



Chapter Objectives

This chapter will

- ▲ describe the theories currently used to study motor development,
- ▲ illustrate how different theories explain changes in motor behavior, and
- ▲ describe the history of the field of motor development.

MATURATIONAL PERSPECTIVE

In a nutshell, the maturational perspective explains developmental change as a function of maturational processes (in particular, through the central nervous system) that control or dictate motor development. According to the assumptions of this theory, motor development is an internal or innate process driven by a biological or genetic time clock. The environment may speed or slow the process of change, but it cannot change one's biologically determined course.

The maturational perspective became popular during the 1930s, led by Arnold Gesell (Gesell, 1928, 1954; Salkind, 1981). Gesell believed that the biological and evolutionary history of humans determined their orderly and invariable sequence of development (i.e., each stage of development corresponds with a stage of evolution). The rate at which a person passes through that developmental sequence, however, can be different for each individual. He explained maturation as a process controlled by internal (genetic) factors rather than external (environmental) factors. Gesell believed that environmental factors would only temporarily affect motor development since hereditary factors were ultimately in control of development.

Using identical twins as subjects, Gesell and his associates introduced the co-twin control strategy to developmental research (figure 2.2). What better way to test the different effects of environment and heredity than to look at twins? In this strategy, one twin receives a specific training (the experimental treatment) while the other receives no special training (the control treatment). Thus, the control develops naturally, as any child would without special training. In this manner, he examined the effects of the environment on development.

After a certain period of time, the twins were measured and compared with previously determined developmental criteria to see if the enhanced experience affected the "experimental" child in any way. Co-twin research provided significant contributions to the study of motor development. In particular, these studies allowed developmentalists to begin identifying the sequence of skill development, noting variations in the rate of skill onset.

In addition to describing the course of motor development, many maturationists were interested in the processes underlying development. Myrtle McGraw (1943), for example, associated changes in motor behavior with development of the nervous system. She considered maturation of the central nervous system to be the trigger for the appearance of new skills. McGraw was also



Maturationists believe that genetics and

heredity are primarily responsible for motor development and that the environment has little effect.



Figure 2.2 Using twins in studies allowed researchers like Gesell and McGraw to "control" genetics while manipulating the environment.



People have interpreted the maturationist perspective to mean that motor skills will automatically emerge, regardless of differing environments. This has influenced many teaching, parenting, and research concepts during the 20th and into the 21st centuries.

interested in learning, but those who followed in the study of development generally overlooked this aspect of her work (Clark & Whittall, 1989a). Use of the maturational perspective as a research tool in motor development began to wane by the 1950s. However, the influence of this theory is still felt to this day. For example, the focus on maturation as the primary developmental process led researchers and laypersons alike to assume that basic motor skills will automatically materialize. Hence, even today many researchers, teachers, and practitioners feel it is unnecessary to facilitate development of basic skills. In addition, the maturationists' emphasis on the nervous system as the *one* system triggering behavioral advancement evolved to almost single-minded emphasis on that system—to the point that no other system was believed to have much significance. The cardiovascular, skeletal, endocrine, or even muscular systems were not deemed of primary importance to motor development. By the mid-1940s, developmental psychologists began to change the focus of their research, and their interest in motor development waned. At this point, physical educators took up the study of motor development, influenced by the maturational perspective. From this time to 1970, people studied motor development by describing movement and identifying age group norms (Clark & Whittall, 1989a). During this period, motor developmentalists from the physical education discipline focused their attention on school-age children. Researchers still used the maturational perspective; their task was therefore to identify the naturally occurring sequence of changes.

Normative Descriptive Period

Anna Espenschade, Ruth Glassow, and G. Lawrence Rarick led a normative description movement during this era. In the 1950s, education became concerned with standardized tests and norms. Consistent with this concern, motor developmentalists began to describe children's average performance in terms of quantitative scores on motor performance

tests. For example, they described the average running speed and jumping and throwing distance of children at specific ages. Although motor developmentalists were influenced by the maturational perspective, they focused on the *products* (scores, outcomes) of development rather than the developmental *processes* that led to these quantitative scores.

Biomechanical Descriptive Period

Ruth Glassow led another descriptive movement during this era. Glassow made careful biomechanical descriptions of the movement patterns children used in performing fundamental skills such as jumping. Lolas Halverson (figure 2.3) and others continued these biomechanical descriptions with longitudinal observations of children. As a result, the developmentalists were able to identify the course of sequential improvement through which children moved in attaining biomechanically efficient movement patterns. The knowledge obtained from the normative and biomechanical descriptive periods was valuable in that it provided educators with information on age-related changes in motor development. Because description prevailed as the primary tool of these researchers during this time, motor development became labeled as descriptive. Interest in the



Figure 2.3 Lolas Halverson paved the way for contemporary research in motor development.

processes underlying age-related changes, which had been so meticulously recorded prior to this period of history, seemed to disappear.

Information Processing Perspective

A different theoretical approach focuses on behavioral or environmental causes of development (e.g., Bandura's social learning [Bandura 1986] and Skinner's behaviorism, among others). The perspective most often associated with motor behavior and development is called **information processing**. According to this perspective, the brain acts like a computer, inputting information, processing it, and outputting movement. The process of motor learning and development, then, is described in terms of computer-like operations that occur as a result of some external or environmental input.

This theoretical perspective appeared around 1970 and became the dominant perspective among experimental psychologists, developmental psychologists, and motor learning scientists specializing in physical education during the 1970s and 1980s (Schmidt & Wrisberg, 2000; Schmidt & Lee, 1999). This perspective emphasized concepts such as the formation of stimulus-response bonds, feedback, and knowledge of results (for more detailed information, see Schmidt & Wrisberg, 2000; Pick, 1989). Although some motor developmentalists continued with the product-oriented work of the normative and biological descriptive era, others adopted the information processing perspective. Researchers studied many aspects of performance, such as attention, memory, and effects of feedback, across age levels (Thomas, 1984; French & Thomas, 1987). Motor learning researchers and experimental psychologists tended to study the perceptual-cognitive mechanism in young adults first. Then, developmentalists studied children and older adults, comparing them with the young adults. In this way, they could identify the processes that control movement and change with development (Clark & Whittall, 1989a). Today, the information processing perspective is still a viable approach to the study of motor development.

Within the framework of information processing, some developmentalists continued to study perceptual-motor development in children. This work began in the 1960s with proposals that linked learning disabilities to children's delayed perceptual-motor development. Early research focused on this link; by the 1970s, researchers had turned their attention to the development of sensory and perceptual abilities, adopting information processing research strategies (Clark & Whittall, 1989a). Therefore, much of what we know about perceptual-motor development resulted from researchers within an information processing and mechanistic theoretical standpoint.

ECOLOGICAL PERSPECTIVE

A new perspective on development appeared during the 1980s and has become increasingly dominant as the theoretical perspective used by motor development researchers today. This approach is broadly termed the **ecological perspective** because it stresses the interrelationships between the individual, the environment, and the task. Does this sound familiar? It should—it's the perspective adopted by this text! We adopted this perspective because we feel it best describes, explains, and predicts motor development. According to the ecological perspective, you must consider the interaction of all elements (body type, motivation, temperature, ball size) to understand the emergence of a motor skill (kicking) (Robertson, 1989). Although one element or system may be more important or may cast a larger influence at any given time, all systems play a role in the resultant movement. This point makes the ecological perspective very appealing—at any given moment, how you move is not related to just your body or your environment but to the complex interplay of many internal and external factors.



The ecological perspective takes into account many different systems that exist both within the body (e.g., cardiovascular, muscular) and outside the body (e.g., ecosystem, social, cultural) when observing the development of motor skills across the life span.

The ecological perspective has two branches, one concerned with motor control and coordination (dynamic systems) and the other with perception (perception-action). The two branches are linked by several fundamental assumptions that differ notably from the maturational and information processing perspectives. In contrast to the maturational perspective, the ecological perspective considers motor development to be the development of multiple systems rather than only one (the central nervous system, or CNS). Because these different systems change throughout your life, motor development is considered a life span process. In information processing theory, an “executive” function is thought to decide all action, based on calculations of perceptual information resulting in hundreds of commands to control the individual muscles. The ecological perspective maintains that a central executive would be overwhelmed by this task, and in addition, this is a very inefficient way to move. Rather, perception of the environment is direct, and muscles self-assemble into groups, reducing the number of decisions required of the higher brain centers (Konczak, 1990). Let’s look more closely at each branch of the ecological perspective.

Dynamic Systems Approach

One branch of the ecological systems perspective is called the **dynamic systems approach**. In the early 1980s, Peter Kugler, Scott Kelso, and Michael Turvey (1980, 1982) and others introduced this approach as an alternative to existing motor control and coordination theories. Following the writings of Soviet physiologist Nikolai Bernstein, they suggested that the very organization of physical and chemical systems constrains behavior. Think about it: Your body can move in many different ways. However, because of the structure of your hip joint and legs (your skeletal system), you, as an adult, tend to walk (as opposed to crawl, scoot, or squirm) as a primary mode of transportation. The structural organization of your body encourages—constrains—you to walk. In other words, your body’s structure removes some of the movement choices your CNS might have to make (i.e., among crawling, scooting, squirming, or walking). It’s not that you cannot perform these movements; it’s just that because of your body structure, you are more “attracted” to walking.

Unlike the maturational and information processing perspectives, the dynamic systems approach suggests that coordinated behavior is “softly assembled” rather than “hard wired.” This means the interacting systems within your body act together as a functional unit to enable you to walk when you need to. By *not* having a hard-wired plan, you have greater flexibility in walking, which allows you to adapt your walk to many different situations. This process is called spontaneous self-organization of body systems. As we stated in chapter 1, movement emerges from the interaction between constraints (individual, environmental, task).

The resultant behavior emerges or self-organizes from these interrelationships. If you change any one of these, the emergent movement may change (Clark, 1995). This is the concept of constraints within the dynamic systems approach.

An important motor development concept to come from the dynamic systems approach is the notion of **rate limiters**, or **controllers**. The body’s systems do not develop at the same rate. Some might mature quickly, others more slowly. Consider the hypothetical example graphed in figure 2.4. The development of four hypothetical systems is pictured in each of the small graphs numbered 1 to 4. As time passes, the development of system 1 remains at a constant value. System 2 plateaus, advances in a large step, and then plateaus again. System 3 advances gradually and more continuously, whereas system 4 alternately advances and plateaus in a steplike fashion. The exhibited behavior, represented in the large graph, is the product of all the individual systems.

An individual might begin to perform a new skill, such as walking, only when the slowest of the necessary systems for that skill reaches a certain point. Any such system or set of

? Imagine a human infant is born in a space station on the moon. Predict the types of movements you would see during the first 2 years of life; in particular, how would you expect the infant to get around?



One of the fundamental principles or assumptions of the dynamic

systems approach is that movements and motor behaviors self-organize or emerge from the interactions between the individual environment and tasks within a context.

A **rate limiter**, or **controller**, is a system within an individual that holds back or slows the emergence of a motor skill.

systems is known as a rate limiter, or controller, for that skill because that system's development controls the individual's rate of development at that time. Suppose that system 4 in figure 2.4 is the muscular system. Perhaps an infant's muscular strength must reach a certain level before the legs are strong enough to support the infant's weight on one leg to walk. Hence, *muscular strength* would be a rate limiter, or controller, for walking.

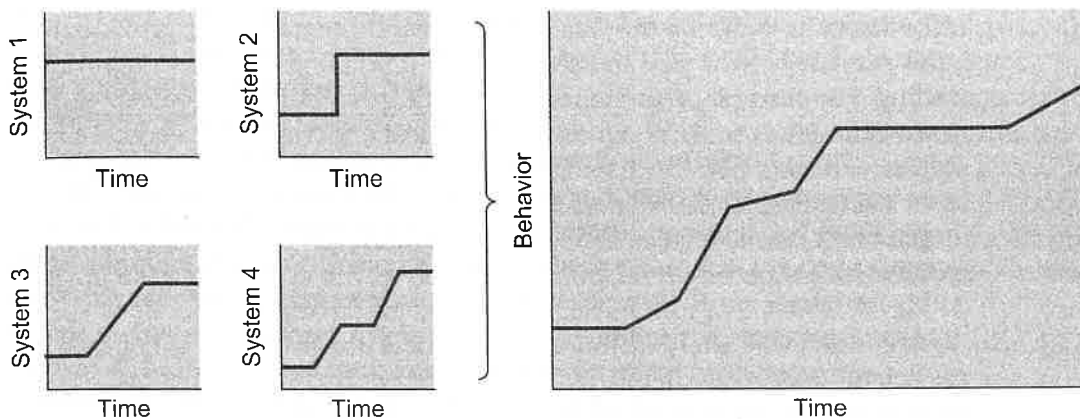


Figure 2.4 Here, four developing systems are depicted as contributing to behavior within an environmental context and for some particular task. The horizontal axis is time, and the vertical axis represents several parallel components or systems developing in different ways.

Adapted from Thelen, Ulrich, and Jensen 1989.

These tenets of the dynamic systems approach differ significantly from those of the maturational perspective. Maturationists tended to focus on the central nervous system as the only system relevant to development and the only rate controller. The dynamic systems approach focuses on many systems and acknowledges that different systems might be rate controllers for different skills (Thelen, 1998).

Another feature of the dynamic systems approach is that it allows for the study of development across the life span. The concept of a system acting as a rate limiter, or controller, for a movement behavior applies into older adulthood as well. The maturational perspective does not address aging since the predetermined endpoint of motor development is maturation, which occurs within the first several decades of life. In contrast, the dynamic systems approach accounts for changes in older adults as well as advancement in youths. When one or more of an individual's systems decline to a critical point, a change in behavior might occur. This system is a rate controller; it is the first to decline to some critical point, and it triggers the reorganization of a movement to a less efficient pattern. For example, if an individual's shoulder joint deteriorates as a result of arthritis and loses flexibility, at some point that individual might have to use a different overhand throwing motion or even throw underhand. The dynamic systems approach is very appropriate for explaining developmental changes because changes do not necessarily occur in all systems over the entire span of older adulthood. Disease or injury might strike one system, or systems might be differentially affected by lifestyle. An active older adult who maintains a regular and balanced exercise program might experience fewer declines in many of the systems than a sedentary peer might.

? in your experience, what have been significant rate limiters in your motor behavior? How have these changed at different times in your life?

Perception–Action Approach

The second branch of the ecological perspective is the **perception–action approach**. J.J. Gibson proposed this model in his writings during the 1960s and 1970s (1966, 1979), but

When a person looks at an object, he directly perceives the function that the object will allow, based on both his body and the object's size, shape, texture, and so forth. This is called an *affordance*.

Body scaling involves using a particular individual's body proportions (an internal reference system) when making movement decisions (picking equipment, selecting a gait pattern).



The concept of body scaling means that an

object, although it has an absolute size and shape, has a function relative to the size and shape of the person using it. An activity may become easier or more difficult if the equipment size is changed relative to a person's body dimensions.

? What activities would a 10-speed bicycle afford for an infant, an adult, a paraplegic, or a chimpanzee?

those who study movement have only recently adopted this approach. Gibson proposed that a close interrelationship exists between the perceptual system and the motor system, emphasizing that these systems evolved together in animals and humans. In this approach, we cannot study perception independent of movement if our findings are to be *ecologically valid*—that is, applicable to real-world movement behavior. Likewise, the development of perception and the development of movement must be studied together. In addition, we cannot study the individual while ignoring the surrounding environment. Gibson used the term **affordance** to describe the function an environmental object provides to an individual; this is related to the size and shape of the object and the individual within a particular setting. For example, a horizontal surface affords a human a place to sit, but a vertical surface does not. A squirrel can rest on a vertical tree trunk, so a vertical surface affords a squirrel a resting place. A baseball bat affords an adult, but not an infant, the opportunity to swing. Hence, the relationship between individual and environment is so intertwined that one's characteristics define objects' meanings. This implies that people assess environmental properties in relation to themselves, not according to an objective standard (Konczak, 1990). For example, an individual perceiving whether he or she can walk up a flight of stairs with alternate footsteps considers not just the height of each stair alone but the height of each stair in relation to the climber's body size. Obviously, a comfortable step height for an adult is not the same as that for a toddler. The use of intrinsic (relative to body size) rather than extrinsic dimensions is termed **body scaling**.

The implications of these ideas for motor development are that affordances change as individuals change, resulting in new movement patterns. Growth in size or enhanced movement capabilities might allow actions not previously afforded. When an infant first faces stairs, her perception of their function is not likely to be "climbable" because of her small size and lack of strength. As a toddler, though, she grows to a size that makes climbing stairs with alternate footsteps easy. Scaling environmental objects to one's body size permits actions that are otherwise impossible. Body scaling also applies to other age periods. For example, steps that are an appropriate height for most adults might be too high for an older adult with arthritis to climb comfortably with alternate footsteps. A wall-mounted telephone might be at a comfortable height for most adults, but it may be a frustrating inch too high for someone in a wheelchair. At any age, achievement of a movement goal relates to the individual, who is a certain shape and size, and to environmental objects, which afford certain movements to that individual.

Gibson also rejected the notion of a CNS executive that performs almost limitless calculations on stimulus information to determine the speed and direction of both the person and the moving objects. The information processing perspective holds that such calculations are used to anticipate future positions so that we can reach up to catch a thrown ball, for example. Instead, according to Gibson, individuals perceive their environment directly by constantly moving their eyes, heads, and bodies. This activity creates an optic flow field that provides both space and time information. For example, the image of a baseball approaching a batter not only indicates the ball's location but also expands on the eye's retina. The batter uses this rate of image expansion to time his swing—that is, the rate of expansion gives the batter's central nervous system direct information about when the ball will be in range. Likewise, the expansion rate of an oncoming car's image on a driver's retina yields the "time to collision." From Gibson's perspective, an individual can perceive this time to collision directly and does not need to perform a complicated calculation of speeds and distances to predict where and when collision and interceptions will occur.

The ecological perspective has been taking hold in motor development research throughout the past two decades. Developmentalists are asking different types of questions, such as, "How does an infant's context affect her motor behavior?" (Adolph, 1997

Adolph, Vereijken, & Shrout, 2003). Concurrently, they have developed new types of research studies, such as examining the relationship between infant reflexes and adult movements (Thelen & Ulrich, 1991). The ecological perspective encourages professionals to view developing individuals in a very different way than before. As a result, these perspectives will excite and challenge students in the field. In many sections of this text, we examine the maturation and dynamic systems approaches on a particular issue and highlight the differences between these perspectives.



Summary and Synthesis

Chapter 2 reviews the history and different theoretical viewpoints specific to motor development—the maturational, information processing, and ecological perspectives. The maturation perspective emphasizes biological development, specifically maturation of the central nervous system. The information processing perspective sees the environment as the main force driving motor development. Ecological theorists stress the interaction between all body systems and the inseparable nature of the individual, environment, and task.

Diametrically opposed perspectives cannot be merged, but students of motor development are free to view behavior from different perspectives. It is important to remember that these theoretical viewpoints often focus only on specific aspects of development; that is, developmentalists with a particular perspective tend to study certain behaviors or age spans. Maturationists focus on infancy, whereas descriptive developmentalists focus on late childhood and adolescence. Information processing theorists search for age differences, whereas those studying from an ecological perspective observe transitions from one skill to another (e.g., from crawling to walking).



Discussion Questions

1. Who are the key researchers in the field of motor development from the 1920s until today?
2. How can a teacher or therapist use the concept of body scaling to help individuals develop different motor skills?
3. Why should physical educators be interested in affordances?



Learning Activities

Body Scaling to Design Sports Equipment

You have been hired by Schmidt's Tennis Supplies to design a line of "body scaled" tennis rackets. They would like their product line to be distinguishable from others on the market. You must prepare an initial report, discussing important aspects of the new rackets, such as the available product lines from other companies and how your rackets will differ from theirs. Develop this report, answering the following questions as a guide.

1. What are the important individual constraints to consider when body scaling tennis rackets?
2. How have other companies body scaled their rackets? Upon what individual constraint or constraints do they scale?
3. What are novel ways to scale Schmidt's new rackets? What have other companies overlooked?

