



Fundamental Concepts

CHAPTER OBJECTIVES

This chapter

- ▶ defines motor development,
- ▶ distinguishes developmental issues from other concerns,
- ▶ describes some of the basic tools used by researchers in motor development,
- ▶ explains why development occurs over a life span, and
- ▶ introduces a model that guides our discussion of motor development.

Motor Development in the Real World

The Up Series

In 1964, director Paul Almond filmed a group of 14 British children, all 7 years old, from diverse socioeconomic backgrounds and created a documentary about their lives titled *7 Up!* In 1971, Michael Apter followed up with *7 Plus Seven*, and he brought out a new installment of the series every 7 years, following these same individuals through childhood and adolescence, into adulthood, and then into middle age. Apter hoped to explore the influence of the British class system over time and see if the Jesuit motto "Give me a child until he is seven and I will give you the man" held true. The latest installment, *56 Up*, premiered on British television on May 14, 2012, and was released in the United States in January 2013. In total, the *Up* series showed the lives of the participants over the course of 49 years, from childhood into middle adulthood, thus providing a window into the group and individual development.

If we developed a series of documentaries addressing motor development, who might watch? Many professionals might be interested. Educators, especially physical and early childhood educators, might be interested in which practices work best and whether they are developmentally appropriate. Therapists would want to know the factors that affect movement abilities. Engineers and designers might be interested in changes throughout adulthood in order to make appropriately sized and arranged living spaces, control panels, work equipment, sport gear, and vehicles. Health care providers might want to determine how movement and exercise early in life affect health status later on. Clearly, then, motor development interests many people for many reasons. Indeed, we can learn a great deal by examining change in movement patterns—and why it occurs—from birth until old age. Movement is an integral part of our lives, and its change is inevitable.

Defining Motor Development

Our imaginary documentary series might give you a rough idea of what motor development is. Let's now be more exact and give the field some boundaries, much as a producer would do in order to decide which segments are appropriate for the motor development film and which are not.

Development is defined by several characteristics. First, it is a continuous process of change in functional capacity. Think of functional capacity as the capability to exist—to live, move, and work—in the real world. This is a cumulative process. Living organisms are always developing, but the amount of change may be more noticeable, or less noticeable, at various points in the life span.

Second, development is related to (but not dependent on) age. As age advances, development proceeds. However, development can be faster or slower at different times, and rates of development can differ among individuals of the same age. Individuals do not necessarily advance in age and advance in development at the same rate. Further, development does not *stop* at a particular age but rather continues throughout life.

Third, development involves sequential change. One step leads to the next step in an orderly and irreversible fashion. This change results from interactions both within the individual and

between the individual and the environment. All individuals of a species undergo predictable patterns of development, but the result of development is always a group of unique individuals.

Individuals function in a variety of arenas, including the physical, social, cognitive, and psychological. Hence, we use terms such as **cognitive development** or **social development** to address the process of change in particular arenas. Social scientists often specialize in the study of one aspect of development.

We use the term **motor development** to refer to the development of movement abilities. Those who study motor development explore developmental changes in movements as well as the factors underlying those changes. Such study addresses both the process of change and the resultant movement outcome. Not all change in movement constitutes development. For example, if a tennis teacher elicits a change in a student's forehand stroke by changing the student's grip on the racket, we do not view the change as motor development. Rather, we use the term **motor learning**, which refers to movement changes that are relatively permanent but related to *experience* or practice rather than age. We use the term **motor behavior** when we prefer not to distinguish between motor learning and motor development or when we want to include both.

Motor control refers to the nervous system's control of the muscles that permits skilled and coordinated movements. In recent years, researchers in motor development and in motor control have found much in common. Understanding how the nervous system and movement abilities change with age expands our knowledge of motor control, and we now see much overlap in motor development and control research.



Scan news websites such as MSNBC.com or CNN.com for stories related to motor development. What key words did you search for besides *motor* and *development* in order to focus in on this topic?

Undoubtedly, you have heard the term *development* paired with the term *growth*, as in “growth and development.” **Physical growth** is a quantitative increase in size or magnitude. Living organisms experience a period of growth in physical size. For humans, this growth period starts with conception and ends in late adolescence or the early 20s. Changes in the size of tissues after the physical growth period (e.g., an increase in muscle mass with resistance training) are described with other terms. Thus, the phrase *growth and development* includes change in both size and functional capacity.

The term *maturation* is also paired with the term *growth*, but it is not the same as development. **Maturation** connotes progress toward physical maturity, the state of optimal functional integration of an individual's body systems and the ability to reproduce. Development continues long after physical maturity is reached.

Physiological change does not stop at the end of the physical growth period. Rather, it can occur throughout life. Physiological change tends to be slower after the growth period but nevertheless remains prominent. The term **aging** can be used in a broad sense to refer to the process of growing older regardless of chronological age; it can also refer specifically to changes that lead to a loss of adaptability or function and eventually to death (Spirduso, Francis, & MacRae, 2005).

The physiological processes of growth and aging fall on a continuum of life span development. For many years, researchers examined motor development almost exclusively from early childhood through puberty. However, the population across the globe has aged. In many countries—including the United States, China, Russia, Australia, Canada, and the majority of the European Union's nations—by 2030 at least 13% of the population will be aged 65 years or older (Kinsella & Velkoff, 2001). This change brings more urgency to the need for better understanding of motor development in the later years. Although some motor development students might be particularly interested in one portion of the continuum, motor development as a field still concerns change in movement across the life span. Understanding what drives change in one part of the life span often helps us understand change in another part. This process of examining change is part of adopting a developmental perspective.

Motor development refers to the continuous, age-related process of change in movement as well as the interacting constraints (or factors) in the individual, environment, and task that drive these changes.

Motor learning refers to the relatively permanent gains in motor skill capability associated with practice or experience (Schmidt & Lee, 2014).

Motor control is the study of the neural, physical, and behavioral aspects of movement (Schmidt & Lee, 2014).

Physical growth is an increase in size or body mass resulting from an increase in complete, already formed body parts (Timiras, 1972).

Physiological **maturation** is a qualitative advance in biological makeup and may refer to cell, organ, or system advancement in biochemical composition rather than to size alone (Teeple, 1978).

Aging is the process, occurring with the passage of time, that leads to loss of adaptability or full function and eventually to death (Spirduso, Francis, & MacRae, 2005).

Constraints: A Model for Studying Motor Development

It is useful to have a model or plan for studying the change in movement that occurs over the life span. A model helps us include all the relevant factors in our observation of motor behavior. This is particularly true as we think about the complexity of motor skills and how our skills change over the life span. For this textbook, we adopted a model associated with a contemporary theoretical approach known as the ecological perspective (see chapter 2). We find that this model helps us make sense of developmental changes by providing a framework for observing change. We believe this model—Newell's constraints model—will help you better understand motor development across the life span.

Newell's Model

Karl Newell (1986) suggested that movements arise from the interactions of the organism, the environment in which the movement occurs, and the task to be undertaken. If any of these three factors change, the resultant movement changes. We can picture the three factors as points on a triangle with a circle of arrows representing their interaction (figure 1.1). Because we are concerned only with human movement here, we use the term *individual* instead of *organism*. In short, to understand movement, we must consider the relationships between the characteristics of the individual mover, his surroundings, and his purpose or reasons for moving. From the interaction of all these characteristics, specific movements emerge. This model reminds us that we must consider all three corners of the triangle in order to understand motor development.

Picture the different ways in which individuals can walk—for example, a toddler taking her first steps, a child walking in deep sand, an adult moving across an icy patch, or an older adult trying to catch a bus. In each example, the individual must modify his or her walking pattern in some way. These examples illustrate that changing one of the factors often results in a change in the interaction with one or both of the other factors, and a different way of walking arises from the interaction. For example, whether you are barefoot or wearing rubber-soled shoes might not make a difference when you're walking across a dry tile floor, but your walk might change notably if the floor were wet and slippery. The *interaction* of individual, task, and environment changes the movement, and, over time, patterns of interactions lead to changes in motor development.

Why is Newell's model so helpful in studying motor development? It reflects the dynamic, constantly changing interactions in motor development. It allows us to look at the individual

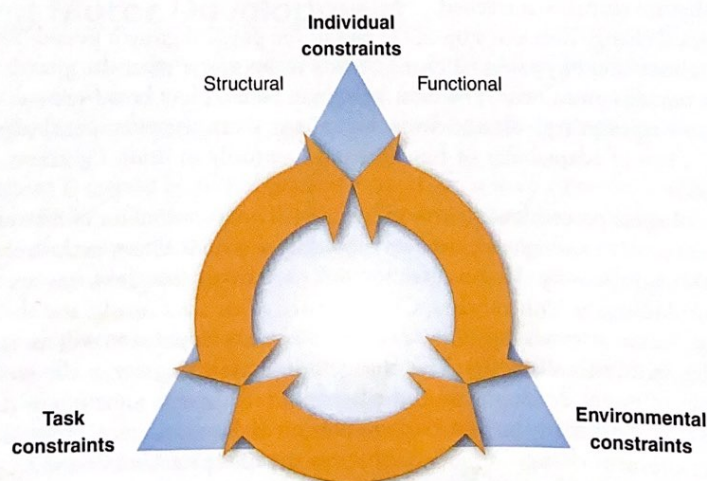


FIGURE 1.1 Newell's model of constraints.

and the many body systems that constantly undergo age-related changes. At the same time, the model emphasizes the influence of where the individual moves (environment) and what the individual does (task) on individual movements. Changes in the individual lead to changes in his or her interaction with the environment and task and subsequently change the way the individual moves. For example, a young child may enjoy tumbling on mats in his preschool. His parents may put him in a gymnastics class (change in environment); at that class, the instructors may focus on equipment rather than tumbling stunts (change in task). Over time and through his experience focusing on specific equipment in the gymnastics class, the boy may become proficient at the pommel horse. Another example is an older adult who, because of hip arthritis, chooses to walk only when absolutely necessary and stops attending her walking group. Changes in her social environment lead to disengagement in exercise, which in turn leads to loss of strength, flexibility, and mobility and, ultimately, to more hip pain. In both of these examples, the individual, environment, and task influence—and are influenced by—each other.

Newell calls the three factors we placed on the points of our triangle **constraints**. A constraint is somewhat like a restraint: It *limits* or *discourages* (in this case, movement), but at the same time it *permits* or *encourages* (in this case, other movements). It's important not to consider constraints as negative or bad. Constraints simply provide channels from which movements most easily emerge. A riverbed acts as a constraint: It restrains the river water from flowing anywhere and everywhere, but it also channels the water to follow a specific path. Movement constraints are characteristics that shape movement. They restrain and channel movement to a particular time and place in space; that is, they give movement a particular form.

Individual constraints, the top point on our triangle, are a person's unique physical and mental characteristics. For example, height, limb length, strength, and motivation can all influence the way an individual moves. Consider the swimmer with a disability in figure 1.2. The disability constrains, but does not prevent, this individual's ability to swim; it simply modifies the way in which the swimmer performs his strokes. Individual constraints are either structural or functional.

- **Structural constraints** relate to the individual's body structure. They change with growth and aging; however, they tend to change slowly over time. Examples include height, weight, muscle mass, and leg length. As we discuss these changes throughout the text, you will see how structural factors constrain movement.
- **Functional constraints** relate not to structure but to behavioral function. Examples include motivation, fear, experiences, and attentional focus. Such constraints can change over a much shorter period of time. For instance, you might be motivated to run several miles in cool weather but not in hot, humid weather. This functional constraint shapes your movement to running, walking, or even sitting.

For many professionals, it is important to know whether the student's or client's movement is being shaped by structural or functional constraints. Such information can help one understand how much a movement could change in a short time and whether a change in an environmental or task constraint would be necessary in order to modify the resultant movements. For example, knowing that young volleyball players cannot block a ball at the net because they are not yet at their adult height would lead a youth sports organizer to change the task by using a lower net height.

Environmental constraints exist outside the body, as a property of the world around us. They are global rather than task specific and can be physical or sociocultural. Physical environmental constraints are characteristics of the environment, such as temperature, amount of light, humidity, gravity, and the surfaces of floors and walls. The example of a runner not feeling motivated to run in humidity represents the functional constraint of motivation interacting with two environmental constraints—temperature and humidity—to constrain movement.

One's sociocultural environment can also be a strong force in encouraging or discouraging behaviors, including movement behaviors. One example is how change in the sociocultural environment in Western society has changed the involvement of girls and women in sport over the past three decades. In the 1950s, society did not expect girls to participate in sport. As a

A **constraint** is a characteristic of the individual, environment, or task that encourages some movements while discouraging others.

Individual constraints are a person's or organism's unique physical and mental characteristics.

Structural constraints are individual constraints related to the body's structure.

Functional constraints are individual constraints related to behavioral function.

Environmental constraints are constraints related to the world around us.



FIGURE 1.2 This swimmer's truncated limb is a structural constraint that gives rise to a swimming movement that is different from that of someone without a truncated limb.

Michael Svoboda/E+/Getty Images

Task constraints include the goals and rule structure of a particular movement or activity.

result, girls were channeled away from sport.

Task constraints are also external to the body. They include the goals of a movement or activity. These constraints differ from individual motivation or goals in that they are specific to the task. For example, in basketball the goal is to get the ball in the hoop—this is true for any individual playing the game. Second, task constraints include the rules that surround a movement or activity. If we think about basketball, players could get down the court much more quickly if they could simply run with the ball rather than dribble it. However, the rules dictate that players *must* dribble while running with the ball, meaning that the resultant movement is constrained to include bouncing the ball. Finally, the equipment we use is a task constraint. For example, using a strung racket rather than a wood paddle changes the game played on an enclosed (racquetball) court. Recall also the case of the youth sports organizer, who by lowering net height used the interaction of a structural individual constraint (body height) and a task constraint to allow a certain movement (blocking) to emerge in the game played by young volleyball players. You can probably imagine many of the task constraints in the depicted situation. The basketball player must pass the ball to a teammate while protecting the ball from a defender.

Throughout this discussion of motor development we demonstrate how changing individual, environmental, and task constraints shape the movement that arises from their interaction. Newell's model guides us in identifying the developmental factors affecting movements, helps us create developmentally appropriate tasks and environments, and helps us understand individual movers as different from group norms or averages.

Changing Views on the Role of Constraints

It is important to recognize that in the history of motor development research certain researchers and practitioners focused primarily on individual factors to the exclusion of others. For example, in the 1940s it was assumed that an individual constraint—specifically, the structural constraint of the nervous system alone—shaped movement in infants and children (see chapter

2 for a discussion of this concept). Later, in the 1960s, developmentalists commonly believed that environmental and task constraints, more than individual constraints, shaped movement. Only recently have motor developmentalists begun focusing on all three types of constraints simultaneously as well as carefully examining how constraints interact with and influence each other over time.

When one or two types of constraints are deemphasized, so is the rich effect of the three constraints interacting to shape movement. Thus, such an approach limits the resulting view of the emerging movement. In our survey of motor development we identify the effects of these various viewpoints on the importance of the three constraints. Sometimes what we know about an aspect of motor development is influenced by the perspective of the researcher who studied that behavior. It is much like seeing the color of a flower change as we try on sunglasses with lenses of different colors. We might “color” our conclusions about motor development as we emphasize one type of constraint and deemphasize other types.



Imagine you are a physical educator or a coach. Knowing how height and body size change with growth, how would you adapt the game of basketball (especially the task, through the equipment used) so that movements (shooting, dribbling, passing) remain nearly the same during the growth years?

Newell's model is more global than most models previously used in the study of motor development. We can better account for the complexity of age-related change in movement with this model through the interactions of individual, environment, and task. Keep the model in mind throughout our survey of motor development.

Constraints and Atypical Development

To understand the basics of constraints, we explain concepts using typical motor development. That is, we use examples that describe what we might expect in people with average individual constraints (strength, height, motivation), who move in typical environments (gymnasiums, playgrounds, grocery stores), and who perform normal tasks (sport, activities of daily living). Essentially, this is motor development “on average.” People can develop in different ways and still be considered to be in an average range. However, individuals can deviate from the average developmental course in a variety of ways. In some instances, development is advanced (motor skills appear sooner than expected) or delayed (motor skills appear later than expected). In others, development is actually different (the person moves in unique ways). When we discuss constraints and atypical development, we focus on delayed and different development, particularly in individuals with disabilities. Interacting constraints lead to movement changes over individuals' lives. Therefore, we know that differences in structural and functional individual constraints can lead to atypical developmental trajectories. For example, a child with cerebral palsy may be delayed in the acquisition of fundamental motor skills because of muscle spasticity, or an adult with multiple sclerosis will see motor proficiency diminish as a function of deteriorating myelin sheaths in the brain and spinal cord. In certain conditions, people may exhibit motor coordination delays that can be overcome with enhanced practice or experience. In the language of constraints, enhanced practice represents a change in task constraints. Movement practitioners must keep in mind how movement can change as a result of changing constraints and thereby adjust environment and task constraints to accommodate differences in individual constraints. Throughout the text we provide examples of research related to atypical development.

How Do We Know It Is Change?

We've established that age-related change is fundamental in the study of motor development and the developmental perspective. Developmentalists are focused on change. How do we know, though, that a change is age related and not a fluctuation of behavior (a good or bad day

on the court, for example) or a product of our measuring instrument (a radar gun versus video motion analysis)? One way to discern developmental change is to carefully observe individuals' movements and then describe differences between people of different age groups or instances of observation.



Web Study Guide Gain experience in observing movement by doing Lab Activity 1.1, Observation as a Tool of Inquiry, in the web study guide.

In addition, behavioral scientists use statistical techniques that can identify significant change. We sometimes discuss these techniques in the context of a research study. For now, let's focus on the straightforward technique of picturing change by graphing an aspect of development over time. We can then see whether a trend is emerging.

Picturing Change

When we picture age-related measurements by graphing, we traditionally put time or age on the horizontal axis. Time can be measured in days, weeks, months, years, or decades, depending on our frame of reference. A measurement of interest in infancy might be plotted in days or weeks, whereas a measurement of interest over the life span might be plotted in years or decades.

The measurement is plotted on the vertical axis. We usually arrange the measurements so that "more," "faster," or "more advanced" is higher on the scale. Figure 1.3 shows a typical graph of the measurement of growth in childhood. It is common to take a measurement periodically and plot its value at selected chronological ages. We assume that change has occurred consistently in the time between our measurements, so we often connect our data points to make a line. When we graph change using a developmental perspective, we should not make the assumption that more is always better. Individuals move in a variety of ways that are qualitatively different. Some ways of moving may result in longer throws or faster runs, but that does not imply that children who do not move this way are in error or are wrong. It simply means these children move at a different or lower developmental level.

The curve plotted in describing developmental change can be called a **developmental trajectory**. This notion is useful in thinking about the early influences or constraints on some aspect of development and how they might influence development over the balance of the life span. A hypothetical behavior is plotted in figure 1.4 as a red line. Let us say that at age 3 years some constraint is imposed on the behavior. If that constraint restrains the behavior, the developmental trajectory for the behavior is changed, perhaps for the balance of the life span, as pictured by the blue line. If that constraint instead facilitates an advancement in the behavior, the developmental trajectory is also altered, but in a positive way, as pictured by the green line. Hence we can see that a small change in development can set an individual on very different development trajectories.

Note that a severely negative influence or constraint could result in **arrested development**. This is pictured in figure 1.4 by the purple line. Truly arrested development is rare, but Seefeldt (1980) proposed the notion of a proficiency barrier in regard to the motor development of children. Seefeldt hypothesized that if an individual does not attain a certain level of motor skill proficiency in

A **developmental trajectory** is the course of a behavior over age or time (Nagin, 1999).

Arrested development is a failure to develop beyond a particular point of development.

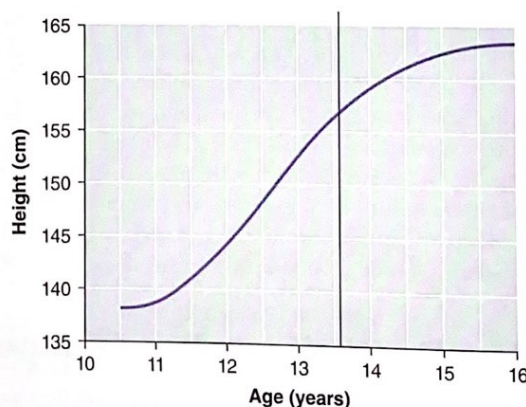


FIGURE 1.3 A typical graphical representation of growth in childhood.

middle childhood, that individual at older ages would find it difficult to become a proficient mover. If a proficiency barrier for the behavior in figure 1.4 existed at age 3, the purple line might show the developmental trajectory of an individual who was unable to cross the barrier.

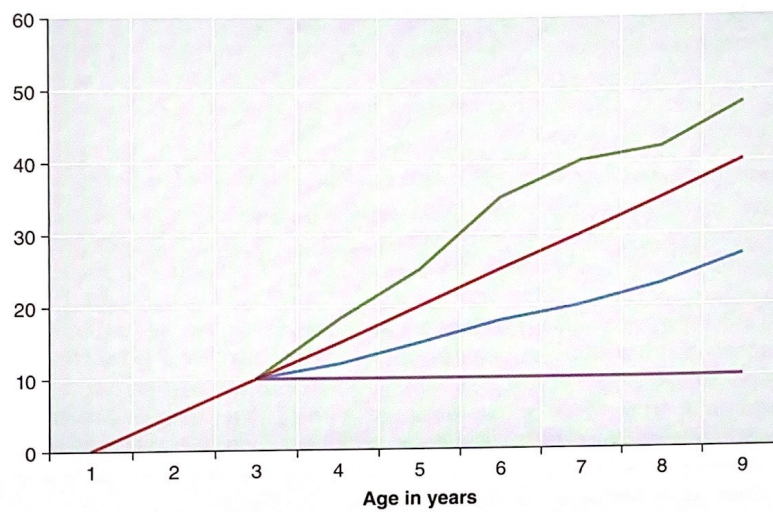


FIGURE 1.4 Developmental trajectories.