Ainsworth, M. D., 226, 228
Akst, H., 227
Alderson-Day, B., 173
Aldridge, M. A., 390
Alibali, M. W., 318, 323
Allen, J. P., 10
Alloway, T. P., 357
Alpert, R., 287
Amaya, G., 312
American Psychologist, 289
Anderson, J., 365
Arnett, J. J., 148
Arseth, A. K., 149
Averill, J. R., 12

Baddeley, A. D., 324, 366
Baer, D. M., 284
Bahrick, L. E., 396
Bailey, D. H., 344
Baillargeon, R., 76, 388, 410
Bak, M., 301
Bakeman, R., 195
Baker, D. B., 282
Baker, R. K., 389
Bakermans-Kranenburg, M. J., 264
Bakhtiar, A., 360
Baldwin, J. M., 1
Balle-Jensen, L., 194
Banaji, M. R., 75
Bandura, A., 190, 277, 278–279, 288–300, *295*, 301, 302, 303, 304, 305, 306, 307–308, 310, 314, 315, 328, 423
Barbaranelli, C., 299, 303
Barbu-Roth, M., 415
Barch, D. M., 257
Bardi, L., 228
Barnett, D., 229
Barr, R., 289, 312
Barry, O., 176
Basalla, G., 245
Bates, E. A., 357
Battaglia, M., 268
Bauer, P. J., 337, 367
Baumrind, D., 202
Beach, S. R. H., 21, 264
Beaulieu, D. A., 229
Bedny, M., 408
Beebe, M., 182
Begus, K., 369
Beilin, H., 73, 81, 434
Belsky, J., 219, 264, 270
Bendicsen, H. K., 132
Berger, S. E., 398
Bergman, A., 115
Bergson, H., 279
Berland, J. C., 165
Bernier, E. P., 77, 409
Bertenthal, B. I., 416
Best, J. R., 170, 326, 366
Bhaskar, R., 154
Bialystok, E., 201
Bidell, T. R., 86, 87
Bigler, R. S., 336
Bijou, S. W., 283, 284
Binet, A., 27, 156, 430
Biondi, M., 399
Bjorklund, D. F., 218, 233, 239, 245, 246, 271, 332, 334
Blair, C., 366
Blätter, F., *13*
Blehar, M .C., 228
Blizinsky, K. D., 178
Bloom, P., 91, 313
Blumenthal, T. D., 252
Blurton-Jones, N., 230
Boas, D. A., 399
Boguszewski, K., 366
Boldt, B. R., 202
Bornstein, M. H., 195, 242, 369
Borst, G., 92
Bovet, M., 73
Bower, T. G. R., 77, 390
Bowers, E. P., 191
Bowker, J. C., 311
Bowlby, J., 99, 115, 129, 211, 214, 224–227, 234, 236, 241, 403, 423
Bowman, C. R., 56
Boyce, W. T., 264
Bradley, B. S., 283
Braga, E. S., 390
Brainerd, C. J., 330, 335, 336, 359
Brandeau, K., 360
Brannon, E. M., 90, 344
Breland, K., 282, 305
Breland, M., 282, 305
Bremner, J. G., 77, 91
Bretherton, I., 130
Breuer, J., 97
Breznitz, Z., 326
Bringuier, J., 59
Brink, K. A., 408
Brody, G. H., 21, 260, 264, 270
Bronfenbrenner, U., 185, 189, 190, 191, 209, 238
Brown, A. L., 158, 174, 333, 357, 364
Brown, R. D., 332
Brown, T. T., 250, 367
Bruce, J., 254
Brückner, G. H., 217
Bruner, J. S., 134
Brunk, M. A., 293
Brush, S. G., 432
Bryant, P. E., 73, 78
Buchanan, C. M., 298
Buckel, R., 369
Budak, D., 192
Bugental, D. B., 229, 245, 246
Bukowski, W. M., 311
Bullock, M., 357
Burman, E., 432
Burnham, J. C., 98
Bussey, K., 302
Butler, S., 218

Cacioppo, J. T., 248
Cacioppo, S., 248
Cairns, R. B., 215
Caldara, R., 251
Call, J., 239, 243
Calvert, S. L., 311
Campbell, C., 130
Campione, J. C., 174
Campos, J. J., 386

Cañal-Bruland, R., 394
Cangelosi, A., 373, 374
Cannizzo, S. R., 333
Caprara, G. V., 299, 303, 417
Carello, C., 222
Carey, S., 344, 407
Carey, S. C., 410
Carpendale, J. I. M., 80
Carpenter, M., 244, 312
Carr, H. A., 284
Carraher, D. W., 198
Carraher, T. N., 198
Carrazza, C., 313
Carroll, L., 154, 337, 434
Carver, L. J., 256, 368
Case, R., 74, 83–85, *85*, 94
Casey, B. J., 253
Cassidy, D. J., 333
Cassidy, J., 129, 228, 230, 236, 242, 243
Cassirer, E., 15
Caudill, W., 194
Caudle, F. M., 379, 386
Caylak, E., 268
Ceci, S. J., 359
Cernoch, J. M., 228
Chae, Y., 359
Champagne, F. A., 261, 263
Charcot, J., 97
Charlesworth, W. R., 232, 238, 241
Chassin, L., 418
Chavajay, P., 192, 193
Chen, C., 254
Chen, E., 202
Chen, X., 198, 200
Chen, Y., 21
Chen, Z., 344, 345
Cheng, Y., 254
Cheon, B. K., 178
Chi, M. T. H., 335
Chiao, J. Y., 178
Child, I., 99
Childs, C. P., 199
Child Trends Data Bank, 200
Cho, G. E., 199
Chodorow, N., 129
Chomsky, N., 67, 285, 321
Christie, A., 428
Church, R. B., 92
Cicchettii, D., 238, 270
Cillessen, A. H. N., 230
Clément, F., 314
Clerc, J., 334
Coffman, J. L., 339, 358
Cohen, L., 330
Cohen, R., 257
Cole, M., 155, 158, 175, 195
Cole, W. G., 412
Coleman, P. K., 298
Collins, J. L., 297
Collins, W. A., 246, 304
Cook, L. C., 417
Cookston, J. T., 201
Cooper, C. R., 193
Copernicus, N., 430
Cornoldi, C., 338
Corpuz, R., 229
Correa-Chávez, M., 196, 365
Cosmides, L., 215, 232, 233
Cote, L. R., 195
Courage, M. L., 360
Coyle, T. R., 334
Craighero, L., 313
Crane, C. C., 313
Crick, N. R., 433
Crosnoe, R., 202
Cross, D. R., 184
Csernansky, J. G., 257
Csibra, G., 230, 314
Cunningham, W., 339
Cybele, R. C., 366

Daele, L. van den, 32
Dahl, A., 386
Darwin, C., 17, 98, 213, 218, 227, 232, 430
Davidson, D. H., 195
Davidson, P., 82
Davies, P. T., 231, 261, 270
Da Vinci, L., 101
Davis, B., 227
Dawson, G., 256
Deater-Deckard, K., 366
Decety, J., 254
Dede, C., 192
Dekker, E., 280
DeLoache, J. S., 221, 333, 364
DeMarie, D., 339
De Marsico, M., 180
DeMaster, D., 368
De Morgan, Augustus, 434
Descartes, R., 19, 348
Devine, R. T., 412
De Vries, P., 101
Dexter, A., 192
Diamond, A., 92, 255, 399
Dissanayake, C., 313
Dodell-Feber, D., 408
Dodge, K. A., 341, 417
Doestoevsky, F., 173
Dollard, J., 286, 287
Doob, L., 286
Dornbusch, S. M., 202
Dorr, D., 301
Dowling, A. S., 120
Doyle, A. C., 11
Drake, S. G., 171
Drell, M. B., 366
Dugmore, N., 123
Duh, C. J., 205
Dukes, C., 332
Dunlosky, J., 358
Dunn, J., 175

Ebbinghaus, H., 278
Ebstein, R. P., 243
Eccles, J., 303
Eddington, A., 1
Edelman, G. M., 251
Edelman, M. S., 239
Eibl-Eibesfeldt, I., 217, 222, 223, 224
Eigsti, I., 313
Einstein, A., 28, 29, 36, 53, 58, 68, 145, 430
Eisenberg, N., 418
Eisner, M. P., 311
Ejesi, K., 201
Elder, G. H., Jr., 188, 190
Eliot, G., 19, 363
Eliot, T. S., 141
Elkind, D., 94
Elliott, J., 357
Ellis, B. J., 218, 233, 239, 245, 246, 264, 271
Elman, J. L., 357
Elovainio, M., 293
Engels, F., 156
Ensor, R., 177
Eppler, M., 377

Erikson, E. H., 2, *21*, 23, 95, 96, 99, 132–149, 151–152, 154, 220, 255, 265, 403, 422, 423, 424, 425, 426, 427, 428
Erlich, N., 221
Eron, L. D., 13
Escalona, S., 99
Esposito, G., 242
Euclid, 68
Evans, G. W., 365
Evans, R. I., 28, 137, 138, 139, 288

Fast, L. A., 298
Federal Interagency Forum on Child and Family Statistics, 184
Fein, D. A., 313
Feldman, J. F., 358
Feldman, R., 242
Fernbach, P. M., 372
Fernyhough, C., 173
Ferrara, R. A., 174
Ferron, J., 339
Fey, S., 301
Fireman, G., 81
Fischer, K. W., 74, 85–88, 94, 154, 411
Fisher, D. M., 414
Fisher, P. A., 254
Fisher, S., 127
Fitzpatrick, C., 360
Fivush, R., 203, 331, 340, 433
Flavell, J. H., 52, 68, 71, 72, 79, 89, 333, 334, 337, 338, 339, 401
Fliess, W., 97
Flynn, E. G., 290, 310
Fodor, J. A., 411
Fogassi, L., 313
Fogel, A., 417
Fonagy, P., 130
Fox, N. A., 236
Fox, R., 389
Fraleigh, M. J., 202
Fraley, R. C., 131
Franchak, J. M., 381, 386
Frankenhuis, W. E., 219, 270
Franz, A., 317
Frazier, B. N., 302
Frederick II, 240
Freedland, R. L., 416
Freitag, C., 369
Freud, A., 99, 103, 133, 138, 220
Freud, S., 2, 4, 5, 10, *21*, 23, 33, 95, 96–129, 130, 131, 132, 133, 134, 137, 139, 141, 144, 145, 146, 147, 148, 150–151, 152, 154, 156, 163, 220, 231, 239, 241, 265, 278, 281, 286, 287, 289, 291, 300, 303, 304, 305, 306, 308, 403, 422, 423, 424, 426, 427, 428
Freund, L. S., 164
Frias, M. T., 229
Friedrichs, A. G., 338
Frisch, Karl von, 214
Froimson, J., 241
Fuligni, A. J., 149, 150, 202
Fung, H., 202

Gabbard, G. O., 129
Gallistel, C. R., 77, 78
Galsworthy, J., 421
Garcia, C., 199
Garcia, J., 285
Garcia, V., 372
Garcia Coll, C., 201
Gardner, H., 411
Gardner, R., 292
Gardner, W. P., 167
Garvey, A., 417
Gathercole, S. E., 357
Gatzke-Kopp, L. M., 238
Gauvain, M., 162, 165, 167, 182, 199
Gay, J., 175
Gazzaley, A., 132
Gazzola, V., 245
Gearhart, M., 186
Geary, D. C., 233, 344
Geert, P. van, 417
Geisel, T. S. (Dr. Seuss), 137
Gelderen, L. van, 198
Geldhof, G. J., 191, 230
Gelman, R., 73, 77, 78, 410
Gelman, S. A., 75, 302, 407, 433
Gergely, G., 314
Gerhardstein, P., 331
Gesell, A., 9
Ghetti, S., 338, 368
Gibson, E. J., *21*, 23, 24, 74, 188, 237, 377, 378–397, 399, 403, 407, 412, 422, 423, 424, 425, 426, 427
Gibson, J. J., 378, 383, 390, 395
Gill, M. M., 132
Gill-Alvarez, F., 19
Gillath, O., 242
Glatz, T., 298
Glenberg, A. M., 368
Glick, J. A., 175
Gluck, S., 205
Gobbo, C., 82
Godwin, C. A., 132
Godwin, J., 341
Goethe, J. W. von, 96
Golding, C., 179
Goldin-Meadow, S., 92, 369
Goldsmith, D., 194
Goldstein, W., 194
Göncü, A., 158
Gonzales, M., 198
Gonzales, N., 150
Goodman, G., 359
Gopnik, A., 76, 371, 406, 408
Gordon, I., 242
Gordon, W., 65
Gorky, M., 139
Gottlieb, G., 215
Gould, S. J., 227
Graesser, A. C., 358
Graham, A. M., 254
Grammer, J. K., 339, 358
Greenberg, R. P., 127
Greenfield, P. M., 170, 198, 199, 200
Greenwald, A. B., 247
Griffin, A. M., 221
Griffiths, T. L., 371
Griggs, R. A., 280
Griskevicius, V., 246
Groen, J., 280
Gross, D., 390
Grossman, T., 254, 255, 368
Guan, S. A., 170
Guberman, S. R., 186
Gunderson, E. A., 298
Gureckis, T. M., 350
Gutbir, T., 243
Gweon, H., 408

Haan, M. de, 248, 250, 367
Hacker, D. J., 358
Haden, C. A., 335
Haggbloom, S. J., 289
Hahn, C., 369
Haist, F., 250, 367
Haldane, J. B. S., 212
Hall, C. S., 100, 102, 106, 114, 121, 122, 151
Hall, G. S., 98
Hallinan, E. V., 90
Haltigan, J. D., 131
Hamlin, J. K., 90, 91, 313
Harkness, S., 176
Harris, F. R., 284
Harris, P. L., 75, 314
Hart, B., 372
Hartmann, H., 99, 132
Hartup, W. W., 379
Hawkins, L. B., 399
Hawley, P. H., 230, 234
Hay, J. F., 372
Hayes, C., 243
Hayes, M., 198
Hayne, C., 289
Haynes, O. M., 195
Heatherton, T. F., 291
Hebb, D. O., 20, 285, 335
Hegel, G. W. F., 157
Heider, K. G., 292
Heine, S., 184
Heinrichs, M., 390
Helt, M. S., 313
Helwig, C. C., 411
Hencke, R. W., 86
Henderson, A. M., 313
Henggeler, S. W., 293
Henrich, J., 184
Hentges, R. F., 238
Herrmann, E., 243
Herrmann, P. A., 313
Hess, E. H., 216
Hessel, E., 10
Hickmann, M., 153
Hicks, V. C., 284
Hildebrand, E. A., 313
Hill, P. L., 148
Hillairet de Boisferon, A., 387
Hinde, R. A., 230
Hindorff, L. A., 260
Hines, M., 311
Hintzman, D. L., 363
Hirshkowitz, A., 399
Hitch, G. J., 326
Hitler, A., 138
Hobbes, T., 17
Hogan, J. D., 67
Holmes, C. J., 366
Holmes, O. W., 58, 330
Honeycutt, H., 264, 271
Hopkins, J. R., 133, 147
Horga, G., 260
Horney, K., 99, 129
Horst, J. S., 352
Hoss, R. A., 221
Hou, Y., 341
Houdé, O., 92
Howard, L. H., 313
Howe, M. L., 331, 359
Hoyt, J. D., 338
Huang, Y., 410
Hudson, J. A., 159, 336
Huggenberger, H. J., 252
Hughes, C., 177, 412
Hull, C., 286, 378
Hume, D., 14
Hurley, K. B., 387
Hutchins, E., 159
Hutchinson, G. E., 212
Hyde, L. W., 267, 268, 269

Iaccino, W. J., 67
IJzendoorn, M. H. van, 229, 264
Influs, M., 243
Inhelder, B., 28, 29, 55, 73, 74
Ishak, S., 392
Islam, T., 242

James, W., 15, 285
Jankowski, J. J., 358
Jantz, T. K., 132
Jaswal, V. K., 312
Jenkins, E., 317, 329, 342, 343
Jenkins, G. W., 416
Jennings, J. A., 188
Jensen, P. S., 240
Jernigan, T. L., 250, 367
Joanisse, M. F., 351
Johann, M., 242
Johnson, M. H., 250, 253, 255, 367, 368
Johnson, S. P., 77, 380
Johnson-Laird, P. N., 125
Johnston, J., 383
Johnston, M. K., 283
Jokela, M., 293
Jones, E., 96, 98, 100
Jones, J. D., 236, 243
Jones, M. C., 281
Jones, M. N., 373
Jong, P. F. de, 198
Joyce, J., 297
Joyce, N., 282
Juang, L. P., 201
Jung, C., 98, 99

Kaciroti, N., 302
Kaiser, M. K., 355
Kaminski, J., 239, 243
Kamp, J. van der, 394
Karasik, L. B., 392
Karmiloff-Smith, A., 92, 249, 343
Karraker, K. H., 298
Karremans, J., 230
Kasparov, G., 322
Kaur, T., 260
Kearins, J. M., 171
Kearney, J. K., 394
Keating, D. P., 91
Keeney, T. J., 333
Keil, F. C., 407
Keil, V., 341
Kellman, P. J., 389
Keltikangas-Järvinen, L., 293
Kendal, R. L., 290
Kendler, H. H., 318, 362
Kenny, S., 360
Keysers, C., 245
Kierkegaard, S., 152
Killen, M., 311
Kimble, G. A., 279
Kim-Spoon, J., 366
King, B. J., 417
King, M., 243
King, R. A., 120
Kingsolver, B., 335
Kinzler, K. D., 409
Kirkwood, H., 357
Kitayama, S., 154

Kivimäki, M., 293
Klahr, D., 323, 346, 357, 358
Klein, G. S., 132
Klein, M., 99, 132
Klopfer, P. H., 220
Kluger, J., 132
Knott, L. M., 359
Koch, B. J., 132
Koelling, R. A., 285
Koeltzow, T. E., 366
Koenig, M. A., 75, 314
Koenig, O., 222
Koeske, R. D., 335
Koffka, K., 378
Kohlberg, L., 75
Kolkman, M. E., 326
Krafft, C. E., 249
Kretch, K. S., 386, 392
Kreutzer, M. A., 338
Krieger, S. C., 132
Kris, E., 99
Kroesbergen, E. H., 326
Kroger, J., 149
Krowitz, A., 386
Kruger, A. C., 186
Kuhl, P. K., 22
Kuhn, D., 71, 181, 193
Kuhn, T., 429, 430, 431, 434
Kuo, S. I., 246

Laible, D., 241
Lam, S., 299
Lambercier, M., 28
Lampl, M., 381
Lane, J. D., 408
Langer, A., 386
Langlois, J. H., 221
Lansu, T. A. M., 230
Lazzarin, F., 338
Le Corre, M., 344
Lee, J. K., 368
Lee, S., 198
Legare, C. H., 313
Leibniz, G. W., 14–15
Leichtman, M. D., 359
Leiderman, P. H., 202
Leinbach, J., 350
Leon, M., 300
Leonard, C., 338
Leontiev, A. N., 156
Lerner, J. V., 191
Lerner, R. M., 191
Levy, R. I., 292
Lewis, M. C., 417
Li, Y. J., 341
Liben, L. S., 56, 91, 336
Libertus, M. E., 90
Lickliter, R., 264, 271
Lillard, A. S., 366
Lin, S., 202
Lindsay, R. K., 322
Lindzey, G., 122, 151
Lingeman, J. M., 413
Linzarini, A., 92
Lipp, O. V., 221
Lobo, S. A., 398
LoBue, V., 221
Locke, J., 14, 19, 305
Lofruthe, A., 369
Looft, W. R., 71
López, A., 196
Lorenz, K. Z., 211, 214, 216, 219, 220, 221, 227, 234
Lortie-Forgues, H., 343
Lourenco, O., 68, 70, 77
Love, B. C., 350
Love, M., 390
Lukowski, A. F., 337
Lumeng, J. C., 302
Luria, A. R., 155, 156, 162, 173, 186
Lyons, K. E., 338

Mace, W. M., 364
Machado, A., 68, 70, 77
Mackay, K., 359
MacNeill, L. A., 231
Macris, D. M., 372
MacWhinney, B. J., 350
Maddux, J. E., 296
Mahajan, N., 91, 313
Mahalingam, R., 150
Mahler, M. S., 115, 228
Main, M., 228
Malloy, A., 359
Malti, T., 311
Manago, A. M., 170, 199
Mandler, G., 362
Manning, L. G., 270
Marcia, J. E., 149
Marini, Z., 82
Markman, E. M., 371
Marks, A., 201
Markus, H. R., 154
Marshall, P. J., 313
Martin, M. J., 231, 238
Martinussen, M., 149
Marx, K., 98, 156
Mascaro, O., 230, 314
Mascolo, M. F., 82, 87
Mash, C., 242
Masten, A. S., 366
Matlen, B. J., 358
Maurice-Naville, D., 80
Maynard, A. M., 199, 200
Mayor, J., 353
McCain, G., 12
McCloskey, M., 355
McDaniel, C., 389
McDonald, F. J., 301
McDonald, J., 262, 350
McGrew, W. C., 230
McLean, K. C., 149
McMurray, B., 352, 369
McPartland, J., 256
McWilliams, K., 359
Mead, G. H., 15
Mehta, M. A., 254
Mejía-Arauz, R., 192, 196, 206, 365
Meltzoff, A. N., 225, 310, 312, 313, 406
Mendelson, T., 228
Metcalfe, J., 368
Michaels, C. F., 222
Mikulincer, M., 229
Miller, A., 143
Miller, G. E., 265
Miller, N. E., 286, 287
Miller, P. H., 6, 74, 169, 205, 247, *259*, 326, 333, 334, *334*, 339, 366, 401, 432, 433
Miller, P. J., 199, 202
Miller, S. A., 77, 339
Miller, W. N. E., 286
Mills, C. M., 314
Mitchell, L., 148
Miyake, A., 366
Moffitt, T. E., 269, 366
Molenaar, P. C. M., 417

Molloy, L. E., 10
Molnar, P., 312
Montag, J. L., 373
Montagu, A., 213
Montangero, J., 80
Montero, I., 173
Montessori, M., 17
Montgomery, D. E., 366
Moore, M. K., 225, 312
Morelli, G. A., 194
Morgan, R., 397
Morra, S., 82
Morris, P. A., 189, 191
Morsella, E., 132
Mowrer, O. H., 286
Mrazek, A. J., 178
Muentener, P., 312
Müller, U., 80, 91
Munakata, Y., 352
Munholland, K. A., 130
Munroe, R. L., 182, 199
Murphy, M. L. M., 265
Murray, F. B., 75
Murry, V. M., 21
Muscatell, K., 254
Mushin, I., 312

Naglieri, J., 366
Nagy, E., 312
Najafi, B., 192, 206
Narr, R. K., 359
National Center for Education Statistics, 198
Needham, A., 388
Nelson, C. A., 358
Nelson, C. A., III, 236
Nelson, K., 203, 336, 340
Neubauer, P. B., 120
Neville, H. J., 251
Nevo, E., 326
Newcomb, A. F., 304
Newcombe, N. S., 352
Newell, A., 321
Newport, E. L., 247
Newton, H. P., 138
Newton, I., 12, 355, 406
Ng, F., 299
Nielson, M., 312
Nietzsche, F., 104
Norenzayan, A., 184
Nowak, A., 417
Nunes, T., 78

Oakes, L. M., 352, 387
Oberlander, T. F., 263
Ogle, C. M., 359
Okamoto, Y., *85*
Omark, D. R., 239
Opfer, J. E., 405
Oppenheim, D., 194
Ornstein, P. A., 339, 358
Ortigo, K. M., 129
Orvos, H., 312
Osser, H., 383
Oudekerk, B. A., 10
Over, H., 244, 312
Overton, W. F., 14, 417
Owsley, C. J., 383

Paik, J. H., 198, 205
Palmer, C., 390
Palombo, J., 132
Panagiotides, H., 256
Panchanathan, K., 219
Papert, S., 26
Paris, S. G., 184
Parke, R. D., 115
Parker, I., 431
Parmiggiani, A., 373
Pasteur, L., 287
Pastorelli, C., 303, 417
Pathman, T., 368
Patterson, G. R., 306
Pavlov, I., 286
Paz-Alonso, P. M., 359
Peace, M. A., 181
Pecheux, M., 390
Peeke, H. V. S., 228
Pelucchi, B., 372
Pepper, S. C., 14, 15–16
Perez, S. M., 162, 165, 167
Perfors, A., 371
Perner, J., 404
Perry, D. G., 315
Peterson, B. S., 260
Peterson, C., 89, 341
Pettigrew, T. L., 389
Pfeifer, J. H., 254
Philibert, R. A., 21, 264
Piaget, J., 2, 3–4, 5, 7, 8, 9, 10, 11, 13, 18, *21*, 23, 24, 25, 26–83, 85, 86, 87, 88, 89–94, 96, 99, 100, 102, 109, 112, 120, 122, 125, 137, 145, 148, 154, 155, 156, 157, 159, 163, 168, 169, 172, 173, 177, 179, 188, 203, 219, 220, 235, 237, 239, 247, 255, 265, 278, 284, 285, 289, 296, 300, 301, 303, 304, 305, 306, 308, 318, 320, 322, 327, 328, 330, 341, 346, 352, 361, 362, 368, 373, 381, 393, 404, 405, 407, 408, 412, 415, 422, 423, 424, 425, 426, 427, 428, 430, 431
Piaget, V., 35
Piazza, M., 410
Pick, A. D., 379, 381, 383, 388, 390, 392, 394, 396
Pick, H. L., 388, 396
Pietromonaco, P. R., 242
Pilling, K., 312
Pine, F., 115
Ping, R. M., 369
Pipe, M., 359
Plato, 363–364
Plötner, M., 244
Pluess, M., 219, 270
Plumert, J. M., 352, 394
Plunkett, K., 353
Poincaré, J. H., 12
Pollak, S. C., 131
Pollak, S. D., 262
Pomeranatz, E. M., 299
Pornpattananangkul, N., 178
Porter, R. H., 228
Poulin-Dubois, D., 389
Powell, L., 410
Powers, A., 253
Powers, S. I., 242
Pratkanis, A. R., 247
Price, J. M., 341
Price-Williams, D. R., 65
Profet, M., 240
Proffitt, D. R., 355
Purtell, K. M., 339

Rader, N., 385
Rakison, D. H., 348, 351, 352

Ramani, G. B., 358
Ramirez, M, III, 65
Ramsey, J. L., 221
Rank, O., 99
Rapaport, D., 99, 132
Rapport, S., 213
Ratner, H. H., 186
Rau, L., 287
Raver, C. C., 366
Rayner, R., 280
Razza, R. A., 366
Reddy, V., 287
Reese, H. W., 14, 16
Regalila, C., 299
Regolin, L., 228
Reyher, J., 128
Reyna, V. F., 330, 335, 336, 359
Rhodes, M., 244
Rholes, W. S., 242
Rice, K., 129
Richey, E. M., 366
Ridley-Johnson, R., 414
Riegel, K., 16
Riggins, T., 358
Risley, R. R., 372
Ritter, P. L., 202
Rivas-Drake, D., 150
Rivera, N., 199
Rizzolatti, G., 313
Roberts, D. F., 202
Robinson, S. R., 19, 343, 381, 384, 386
Robson, C., 301
Robson, K. S., 227
Rochat, P., 76, 397
Roediger, H. L., 363
Rogoff, B., 158, 163, 165, 166, 167, 169, 170, 171, 180, 183, 185, 192, 194, 196, 206, 208, 365
Rohleder, N., 265
Roisman, G. I., 131
Romens, S. E., 262
Ronai, Z., 242
Rose, A. J., 433
Rose, S. A., 358
Rosenberger, N., 148
Ross, D., 277, 290
Ross, S. A., 277, 290
Rosser, S. V., 432
Rousseau, J. J., 17
Rousselet, G. A., 251
Rovee-Collier, C. K., 331
Rubenstein, A. J., 221
Rubin, K. H., 311
Ruffman, T., 73
Runions, K. C., 301
Russell, J., 76
Russell, J. W., 302
Russell, M. J., 228
Ruvalcaba, O., 196

Sabbagh, M. A., 75
Saby, J. N., 313
Saffran, J. R., 372
Sagi, A., 229
Sagi-Schwartz, A., 229
Salmon, K., 359
Sameroff, A. J., 230
Samuelson, L. K., 352, 416, 417
Sandel, T. L., 199
Sargent, J. D., 291
Saxe, G. B., 186, 197
Saxe, R., 408
Scabini, E., 299
Scarr, S., 6
Schachinger, H., 252
Schamberg, M. A., 365
Schauble, L., 343
Scheper-Hughes, N., 179
Schlein, S. P., 146
Schlesinger, M., 352, 369, 373, 374
Schliemann, A. D., 198
Schnable, P. S., 259
Schneider, W., 334, 339, 357
Scholnick, E. K., 432, 433
Schonert-Reichl, K. A., 367
Schore, A. N., 131
Schwarzer, G., 369
Scribner, S., 155
Sears, R. R., 286, 287
Segal, E. M., 12
Seidenberg, M. S., 351
Seier, W. L., 247, 339
Setoh, P., 410
Seuss. *See* Geisel, T. S. (Dr. Seuss)
Shackman, J. E., 131
Shahaeian, A., 89
Shakespeare, W., 18, 155, 212
Shalev, I., 264
Shanahan, M. J., 188
Shanker, S. G., 417
Shao, Y., 341
Shapley, H., 213
Sharp, D. W., 175, 413
Shaver, P. R., 228, 229, 230, 236, 243
Shaw, G. B., 139
Sheese, R., 82
Sherman, L. J., 129
Shweder, R. A., 184, 194
Siegal, M., 76
Siegler, R. S., 71, 198, 317, 320, 323, 328, 329, 334, 342, 343, 344, *344*, 345, 346, 353, *353*, 354, 355, 358, 405, 430
Signorella, M. L., 336
Simion, F., 228
Simon, H. A., 321
Simon, T., 27
Simpson, J. A., 242, 246
Sinclair, H., 73
Skerry, A. E., 77, 409
Skinner, B. F., 282, 283, 285, 289
Slater, A. M., 77
Slaughter, V., 89, 221
Slavich, G. M., 265
Sloane, H. N., 283
Sloutsky, V., 90
Smetana, J. G., 311
Smith, E. D., 366
Smith, J. D., 306
Smith, L., 80
Smith, L. B., 373, 401, 412, 413, 414, 415
Snyder, P. J., 313
Sobel, D. M., 372
Soken, N., 387
Solomon, J., 228
Somerville, L. H., 254
Sommerville, J. A., 313
Soska, K. C., 380
Southgate, V., 369
Sowell, E. R., 92
Spangler, G., 242
Spelke, E. S., 77, 389, 409, 410
Spencer, J. P., 416
Sperber, D., 233, 314
Spiker, C. C., 18

Spinrad, T. L., 418
Spitz, R. A., 99, 115
Spock, B., 139
Spranger, E., 17
Spranger, M., 373
Stalin, J., 157
Starr, A., 90
Steele, H., 130
Steele, M., 130
Steenbeck, H., 417
Stein, G., 297
Steinberg, L., 253
Sterbini, A. S., 180
Stern, D. N., 115
Stern, E., 343
Stevenson, H. W., 198
Stigler, J. W., 197, 198
Stiles, J., 250, 367
Stipek, D., 247
Strachey, J., *105*
Streri, A., 390
Sturge-Apple, M. L., 270
Sullivan, H. S., 99
Sung, S., 246
Suomi, S. J., 230
Suor, C. M., 270
Suor, J. J., 270
Super, C. M., 176
Suter, S. E., 252
Suwalsky, J. T. D., 195, 369
Svaren, J., 262
Svoboda, C. P., 71
Syed, M., 148, 149, 201
Szeminska, A., 28

Tamis-LeMonda, C. S., 388, 392, 398
Taraban, R., 350
Taylor, A. M., 240
Taylor, M. G., 433
Telzer, E. H., 150
Temperini, M., 180
Tenenbaum, J. B., 371
Tharp, R. G., 182
Thayer, G. H., 217
Thelen, E., 401, 412, 413, 414, 415
Thiessen, D., 233
Thiessen, E. D., 372
Thioux, M., 245
Thompson, R. A., 240, 241
Thorndike, E. L., 222
Tinbergen, N., 214, 217, 236
Tobin, J. J., 195
Tolman, E. C., 7
Tomaselli, K., 312
Tomasello, M., 186, 239, 243, 244, 245, 253
Tong, R. P., 432
Tooby, J., 215, 232, 233
Toulmin, S., 158
Towse, J., 326
Trembath, D., 313
Triesch, J., 317
Tsai, K., 150
Tuddenham, R. D., 29
Tulviste, P., 168
Turiano, N. A., 148
Turiel, E., 411
Twain, M., 106, 278

Valenzi, S., 242
Vallacher, R. R., 417
Valsiner, J., 158
van der Kamp, J. *See* Kamp, J. van der
Van de Vijver, 175
Van de Walle, G., 344
van IJzendoorn, M. H. *See* IJzendoorn, M. H. van
van't Noordende, J. E., 326
Vivanti, G., 313
Vizioli, L., 251
Voltaire, 71
Vondra, J. I., 229
Vuyk, R., 80
Vygotsky, L. S., 2, 9, *21*, 23, 24, 86, 153–188, 192, 198, 204–205, 207–209, 231, 232, 239, 265, 300, 303, 304, 306, 327, 328, 330, 362, 403, 419, 422, 423, 424, 426

Waddington, C. H., 217
Wadsworth, M. E., 270
Walk, R. D., 377, 386
Wall, S., 228
Wallace, A., 213
Wallace, J. G., 323, 357
Wallbank, T. W., 240
Walters, R. H., 277, 288, 306
Walton, G. E., 390
Wang, F. L., 418
Wang, Q., 340, 341
Wang, S.–H., 199
Wang, Z., 310
Warneken, F., 244
Wason, P. C., 125
Wass, R., 179
Waters, E., 228
Watson, J. B., 279, 280, 282, 304
Watson, J. S., 396
Webb, S. J., 256
Weerth, C. de, 270
Weinert, F. E., 339
Weinstein, H., 194
Weintraub, R. A., 5
Wellman, H. M., 89, 337, 371, 407, 408
Wellman, H. W., 404
Wen, N. J., 313
Wertsch, J. V., 45, 153, 155, 156, 158, 176
Wesley, F., 430
Westen, D., 129
White, B. L., 9
White, R. W., 132
White, S., 182
White, S. H., 15, 285
White, T. L., 359
Whitehouse, H., 313
Whiten, A., 310, 312
Whiting, J., 99, 286
Whittle, S., 254
Wilcox, T., 399
Williamson, R. A., 310, 312
Wilson, A., 243
Wilson, E. O., 212, 214
Wimmer, H., 404
Winkler-Rhoades, N., 410
Winnicott, D. W., 115
Winsler, A., 173
Witenberg, R. T., 301
Witt, J. K., 368
Wober, M., 176
Wohlwill, J. F., 71
Wolf, M. M., 284
Wood, L. A., 290, 310

Woodward, A. L., 90, 313
Wright, H., 213
Wu, D., 410
Wu, D. Y. H., 195
Wynn, K., 91, 313

Xu, F., 371, 372

Yermolayeva, R., 348, 351, 352
Yonas, A., 379
Young, J. W., 19
Yu, T., 264

Zajonc, R. B., 306
Zaman, W., 203
Zeanah, C. H., 236
Zeitlin, M., 176
Zelli, A., 417
Zeng, R., 199, 200
Zhang, X., 192, 196
Zimmerman, P., 242
Zochowski, M., 417

This page intentionally left blank

SUBJECT INDEX

Note: Page numbers in italic represent figures or tables.

Abilities. *See also* Competencies
  assessing, 175–176, 249
  concrete operations, 48 (*See also* Concrete operational period)
  ego and, 102 (*See also* Ego)
  emergence of, 414
  of infants, 22, 81–82, 90–91, 224–225, 233, 244, 251, 369 (*See also* Locomotion, of infants)
  mathematical, 197, 297 (*See also* Mathematical understanding)
  overestimation of, 198
  skill development, 10, 18, 22, 86, 163
  underestimation of, 76–78
  verbal, 74, 173, 186
Abnormal behavior
  behavior modification and, 284
  environment and, 222
  Erikson's study of, 146
  normal–abnormal continuum, 110–111
  origins of, 108–109
Abstract modeling, 290, 296. *See also* Modeling
Abstract vs. concrete thought, 168, 181
Accommodation. *See also* Equilibration
  defined, 58
  in information processing, 323
  Piagetian view of, 58–62, 72, 120, 219, 235, 422, 426
Acculturation, 201
Action mirroring, 313
Activation
  of attachment, 226, 227, 228–230
  of brain and neural networks, 245, 255, 348, 367, 368–369, 399
  in connectionist models, 348–349, 352, 356, 423, 427
  of evolved behavior, 235
  of stress responses, 264
Adaptation
  aggression and, 231
  biological approach to, 13, 31, 62, 63
  cognitive, 58–60, 233
  during development, 245–248
  to environment, 31, 33, 34, 69, 226, 237, 378, 395, 422, 424, 425
  ethology and, 13, 22, 218, 219, 235
  genetics and, 215, 271
  intelligence and, 31
  optimal, 237
  to social/cultural change, 200, 221
Adaptive behavior, 199, 426
Affordances, 379–381, 396, 397, 422, 424, 426
Agency
  in Gibson's theory, 394, 396
  in social learning theory, 299–300
Aggression
  culture and, 231, 292, 306
  as destructive instinct, 100, 111, 234
  displaced, 125, 239
  gender and, 302, 433
  imitation and, 288, 291
  information processing and, 341
  instigators of, 6, 13, 131, 219, 246, 291, 298, 301, 417, 418
  natural settings and, 310–311
  relational, 311
  social learning theory and, 277, 286, 306–307
  study of, 13, 127, 230–231, 237, 290–291, 418–419, 433
  superego and, 105
Alice's Adventures in Wonderland (Carroll), 154
Altruistic behavior, 214
Anal stage (in Freud's theory), 109, 114, 116–117, 122, 220
"Analysis of a Phobia in a Five-Year-Old Boy" (Freud), 119
Animal Dreams (Kingsolver), 335
Anxiety
  arousing, 103–104, 113, 116, 281
  coping with, 109, 113, 130, 140, 298
  defined, 121
  effect on ego, 102–103, 117–118
  Freud's study of, 10, 100
  stage regression and, 33, 114
  stress and, 219, 270
Appropriation, 169, 177, 185
Artificial intelligence, 321–322, 373
Assessment
  of abilities, 175–176, 249
  of attachment, 229
  of development, 65, 91, 362, 404
  dynamic, 174, 179–180, 183
  in education, 66
  in information-processing theory, 328, 345, 362
  motivation and, 309
  nonverbal, 77
Assimilation. *See also* Equilibration
  defined, 58
  in information processing, 323
  Piagetian view of, 58–62, 67, 72, 120, 219, 235, 422, 426
Associations. *See also* Free association; Stimulus–response model
  in connectionist models, 7, 356
  environmental effects, 20
  in language, 321, 351
  learning and, 355, 361, 423, 431
  in social learning, 280, 282, 311
Attachment
  activation of, 226, 227, 228–230
  applications of, 123, 236
  Bowlby's theory of, 99, 129, 224–227
  infant–caretaker, 99, 114–116, 123, 129–131, 214, 224–232
  research in, 236, 241–243
  significance of, 130, 183

Attractor state, 415, 417, 419
Autobiographical memory, 331. *See also* Memory
Automatization, 354, 427
Autonomy vs. shame and doubt (in Erikson's theory), 135, *136*, 137, 140–141
Avoidant attachment, 229. *See also* Attachment

Baby box, 283
Babyishness, 227, *227*
Baddeley's memory model, 324, 366
Balance-scale task, *344*, 344–345
Basic trust vs. basic mistrust (in Erikson's theory), *136*, 139–140
Bayesian networks (models), 312, 369–373, 403, 409, 427
Behaviorism, 67, 278, 279. *See also* Learning theory
Behavior modification, 278, 283, 284. *See also* Learning theory
Bioecological theory. *See* Bronfenbrenner's bioecological theory
Biological approach (in Piaget's theory), 31
Biological energy (in Freud's theory), 100, 101, 423
Biology vs. culture. *See* Nature vs. nurture
Bowel training, 140, 141. *See also* Toilet training
Brain. *See also* Neuroscience
  anatomy of, 233, 249–250, 399
  behavior and, 22, 92, 132, 236, 245, 414
  connectionist models of (*See* Connectionist models)
  development of, 250–256, 367, 368, 424, 425
  emotion processing in, 131 (*See also* Emotions)
  evolution of, 232, 248
  genetics and, 21, 178, 253, 257–258, 267, 268–269
  id/ego/superego as regions of, 105–106
  imaging of, 131, 212, 242, 248–249, 268, 398–399 (*See also* Neuroimaging)
  maturation of, 22, 64, 83, 88, 91–92, 339, 426
  patterns of activity in, 313, 366, 369
  plasticity of (*See* Plasticity)
  research on, 248, 253, 408
Bronfenbrenner's bioecological theory, 188–192

Candidate gene approach, 259. *See also* Genetics
Capitalistic view of human nature. *See* Human nature
Caretakers, infant–caretaker attachment, 224–232
Case's neo-Piagetian theory, 83–85, *85*
Cathexis, 114, 118
Causation, triadic reciprocal, 292, 304, 305, 315
Central conceptual structures, 84
Central executive, 324, 325. *See also* Executive function
Centration, 46
Change. *See also* Qualitative vs. quantitative development
  in children over time, 8, 9, 80–81
  dialectical, 157, 176–177
  phylogenetic vs. ontogenetic, 218
  social change and culture, 198–200
  structural, 33, 65, 82, 250, 303
Childhood and Society (Erickson), 133
Child-in-activity-in-culture concept of Vygotsky, 158–163, 168, 179
Child's Conception of Physical Causality, The (Piaget), 28
Child's Conception of the World (Piaget), 28
Chunking, 335, 357, 360
Civilization and Its Discontents (Freud), 98
Classical conditioning, 280, 282, 284. *See also* Conditioning
Classical learning theory, 278, 279, 428. *See also* Learning theory
Class inclusion, 49, 50, 51, 63, 64, 89, 188
Clinical methods, 34, 65, 79
Cognition. *See also* Metacognition
  brain development and, 252–253
  central role of, 66–68
  culture and, 160
  embodied, 368–369, 396
  hot vs. cold, 308–309, 423
  human evolution of, 243–245
  perception and, 397
  physical maturation and, 22
  social cognition, 47–48, 125, 365 (*See also* Intelligence; Social cognition)
Cognitive adaptation, 58–60, 233. *See also* Adaptation
Cognitive architecture, 323, 329, 346, 361
Cognitive capacity, 66, 84–85. *See also* Memory
Cognitive development. *See also* Learning
  in information-processing theory, 318, 349
  in Piaget's theory, 62–65, 89, 91–92
  in social learning theory, 303–304, 309–310
  in Vygotsky's theory, 174, 183
Cognitive equilibration, 60–61. *See also* Equilibration
Cognitive growth, 31
Cognitive immaturity, 247
Cognitive neuroscience. *See* Neuroscience
Cognitive organization, 57–58, 245. *See also* Structuralism
Cognitive psychology, 214–215, 285, 352. *See also* Cognitive science
Cognitive rehearsal, 294
Cognitive science, 132, 312, 322, 357, 365. *See also* Information-processing theory

Cognitive-structural theory. *See* Piaget's cognitive-structural theory
Collaborative learning, 179, 180–181, 187, 190, 239
Collaborative problem solving, 166, 192–193, 244
Collective efficacy, 299
Collectivism, 199–200, 204, 340
Commitment, 149
Communication, 387–388, 417. *See also* Language; Speech
Compensation, 49, 60, 73, 101
Competencies. *See also* Abilities
  assessing, 389, 428
  culture and, 140
  peer collaborations, 192
  research on, 78
  secure attachment and, 229
  social learning and, 289
  zone of proximal development, 163
Computational models. *See also* Bayesian networks (models); Connectionist models; Production systems
  applications of, 403
  defined, 320
  development of, 329
  purpose of, 321, 322
  robotics compared with, 373
  self-correction in, 327, 351
  shortcomings with, 362–363
  types of, 346–347
Computer processing, 319, 321, 363–364. *See also* Information-processing theory
Concrete operational period, 36, 48–51, 54, 55, 73
Conditioning, 278. *See also* Classical conditioning; Operant conditioning
Conflicts
  in collaborative problem solving, 192
  dominance hierarchy and, 231
  in Erikson's theory, 147
  in families, 201
  internal, 121
  reinforcement and, 73, 307
Conjunction, 53
Connectionist models. *See also* Neural networks
  application of, 312, 360–361, 364, 403
  complexity of, 369
  described, *347*, 347–353
  developmental issues with, 422–425, 427
  distributed activation (*See* Activation)
  dynamic systems vs., 416
  as a neural network, 7, 347–348
  social context and, 365
Conscience, 105, 110, 118, 141–142, 287. *See also* Superego
Conscious behavior, *105*, 107, 108, 132
Conservation
  age differences and, 345
  culture and, 165
  development of, 188, 291, 306, 430
  perceptual learning and, 397
  Piagetian view of, 48, 60, 68, 70–71, 73–76, 89, 92
  training in, 369
Construction of Reality in the Child (Piaget), 43
Contextualism. *See also* Developing-person-in-context
  distinguishing among worldviews, 422, 423, 429
  in Erikson's theory, 145
  human nature and, 177, 234, 304
  origin of, 188
  purpose of, 15–16, 417
  qualitative and quantitative change in, 18
Contextual metaphors, 16
Control systems, 225–226, 234, 423
Conversations, culture and, 202–203
Coordination
  of assimilation and accommodation, 60
  in children, 87–88
  eye–hand, 65
  in infants, 81–82
  of secondary schemes, 39–40
Core knowledge theory
  conceptual development, 403
  described, 409–412, 428
  developmental issues in, 419, 422, 423, 424, 425, 426
Created environment, 293
Crisis vs. commitment, 149
Critical periods, 21, 219
Critical psychology, 431–432
Cross-cultural psychology, 162, 432
Cross-cultural research, 187, 194–198
Cultural apprenticeships, 166
Cultural neuroscience, 178. *See also* Neuroscience
Cultural psychology. *See also* Vygotsky's sociocultural theory
  origins of, 2, 162, 432
  trends in, 205–207
Cultural transmission, 244
Culture
  aggression and, 231, 292, 306
  beliefs and practices in, 196, 308
  biology vs. (*See* Nature vs. nurture)
  competencies and, 140
  contexts of, 190
  dynamic skills and, 87
  effects of schooling, 175, 194, 196–198, 200
  imitation and, 140, 221, 313
  infant sleeping arrangements and, 194
  influence of, 432
  information processing and, 194–196, 365
  learning and, 221
  memory and, 340–341
  narratives and conversations, 202–203
  peer collaboration and, 192–193
  physical ecology and, 161
  psychosocial dimensions of, 134–135
  research across, 194–198
  role of, 145, 146, 160–161
  social change and, 198–200

Culture (*continued*)
  social-cultural factors in locomotion, 392
  social experience and, 64–65
  study of, 6, 175–176, 207 (*See also* Vygotsky's socio-cultural theory)
  theory of mind and, 89
  tools of, 170–171, 422

Darwinian algorithms, 233
Death of a Salesman (Miller), 143
Décalages, 70, 361
Deconditioning, 280, 281. *See also* Conditioning
Defense mechanisms, 103–105, 109, 123
Depression
  in adolescence, 201, 264, 265
  altered brain functioning and, 269–270
  disturbed relationships and, 130
  Freud and, 111
  genetics and, 258, 262, 267, 269
  maternal, 298
  pathways to, 418–419
Despair. *See* Integrity vs. despair (in Erikson's theory)
Destructive instinct, 100, 111, 234
Developing-person-in-context, 188–191
Development, mechanisms of
  in Erikson's theory, *136*, 144–145, 147, 426, 427
  in ethology, 234, 426, 427
  in Freud's theory, 120–122, 426, 427
  in Gibson's theory, 392, 427
  in information-processing theory, 353–355, 427
  in Piaget's theory, 57–62, 426, 427
  review of, 426–428
  in social learning theory, 303–304, 426, 427
  in Vygotsky's theory, 176–177, 426, 427
Developmental cascade, 10, 269, 307, 358, 369, 402, 415, 418
Developmental continuity, 364, 402
Developmental issues. *See also specific issues*
  in connectionist models, 422–425, 427
  in core knowledge theory, 419, 422, 423, 424, 425, 426
  in Erikson's theory, *21*, 145
  in ethology, *21*, 234–235
  in Freud's theory, *21*, 122–123
  in Gibson's theory, *21*, 393–394
  in information-processing theory, *21*, 355–357
  in Piaget's theory, *21*, 62–65
  in social learning theory, *21*, 304–306
  in Vygotsky's theory, *21*, 177–179
Developmental neurogenetics, 268–269
Developmental neuroscience. *See* Neuroscience
Developmental Psychology of Jean Piaget, The (Flavell), 68
Developmental range, 86
Developmental robotics. *See* Robotics
Developmental social cognitive science, 368. *See also* Cognitive science
Developmental theories. *See also specific theories and studies*
  chronology of, 23
  introduction to, 2, 402
  value of, 11–13
Dialectical change (process), 157, 176–177, 178, 423, 426. *See also* Change
Differential susceptibility hypothesis, 264
Discrimination
  in learning, 37, 67, 165
  racial, 270, 310
Disequilibrium, 60, 61, 65, 120, 177, 265
Disorganized attachment, 228
Displaced aggression. *See* Aggression
Displacement, 43
Distinctive features of information, 382–383
Diversity
  cultural, 158, 178, 199, 206, 266, 419
  of development, 183–184
  genetic, 266
  racial/ethnic, 6
  social–cultural aspects of, 310
Domain-specific knowledge. *See* Knowledge
Dominance hierarchy, 230–231
Don Quixote (Cervantes), 96
"Dostoevsky and Parricide" (Freud), 98
Dream analysis, 34–35, 97, 102, 111, 112, 126, 127
Drive energy, 100
Dynamic assessment, 174, 179–180, 183. *See also* Assessment
Dynamic equilibration, 10, 417. *See also* Equilibration
Dynamic skills, 86–87. *See also* Skills
Dynamic structuralism, 86
Dynamic-systems theory
  behavior and, 413–414, 422–423, 425, 426
  development and, 427
  Fischer's views on, 87
  origins of, 2, 403
  overview of, 412–418, 419
  progress in, 428
Dysfunctional families, 306–307. *See also* Families

Early experiences, 21, 108, 124, 131, 194, 220, 264
Early Growth of Logic in the Child, The (Piaget), 78
Ecological-systems theory. *See* Bronfenbrenner's bioecological theory
Ecological theory of perceptual development. *See* Gibson's ecological theory of perceptual development
Education. *See also* Instruction; Learning
  collaborative problem solving, 193
  goal of, 17

implications for, 405
informal vs. formal, 199, 200, 410
Vygotsky and, 156, 157
Educational neuroscience, 256. *See also* Neuroscience
Ego. *See also* Id; Superego
defense mechanisms, 108, 123
defined, 101
development of, 119
function of, 102–105, 132
id and superego vs., 111, 121
organization of, 423
satisfying, 117
strengthening, 422, 426
structural relationships, *105*, 105–106, 122
Egocentric speech, 45, 172. *See also* Speech
Egocentrism, 45–46, 47, 53–54, 247
Ego ideal, 105
Embodied cognition, 368–369, 396, 412, 417. *See also* Cognition
Embodied perception, 396–397
Emerging adulthood, 148–149
Emotions
behavior and, 164–165, 183, 256
cognition and, 75, 124–125
inferring, 397
personality and, 122
processing of, 131, 242, 249, 299–300, 368
understanding, 205, 297, 340, 424
Enactive rehearsal, 294
Encoding, process of, 323, 354–355, 357
Environment
adapting to (*See* Adaptation)
affordances in, 380
being in equilibrium with, 60, 61, 64
effect on development, 20–21, 32, 60, 80, 92, 145, 154, 229, 246, 256, 422
epistemology and, 30–31
ethology and, 13, 22, 219, 230, 235
genetic connections with, 263–264, 271
heredity vs., 20, 235, 263–264 (*See also* Genetics; Nature vs. nurture)
hostile (harsh), 185, 219, 242, 268, 293
individualism's effects on, 199
interacting with, 36, 163, 341
learning theory and, 278, 279, 298
macro vs. micro, 271
natural, 221, 222, 241, 310–311, 380, 385
perception of, 397
physical, 9, 61, 64–65, 154, 216, 233, 252, 364, 368, 414
social–cultural, 86, 109, 303 (*See also* Vygotsky's socio-cultural theory)
stimulation from, 251–252
stress in, 189
thought and, 31, 51, 86, 103
triadic reciprocal causation, 292
types of, 293
Environment–person–behavior system, 292–293
Epigenetics, 135, 144, 258, *259*, 262–264, 270, 403. *See also* Genetics
Episodic buffer, 325
Epistemology. *See* Genetic epistemology
Equilibration. *See also* Cognitive equilibration; Dynamic equilibration
cognitive, 60–61
Freudian view of, 120, 144
as a functional invariant, 57
observable behavior and, 4
Piagetian view of, 7, 31, 61, 64, 65, 73, 80–81, 83, 177, 422, 423, 425, 426, 427
Erikson's psychosocial theory
applications of, 146
biographical sketch of Erikson, 133
contemporary research, 148–150
development issues, position on, *21*, 145
emphasis on identity, 137–138
mechanisms of development in, *136*, 144–145, 147, 426, 427
methodology of, 138–139
orientation to, 133–139
psychosocial stages in, 134–137
stages in, 139–144
strengths of, 146–147
weaknesses of, 147
Erogenous zones, 113, 116. *See also* Anal stage (in Freud's theory); Oral stage (in Freud's theory)
Eros, 100
Ethnography, 175
Ethograms, 222, 223
Ethology
aggression, study of, 230, 231, 237, 291
applications of, 236
attachment (*See* Attachment)
defined, 13, 212
developmental issues, position on, *21*, 234–235
evolutionary perspective of, 218–219, 270
genetics and, 270–271 (*See also* Genetics)
importance of, 236–239
introduction to, 212
learning predispositions in, 219–221
limitations of, 239–241
mechanisms of development in, 234, 426, 427
methodology, 221–224, 238–239
orientation to, 215–224
origins of, 2, 23, 24, 213–215
peer interactions, 230–232
problem solving, 232–233
research in, 241–248
species-specific innate behavior, 215–217
strengths of, 236–239
weakness of, 239–241
Evolutionary psychology, 214–215, 232, 233, 270
Evolutionary theory, 2, 218
Executive control structures, 83, 423

Executive function, 366–367, 408, 411
Executive processing space, 83
Exosystem, 189, 190
Experience. *See* Early experiences
External vs. internal dialogue, 168, 187
Eye–hand coordination, 65. *See also* Coordination
Eye tracking, 386–387
Eyewitness testimony, 358–359

Facts, 4, 11–12
Families. *See also* Immigrant families
  attachment theory and, 236
  child rearing in, 202
  collective efficacy in, 299
  conflicts in, 201
  culture of, 160–161, 202–203, 205, 206, 340
  dysfunctional, 306–307
  genetic influence on, 21, 257
  influence on behavior, 147, 270, 306–307
  interactions in, 189, 194, 407
  nontraditional, 6
  obligations of, 148–149, 150, 201
  social relationships in, 50, 64–65, 175, 196, 199
  structure of, 190
Fear. *See also* Anxiety
  of animals, 119–120, 221, 280–281
  Darwin's observations on, 213
  of death, 108, 144
  Erikson's study of, 140, 143
  facial expressions of, 225, 256
  Freud's study of, 117, 127
  of height, 386
  overcoming, 292
Feminist theories, 6, 432–434
Fischer's neo-Piagetian theory, 85–88
Fixation, 104, 114
Fixed action patterns. *See also* Sign stimuli
  abnormal behavior and, 222
  complexity of, 216–217
  development of, 423, 426
  evolutionary nature of, 218, 226, 233
  in infants, 216, 225
  qualitative and quantitative change, 234–235
  studies of, 223–224
Flow diagrams, 324, *325*, 329, 346, 355, 362, 363
Foreclosure person, 149
Forever Panting (De Vries), 101
Formal operational period, 36, 51–55
Free association, 104, 111–112, 126. *See also* Associations
Freud's psychoanalytic theory
  applications of, 123–124
  biographical sketch of Freud, 96–99
  biologically based drives, 10
  case study ("Little Hans"), 119–120, 123, 281
  contemporary research, 129–132
  developmental issues, position on, *21*, 122–123
  dynamic approach to, 100–101
  introduction to, 96
  mechanisms of development in, 120–122, 426, 427
  methodology of, 111–113
  normal–abnormal continuum in, 110–111
  orientation to, 99–113
  origins of, 4, 23, 24
  progress in, 428
  stage approach to, 108–110, 113–120
  strengths of, 124–126
  structural approach to, 101–106
  topographic approach to, 106–108
  weaknesses of, 126–129
Frustration and Aggression (Dollard, Doob, Miller, Mowrer, & Sears), 286
Function, 46
Functional causes of behavior, 237, 240
Functional invariants, 57, 58, 60, 72
Future of an Illusion, The (Freud), 98
Gandhi's Truth (Erikson), 139
Gender
  aggression and, 302, 433
  behavior and, 232, 288, 310, 336
  biases in research, 433–434
  culture and, 6, 179, 203, 205
  identity and, 149
  relationships and, 129
  role of, 129, 133, 179, 302–303, 432
  stereotypes of, 336
Generalization, 355
Generativity vs. stagnation and self-absorption (in Erikson's theory), *136*, 143–144
Genetic epistemology, 29–31, 43, 62, 69, 79
Genetic polymorphisms, 259, 265, 268, 269
Genetics. *See also* Epigenetics
  adaptation and, 215, 271
  applications of, 267
  behavior and, 218, 257, 262
  brain development and activity (*See* Brain)
  depression and, 258, 262, 267, 269
  ethology and, 270–271
  gene X environment interactions, 21, 258–262, 265, 266–267, 269, 403
  genotypes vs. phenotypes, 258, 259
  introduction to, 257–258
  nature vs. nurture, 21, *21*, 425
  new technology in, 212
  research in, 257–258
  social behavior and, 214
  theoretical issues in, 264–267, 424, 426
Genital stage (in Freud's theory), 109, 110, 119, 122
Genomes, study of, 259–260
Gibson's ecological theory of perceptual development
  affordances, 379–381, 396, 397, 422, 424, 426

applications of, 394
biographical sketch of Gibson, 378–379
contemporary research, 397–399
developmental issues, position on, *21*, 393–394
ecological perspectives of, 379–381, 395–396
human perception, 384–385
infant learning, 387–392
information processing and, 395–396
introduction to, 378
mechanisms of development in, 392, 427
methodology in, 385–387
orientation to, 379–387
origins of, 23, 24
stimulation, 381–384
strengths of, 395–397
weaknesses of, 397
Guided participation, 166
Guilt. *See* Initiative vs. guilt (in Erikson's theory)

Hallucinatory wish fulfillment. *See* Primary-process thought
Hamlet (Shakespeare), 155
Heredity vs. environment, 20, 145, 235. *See also* Nature vs. nurture
History-of-science, 428–431
Horizontal décalages. *See* Décalages
Human nature
capitalistic view of, 16–17
in Erikson's theory, 145, 423
in ethology, 234, 422
in Freud's theory, 122, 422, 423, 424
in Gibson's theory, 393, 422, 423
in information-processing theory, 355–356, 422, 423
introduction to, 14–17
mechanistic view of, 14, 15, 17, 72–74, 422, 423, 429
mercantilistic view of, 17, 18, 122
organismic view of, 14–15, 17–18, 122, 304, 419, 422, 423, 429
in Piaget's theory, 62, 422, 423, 424
review of, 422–424
in social learning theory, 177–178, 304, 422, 423–424
in Vygotsky's theory, 177–178, 422, 423, 424
Hypnosis, 97, 108, 127, 128
Hypotheses
accuracy of, 370–371, 415
defined, 4
experimenting with, 53
formulating, 15, 52, 233, 238, 265, 284, 356, 368
importance of, 352, 434
testing, 15, 30, 55, 71, 127–128, 361–362, 405, 416
Hypothetical constructs, 3–4, 12
Hypothetico-deductive thought, 52
Hysteria, 97, 128

Id. *See also* Ego; Superego
defined, 101
ego and superego vs., 111
function of, 101–102
organization of, 423
satisfying, 118
structural relationships, *105*, 105–106
the unconscious, 107
Identity, 46, 137–138, 149, 422
Identity-achieved person, 149
Identity and repudiation vs. identity diffusion (in Erikson's theory), *136*, 137, 142–143
Identity crisis, 138
Identity-diffused person, 149
Identity diffusion, 143
Identity: Youth and Crisis (Erikson), 133
Imaging (brain), 131, 212, 242, 248–249, 255, 268, 398–399. *See also* Neuroimaging
Imitation
aggression and, 288, 291
of behavior, 127, 186–187, 188, 231, 287–288, 302, 312–314
culture and, 140, 221, 313
by infants, 90, 225, 410
learning and, 83, 186, 277
mental representations and, 42
motivation and, 296
neural networks and, 313, 424
origins of, 44
reinforcement and, 67, 287
Immaturity, 247, 256, 360
Immediate causes of behavior, 237
Immigrant families, 200–202
Implicit memory, 132. *See also* Memory
Imposed environment, 293. *See also* Environment
Imprinting, 219–220, 225, 272
Individualism, 199–200
Industry vs. inferiority (in Erikson's theory), *136*, 142
Infant–caretaker attachment, 224–232. *See also* Attachment
Information processing
cognitive contributions to, 294
continuity vs. discontinuity in, 364, 407, 428, 431
function of, 422
by infants, 194–195, 251, 364–367, 372
multitasking and, 360
organizing information, 11–12
social, 341
systems for, 323–324
Information-processing theory
applications of, 357–360
attachment and, 226
cognitive development and, 125
compared with perceptual learning, 382
computational modeling in, 346–353
contemporary research, 365–374
development as self-modification in, 326–327
development issues, position on, *21*, 355–357
history of, 320–322
introduction to, 318–320

Information-processing theory (*continued*)
mathematical understanding in, 341–344
mechanisms of development in, 353–355, 427
memory and, 330–337
metamemory and, 337–341
methodology in, 328–330, 361–362
orientation to, 322–330
origins of, 2, 23, 24
problem solving, rules for, 344–346
progress in, 428, 429
strengths of, 360–362
task analysis in, 327–328
weaknesses of, 362–365
Initiative vs. guilt (in Erikson's theory), *136*, 141–142
Innate behavior. *See* Fixed action patterns
Innate vs. acquired. *See* Nature vs. nurture
Inner speech, 169, 172. *See also* Speech
Insecure attachment, 131, 229, 240, 242. *See also* Attachment
Insecure–avoidant babies, 228
Insecure–resistant babies, 228
Instruction. *See also* Education
applications of, 357
change and, 92
cultural practices, 160, 161, 165–166, 186, 221
problem-based learning, 181
readiness for (*See* Readiness)
scaffolding and, 86
in scientific thought, 53
zone of proximal development and, 179, 180
Integrity vs. despair (in Erikson's theory), *136*, 144
Intellectual functioning, 169–174
Intelligence
artificial, 321–322, 373
environment and, 31
evolution of, 213
information processing and, 328
intelligence-testing approach to, 232
social cognition and, 176
tests of, 27, 411
Intelligent behavior, 58
Interactions, with objects, 388–390, 407, 409, 425
Intermental vs. intramental, 167–169, 172, 177
Internal conflicts, 121. *See also* Conflicts
Internal working models, 129–130, 225
Interpretation of Dreams, The (Freud), 97
Intersubjectivity, 166–167, 177, 183, 186, 187, 204
Intimacy and solidarity vs. isolation (in Erikson's theory), *136*, 143
Intrinsic motivation, 62, 423. *See also* Motivation
Introspection, 126, 279, 285
Invariant functions, 63, 427
Invariants in information, 383
Irrational thought, 125, 304. *See also* Thought
Isolation. *See* Intimacy and solidarity vs. isolation (in Erikson's theory)

Judgment and Reasoning in the Child (Piaget), 28

Knowledge
connectionist models and, 348–349
core (*See* Core knowledge theory)
domain-specific, 409–410, 428
Piaget's view of, 30–31
role of, in memory, 334–337

Language. *See also* Communication
behaviorism and, 278
bilingualism, 201
computational approaches to, 369–373
development of, 11, 22, 171, 173, 186, 247, 285, 298
discriminating phonemes, 251
impairment in, 351
importance of, 171, 245
learning, 220–221, 251, 296, 321
pragmatics of, 174
social uses of, 203
thought and, 9, 44–45
Language and Thought of the Child, The (Piaget), 28
Latency period (in Freud's theory), 109, 118–119
Learning. *See also* Education
alternate conceptions of, 285
by children, 65–66, 142, 289–290, 370–371, 380
cognitive contributions to, 294–296, 311–312
collaborative, 179, 180–181, 187, 190, 239
connectionist models and, 349
importance of, 217
by infants, 220–221, 387–392, 397–399
maturation vs. (*See* Nature vs. nurture)
observational, 288, 289–292, *295*, 303, 305, 310, 311, 427
perceptual (*See* Gibson's ecological theory of perceptual development)
predispositions to, 219–221, 235
readiness for, 180, 183, 220, 242, 364, 366
self-efficacy and agency, 296–300
social learning and personality, 286, 292
specific and general skills, 220–221
statistical, 312, 372
theories of (*See specific theories of learning*)
Learning sciences, 312
Learning theory. *See also* Social learning theory
academic psychology and, 67
discontent with, 285, 321
failures in, 430
history of, 279–286
modification of, 67
nature vs. nurture, 305

origins of, 2, 23, 278
reinforcement in (*See* Reinforcement)
Libido, 100, 101, 104, 113, 115
"Little Albert" experiment, 280
"Little Hans." *See* "Analysis of a Phobia in a Five-Year-Old Boy" (Freud)
Locomotion
cognition and, 243
of infants, 188, 380–381, 385–387, 390–392, *391*, 413
patterns in, 416
Logicomathematical systems/structures, 32, 49, 53, 64, 65, 71, 81
Long-term memory. *See* Memory

Macroenvironments, 271. *See also* Environment
Macrosystem, 190
Mathematical understanding. *See also* Logicomathematical systems/structures
in children, 66, 297, 341–344, 404
in connectionist models, 349
culture and, 196–198
gender and, 303
in information-processing theory, 341–344, 357
research in, 358
Maturation vs. learning. *See* Nature vs. nurture
Mechanisms of development. *See* Development, mechanisms of
Mechanistic view of human nature. *See* Human nature
Memory. *See also* Information processing; Working memory
autobiographical, 331
capacity of, 9, 74, 82–83, 247, 324, 325–326, 339, 357
development of, 9, 10, 18–19, 330–332, 338, 356, 359–360
distortions in, 126
flow diagram of, *325*
implicit, 132
input vs. output, 318–319
knowledge, role of, 334–337
long-term, 319, 324, 325–326, 331, 358, 361, 368
metaphors in, 363
repression of, 104, 124, 128
research in, 358–360
retrieval from, 325–326, 331, 335, 356
social–cultural context of, 340–341
strategies in, 8, 332–334, 355, 358, 427
Memory span, 324–325, 326
Mental embryology, 31
Mental imagery, 36, 100, 107, 186, 197, 323, 332
Mental operations
behavior and, 309
compensation, 60
in concrete operational period, 36, 46, 48
in formal operational period, 36, 51, 53
information processing and, 319, 346, 360
origins of, 2
in preoperational period, 45
reversibility, 46, 48–49, 125, 168
Mental representations, 44–45, 51, 62
Mercantilistic view of human nature. *See* Human nature
Mesosystem, 189, 190
Metacognition, 337, 357, 364
Metamemory, 56–57, 337–339, 356. *See also* Memory
Methodologies
in Erikson's theory, 138–139
in ethology, 221–224, 238–239
in Freud's theory, 111–113
in Gibson's theory, 385–387
in information-processing theory, 328–330, 361–362
in Piaget's theory, 34–35, 78–79
in Vygotsky's theory, 174–176
Microenvironments, 271. *See also* Environment
Microgenetic methods, 174, 179, 328–329, 342, 355, 416, 427
Microsystem, 189, 190
Middlemarch (Eliot), 363
Mirror neuron system, 313, 369
Mistrust. *See* Basic trust vs. basic mistrust (in Erikson's theory)
Modeling
abstract, 290, 296
Baddeley's memory model, 324, 366
Bayesian networks (models), 312, 369–373, 403, 409, 427
computational models (*See* Computational models)
connectionist models (*See* Connectionist models)
overlapping-waves model, *353*, 353–354
stimulus–response model, 234, 280–281, 323, 423, 431
for working memory, 369
Models, 5
Modularity, 411
Molecular genetics, 257–258. *See also* Genetics
Moral disengagement, 301
Moral Judgment of the Child, The (Piaget), 28
Moral reasoning. *See* Reasoning
Moratorium person, 149
"Moses of Michelangelo, The" (Freud), 98
Motivation
cognitive ability and, 179, 184, 241, 304
conscious, 108
controlling, 180, 309
imitation and, 296
intrinsic, 62, 423
unconscious, 98, 127
Multimodal stimulation, 385
Multitasking, 360

Narratives and conversations, development through, 202–203
Nativism vs. empiricism. *See* Nature vs. nurture

Nature vs. nurture
in connectionist models, 425
in Erikson's theory, 145, 425
in ethology, 235, 425
in Freud's theory, 123
genetics, 21, 425
in Gibson's theory, 393, 425
in information-processing theory, 356–357, 425
introduction to, 19–22, *21*
in learning theory, 305
in neuroscience, 22, 425
in Piaget's theory, 63–65, 425
review of, 425
in social learning theory, 305, 425
in Vygotsky's theory, 178–179, 425
Neo-Freudians, 132
Neo-Piagetian theory
Case's theory, 83–85, *85*
Fischer's theory, 85–88, 154
introduction to, 82
origins of, 23
themes in, 88–89
Nervous energy. *See* Drive energy; Libido; Psychic energy; Tension
Neural networks. *See also* Connectionist models; Neuroscience
imaging of, 249, 255
imitation and, 313, 424
increased specialization in, 251
maintaining, 131, 410
strengthening, 20, 255, 426–427
Neural transmission, 250, 356
Neuroconstructivism, 92, 254
Neurodevelopmental disorders, 92, 254
Neurogenetics, 268–269. *See also* Genetics
Neuroimaging
information processing and, 318
purpose of, 91, 215, 249, 254, 398–399
research in, 131, 367
types of, 91
Neurolaw, 256
Neuropsychoanalysis, 131
Neuroscience. *See also* Brain; *entries beginning with cognitive*
applications of, 255–256, 403
attachment research, 242
brain development, 250–253
connectionist models in, 347
developmental cognitive neuroscience, 91, 131
introduction to, 248–250
nature vs. nurture, *21*, 22, 425
research in, 256–257, 270, 367–368
theoretical issues in, 253–255, 424, 427
Nonlogical thought, 124–125. *See also* Thought
Numerical reasoning. *See* Reasoning

Object permanence
development of, 306, 407, 417
ethological view of, 243
Piagetian view of, 8, 42–43, 76, 77, 88, 89, 90, 92, 188
Object relations, 129
Observational learning. *See* Learning
Oedipus complex, 105, 117, 118, 127, 141
Ontogenetic causes of behavior, 237
Ontogenetic change, 218
Operant conditioning, 280, 282–284, 288, 331. *See also* Conditioning
Operations, 48–50, 52. *See also* Concrete operational period; Formal operational period
Optimal adaptation, 237. *See also* Adaptation
Optimal level of development, 86
Oral stage (in Freud's theory), 109, 113–116, 122, 226
Organismic view of human nature. *See* Human nature
Origins of Intelligence in Children, The (Piaget), 37
Overimitation, 312. *See also* Imitation
Overlapping-waves model, *353*, 353–354. *See also* Modeling

Paradigms, 429–431
Parallel distributed processing, 348
Peer collaborations. *See* Collaborative problem solving
Peer interactions, 230–232
Pendulum problem, 52, 62, 69
Penis envy, 118, 129
Perceptual conscious. *See* Conscious
Perceptual learning. *See* Gibson's ecological theory of perceptual development
Performance, theory of, 74
Personality. *See also* Ego; Id; Superego
abnormal, 111
anal, 98, 127, 141
development of, 96, 100, 104, 108, 114, 121–122, 124, 135, 140, 417
disturbed, 109
identity diffusion and, 143
social learning and, 286, 292
Personality and Psychotherapy (Dollard & Miller), 286
Person-in-context. *See* Developing-person-in-context
Phallic stage (in Freud's theory), 109, 117–118, 122
Philosophy of science, 7, 69
Phonological loop, 324–325, 326
Phylogenetic causes of behavior, 223, 237, 272
Phylogenetic change, 218, 239. *See also* Change
Physical maturation
Bandura's view of, 303, 305, 425
biological aspects, 10
cognition and, 22
Erikson's view of, 134, 144
ethological aspects, 215, 234
Freudian view of, 109, 121
Piagetian view of, 61, 63, 64, 425
Piaget's cognitive-structural theory
applications of, 65–66

assumptions in, 3–4
biographical sketch of Piaget, 26–29
biological approach to, 31
contemporary research, 89–92
developmental issues, position on, *21*, 62–65
ecological validity of, 69–70
equilibration in (*See* Equilibration)
focus of, 5, 24, 26
formula for development in, 64–65
genetic epistemology, 29–31
hypothetical constructs in, 3–4
logicomathematical experiences, 32, 49, 53, 64, 65, 71, 81
mechanisms of development in, 57–62, 426, 427
methodology of, 34–35, 78–79
modifications of, 80–82
orientation to, 29–35
origins of, 23
social experiences, 64–65
stage approach to, 16, 32–55, 70–72, 80
strengths of, 66–70
structuralism in, 32
weaknesses of, 70–79

Plasticity, 218–219, 245, 247, 250–251, 256, 270, 367
Play, concept of, 144–145, 167
Pleasure principle, 100, 102, 121
Pluralist–constructivist model, 200
Polymorphisms. *See* Genetic polymorphisms
Preconscious behavior, *105*, 107, 108
Preoperational period, 36, 41, 43–48, 55, 73
Primary circular reactions, 37–38
Primary-process thought, 102, 103. *See also* Thought
Principles of Perceptual Learning and Development (Gibson), 379
Private speech, 172–173. *See also* Egocentric speech
Probabilistic models, 269, 312. *See also* Modeling
Problem-based learning. *See* Collaborative learning
Problem solving
by children, 83–84, 164, 167
collaborative, 166, 192–193
development of skills in, 104, 425
ethological study of, 232–233
guided participation, 166
microgenetic method, 174 (*See also* Microgenetic methods)
zone of proximal development, 163 (*See also* Zone of proximal development (Vygotsky))
Processing space. *See* Executive processing space
Production deficiency, 333, 337
Production systems, 346–347, 351
Prospectivity, 394
Psychic energy, 100, 101
Psychoanalytic theory. *See also* Freud's psychoanalytic theory
expansion of, 146
importance of, 96, 98–99
nonlogical thought in, 124–125
Psychological energy, 100
Psychopathology, 130–131, 229, 236, 242, 253, 269, 424
Psychopathology of Everyday Life, The (Freud), 111
Psychosexual stages of development
in Erikson's theory, 133, 134
in Freud's theory, 108, 118, 134 (*See also specific stages*)
Psychosocial development, 134–135. *See also* Erikson's psychoanalytic theory

Qualitative vs. quantitative development
in Erikson's theory, 145, 424
in ethology, 234–235
in Freud's theory, 122–123, 424
in Gibson's theory, 393
in information-processing theory, 356, 364, 424, 425
introduction to, 17–19
organismic, 419
in Piaget's theory, 62–63, 424
review of, 424–425
in social learning theory, 305, 424
in Vygotsky's theory, 178, 424

Reaction formation, 104, 125
Readiness
cognitive, 92, 176, 305, 310
for learning, 180, 183, 220, 242, 305, 364, 366
measurement of, 174
in Piaget's theory, 65, 67, 73
Reality principle, 100, 121
Reasoning. *See also* Collaborative problem solving; Thought
causal, 46, 352, 408
by children, 27, 68–69, 83, 86, 89, 125, 157
concrete operational, 77
formal operational, 78
limitations in, 50
moral, 192, 196, 300–301, 411
numerical, 249
origin of reasoning tests, 27
preverbal vs. verbal, 410
scientific, 89, 171, 343
semilogical, 46–47
spatial, 249
transitive, 239
Reductionist strategy, 188, 214, 279–280, 423
Reflective abstraction, 80
Reflexes
attachment and, 224, 225, 226
classical conditioning, 282
in ethology, 423
in Fischer's theory, 87
in fixed action patterns, 216–217, 234
in infants, 216, 217, 224, 246
as innate behavior, 216, 217, 218, 234, 280, 414–415, 423
in learning theory, 278
nature vs. nurture, 63, 69
in sensorimotor period, 36–37, 54
Regression, 33, 104, 114
Rehearsal, cognitive and enactive, 394
Reinforcement
conflict and, 73, 307
imitation and, 67, 287

Reinforcement (*continued*)
in learning theory, 4, 10, 13, 16, 67, 278, 282–284, 321, 423
in natural settings, 310
observational learning and, 290, 310
self-regulation and, 315
social, 67, 293, 306
vicarious, 288
Relational aggression. *See* Aggression
Relational-developmental-systems theory, 417
Repression
anxiety and, 109
attachment and, 226
consciousness and, 103, *105*
internal conflicts and, 121
of memories, 104, 124, 128
Oedipus complex and, 127
of sexual desire, 118
Resistant attachment, 229. *See also* Attachment
Retention, 140, *295*, 315
Retrieval, from memory, 325–326, 331, 335, 356. *See also* Memory
Reversibility. *See* Mental reversibility
Rigidity of thought, 46. *See also* Thought
Robotics, 170, 321–322, 373–374
Rule-assessment approach, 328, 345

Scaffolding, 167
Schemes
concrete operations, 51
coordinating secondary, 39–40
defined, 32
primary circular reactions, 37–38
Schooling, effects of
culture and, 175, 194, 196–198, 200
self-efficacy and, 298
Scientific reasoning. *See* Reasoning
Scientific theory, 3, 23, 429–431
Scientific vs. spontaneous concepts, 181
Scripts, 336–337, 357, 367
Secondary circular reactions, 38–39
Secondary-process thought, 102–103. *See also* Thought
Secure attachment, 228, 229, 236, 240. *See also* Attachment
Selected environment, 293. *See also* Environment
Selective memory, 333–334, *334*. *See also* Memory
Self-absorption. *See* Generativity vs. stagnation and self-absorption (in Erikson's theory)
Self-concept, 116, 129, 187, 199, 396
Self-correction, 225, 327
Self-efficacy, 296–299, 302–303
Self-modification, 326–327, 351, 363
Self-regulation
aggression and, 418
in connectionist models, 427
gender roles and, 302
genetic influences on, 261–262
importance of, 423
in Piaget's theory, 62, 122, 423
in social learning theory, 422, 423
in Vygotsky's theory, 168, 180, 423
Self-righting tendency, 217
Semilogical reasoning, 46–47. *See also* Reasoning
Sensitive periods, 219
Sensorimotor period (development)
Fischer's view of, 87–88
motor exploration in, 220, 368–369
object permanence, 42–43
origins of, 2
overview of, 42, 54
stages in Piaget's theory, 36–42
thought without speech, 172
Sexuality
of children, 117–119, 128–129
culture and, 193
genital stage and, 110, 119
infantile, 98, 151
maturity, 306
repression of memories of, 104, 124, 128 (*See also* Repression)
Shame and doubt. *See* Autonomy vs. shame and doubt (in Erikson's theory)
Shaping, 282
Signaling behaviors, 225, 227
Signs, 44, 170. *See also* Symbols
Sign stimuli, 216–217, 234, 272, 423
Situational influences on behavior, 308–309
Skills, 86. *See also* Abilities
Skinner box, 278, 283
Skinnerian operant learning theory, 4, 13. *See also* Learning theory
Social change, 198–200. *See also* Change
Social cognition, 47–48, 125, 175, 365. *See also* Cognition; Intelligence
Social cognitive theory, 278, 288. *See also* Learning theory
Social constructionists, 6
Social deviance, 417
Social information processing, 341. *See also* Information processing
Social learning theory. *See also* Learning theory
aggression in, 13
applications of, 306–308
causal model of, 292–293
classical learning theory vs., 428
contemporary research, 311–314
cultural effects, 292
developmental issues, position on, *21*, 304–306
gender-role development in, 302–303
history of, 286–289
introduction to, 278–279
mechanisms of development in, 303–304, 426, 427
moral judgments and behavior in, 300–301
observational learning, 289–292

orientation to, 289–300
origins of, 2, 23, 24, 286
progress in, 428
psychoanalytic theory and, 99
selective social learning, 314
strengths in, 308–309
testability of, 309
weaknesses in, 309–311
Social reciprocity, 243
Sociocultural theory. *See* Vygotsky's sociocultural theory
Solidarity, 190, 194. *See also* Intimacy and solidarity vs. isolation (in Erikson's theory)
Spatial reasoning. *See* Reasoning
Species-specific innate behavior, 215–217, 305
Specific and general learning skills, 220–221. *See also* Skills
Specific language impairment, 351. *See also* Language
Speech. *See also* Communication; Language
angry vs. neutral, 254
development of, 171–174
ecology of, 387
egocentric, 45, 172
inner, 169, 172
oral pleasure and, 134
private, 172–173
spontaneous, 34
Spontaneous vs. scientific concepts, 181
Stage approach
in Erikson's theory, 134–137
in Freud's theory, 108–110, 113–120
in Piaget's theory, 16, 32–34, 70–72, 80
in Vygotsky's theory, 178
Stagnation. *See* Generativity vs. stagnation and self-absorption (in Erikson's theory)
Statistical learning, 312, 372, 409, 427. *See also* Learning
Stepping reflex, 392, 414. *See also* Reflexes
Stimulation, 381–384
Stimulus–response model, 234, 280–281, 323, 423, 431. *See also* Modeling
Strategies
choosing, 326–327
cognitive, 170, 284, 368
constructing, 355
cultural, 154, 171, 197
development of, 74, 353–354, 357, 414
for mathematical understanding, 197, 297, 338, 342
in memory development, 8, 332–334, 355, 358, 427
prosocial, 231
reductionist, 279–280
Stress
activation of responses to, 264
anxiety and, 219, 270
in environment, 189
responding to, 242, 262, 268–270
Structural approach (in Freud's theory), 101–106
Structuralism, 32, 62
Sublimation, 101
Superego. *See also* Ego; Id
defined, 101
development of, 105, 117, 119, 123
function of, 117
organization of, 423
structural relationships, *105*, 105–106
Symbols, 44, 197

Task analysis, 327–328, 346, 357
Temporal–spatial representations, 50
Tension, 100, 121, 161
Tension-reduction process, 144
Tertiary circular reactions, 40
Theories. *See also specific theories*
development issues, position on, 419
foundational, 405
historical progress of, 428–431, 434
overview of, 403
principles of, 402
themes in, 403–419
Theory of mind, 89, 125–126, 174, 404, 405, 407, 408–409
Theory theory
application of, 404–409
conceptual development, 403
domain-specific development, 72, 91, 410–411, 425, 428
how children develop, 424, 426, 427
organismic quality of, 419, 422
purpose of, 2
Thought. *See also* Reasoning
abstract vs. concrete, 168, 181
complexity of, 360–361
concrete operational vs. formal operational, 53–54, 58
controlling, 170, 173, 252–253
development of, 11, 73, 123, 157, 243–244
environment and, 31, 51, 86, 103
formal operational, 52, 53, 61
general structures of, 35
hypothetico-deductive thought, 52
irrational, 125, 304
language and, 9, 44–45
learning and, 66
nonlogical, 124–125
preconscious vs. conscious, 107
primary-process, 102, 103
rational vs. irrational, 125, 304, 424
representational vs. sensorimotor, 44–45
rigidity of, 46
secondary-process, 102–103
without speech, 172 (*See also* Speech)
Thought and Language (Vygotsky), 158
Toilet training, 99, 104, 114, 116–117, 287
Topographic approach (in Freud's theory), 106–108
Totem and Taboo (Freud), 98
Transitive reasoning, 239. *See also* Reasoning
Triadic reciprocal causation, 292, 304, 305, 315

Triadic reciprocal determinism, 190
Trust. *See* Basic trust vs. basic mistrust (in Erikson's theory)

Unconscious behavior, *105*, 107, 108, 127, 132
Universality of Piaget's stages, 34
Utilization deficiency, 334

Vicarious reinforcement, 288. *See also* Reinforcement
Visual cliff, 377, 379, 386, 390
Visuospatial sketchpad, 324, 325
Vygotsky's sociocultural theory
  applications of, 179–182
  assimilation of, 204–205
  background sketch of Vygotsky, 155–158
  child-in-activity-in-culture concept, 158–163, 168, 179
  compared to social learning theory, 289
  contemporary research, 192–207
  developmental issues, position on, *21*, 177–179
  individual mental functioning in, 167–169
  intellectual functioning in, 169–174
  introduction to, 154–155
  mechanisms of development in, 176–177, 426, 427
  methodology of, 174–176
  orientation to, 158–176
  origins of, 23, 24
  progress in, 428
  proximal development (*See* Zone of proximal development (Vygotsky))
  strengths of, 182–184
  weaknesses of, 184–188

Walden Two (Skinner), 283
Why War? (Freud), 98
Working memory. *See also* Memory
  applications of, 357
  automatization and, 354
  components of, 324–326
  efficiency of, 83
  executive functioning and, 173, 366, 411
  importance of, 339, 357, 428
  increasing, 88, 91, 326, 351, 367, 427
  information processing and, 364
  language learning and, 247
  modeling, 369
  performance and, 333, 361
  stress and, 365
  theory of mind and, 411–412
  theory of performance and, 74
Worldview, 14, 419, 422–424. *See also specific worldviews*

Young Man Luther (Erikson), 138

Zone of proximal development (Vygotsky)
  analysis of, 163–167, 265
  cognition and, 186, 204
  collaboration in, 177
  defined, 163
  dynamic assessment of, 174, 179–180
  scaffolding and, 86
  vagueness of, 182, 184–185

Patricia Miller's classic book is the ideal introduction for anyone interested in the study of child development. With her engaging tone and exceptional scholarship, Miller focuses on what is most exciting about each of the field's major theoretical approaches, and how each theory contributes to a broader understanding of developmental psychology. Revised to reflect the latest empirical and theoretical findings as well as our changing world, *Theories of Developmental Psychology*, Sixth Edition, is the most current and balanced presentation of developmental theory available today.

NEW TO THE SIXTH EDITION:

- New coverage of biological approaches to development throughout the text and featured in an expanded *Chapter 5, Biological Approaches: Ethology, Evolution, Neuroscience, and Genetics.*

- New section, *Immigrant Families,* exploring the process of development in the context of adapting to a new culture.

- New section, *Social Change,* exploring how shifts in demographics, advances in information and communication technologies, and globalization affect development.

- New sections, *Mathematical Understanding, Developmental Cognitive Neuroscience, Embodied Cognition, Bayesian Computational Models,* and *Developmental Robotics* in *Chapter 6, Information Processing Theory,* presenting the most up-to-date research and trends.

- New coverage of theoretical approaches to atypical development, such as *autism spectrum disorders, psychopathology, bullying,* and *altered stress regulation systems.*

- New focus on the *"state-of-the-art" in developmental theorizing today* in the newly titled *Chapter 9, Theories Today: Themes and Perspectives,* with new coverage of *theory of mind* research, *dynamic-systems* theory, and an all-new section on *Core Knowledge* theories.

worth publishers
Macmillan Learning
macmillanlearning.com
COVER PHOTO: SERGEY NIVENS/SHUTTERSTOCK

ISBN-13: 978-1-4292-7898-0
ISBN-10: 1-4292-7898-6
90000
9 781429 278980