CHAPTER 3

Motor Development: A Theoretical Model

KEY TERMS

Descriptive theory
Explanatory theory
Phases of motor development
Inductive method
Deductive method
Category of movement
Reflexes
Rudimentary movement abilities
Fundamental movement skills
Specialized movement skills
Heuristic
Algorithm
Triangulated Hourglass Model of motor development

CHAPTER COMPETENCIES

Upon completion of this chapter you should be able to:

- Define life span motor development
- View an individual's motor behavior as "more" or "less" advanced on a developmental continuum rather than as "good" or "bad"
- Demonstrate an understanding of neural, physiological, perceptual, and cognitive changes across the life span
- Distinguish between inductive and deductive theory formulation
- Describe the phases of motor development
- List and describe the stages within the phases of motor development
- Explain how the requirements of the movement task, the biology of the individual, and conditions of the learning environment interact with the Triangulated Hourglass Model of motor development
- Demonstrate knowledge of both how and why using a heuristic device as a metaphor for understanding is helpful in conceptualizing the products and processes of motor development

KEY CONCEPT

The processes and products of motor development across the lifespan may be conceptualized through use of a triangulated hourglass heuristic.

A major function of theory is to integrate existing facts, to organize them in such a way as to give them meaning. Theories of development take existing facts about the human organism and provide a developmental model congruent with these facts. Therefore, theory formulation serves as a basis for fact testing and vice versa. Facts are important, but they alone do not constitute a science. The development of a science depends on the advancement of theory as well as on the accumulation of facts. In the study of human behavior, especially in the areas of cognitive and affective development, theory formulation has gained increased importance over the past several years. Theory has played a critical dual role in both of these areas; namely, it has served and continues to serve as an integrator of existing facts and as a basis for the derivation of new facts (Bigge & Shermis, 2004; Lerner, 2007).

Describing and Explaining Motor Development

Until the 1980s, interest in motor development had been concerned primarily with describing and cataloging data, with little interest in developmental models leading to theoretical explanations of behavior across the life span. This research was necessary and important to our knowledge base. But it did little to help us answer the critically important questions of what lies underneath the process of motor development and how the process occurs. Only a limited number of comprehensive models of motor development exist, and there are still few comprehensive theories of motor development. Now, however, scholars in motor development are reexamining their work with a view toward more carefully thought out research grounded in sound theoretical frameworks. The intent of this chapter is to present a comprehensive model of motor development, based on two specific theoretical viewpoints: *descriptive* phase-stage theory and *explanatory* dynamic systems theory. We will present this model in the form of an hourglass accompanied by an overlapping inverted triangle. Our intent here is to use this visual representation as a way to conceptualize both the descriptive products (hourglass) and explanatory processes (inverted triangle) of motor development as it typically unfolds across the life span. As with all theoretical models ours too will fall short. It has, however, served as a plinth (basis) by many for better understanding *what* is occurring and *why* it is occurring in this amazing process that we call motor development.

CONCEPT 3.1

Few comprehensive theoretical models of motor development exist.

The first function of a theoretical model of motor development should be to integrate the existing facts encompassed by the area of study. The second function should be to serve as a basis for the generation of new facts. One might argue that the facts could be interpreted in more than one way, that is, from different theoretical perspectives. This is entirely possible and desirable. Different viewpoints generate theoretical arguments and debates, the spark for research to shed new light on differing theoretical interpretations. Even if theoretical differences do not exist, research should be undertaken to determine whether the hypotheses derived from the theory can be both experimentally and ecologically supported.

Theory should undergird all research and science, and the study of motor development is no exception. It is our view that developmental theory must be both **descriptive** and **explanatory.** In other words, the developmentalist should be interested in what people are typically like at particular age periods (description) and why these

characteristics occur (explanation). Without a theoretical construct, research in motor development, or any other area, tends to yield little more than isolated facts. However, without an existing body of knowledge (facts), we cannot formulate theory, and without the formulation and constant testing of theory, we cannot hope for a higher level of understanding and awareness of the phenomenon that we call motor development.

CONCEPT 3.2

Theoretical models attempt to describe and explain behavior and may be inductive or deductive.

A theory is a group of statements, concepts, or principles that integrate existing facts and lead to the generation of new facts. The **phases of motor development** presented in this chapter are not based solely on the accumulation of facts. Such a model would result from using an **inductive method** of theory formulation. In the inductive method the investigator first starts with a set of facts and then tries to find a conceptual framework around which to organize and explain them. The **deductive method** of theory formulation, as used here, is based on inference and has three primary qualifications. First, the theory should integrate existing facts and account for existing empirical evidence that bears on the content of the theory. Second, the theory should lend itself to the formulation of testable hypotheses in the form of: If _____, then _____ statements. Third, the theory should meet the empirical test; that is, experimentally tested hypotheses should yield results that lend further support to the theory.

The use of a deductive, rather than an inductive, model enables us to see how well-accumulated facts fit together into a cohesive, understandable whole. It also enables us to identify the information needed to fill in gaps in the theory or to clarify or refine it. The phases of motor development outlined here are deductively based and serve as a model for theory formulation. In subsequent sections of the text each phase will be explored in greater detail.

THE PHASES OF MOTOR DEVELOPMENT

The process of motor development reveals itself primarily through changes in movement behavior over time. All of us, infants, children, adolescents, and adults, are involved in the lifelong process of learning how to move with control and competence in response to challenges we face daily in our constantly changing environment. We are able to observe developmental differences in movement behavior. We can do this through observation of changes in process (form) and product (performance). A primary means by which motor development may be observed is through studying changes in movement behavior throughout the life cycle. In other words, a "window" to the process of motor development is provided through an individual's observable movement behavior, which provides us with clues to underlying motor processes.

CONCEPT 3.3

The process of motor development may be viewed as phase-like and stage-like.

Observable movement may be grouped into three functional categories according to their purpose and across all of the phases of motor development: stabilizing movement tasks, locomotor movement tasks, and manipulative movement tasks, or combinations of the three. In the broadest sense, a stability movement is any movement in which some degree of balance or posture is required (i.e., virtually all gross motor activity). In a narrower sense, a stability movement is one that is both nonlocomotor and nonmanipulative. The category conveniently encompasses movements such as twisting, turning, pushing, and pulling that cannot be classified as locomotor or manipulative. In this book, stability, as a **category of movement,** is viewed as more than a convenient catchall term, but as less than a global term applicable to all movement. The *stability movement* category refers to any movement that places a premium on gaining and maintaining

one's equilibrium in relation to the force of gravity. Thus, axial movements (another term sometimes used for nonlocomotor movements) as well as inverted and body rolling postures are considered here as stability movements. So too are standing on one foot or remaining upright while sitting in a chair.

The *locomotor movement* category refers to movements that involve a change in location of the body relative to a fixed point on the surface. To transport oneself from point A to point B by walking, running, hopping, jumping, or skipping is to perform a locomotor task. In our use of the term, such activities as the forward roll and backward roll may be considered both locomotor and stability movements—locomotor because the body is moving from point to point, stability because of the premium placed on maintaining equilibrium in an unusual balancing situation.

The *manipulative movement* category refers to both gross and fine motor manipulation. Gross motor manipulation involves imparting force to, or receiving force from, objects. The tasks of throwing, catching, kicking, and striking an object, as well as trapping and volleying, are gross motor manipulative movements. Fine motor manipulation involves intricate use of the muscles of the hand and wrist. Sewing, cutting with scissors, and typing are fine motor manipulative movements. A large number of movements involve a combination of stability, locomotor, and/or manipulative movements. For example, jumping rope involves locomotion (jumping), manipulation (turning the rope), and stability (maintaining balance). Likewise, playing soccer involves locomotor skills (running and jumping), manipulative skills (dribbling, passing, kicking, and heading), and stability skills (dodging, reaching, turning, and twisting).

In summary, if movement serves as a window to the process of motor development, then one way of studying this process is through examining the sequential progression of movement skills throughout the entire life span. The following phases of motor development and the developmental stages within each phase are designed to serve as a model for this study. (See Figure 3.1 for a visual representation of the four phases and their corresponding stages.)

Reflexive Movement Phase

The first movements the fetus makes are reflexive. **Reflexes** are involuntary, subcortically controlled movements that form the basis for the phases of motor development. Through reflex activity the infant gains information about the immediate environment. The infant's reactions to touch, light, sounds, and changes in pressure trigger involuntary movement activity. These involuntary movements, coupled with increasing cortical sophistication in the early months of postnatal life, play an important role in helping the child learn more about his or her body and the outside world.

Primitive reflexes may be classified as information-gathering, nourishment-seeking, and protective responses. They are information-gathering in that they help stimulate cortical activity and development. They are nourishment-seeking and protective because there is considerable evidence that they are phylogenetic in nature. Primitive reflexes such as the rooting and sucking reflexes are thought to be primitive survival mechanisms. Without them, the newborn would be unable to obtain nourishment.

Postural reflexes are the second form of involuntary movement. They are remarkably similar in appearance to later voluntary behaviors but are entirely involuntary. These reflexes seem to serve as neuromotor testing devices for stability, locomotor, and manipulative mechanisms that will be used later with conscious control. The primary stepping reflex and the crawling reflex, for example, closely resemble later voluntary walking and crawling behaviors. The palmar grasping reflex is closely related to later voluntary grasping and releasing behaviors. The labyrinthine righting reflex and the propping reflexes are related to later balancing abilities. The reflexive phase of motor development may be divided into two overlapping stages.

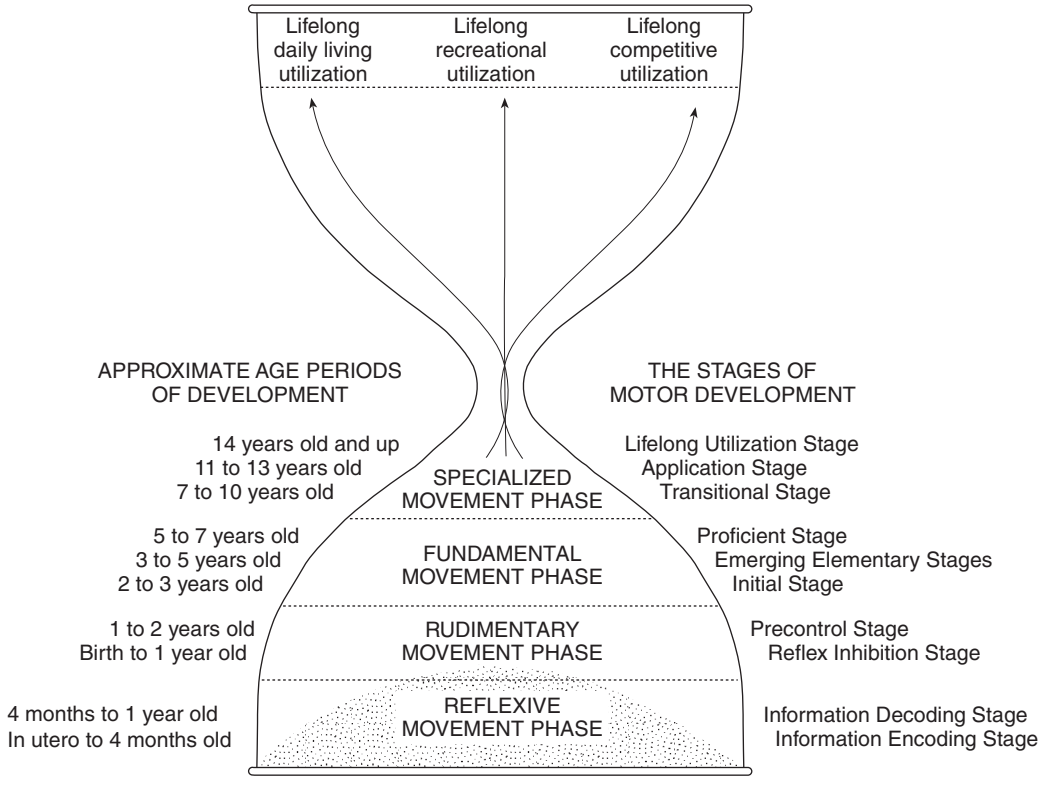

Figure 3.1
The phases and stages of motor development.

CONCEPT 3.4

Reflexes are the first forms of human movement and, because they are not learned, are considered to be "abilities" rather than "skills."

Information Encoding Stage

The information encoding (gathering) stage of the reflexive movement phase is characterized by observable involuntary movement activity during the fetal period until about the fourth month of infancy. During this stage lower brain centers are more highly developed than the motor cortex and are essentially in command of fetal and neonatal movement. These brain centers are capable of causing involuntary reactions to a variety of stimuli of varying intensity and duration. Reflexes now serve as the primary means by which the infant is able to gather information, seek nourishment, and find protection through movement.

Information Decoding Stage

The information decoding (processing) stage of the reflex phase begins around the fourth month. During this time there is a gradual inhibition of many reflexes as higher brain centers continue to develop. Lower brain centers gradually relinquish control over skeletal movements and are replaced by voluntary movement activity mediated by the motor area of the cerebral cortex. The decoding stage replaces sensorimotor activity with perceptual-motor ability. That is, the infant's development of voluntary control of skeletal movements involves processing sensory

stimuli with stored information, not merely reacting to stimuli.

Chapter 7 focuses on the primitive and postural reflexes of infancy as they relate to the information encoding and decoding stages. Special attention is given to the relationship between the reflexive phase of development and voluntary movement.

Rudimentary Movement Phase

The first forms of voluntary movement are rudimentary movements. They are seen in the infant beginning at birth to about age 2. Rudimentary movements are maturationally determined and are characterized by a highly predictable sequence of appearance. This sequence is resistant to change under normal conditions. The rate at which these abilities appear will vary from child to child, however, and depends on biological, environmental, and task factors. The **rudimentary movement abilities** of the infant represent the basic forms of maturationally dependent voluntary movement required for survival. They involve stability movements such as gaining control of the head, neck, and trunk muscles; the manipulative tasks of reaching, grasping, and releasing; and the locomotor movements of creeping, crawling, and walking. The rudimentary movement phase of development may be subdivided into two stages that represent progressively higher orders of motor control.

CONCEPT 3.5

The sequence of movement skill acquisition during the rudimentary movement phase is generally fixed, but the rate is variable.

Reflex Inhibition Stage

The reflex inhibition stage of the rudimentary movement phase may be thought of as beginning at birth. At birth, reflexes dominate the infant's movement repertoire. From then on, however, the infant's movements are increasingly influenced by the developing cortex. Development of the cortex, and lessening of certain environmental constraints, causes several reflexes to be inhibited and gradually disappear. Primitive and postural reflexes are replaced by voluntary movement behaviors. At the reflex inhibition level, voluntary movement is poorly differentiated and integrated because the neuromotor apparatus of the infant is still at a rudimentary stage of development. Movements, though purposeful, appear uncontrolled and unrefined. If the infant wishes to make contact with an object, there will be global activity of the entire hand, wrist, arm, shoulder, and even trunk. The process of moving the hand into contact with the object, although voluntary, lacks control.

Precontrol Stage

Around 1 year of age, children begin to bring greater precision and control to their movements. The process of differentiating between sensory and motor systems and integrating perceptual and motor information into a more meaningful and congruent whole takes place. The rapid development of higher cognitive processes and motor processes encourages rapid gains in rudimentary movement abilities during this stage. During the precontrol stage, children learn to gain and maintain their equilibrium, to manipulate objects, and to locomote throughout the environment with an amazing degree of proficiency and control considering the short time they have had to develop these abilities. The maturational process may partially explain the rapidity and extent of development of movement control during this phase, but the growth of motor proficiency is no less amazing.

Chapter 8 provides a detailed explanation of the development of rudimentary movement abilities. Particular attention is paid to the interrelationship between the stages within this phase and the stages within the reflexive phase of development. Attention is also focused on the critical function that the rudimentary movement phase serves in preparing the child for the development of fundamental movement skills.

INTERNATIONAL PERSPECTIVES

The Royal Academy of Dance

The Royal Academy of Dance, located in London, has produced superb *Pre-Primary in Dance* and *Primary in Dance* syllabi and instructional DVDs. They deftly achieve the goals of helping young children become more skillful movers, knowledgeable movers, and expressive movers in a teaching and learning environment that is age-appropriate, developmentally appropriate, and fun. Each of the themed lessons is well presented and pedagogically sound. A diverse group of children depict the joy of moving with skill, efficiency, and purpose. The focus is on a wide variety of the fundamental locomotor, manipulative, and stability skills of early childhood. These skills are important because they form the basis for the more complex and specialized movement, sport, and dance skills of later childhood and beyond. In each of the many lessons children are encouraged to experiment with an endless variety of movement variations and to self-discover ways of moving that increase their movement vocabulary as well as skillfulness. The children are delightful to observe and interaction with the on-camera instructor is joyful. The instructor is a master teacher who, lesson after lesson, demonstrates how to make curricular material personally meaningful and developmentally appropriate for young learners.

In a world often more interested in specializing in movement skill development at an early age, the Royal Academy of Dance has taken a bold step in a different direction: a direction that is focused on the developmental needs, interests, and unique abilities of children as they begin the lifelong quest of being skillful, knowledgeable, and expressive movers. Check out the Royal Academy of Dance website for more information: http://www.radenterprises.co.uk

Fundamental Movement Phase

The **fundamental movement skills** of early childhood are an outgrowth of the rudimentary movement phase of infancy. This phase of motor development represents a time in which young children are actively involved in exploring and experimenting with the movement potential of their bodies. It is a time for discovering how to perform a variety of stabilizing, locomotor, and manipulative movements, first in isolation and then in combination with one another. Children developing fundamental patterns of movement are learning how to respond with motor control and movement competence to a variety of stimuli. They are gaining increased control in the performance of discrete, serial, and continuous movements as evidenced by their ability to accept changes in the task requirements. Fundamental movement patterns are basic observable patterns of behavior. Locomotor activities such as running and jumping, manipulative activities such as throwing and catching, and stability activities such as the beam walk and one-foot balance are examples of fundamental movements that should be developed during the early childhood years.

A major misconception about the developmental concept of the fundamental movement phase is the notion that these skills are maturationally determined and are little influenced by task demands and environmental factors. Some child development experts (not in the motor development area) have written repeatedly about the "natural" unfolding of the child's movement and play skills and the idea that children develop these abilities merely by growing older (maturation). Although maturation does play a role in the development of fundamental movement patterns, it should not be viewed as the only influence. The conditions of the environment—namely, opportunities for practice, encouragement, instruction, and the ecology (context) of the environment—play important roles in the degree to which fundamental movement skills develop.

Fundamental movement skills have utility throughout life and are important components of daily living for adults as well as children. The daily tasks of walking to the store, climbing stairs, and balancing in static and dynamic positions are important basic skills across the life span. Using the forward roll as the independent variable, Haynes (2009) looked at 117 participants across three age cohorts (children: mean age 9.7; young adults: mean age 18.9; older adults: mean age 35.9). Haynes found that the observable components for the forward roll were essentially the same for each group, a finding that lends support to similar sequences of fundamental movement skills as being age-independent.

CONCEPT 3.6

Constraints contained within the requirements of the movement task, the biology of the individual, and the conditions of the learning environment have profound effects on the acquisition of movement skills at each phase of development.

Several researchers and assessment instrument developers have attempted to subdivide fundamental movements into a series of identifiable sequential stages. For the purposes of our model we will view the entire fundamental movement phase as having separate but often overlapping stages: the initial stage, the emerging elementary stages, and the proficient stage. These stages are described briefly here and in greater detail in chapters 11 and 12.

Initial Stage

The initial stage of a fundamental movement phase represents the child's first goal-oriented attempts at performing a fundamental skill. Movement is characterized by missing or improperly sequenced parts, markedly restricted or exaggerated use of the body, and poor rhythmical flow and coordination. The spatial and temporal integration of movement is poor. Typically, the locomotor, manipulative, and stability movements of the 2–3-year-old are at the initial level. Some children may be beyond this level in the performance of some patterns of movement, but most are at the initial stage.

Emerging Elementary Stages

The emerging elementary stages, of which there may be several, involve gaining greater motor control and rhythmical coordination of fundamental movement skills. The synchronization of the temporal and spatial elements of movement is improved, but patterns of movement during these stages are still generally restricted or exaggerated, although better coordinated. Children of normal intelligence and physical functioning tend to advance to the emerging elementary stages primarily through the process of maturation. Observation of the typically developing 3 to 5 year-old child reveals a variety of fundamental movement skills that are emerging in a series of sometimes distinct and sometimes overlapping elementary stages. Many individuals, adults as well as children, fail to get beyond these emerging elementary stages in one or more fundamental movement skills.

Proficient Stage

The proficient stage within the fundamental movement phase is characterized by mechanically efficient, coordinated, and controlled performances. Proficient fundamental movement skills are mature in these three process aspects. With continued opportunities for practice, encouragement, and instruction they will, however, continue to improve in terms of the product components of how far, how fast, how many, and how accurately.

The majority of available data on the acquisition of fundamental movement skills suggests that children can and should be at the proficient stage by age 5 or 6 in most fundamental skills. Manipulative skills that require visually tracking and intercepting moving objects (catching, striking, volleying) tend to develop somewhat later because of the sophisticated visual-motor requirements of these tasks. Even a casual glance at the movements of children and adults reveals that a great many have not developed their fundamental movement skills to a

proficient level. Although some children may reach this stage primarily through maturation and with a minimum of environmental influences, the vast majority require some combination of opportunities for practice, encouragement, and instruction in an environment that fosters learning. Failure to offer such opportunities makes it exceedingly difficult for an individual to achieve proficiency in fundamental movement skills and will inhibit further application and development in the specialized movement phase that follows (O'Keeffe, 2001; Stodden et al., 2008). Seefeldt (1982) was the first to appropriately refer to this as a "proficiency barrier" between fundamental movement skills and their companion specialized sport skills. More recently Clark & Metcalfe (2002) suggested that fundamental motor skills provided the "base camp" to the mountain of motor development leading to motor skillfulness.

Specialized Movement Phase

Specialized movement skills are an outgrowth of the fundamental movement phase. During the specialized phase, movement becomes a tool applied to a variety of complex movement activities for daily living, recreation, and sport pursuits. This is a period when fundamental stability, locomotor, and manipulative skills are progressively refined, combined, and elaborated upon for use in increasingly demanding situations. The fundamental movements of hopping and jumping, for example, may now be applied to rope-jumping activities, to performing folk dances, and to performing the triple jump (hop-step-jump) in track and field. O'Keeffe studied the relationship between fundamental movement skills and sport-specific skills in a test of the Triangulated Hourglass Model of motor development. The results of his investigation led him to conclude that "this study provides empirical evidence in support of Gallahue's theoretical model with respect to the relationship between fundamental skill and sport-specific skill phases and also for dynamical systems theory to explain the learning process" (O'Keeffe, 2001, abstract). In other words, the patterns of movement contained within a fundamental movement skill are the same movement patterns upon which sport-specific skills are based. Therefore, it can be concluded that mastering fundamental skills leads to easier learning of specific skills.

The onset and extent of skill development within the specialized movement phase depends on a variety of task, individual, and environmental factors. Reaction time and movement speed, coordination, body type, height and weight, customs, culture, peer pressure, and emotional makeup are but a few of these constraining factors. The specialized movement phase has three stages.

CONCEPT 3.7

Progress through the specialized movement skill phase depends on mature fundamental movement skill development.

Transitional Stage

Somewhere around their seventh or eighth year, children commonly enter a transitional movement skill stage (Haubenstricker & Seefeldt, 1986). During the transitional period, the individual begins to combine and apply fundamental movement skills to the performance of specialized skills in sport and recreational settings. Walking on a rope bridge, jumping rope, and playing kickball are examples of common transitional skills. Transitional movement skills contain the same elements as fundamental movements with greater form, accuracy, and control. Fundamental movement skills developed and refined during the previous stage are applied to play, game, and daily living situations. Transitional skills are applications of fundamental movement patterns in somewhat more complex and specific forms.

The transitional stage is an exciting time for the parent and the teacher as well as for the child. Children are actively involved in discovering and combining numerous movement patterns and are often elated by their rapidly expanding movement abilities. The goal of concerned parents, teachers, and youth sport coaches during this stage should be to help children increase their motor control and movement competence

in a wide variety of activities. Care must be taken not to cause the child to specialize or restrict his or her activity involvement. A narrow focus on skills during this stage is likely to have undesirable effects on the last two stages of the specialized movement phase.

Application Stage

From about age 11 to age 13 (the middle school years) interesting changes take place in the skill development of the individual. During the previous stage, the child's limited cognitive abilities, affective abilities, and experiences, combined with a natural eagerness to be active, caused the normal focus (without adult interference) on movement to be broad and generalized to "all" activity. In the application stage, increased cognitive sophistication and a broadened experience base enable the individual to make numerous learning and participation decisions based on a variety of task, individual, and environmental factors. For example, the 5-foot, 10-inch (179 cm) 12-year-old who likes team activities and applying strategy to games, who has reasonably good coordination and agility, and who lives in Indiana, may choose to specialize in the development of his or her basketball playing abilities. A similarly built child who does not really enjoy team efforts may choose to specialize in a variety of track and field activities. The individual begins to make conscious decisions for or against participation in certain activities. These decisions are based, in large measure, on how he or she perceives the extent to which factors within the task, himself or herself, and the environment either enhance or inhibit chances for enjoyment and success. This self-examination of strengths and weaknesses, opportunities and restrictions, narrows the choices.

During the application stage, individuals begin to seek out or to avoid participation in specific activities. Increased emphasis is placed on form, skill, accuracy, and the quantitative aspects of movement performance. This is a time for more complex skills to be refined and used in advanced games, lead-up activities, and selected sports.

Lifelong Utilization Stage

The lifelong utilization stage of the specialized phase of motor development begins around age 14 and continues through adulthood. The lifelong utilization stage represents the pinnacle of the process of motor development and is characterized by the use of one's acquired movement repertoire throughout life. The interests, competencies, and choices made during the previous stage are carried over, further refined, and applied to a lifetime of daily living, recreational, and sports-related activities. Factors such as available time and money, equipment and facilities, and physical and mental limitations affect this stage. Among other things, one's level of activity participation will depend on talent, opportunities, physical condition, and personal motivation. An individual's lifetime performance level may range anywhere from professional status and the Olympics; to intercollegiate and interscholastic competition; to participation in organized or unorganized, competitive or cooperative, recreational sports and simple daily living skills.

In essence, the lifelong utilization stage represents a culmination of all preceding stages and phases. It should, however, be viewed as a continuation of a lifetime process. Specialized skill development can and should play a role in our lives, but it is unfair to require children to specialize in one or two skill areas at the expense of developing their movement repertoire in and appreciation for many other areas (Landers, Carson, & Tjeerdsma-Blankenship, 2010).

CONCEPT 3.8

The primary goal of a person's motor development and movement education is to accept the challenge of change in the continuous process of gaining and maintaining motor control and movement competence throughout a lifetime.

THE TRIANGULATED HOURGLASS: A LIFE SPAN MODEL

The age ranges for each phase of motor development should be viewed as general guidelines, illustrative only of the broad concept of age

appropriateness. Individuals often function at different phases depending on their experiential backgrounds and genetic makeups. For example, it is entirely possible for a 10-year-old to function in the specialized movement phase at the lifelong utilization stage in stability activities involving gymnastic movements, but only at the elementary stage of the fundamental movement phase in manipulative and locomotor skills such as throwing, catching, or running. Although we should encourage this precocious behavior in gymnastics, we should also help the child catch up to his or her age-mates in the other areas and develop acceptable levels of proficiency in them as well.

It is important to gather facts about the process of developing motor skills. Throughout this text we discuss study after study, but if we fail to provide you with a theoretical framework and a conceptual grasp of the process of motor development, we will have presented isolated facts that tell you little about their implications for successful developmental teaching, coaching, therapy, and parenting. Therefore, we would like to propose a theoretical model for the process of motor development and work through this model with you. This model as presented is not a comprehensive theory of motor development. It is a **heuristic** device, that is, a conceptual metaphor, or model, of motor development, that provides us with general guidelines for describing and explaining motor behavior. Heuristics differ from algorithms in one important way. Whereas an **algorithm** is a procedure or set of rules guaranteed, if followed, to lead to solution of a given kind of problem, heuristics are rules of thumb giving one clues for how to search for answers to given problems. In the study of development, many theories use heuristic devices that researchers hope will eventually lead to algorithms.

The intent of all heuristic devices (which may be likened to metaphors) is to be helpful in characterization of particular phenomena. As such, they can only be viewed as more or less helpful, not as being right or wrong. Heuristic devices provide a broad framework for better understanding a particular phenomenon. Our hope, therefore, is that the Triangulated Hourglass heuristic will be of genuine help to you in better understanding the phenomena of motor development.

CONCEPT 3.9

The triangulated hourglass model is a helpful heuristic device for conceptualizing, describing, and explaining the process of motor development.

To understand this model, picture yourself as an hourglass (Figure 3.2). Into your hourglass we need to place the stuff of life: "sand." Sand gets into your hourglass from two different containers. One is your hereditary container and the other your environmental container. The hereditary container has a lid. At conception our genetic makeup is determined and the amount of sand in the container is fixed. However, the environmental container has no lid. Sand may be added to the container and to your hourglass. We could reach down into the "sand pile" (i.e., the environment) and get more sand to put into your hourglass.

The two buckets of sand signify that both the environment and heredity influence the process of development. The relative contributions of each have been a volatile topic of debate for years. Arguing the importance of each is a meaningless exercise because sand is funneled from *both* containers into your hourglass. In the final analysis it does not really matter if your hourglass is filled with hereditary sand or environmental sand. What is important is that somehow sand gets into your hourglass and that this stuff of life is the product of *both* heredity and the environment.

Now, what do we know about motor development during the early phases of life? When we look at the reflexive and rudimentary phases of motor development, we know that sand pours into the hourglass primarily, but not exclusively, from the hereditary container. The sequential progression of motor development during the first few years of life is rigid and resistant to change except under environmental extremes. Therefore, we know in the first two phases of motor development that the developmental sequence is highly predictable.

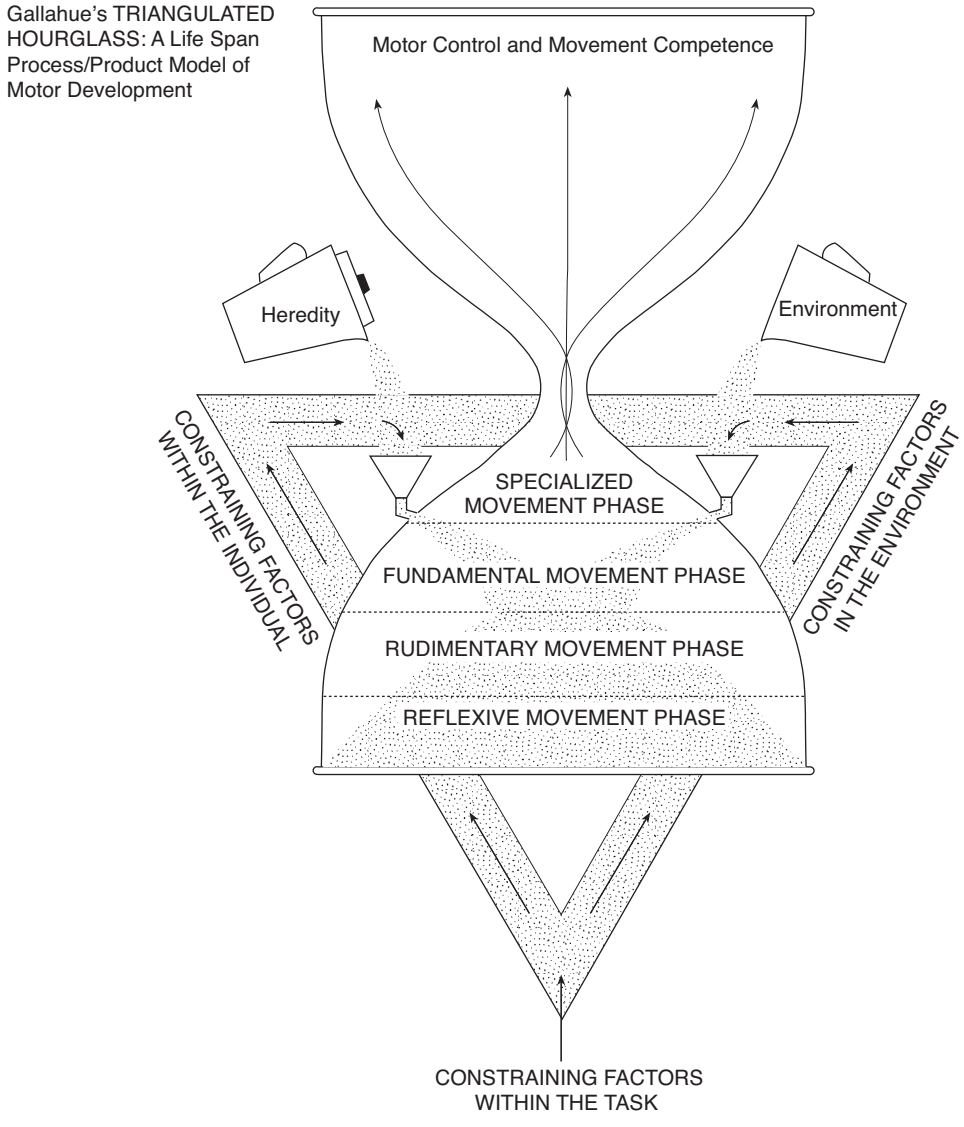

Figure 3.2

Filling an individual's hourglass with "sand" (i.e., the stuff of life). The hourglass represents a descriptive (product) view of development. The inverted triangle represents an explanatory (process) view of development. Both are helpful in understanding motor development as one continually adapts to change in the lifelong quest for gaining and maintaining motor control and movement competence.

For example, children all over the world learn how to sit before they stand, how to stand before they walk, and how to walk before they run. However, we do see considerable variability in the rates at which the very young acquire their rudimentary movement abilities. This is something in which researchers and program developers have become increasingly interested. We have seen a rapid rise in the number of infant stimulation programs and infant-toddler movement programs. Some make

elaborate claims about the worth of these programs and their ultimate importance to the child. Unfortunately, we have little hard evidence at this juncture to either support or refute these claims. The rate of movement skill acquisition is variable from infancy throughout life. If an infant, child, adolescent, or adult receives additional opportunities for practice, encouragement, and instruction in an environment conducive to learning, movement skill acquisition will be promoted. The absence of these

DEVELOPMENTAL DILEMMA

The Mountain of Motor Development

Clark and Metcalfe (2002) published an interesting paper entitled "The Mountain of Motor Development: A Metaphor." In it they deftly discuss the intent and purpose of heuristic devices, or metaphors, in the study of human development. The authors provide an interesting discussion of how to select appropriate metaphors for motor development as well as means for assessing its validity and usefulness. Next, they carefully look at metaphors as descriptors of human behavior, focusing on motor development. They even take time to succinctly describe the triangulated hourglass model prior to presenting their own (see Figure 3.3).

The mountain metaphor is intriguing in that it envisions humankind collectively. Clark and Metcalfe rightfully contend that we each climb our own mountain. Interestingly, however, our own individual mountains vary. Some are high and rugged, others are shorter and more rounded, and still others are only small foothills. In this range of mountains the individual, as the "mountaineer," who is seen as a nonlinear self-organizing adaptive organism, "climbs" as high as possible. How high she or he climbs (the goal of the task) is dependent on the interaction between the biology of the individual and the conditions of the environment. In other words, constraints.

Serving as a framework for understanding, the mountain heuristic device, much like the Triangulated Hourglass, attempts to broadly describe both the products and the processes of motor development. The two appear to differ, however, from the collective framework of each person having his or her own personal mountain to climb (or hourglass to fill). The mountain may be seen as an open system that is dynamic in terms of shape, size, number, and complexity, whereas the hourglass could be viewed (inappropriately, we believe) as a closed and static system that has a "one size/shape fits all" view of development.

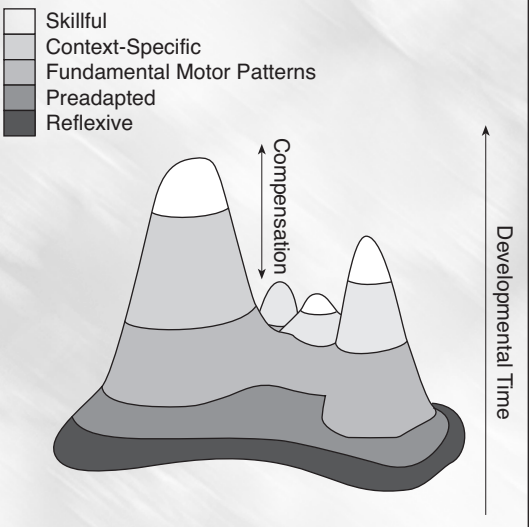

Figure 3.3
The Mountain of Motor Development
Clark, J.E., & Metcalfe, J.S. (2002). The mountain of motor development: A metaphor. In J.E. Clark & J. Humphrey (Eds.). Motor Development: Research and Reviews (pp. 163–190). Reston VA: NASPE Publications.

Do we have a developmental dilemma here? Is motor development a "mountain" or is it an "hourglass"? Is one view of development right and the other wrong? Better yet, given your personal reality (i.e., where you are and with whom you interact on a regular basis), what is your metaphor/heuristic for better understanding the processes and products of motor development?

environmental affordances (i.e., enabling factors) will constrain movement skill acquisition. Furthermore, the acquisition rate will vary depending on the mechanical and physical requirements of each task. For example, if an infant does not have sufficient handholds (an environmental constraint) in her environment to enable her to pull herself up to a stand, she will have to wait until sufficient balance (a biomechanical constraint) and strength in the legs (a physical constraint) have developed, before she is able to bring herself to a standing position unaided. "Contemporary theory explains motor development as a dynamic process in which a motor behavior emerges from the many constraints that surround that behavior" (Clark, 1994, p. 247).

In the fundamental movement phase, boys and girls are beginning to develop a whole host of basic movement skills—running, hopping, jumping, throwing, catching, kicking, and trapping. Unfortunately, many still have the notion that children somehow "automatically" learn how to perform these fundamental movements. Many naively think that children at this phase of development will, through the process of maturation, develop proficient fundamental movement skills. This is not true for the vast majority of children. Most children must have some combination of opportunities for practice, encouragement, and instruction in an ecologically sound environment. These conditions are crucial to helping them through each of the stages within the fundamental movement phase. Furthermore, as the task requirements of a fundamental movement skill change, so too will the process and the product. For example, the perceptual requirements of hitting a pitched ball are considerably more sophisticated than those required to strike a stationary ball or to perform a striking pattern without making contact with another object. Teachers of individuals at the fundamental movement phase must learn to recognize and analyze the task requirements of movement skills to maximize learner success. Teachers who overlook these duties erect proficiency barriers at the specialized movement skill phase.

At the specialized movement skill phase, successful performance of the mechanics of movement depends on mature fundamental movements. After the transitional stage we progress to the final stages in which specialized movement skills are applied to daily living, recreational, and sport experiences.

At some point, the hourglass turns over (Figure 3.4). The timing of this occurrence is variable and often depends more on social and cultural factors than on physical and mechanical factors. For most individuals, the hourglass turns over and the "sand" begins to pour out during the late teens and early 20s. This is a time in which many individuals enter the adult world of work, car payments, mortgages, family responsibilities, and a host of other time-consuming tasks. Time restrictions limit the pursuit of new movement skills and the maintenance of skills mastered during childhood and adolescence.

There are several interesting features in the overturned hourglass that we need to consider. The sand falls through two different filters. One is the *hereditary filter* with which we can do very little. For example, an individual may have inherited a predisposition toward longevity or coronary heart disease. The hereditary filter is going to be either dense, causing the sand to filter through slowly, or easy to penetrate, allowing the sand to flow through more rapidly. Sand that has fallen through the hereditary filter cannot be recovered, but it must pass through a second, or final, filter called the lifestyle filter.

The density of the *lifestyle filter* is determined by such things as physical fitness, nutritional status, diet, exercise, the ability to handle stress, and social and spiritual well-being. The lifestyle filter is environmentally based, and we have a good deal of control over the rate at which sand falls through this filter. Although we can never stop sand from flowing to the bottom of the hourglass, we can slow down the rate at which it falls. A former surgeon general of the United States, Dr. C. Everett Koop, once stated that although we cannot stop the aging process, we can control it by up to 40%. We can directly influence how fast sand falls through our hourglasses. As teachers, coaches, therapists, and parents we have the wonderful opportunity to shovel "sand" into many "hourglasses." We also have the privilege and the obligation to help others develop "lifestyle filters" that will slow the rates at

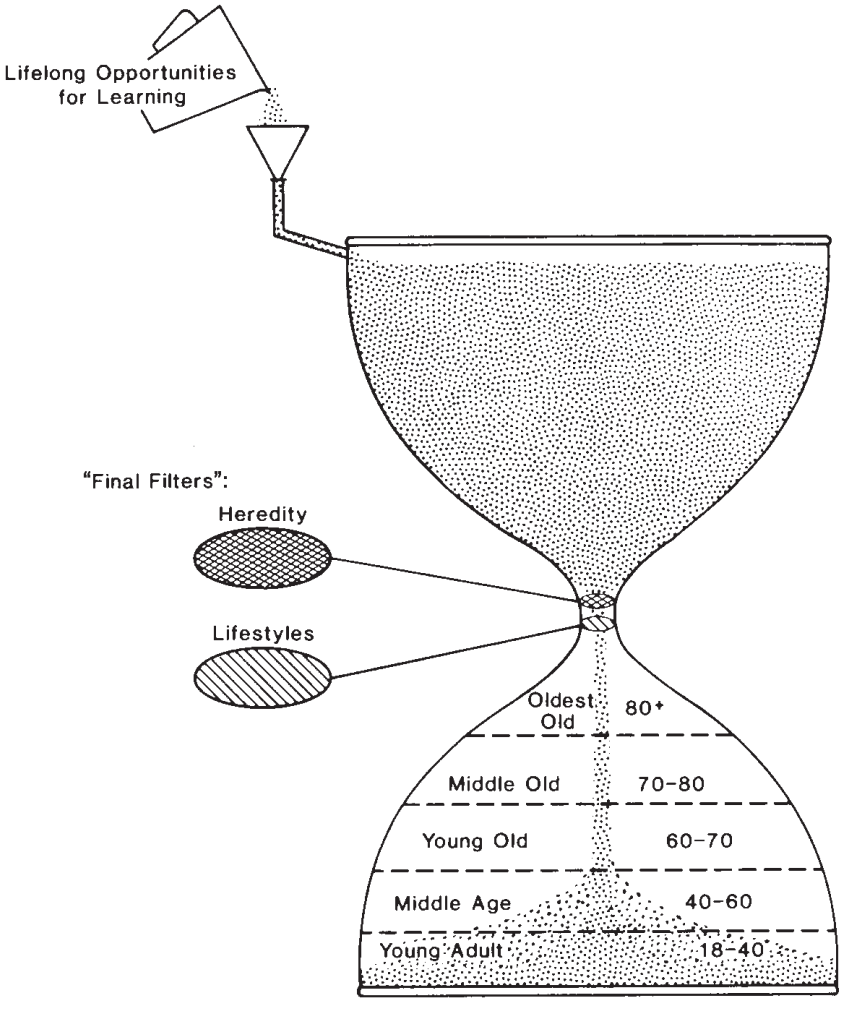

Figure 3.4
Emptying the overturned hourglass of life. Development as seen here is a continuous discontinuous process throughout the life span.

which sand falls in their hourglasses. Sand can still be added even when hourglasses are overturned and the sand is falling to the bottom. Each of us has *lifelong opportunities for learning.* By taking advantage of the numerous opportunities for continued development and physical activity, we can add more sand. We cannot add sand faster than it is falling and claim immortality. We can, however, extend and improve the quality of life.

The **hourglass heuristic** device as described to this point gives the impression that development is an orderly and continuous process. Note, however, that the sand at the bottom of the hourglass in both Figures 3.2 and 3.4 is distributed in a bell-shaped curve. The shape of this curve implies that there is a distribution of movement skills among the categories of movement (locomotion, manipulation, and stability), and within the various movement

tasks. For example, one may be at the elementary stages in some skills, the proficient stage in others, and at a sport skill level in still others. Additionally, one may be at different stages of development within the same skill. For example, when children and adults perform the overhand throw, they are often at the initial stage in their trunk action, an emerging elementary stage in their arm action, and a proficient stage in their leg action. Motor development in the hourglass model, therefore, is a *discontinuous process,* that is, a process that, although phaselike and stagelike in a general sense, is highly variable in a specific sense. Motor development when viewed as discontinuous is in effect a *dynamic* (i.e., nonlinear) process occurring within a self-organizing system (i.e., the "hourglass").

CONCEPT 3.10

Motor development is a discontinuous process occurring within a self-organizing system.

Although depicted as being unidimensional in Figures 3.1, 3.2 and 3.4, the Triangulated Hourglass Model should not be viewed as such. "Real" hourglasses occur in both time and space. They are multidimensional and as such contain, along with the motor domain, both cognitive and affective domains as well. As a result, real hourglasses have height, width, and depth and must be supported if they are to remain upright. Visualize, if you will, an individual's hourglass as being supported by a cognitive pillar, an affective pillar, and a motor pillar. The hourglass is multidimensional; thus, there is a triple interaction among the cognitive, affective, and motor domains. In other words, the Triangulated Hourglass Model is more than a motor model. It is a model of motor development that influences, and is influenced by, a wide variety of cognitive and affective factors operating within both the individual and the environment.

You may find it helpful to visualize the hourglass heuristic device as you proceed through the following sections dealing with motor development during infancy, childhood, adolescence, and adulthood. Remember, however, that it is not important that you accept this model as proposed. Theoretical models are just that—"models." As such they are incomplete, inexact, and subject to verification and further refinement. What is important is that you visualize how the process of motor development occurs. Remember, understanding motor development helps to explain how learning occurs. Both are crucial to the creation of effective, developmentally appropriate instruction.

CONCEPT 3.11

Understanding the process of motor development helps explain how movement skill learning occurs, which is crucial to developmentally appropriate instruction.

SUMMARY

The acquisition of competency in movement is an extensive process beginning with the early reflexive movements of the newborn and continuing throughout life. The process by which an individual progresses from the reflexive movement phase, through the rudimentary and fundamental movement phases, and finally to the specialized movements skill phase of development is influenced by factors within tasks, the individual, and the environment.

Reflexes and rudimentary movement abilities are largely based on maturation. Reflexes appear and disappear in a fairly rigid sequence. Rudimentary movements form the important base upon which fundamental movement skills are developed.

Fundamental movement skills are basic movement patterns that begin developing around the same time that a child is able to walk independently and move freely through his or her environment. These basic locomotor, manipulative, and stability skills go through a definite, observable process from immaturity to maturity. Stages within this phase include the initial, emerging elementary, and proficient stages. Attainment of the mature

stage is influenced greatly by opportunities for practice, encouragement, and instruction in an environment that fosters learning. Under the proper circumstances, children are capable of performing at the mature stage in the vast majority of fundamental movement patterns by age 6. The fundamental movement skills of children entering school are too often incompletely developed. Therefore, the primary grades offer an excellent opportunity to develop fundamental movement skills to their proficient levels. These same fundamental skills will be enhanced and refined to form the specialized movement skills so highly valued for recreational, competitive, and daily living tasks.

The specialized movement skill phase of development is in essence an elaboration of the fundamental phase. Specialized skills are more precise than fundamental skills. They often involve a combination of fundamental movement skills and require a greater degree of precision. Specialized skills involve three related stages. The transitional stage is typically the level of the child in grades three through five. At this level, children are involved in their first real applications of fundamental movements to sport. If the fundamental skills used in a particular sport activity are not at the mature level, the child will resort to less proficient or elementary patterns of movement. Involving children in sport skill refinement before they reach proficient levels of ability in prerequisite fundamentals is unwise. When this happens, the less proficient movements found in the basic patterns are carried over to the related sport skills. The child will regress to his or her characteristic pattern. It is important that sensitive teaching and coaching be incorporated at this point.

When we look at the process of motor development, we need to look at it first from a theoretical perspective. Each of us needs to have a theoretical framework to use as the basis for our actions. It is not important that you agree with the theoretical framework presented here. The Triangulated Hourglass Model is our way of viewing the process of motor development and its implications for life. What is your theoretical framework? How does it influence your teaching, coaching, therapy, or parenting, and how does it influence you personally?

Questions for Reflection

1. The Triangulated Hourglass Model borrows from two differing but complementary views of human development. What are they and in which ways are they both similar and different? How might they be viewed as complementary?
2. Using a heuristic different from the Triangulated Hourglass Model, can you use a metaphor to help yourself and others visualize the processes and products of motor development?
3. If motor development can be viewed as a Triangulated Hourglass or as a mountain metaphor, can it also be viewed, perhaps, as a tree, a train, or even a river or ocean? Select one of the above or choose another metaphor and build your own theoretical model.
4. The Tom Hanks character Forrest Gump in the movie of the same name said, "Life is like a box of chocolates." What did he mean? How could a box of chocolates be used as a metaphor for better understanding human development?
5. Why are theory building and theory testing important?

Critical Readings

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Web Resources

www.nia.nih.gov

Homepage for the National Institute on Aging. The site provides health and research information as well as press releases, a calendar of events, and general information on the NIA in regard to mission and programs.

www.elsevier.com/wps/find/journaldescription.cws_home

Journal of Adolescence Web page. Page includes journal information including description, editorial board, and a guide for authors, online submission, online reviewer form, and abstracting/indexing. Site also contains subscription information and journal-related information.

www.isisweb.org/main.htm

Homepage for the International Society on Infant Studies. ISIS is an organization "devoted to the promotion and dissemination of research on the development of infants." Site contains a description of the society, latest news, and newsletter.

www.srcd.org

Society for Research in Child Development homepage. The society is an international professional association focused on human development. The site includes news for members, job opportunities, suggested publications, summaries of journal articles, and information on becoming a member of the society.