

CHAPTER 12

Development of Fundamental Movement: Locomotor Skills

KEYTERMS

Locomotor skills
Phylogenetic
Ontogenetic
High guard

Middle guard
Age-related
Age-dependent
Norm-referenced tests

Criterion-referenced tests
Reliability
Validity

CHAPTER COMPETENCIES

Upon completion of this chapter, the reader will be able to:

- Describe the developmental sequences for five locomotor skills.
- Observe a child perform a locomotor skill and identify the developmental stage of that child.
- Compare and contrast the total body versus component approach to developmental sequences.
- Identify potential learner constraints influencing locomotor skills.
- Identify interskill sequences in locomotor skills.
- Describe the characteristics of a proficient performer in five locomotor skills.
- Devise a locomotor skill observation assessment checklist as an individual or group activity.
- Describe three common assessment instruments to measure FMS and identify considerations for selection of an instrument.

 KEY CONCEPT

Locomotor skills allow individuals to navigate through space or move their body from one point to another and constitute foundational skills for engagement in sports, games, and lifetime activities.

A group of kindergartners spill out into the playground on a sunny day, running and squealing with the joy of being outside. Two little girls hold hands and start skipping around the playground together while a couple of boys race across the playground to the slide. Another two girls are playing hopscotch. It seems like a typical day on the playground. Watching these children play, we might assume that young children naturally learn these motor skills of childhood and that all children look alike in the patterns of movement they demonstrate, but this is not so. If we were to look carefully at this picture, we might see one girl skipping in an easy, rhythmical pattern with her arms swinging in opposition to her legs. Meanwhile, her friend keeps up by showing a one-sided step-hop pattern with the right knee and right arm coming up together and the left side just stepping (she cannot skip). The boy who reaches the slide first sprints quickly with his heels kicking his buttocks and his arms pumping, while the other, heavier boy runs more slowly with arms straight. Across on the hopscotch area one girl hops with ease, and the other lands on two feet; it seems she cannot hop on one foot. It is clear from this closer analysis that these children vary considerably in their motor development and movement competence. So how do young children learn these seemingly “natural” locomotor skills of childhood? And what factors influence their motor development?

In the previous chapter we examined the body of literature on manipulative skills using a dynamic systems approach. We will use a similar approach in this chapter for locomotor skills. We will start by thinking about the prerequisites for each skill. Then we will identify the *intraskill* (within one skill) sequences using total body and component (where developed) developmental sequences. We will continue to use the idea of how performers shift from *initial*, to *emerging*, and then *proficient* patterns of performance. We will then describe what we know about the performance or technique of a *proficient* and *initial* performer. We will conclude each skill with an examination of the research on potential

constraints (individual, environmental, and task) that might influence the skill and implications for practitioners and clinicians. We will also consider the *interskill* (between skill) sequences, in other words, in what order locomotor skills emerge. Overall, the research on locomotor skills is less prevalent than that on manipulative skills, and constraints that have been studied are typically individual in nature.

Locomotor skills consist of a group of fundamental motor skills (FMS) that allow individuals to navigate through space or move their body from one point to another. Similar to manipulation skills, developing basic competence in these skills is essential for engagement in meaningful physical activity for health and to move effectively in various sports, games, and dances (Robinson et al., 2015). Running, galloping, hopping, skipping, jumping, leaping, and sliding are the most common forms of locomotor skills. Motor development theorists often refer to locomotor skills as **phylogenetic**—that is, these skills are not culturally determined but are common to the “phylum” or species of human beings. Along with this perspective is the notion that they develop more “naturally” and with less need for formal instruction and feedback. In contrast, the manipulative skills are considered more **ontogenetic**; that is, they are more culturally determined and require formal practice and feedback in order to develop competence in them. While at a superficial level, this may seem to be true, for many locomotor skills individuals will not reach proficient patterns of performance without adequate practice and instruction.

► Development of Locomotor Skills

In this section we will describe the development of six locomotor skills; run, gallop/slide, skip, jump, and hop. **TABLE 12.1** identifies the developmental total body sequences of five of these locomotor skills. For each stage, the words in *italics* provide a summary word or two in order to remember the stage, and below that is a description of the pattern of movement. We will then look at five locomotor skills. Similar to manipulative skills we will first ask the question about the prerequisites to being able to perform that skill, then we will discuss how the skill emerges from a total body and component approach, and finally (where there is evidence) we will examine research tied to constraints in action for locomotor skills.

TABLE 12.1 Developmental Sequences of Five Locomotor Skills

Fundamental Motor Skill	Stage 1	Stage 2	Stage 3	Stage 4
	<i>Initial Stage</i>	<i>Emerging Stages</i>		<i>Proficient Stage</i>
Run	<i>Run High Guard</i> Arms—high guard (above head) Flat-footed contact Short stride with wide stance Falls regularly	<i>Run Middle Guard</i> Arms—middle guard not in opposition to legs Vertical component still great Legs near full extension	<i>Heel-Toe Arms Extended</i> Arms—low guard Arm-leg opposition—elbows nearly extended Heel-toe contact	<i>Pumping Arms</i> Heel-toe contact (toe-heel when sprinting) Long stride Arm-leg opposition with elbows bent 90 degrees High heel recovery
Hop (1 foot to 1 foot)	<i>Foot in Front</i> Nonsupport foot in front of support leg with thigh parallel to floor Body erect Hands shoulder height Struggles to produce repetitive hop	<i>Foot by Support Leg</i> Nonsupport knee flexed with knee in front and foot alongside or slightly behind support leg Slight body lean forward Bilateral arm action	<i>Foot Behind Support Leg</i> Nonsupport thigh vertical with foot behind support leg knee flexed More body lean forward Bilateral arm action Consistent hop pattern	<i>Pendular Free Leg</i> Nonsupport leg is bent, knee pumps forward and back in a pendular action Forward body lean Arm opposition with swing leg Powerful hop
Long jump (2 feet to 2 feet)	<i>Braking Arms</i> Arms act as “brakes” coming back toward the body on take-off Large vertical component and limited distance Legs not extended	<i>Winging Arms</i> Arms act as “wings” swinging up and to side of body Vertical component still great Legs near full extension	<i>Arms Swing to Head</i> Arms move forward, elbows in front of trunk at take-off Hands to head height Take-off angle still above 45 degrees Legs often fully extended Good jumping distance	<i>Full Body Extension</i> Complete arm and leg extension at take-off Take-off near 45-degree angle Thighs parallel to surface when feet contact for landing Long jumping distance
	<i>Initial Stage</i>	<i>Emerging Stage</i>	<i>Proficient Stage</i>	
Gallop (step-together, step-together)	<i>Choppy Run</i> Resembles rhythmically uneven run Trail leg crosses in front of lead leg during airborne phase, and remains in front at contact	<i>Stiff Back Leg</i> Slow-moderate tempo, choppy rhythm Trail leg stiff Hips often oriented sideways Vertical component exaggerated	<i>Smooth Rhythmical</i> Smooth, rhythmical pattern, moderate tempo Feet remain close to ground Hips oriented forward	

(continues)

TABLE 12.1 Developmental Sequences of Five Locomotor Skills

(continued)

Fundamental Motor Skill	Stage 1	Stage 2	Stage 3	Stage 4
	<i>Initial Stage</i>	<i>Emerging Stage</i>	<i>Proficient Stage</i>	
Skip (step-hop- step-hop)	<i>Broken Skip</i> Broken skip pattern or irregular rhythm Slow, deliberate movement in step-hop pattern Ineffective arm action	<i>High Arms & Legs</i> Rhythmical skip pattern Arms provide body lift Excessive vertical component	<i>Rhythmical Skip</i> Arm action reduced/hands below shoulders in opposition to legs Easy, rhythmical movement Support foot near surface on hop	

► Running

Running is a form of locomotion that involves projecting the body forward on alternating feet as the bases of support. An extension of walking, running incorporates an airborne phase, during which both feet are off the ground, and can be viewed on a continuum from a slow jog to a fast sprint. Running is probably one of the most important FMS, as it is used in almost all sports and games played by children and in lifetime activities. It is also one of the earliest skills in which children develop competency and early patterns of running occur after the onset of walking.

Prerequisites to Running

A number of factors are important to being able to run, including the ability to demonstrate a contralateral pattern, core strength, and dynamic balance.



Of all the fundamental movement skills, running is probably the most prevalent in sports and lifetime physical activities.

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Children must have enough multi-limb coordination to coordinate both legs and maintain a steady stride. One aspect that is increasingly impacting a child's ability to run well is a child's strength-to-weight ratio, as children need sufficient strength in each leg to propel the body up and forward. As more of our children are overweight and obese, we see increasing deficits in running skills in our gymnasiums.

Proficient Runners

As children progress in their running development, they become more efficient by producing forces in the line of the direction of the movement and eliminate extraneous movements that work against forward momentum in the initial stages of the skill. For example, their arms pump forward and backward and they lean forward as they run. Developmental changes such as these result in greater biomechanical efficiency and typically better product outcomes such as running faster. Children who are competent runners (sprinters) are proficient in several aspects of the run as outlined in **TABLE 12.2**.

However, many young children do not demonstrate the biomechanical efficiencies described above. Initial runners tend to keep their bodies more upright or in a vertical plane when running. Arms do not contribute to the power dynamics of the skill and may be used for balance. Physical growth factors in younger children such as small feet and a high center of gravity make the running task more challenging for a young child from a balance perspective. Thus, initial runners will tend to have a wide stance and short, flat-footed strides as adaptations

TABLE 12.2 Characteristics of a Proficient Sprinter

Proficient runners demonstrate the following:

Force Production

- Trunk leans forward
- Base leg extends 180 degrees at push-off
- Opposite (or swing) leg drives forward with knee bent
- Arms flexed (90-degree angle) and pump in opposition to the legs

Swing Phase

- Demonstrate a flight phase when both feet are off the ground
- After push-off the swing leg bends and heels come close to buttocks in order to shorten the lever of the leg and allow faster movement toward foot contact again

Support Phase

- Heel to toe or ball of foot landing

to poor balance, and to lower the center of gravity and widen the base of support. For the very beginning runner arms are placed in **high guard** (arms lifted to shoulders or higher) or **middle guard** (arms lifted to waist) position. These arm positions help to stabilize the trunk during the run and offer some degree of protection if the young runner falls forward. Neither the leg nor arm actions are efficient from a biomechanical perspective as they work against the line of direction of intended movement. However, these actions help children accomplish the run as they allow the runners to experience the feeling of moving their center of gravity forward outside of the base of support when using alternating bases of support.

Development of Running

Running has been examined from a process and product perspective. The *process* of running examines the pattern of running movement; in this area developmental sequences for running have been proposed from both a total body approach and a component approach. In contrast, *product* measures of running have looked at the outcome of the run. Outcome measures include distance runs such as the mile run, timed sprints in a variety of different distances, and shuttle runs or agility runs where the runner moves

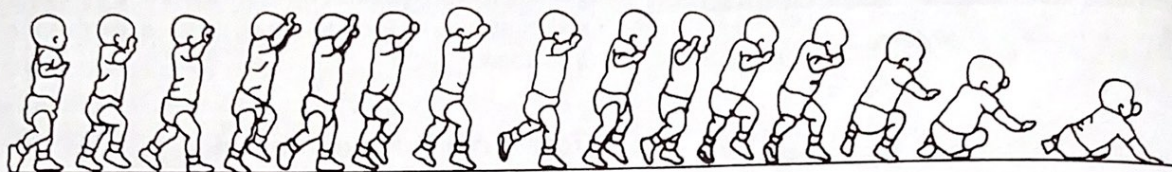
back and forth between two lines. More recently a commonly used product measure of running in physical education is the Pacer test, which is part of the Fitnessgram.

Total Body Developmental Sequence in Running

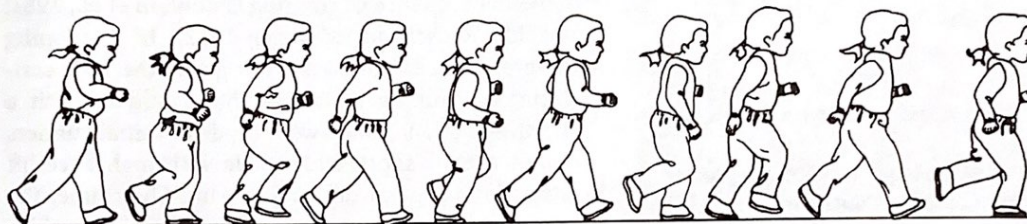
Table 12.1 and **FIGURE 12.1** show the four-stage developmental sequence of running (Fountain et al., 1981; Seefeldt, Reuschlein, & Vogel, 1972). In developing these sequences children were given the task constraint of running as fast as they could to elicit a sprinting action if they were capable. Initial runners demonstrate a short, wide stride with high knee lift (stage 1) and often fall as they run. Over time, the stride width becomes narrower until it is shoulder width apart in stages 3 and 4. Initial arm actions are protective in nature starting in high guard (stage 1) and then dropping to middle guard (stage 2). By stage 3 the arm action is in opposition to the legs but the arms are straight, and it is not until stage 4 that we see the mechanical efficiency of arms at a 90-degree angle pumping in opposition to the legs. The position of the trunk in relation to an imaginary vertical line also changes across developmental time. Initial runners (stages 1 and 2) are more upright. By stage 4, the trunk begins to lean forward, and there is an approximately 10-degree forward lean in the line that runs from the hips to the shoulders (Michigan's Exemplary Physical Education Curriculum Project, 2006). This forward lean contributes to the power dynamics of sprinting, allowing forces to propel the sprinter forward at greater speed.

Running is one of the earliest emerging FMS beginning around 18–22 months with girls being slightly ahead of boys. (See Figure 11.4 in chapter 11.) Boys move through these stages fairly quickly and reach a proficient performance of running by age 4 years. **For girls it is not until a little after their fifth birthday that a stage 4 is obtained.** It is important to remember that these data represent **age-related** changes in FMS and not **age-dependent** changes. That is, 60% of the children tested showed a specific stage at a specific age. Thus, one cannot say that *all* 4-year-old boys will show a stage 4 of running, but many will. For those children that do not follow the age-related changes, some will reach proficient levels of running at earlier ages and others not until much later. In addition to the total body developmental sequences, component sequences have been developed for running.

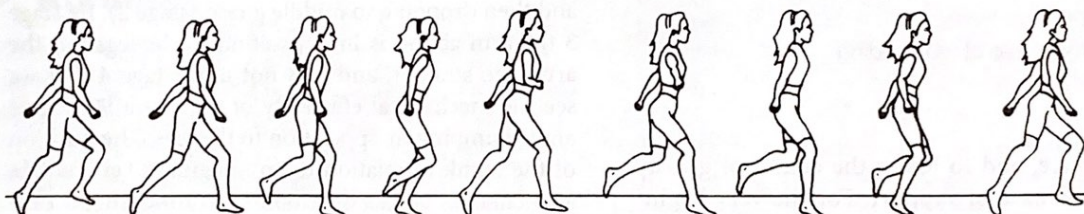
Stage 1



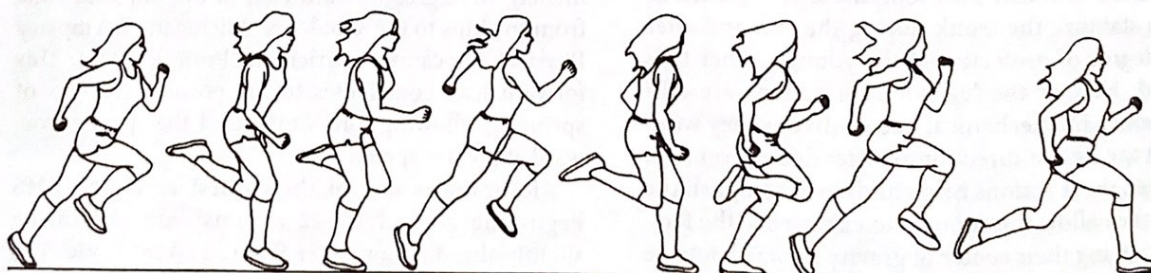
Stage 2



Stage 3



Stage 4

**FIGURE 12.1** Developmental sequences of running.

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Body Component Developmental Sequence in Running

A two-component developmental sequence has been proposed for running (Robertson, 1983; Robertson & Halverson, 1984). **TABLE 12.3** outlines the three-step leg action component and the four-step arm action component. Overall, the characteristics of the component approach to running match the patterns described by the total body framework.

Both the total body and component developmental sequences demonstrate how children become

more mechanically efficient as they progress through the stages of development. Despite this, even the highest levels of these sequences portray basic competence in running. Elite sprinters or long-distance runners take this basic running competence and refine the biomechanical efficiency to the highest levels, limiting the degrees of freedom of limbs so that each gait cycle is the most efficient it can be. The biomechanical literature has excellent examples of kinematic and kinetic (describes the motions of bodies and the force production) data on running.

TABLE 12.3 Component Developmental Sequences of Running

Leg Action	Arm Action
L1 <i>Minimal flight, flat-footed</i> —The foot toes out and the swing leg curves outward. Knee of the swing leg is bent more than 90 degrees.	A1 <i>High guard to middle guard arms</i> —Arms do not contribute to the running action. They are motionless or shift side to side in response to the running motion.
L2 <i>More flight time, may be flat-footed</i> —Longer stride and recovery knee flexed to at least 90 degrees. Thigh has lateral swing causing recovery foot to cross midline of the body in the rear.	A2 <i>Arms swing bilaterally</i> —Arms swing to counter hip and leg motions. Arms appear to flail across the midline.
L3 <i>Heel or ball foot contact, extension of leg on take-off</i> —Longer stride with heel-toe or ball of toe contact. Support leg fully extends at take-off. Higher heel recovery in swing phase and knee lift in forward swing.	A3 <i>Arms extend and flex in opposition</i> —Arms pump in opposition to legs. As they pump forward they flex, and as they swing back they extend. Arms swing across midline of body and out away from trunk.
	A4 <i>Arms pump in opposition to legs at 90-degree angle</i> —Humerus moves forward and back against leg action.

Product Measures of Running

In the 1970s and 1980s a significant amount of research, including some national data collected by the then American Alliance for Health, Physical Education, and Recreation (AAHPERD), was conducted on the product measures of running such as run velocity and run times (AAHPERD, 1976; Branta, Haubenstricker & Seefeldt, 1984; Fountain et al., 1981; Milne, Seefeldt, & Reuschlein, 1976).

Constraints in Running

From a constraints perspective age and gender were found to be important individual constraints. Overall, running speed (average velocities) varied greatly by age, sex, and distance run, with improvements for both boys and girls as a function of age until the teenage years. Branta, Haubenstricker, and Seefeldt (1984) found that running speed increased by about 30% from ages 5–10 years. In their longitudinal Motor Performance Study the mean times for a 30-yard dash for boys and girls, respectively, were 6.77 and 6.88 seconds at age 5, to 4.75 and 4.85 seconds at age 10, to 4.24 and 4.46 seconds at age 14. Giulia and colleagues (2017) support this view of age and gender differences with running time decreasing with age and boys faster than girls. The individual constraint of anthropometric variables and running was not always supported.

Age effects were also present in the 120-foot agility run and the 400-foot shuttle run, where times decreased linearly from ages 5 through 14 years. Process-product research has shown that the developmental stage of running (process) can account for up to 19% of the variance in run times (product) for boys and about 29% for girls (Fountain et al., 1981). A study by Williams et al.

(2019) also made the connection between running time (product) and running biomechanics (process/technique). They found that children with faster running times had better biomechanics (longer stride length, shorter contact time, and mid or forefoot strike pattern). Another study used technology in the form of inertial sensors to determine if this product data could discriminate running performance (process data) in young children. The authors were able to predict running performance with reasonable accuracy (67%) from the sensor data. Given these data on the developmental sequences of running described above, it is easy to see how the greater biomechanical efficiency in the more proficient stages of running could lead to faster running speeds. However, it seems that there is a time lag between the acquisition of proficient running patterns and the ability to translate that into faster running speeds.

Marković et al. (2011) looked at the environmental constraint of floor surface (parquet floor, asphalt and grass) on 97 children age 11 years. They found that running times for a 30-meter sprint and an agility task were best on the asphalt and weakest for agility on the parquet floor. Another study made connections to the individual constraint of a child's understanding of FMS and the environmental constraint of instruction. Hastie et al. (2018) examined the relationship between children's ability to verbally recall skill specific cues and their FMS performance. They found a child's ability to verbally recall cues specific to the FMS was positively related to their FMS performance. Children were 2–17 more times likely to have mastered their FMS if they could verbally recall cues from FMS. The constraint of instruction was highlighted and the authors suggested children should not only practice performing FMS but also learn the critical elements of the skills.

Researchers have been collecting data on running for a long time. One study by Tomkinson et al. (2012) investigated whether distance running times had declined in children over the time period of 1964–2009 (secular decline). They reviewed studies involving 23,897,571 children ages 9–17 years from four Asian countries. Overall, long distance running performance had declined dramatically (equivalent to $-16.6 \pm 1.3\%$), and this decline was consistent for gender and different age groups, but not for different countries. The authors hypothesized that social, behavioral, physical, psychosocial, and physiological constraints may have impacted these declines. However, almost no studies had investigated the impact of such variables on performance.

Almost all of the data on running has been in discrete running tasks and within the context of sport. However, an interesting review of the literature of 50 articles with 2,615 participants provided a summary of match running within a soccer game (Palucci Vieira et al., 2019). This study aimed to examine differences in running performance across playing positions, age groups, and match halves. The amount of running output varied by positional role and age, but there was no clear finding relative to reductions in running activity over the course of match play. Intense training schedules negatively affected players' running performance. The authors concluded that "periodization training emphasizing technical-tactical content" can improve match running performance. Gustin and Bennett (2014) looked at the individual constraint of later maturation on match running in junior Australian football. They found that total distance run, high intensity running distance, and number were significantly greater in earlier versus later maturers. They concluded later maturers were at a serious disadvantage in this Australian football.

There are practical implications to these data for physical educators and coaches. Running emerges in a relatively short time frame in early childhood years. As such, parents, teachers, and coaches should provide plenty of opportunities for young children to practice running and children should receive feedback on their technique. Encouraging children to pump their arms and drive their legs powerfully forward is important. Once running is more developed, young children should also have experiences in the many forms of running such as sprinting, jogging, and changing direction quickly as required in numerous sports and games. These opportunities will provide children with the "base camp" of locomotor skills from which they can move up the mountain of motor development (Clark & Metcalfe, 2002) and apply the skill of running to engagement in lifetime sports and physical activity.



CONCEPT 12.1

Process measures of a fundamental motor skill describe the pattern of movement whereas product measures examine the outcome of the movement; although related, each tells something different about the movement of the child.

► Galloping and Sliding

Galloping and sliding are very similar rhythmical skills. They both require a rhythmic step forward along with a leap step to the other foot. The gait pattern of the movement is asymmetrical and uneven. Galloping emerges first and is the first asymmetric locomotor skill learned by children. Galloping has a forward orientation (hips face forward) in contrast to sliding, which has a sideways orientation.

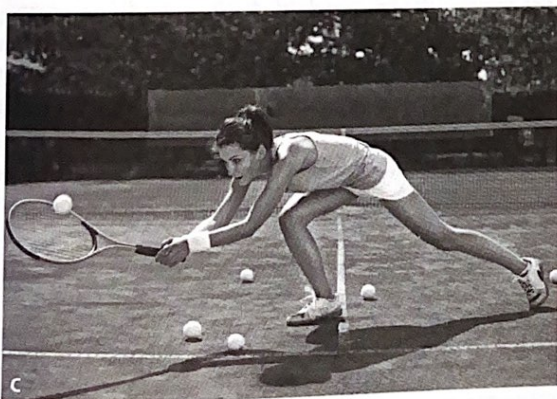
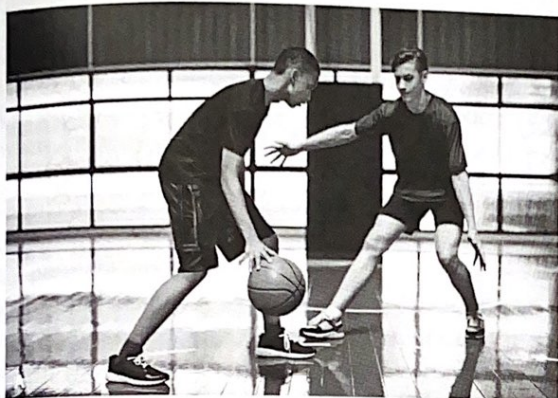
Prerequisites to Galloping & Sliding

In order to gallop or slide children need dynamic balance, leg strength, coordination and the ability to maintain a rhythmical pattern. These skills are also influenced by strength-to-weight ratio, specifically the flight (leap) aspects of the movement. Galloping and sliding do not appear to be very functional skills, but if one looks to dance, galloping and sliding can be seen in many folk and cultural dances around the world. Elementary physical education teachers often use galloping or sliding as an "instant activity" in order to develop leg strength, coordination, and cardiovascular endurance as children enter the gym. Additionally, sliding can be seen in sports like basketball, fielding in baseball or softball, and in preparing to block at the net in volleyball. There is almost no developmental research on sliding, so the focus of this section will be on galloping.

Proficient Gallopers

Galloping is a combination skill made up of a step and a leap-step with an uneven temporal component. That is, galloping requires an uneven pattern where the step takes longer than the leap-step (Clark & Whitall, 1989). Proficient gallopers can maintain a fluid, rhythmical pattern, keep their hips front facing, and move to music or a tempo. They also have sufficient strength in both legs to project their body weight forward and lead with either leg in front (see TABLE 12.4).

Initial gallopers struggle with many aspects of the skill and in the very early stages they look as if they are doing a lopsided run. The rhythm of an initial galloper is "choppy" and often the trail (rear) leg crosses in front



Many athletes have to gallop or slide to defend or get the ball in sports.

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TABLE 12.4 Characteristics of a Proficient Galloper

Proficient gallopers demonstrate the following:

- Smooth, fluid, rhythmical action
- Lead leg that stays in front
- Hips front facing
- Trail leg that lands beside or slightly behind lead leg
- Feet remain close to surface
- Knees that are flexed slightly while in flight
- Ability to lead with both right and left legs in front

of the lead leg in the air. Initial gallopers often have a “favorite” leg and cannot gallop with both legs leading. Galloping in the early stage is often a very “cognitive experience” for them with looks of great concentration on their faces as they try to maintain the pattern of the movement.

Development of Galloping

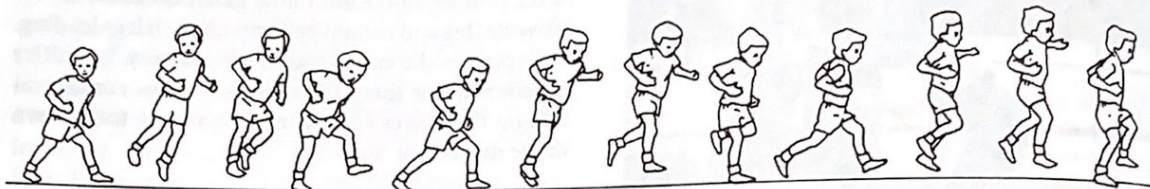
Table 12.1 and **FIGURE 12.2** illustrate the three-stage developmental sequence of galloping (Sapp, 1980). Initial gallopers (stage 1) show an action that looks like a blend of a gallop and a run; they struggle to keep their lead leg in front, and their knees are bent. Emerging gallopers (stage 2) show one of two approaches to the galloping; in both cases a lead and trail leg emerge, and they freeze their degrees of freedom in their back leg by making the back leg stiff. One approach is to lock out the back leg, turn the hip sideways, and drag it along the floor, a movement coined as the “wounded soldier” approach. The other approach is coined “rocking horse.” Children bounce off a locked-out back leg before weight bearing on their front leg again. In stages 1 and 2 there tends to be a high vertical component to the skill. The proficient (stage 3) galloper shows the characteristics identified in Table 12.4. Children in this stage can vary the galloping skill, changing directions and using their hands and arms free for other movements such as those in a dance. There are no 60% data for galloping, but experience tells us that many children as young as 2 years of age show the initial stages of galloping. When we look at the *interskill* (between skills) FMS sequences, an initial or emerging stage of running seems to be a precursor to the initial stage of galloping. There is no data on constraints in galloping although one study (Getchell & Whitall, 2003) looked at a dual task of walking or galloping and clapping in 4- to 10-year-old children. With the more simple task of walk/clap children resembled adults but in the more complex task of gallop/clap, children were more variable than adults but improved with age. While this lab-based study may not seem to have implications for practitioners, it does suggest that the cognitive load of a more complex skill like galloping is high, and younger children need time to learn the skill before being asked to apply it in dance or gymnastics.



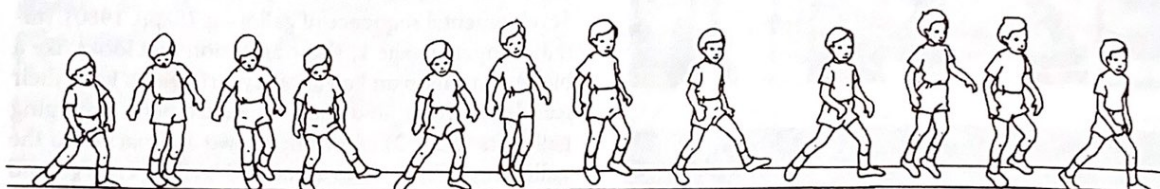
CONCEPT 12.2

Intraskill (within skill) sequences are just as orderly as interskill (between skill) sequences. Both are valuable sources of information to inform instruction of children and physical education curricula.

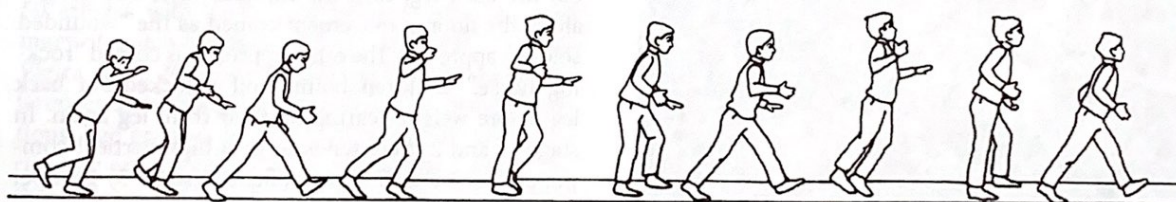
Stage 1



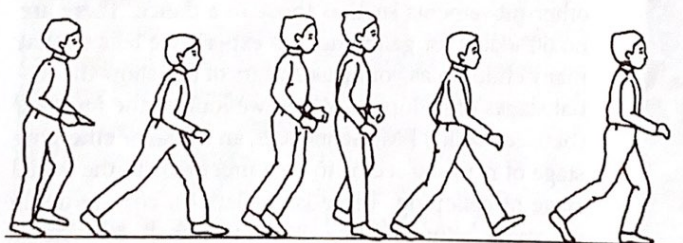
Stage 2



Stage 3



Stage 4

**FIGURE 12.2** Developmental sequences of galloping.

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► Skipping

Like galloping and sliding, skipping is a rhythmical, bipedal combination skill. Skipping is a *combination skill* that requires the child to execute a step-hop on one foot followed by a step-hop on the alternate foot. It is more complex than other locomotor skills as it requires two skills to be performed on the same leg before weight transfer occurs to the other lead leg, and it is rhythmical in nature.

Prerequisites to Skipping

In order to skip, children need to be able to perform a contralateral pattern. For those children who cannot do this, we often see a one-sided skip. Children also need



Skipping can be a difficult skill to master due to its complex nature.

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dynamic balance as they keep moving over their base of support. Multi-limb coordination and leg strength are other factors. Like many other locomotor skills, skipping can be influenced by a child's strength-to-weight ratio where the body is projected off the ground on one foot.

Also like galloping and sliding, skipping is used in many folk and cultural dances around the world. Skipping can also be used functionally by teachers to promote cardiovascular endurance in warm-up games and dances. Anecdotally, Allen Burton, a well-known motor development researcher, once referred to skipping as the "happy skill." There is a certain truth to this. If we look around our playgrounds and backyards, we see young children spontaneously break into a skip with a smile while playing.

Proficient Skippers

Proficient skippers demonstrate an easy, fluid pattern of movement that stays close to the ground. They have sufficient dynamic balance and leg strength in each leg to be able to show a smooth hopping pattern on each leg. Thus, stage 3 of hopping is considered a precursor for skipping to develop. Proficient skippers can also vary the speed and direction of the skip. **TABLE 12.5** illustrates the characteristics of a proficient skipper.

Initial skippers struggle to maintain a rhythmical pattern and have a much higher vertical component to the skip. The skip is less fluid and appears to be broken down into its constituent parts: a step, separated by a hop. The knees and arms drive upward, bringing about this vertical action. Initial skippers also struggle to keep up a continuous step-hop pattern, and the "cognitive load" (amount of concentration necessary) is high. Some of these early skippers also show us the "one-sided skip" where the child will only hop on one side of the body and have an ipsilateral pattern (same arm and same leg come up together).

Development of Skipping

Both the total body approach and the component approach have been used to describe the changes in patterns that children demonstrate as they learn to skip.

TABLE 12.5 Characteristics of a Proficient Skipper

- Rhythmical weight transfer and ability to maintain the pattern easily
- Stays close to the surface
- Limited vertical component
- Limited use of arms as force producers – arms often swing in opposition to legs
- Landing and taking off from the toe

Total Body Developmental Sequence in Skipping

Table 12.1 and **FIGURE 12.3** illustrate the three-stage sequence of skipping (Seefeldt & Haubenstricker, 1974, 1982). Overall, the children move from slower and more deliberate, choppy attempts, to a skip with an exaggerated arm lift, to fluid, rhythmical movement. Initial (stage 1) skippers cannot maintain a consistent step-hop skip beat and show one of three kinds of adaptations to the skill: (1) a broken skip pattern that results in a slow and deliberate step-pause-hop, (2) a double-hop on each side as they are attempting the skill, or (3) the one-sided ipsilateral skip pattern described above. Emerging skippers (stage 2) can maintain a rhythmical step-hop pattern, but the vertical component is high and there are exaggerated and flailing arm actions with high knee actions. The proficient (stage 3) skipper demonstrates the characteristics shown in Table 12.5.

In terms of the interskill sequence, skipping is one of the last locomotor skills to develop. From its initial patterns to proficiency the intraskill sequence develops in the shortest amount of time, from approximately 4.5 years to 6.5 years (Seefeldt & Haubenstricker, 1982). Although girls and boys demonstrate the initial skill around the same time, there is a slight advantage to girls in reaching the proficient form about 6 months before boys, often believed to be associated with a girls earlier maturing central nervous system. (See Figure 11.4).

Component Developmental Sequence of Skipping

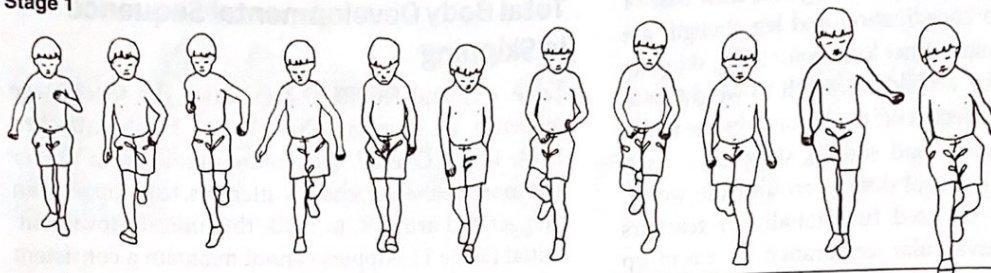
A two-component sequence has also been identified for the leg and arm components (Robertson & Halverson, 1984). **TABLE 12.6** shows the arm and leg components, and these components in many ways reflect the total body stages.

Skipping is a complex and often frustrating skill for young children. Although there is not much empirical data to guide the teaching-learning process, the developmental sequences and age-related data are valuable. As the skill develops so rapidly between the preschool/kindergarten years, parents, teachers, and physical educators should provide children with plenty of opportunities to practice the skill and the prerequisite skill of hopping.

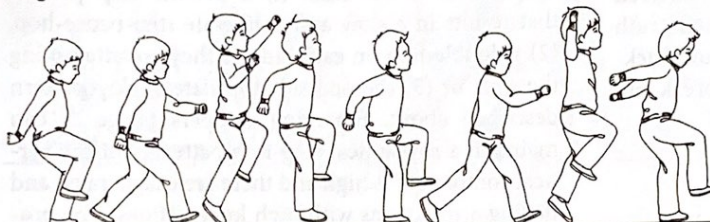
Constraints in Skipping

There is almost no literature on skipping and constraints. Loovis and Butterfield (2000) investigated the impact of the individual constraints of age, gender

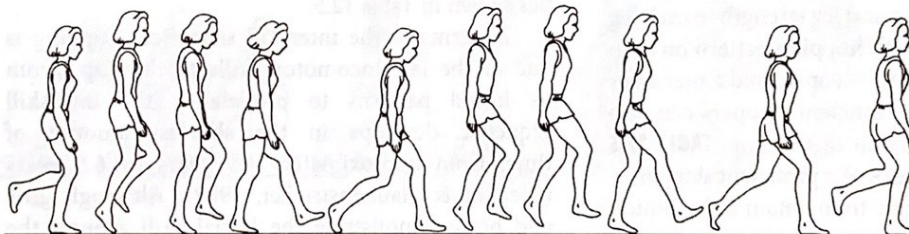
Stage 1



Stage 2



Stage 3


FIGURE 12.3 Developmental sequences of skipping.

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and balance on children's skipping performance in grades K–8. After kindergarten, 95% or more of the children demonstrated mature patterns of skipping,

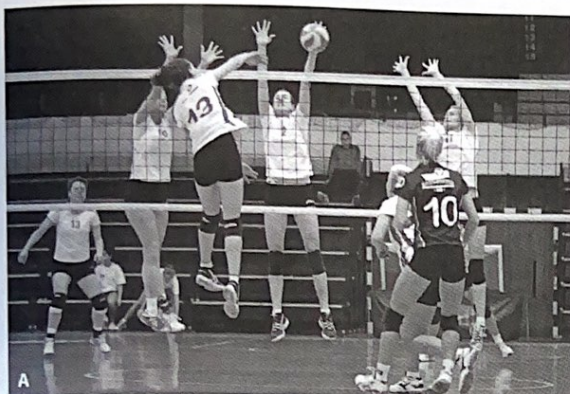
and skipping performance was not related to either sex or age within grades. Overall, static and dynamic balance were not predictive of mature skipping performance with only two exceptions, in second and fourth grade, which the authors could not explain.

TABLE 12.6 Component Developmental Sequences of Skipping

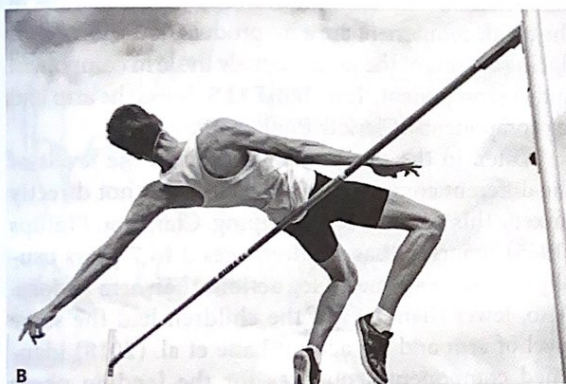
L1 <i>One-sided skip</i> —An ipsilateral pattern where one side skips and the other side just steps.	A1 <i>Bilateral assist</i> —Arms move in unison pumping up and down, resulting in a high vertical component on the hop.
L2 <i>Alternating flat-footed step-hop pattern</i> —A skipping pattern that has a flat-footed landing.	A2 <i>Semi-opposition</i> —Arms move forward together at first, then break into semi-opposition.
L3 <i>Alternating ball of foot step-hop pattern</i> —A proficient skipping pattern with alternating step hop and landing on the ball of the foot.	A3 <i>Opposition</i> —Arms swing loosely in opposition to the nonsupport leg.

► Jumping

Jumping is a body projection skill that involves a take-off and landing on both feet. There are three phases to a jump: a preparatory phase where the body positions itself for the impending jump, a force-producing phase where the body generates the forces necessary to get off the ground, and a follow-through phase where the body lands and attenuates the forces generated. The vertical jump and the horizontal jump are the two jumps on which we have the most information. Jumping in general is a well-utilized skill in many sports. Sports like gymnastics, basketball, and volleyball demonstrate remarkable feats of proficient jumping skills, particularly the vertical jump. Other field events such as high jump and long jump show how elite athletes



A



B



C

The fundamental movement of jumping is a critically important component of a wide variety of sports and dance.

(A) © muzsy/Shutterstock; (B) © sportpoint/Shutterstock; (C) © Nanette Grebe/Shutterstock

can maximize their body mechanics and jump great heights and distances.

Prerequisites to Jumping

Jumping is an explosive skill that requires tremendous leg strength both on take-off and landing. However, as part of the jump the child must be able to swing the arms forcefully above the head and thus also requires

core strength from which the arms can swing and core strength during the landing. In jumping the jumper also needs multi-limb coordination and dynamic balance in order to perform the skill proficiently.

Proficient Jumpers

Proficient jumpers have learned how to control their body dynamics during the preparatory, force producing, and follow-through phases of the jump. Jumping has a significant timing element to it, and proficient jumpers can coordinate multiple body parts to place the body in an effective position to produce the most force in the line of the intended direction of the jump. For long jumpers, the body leans at a 45-degree angle on take-off, and for vertical jumpers, the angle of forces is vertically upward. During the airborne phase jumpers can reposition their body and get their feet underneath them to attenuate the landing forces from the jump. **TABLE 12.7** illustrates the characteristics of a proficient jumper, in this example performing a horizontal jump.

Initial jumping for distance often starts with pre-jumping behaviors. This typically consists of the child repeatedly bouncing up and down with knee flexion and extension and arms moving bilaterally. In

TABLE 12.7 Characteristics of a Proficient Horizontal Jumper

Preparatory Phase

- Knees bent and body leans forward at the hip
- Arms swing forward and back to generate momentum (or start behind body)

Force-Producing Phase

- Arms and legs extend quickly and forcefully upward and forward
- Full extension of the body occurs from the toes through the trunk, with the shoulder angle at 180 degrees, arms extended
- At take-off body lean is close to a 45-degree angle

Flight Phase

- As body is in the air, arms move down and back toward the body
- Legs move forward and up with knees bent

Landing and Follow-Through Phase

- Heels reach forward to touch surface
- Thighs parallel to the surface
- Arms extend forward to pull the body forward
- Hips travel in an arc almost touching the heels at landing and then move upward

these pre-jumping behaviors the child is not actually able to coordinate his body or exert enough force to propel his body off the ground. Initial long jumpers (stage 1) are able to get their body off the ground but cannot jump long distances; the movement is more vertical, and there is little body lean. These children may take off with two feet but often land on one foot. Arm actions are extraneous and flailing in an attempt to maintain balance under the challenging conditions of jumping, and these children frequently fall on landing.

Development of Horizontal Jumping

Jumping has been studied from both a product and process perspective. From a product perspective common product scores are distance or height jumped. Both total body and component sequences have been identified in describing the process of jumping. Both the total body and component sequences share many commonalities with a few differences in arm and leg actions.

Total Body Developmental Sequence of Jumping

The total body approach has identified a four-stage sequence in horizontal jumping (Haubenstricker, Seefeldt, & Branta, 1983; Seefeldt, Reuschlein, & Vogel, 1972). Table 12.1 and **FIGURE 12.4** depict information on the four stages of jumping. These data were generated from a task constraint where children were told to “jump as far as you can” from a standing position using a two-footed take-off. In the initial stage (stage 1) the jump is more vertical than horizontal and arms swing back toward the body (braking arms) to counteract the forward lean that seems so fearful for this initial stage of jumper. During the emerging stages (stages 2 and 3) the arms move from an upward and sideways “winging” position to swinging forcefully forward but not with the arms fully extended. It is not until stage 3 that a forward lean at take-off is demonstrated. By the proficient stage (stage 4), jumpers are leaning at a 45-degree angle at take-off, swinging their arms forcefully above their head with full shoulder extension, and have a momentary position in the air where the body is in full extension. Truly proficient jumpers seem to “hang” in the air for a split second with this full extension before drawing their legs underneath them in preparation for landing. Figure 11.4 shows the age at which 60% of children performed a specific stage of jumping.

Initial jumping behaviors emerge between 1.5 and 2 years of age. By their fourth birthday, both genders have moved to a stage 2 jump with “winging arms.” It takes another two years before children move to stage 3, with boys and girls demonstrating these jumping

behaviors a little after their sixth birthday. Boys reach jumping proficiency by approximately 114 months with girls getting there at 120 months (10 years of age). As such the intratask jumping sequence is one that takes the longest timeframe from the emergence of initial jumping to the onset of proficient jumping.

Component Developmental Sequence of Jumping

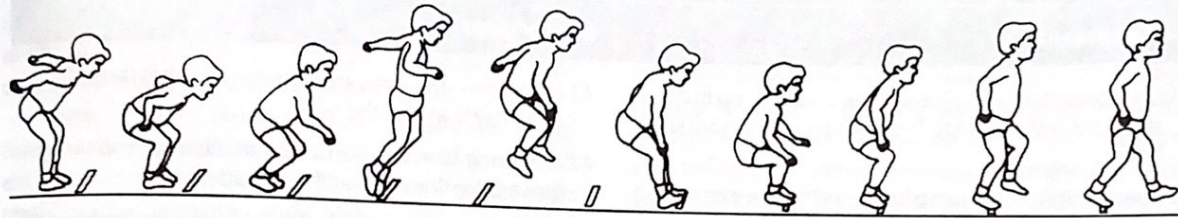
Jumping also has been examined from a component perspective with leg and arm components (Clark & Phillips, 1985; Robertson & Halverson, 1984) and a trunk component (Robertson & Halverson, 1984). Changes in the trunk component are a by-product of the force producing aspects of the jump, namely the arm component and leg component. Thus **TABLE 12.8** shows the arm and leg components (Clark & Phillips, 1985).

Often in the component approach, the levels of the different components are related but not directly linked. This is also true in jumping. Clark and Phillips (1985) reported that children ages 3 to 7 years usually had more advanced leg actions than arm actions. Also, fewer than 30% of the children had the same level of arm and leg action. Lane et al. (2018) identified component sequences for the landing phase of the standing long jump and tested them via pre-longitudinal screening. The study supported the initial components and suggested longitudinal validation. The authors suggested that the landing phase of the long jump was important and needed further investigation.

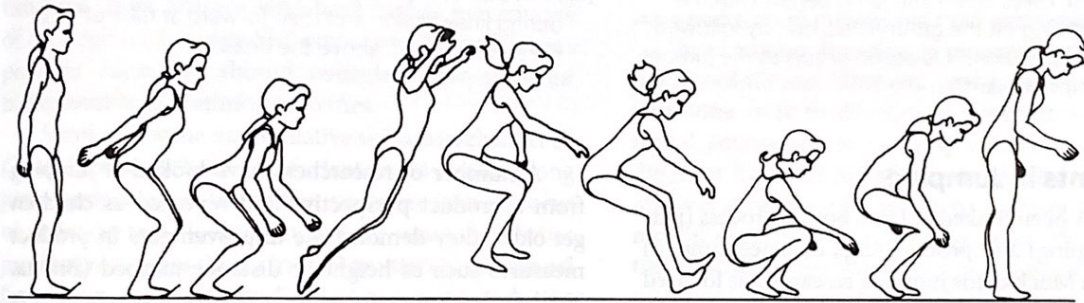
Secular Changes in Jumping

As rates of obesity/overweight have climbed in many countries, it is no wonder that jumping performance has declined. A 30-year review of standing long-jump performance in Australian children ages 11–12 years found secular declines in jumping performance (Fraser et al., 2019). Jump distance decreased 16.4 cm or 11.2%. Even when the analysis accounted for increases in body mass over this time, there were still declines in jumping performance. It may be that declines in skill level account for this data. Another study (Hardy et al., 2018) looked at 30-year changes by sex and age in Australian children's long jump accounting for height, weight, socioeconomic status (SES), and linguistic background. Height, weight, and BMI all increased over the 30 years while not surprisingly muscular strength decreased. Declines in long-jump distance were true for both boys and girls (girls were greater), with greater declines in non-English speaking children and lower-SES children.

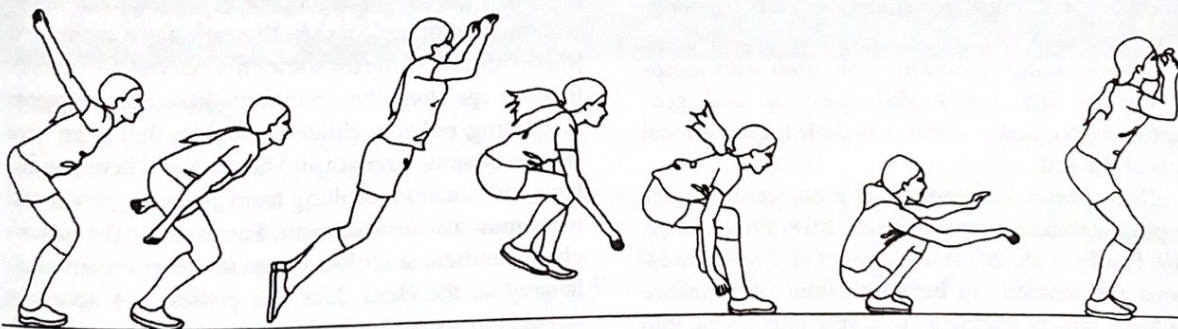
Stage 1



Stage 2



Stage 3



Stage 4

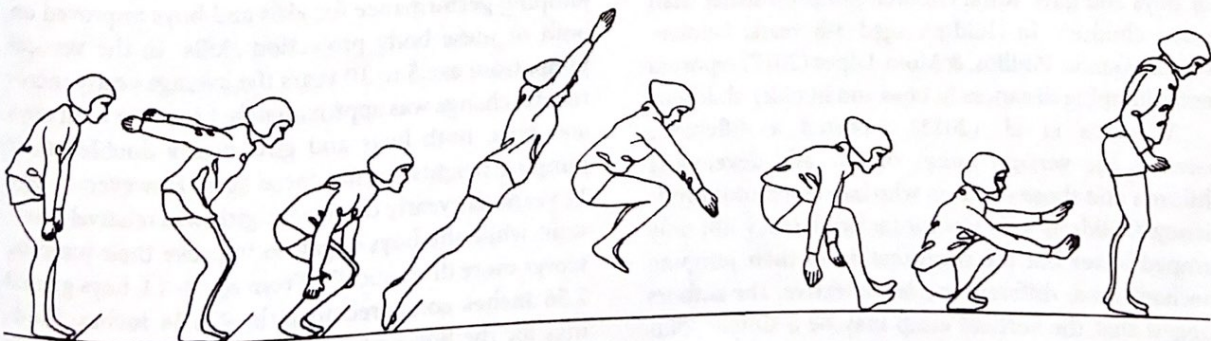


FIGURE 12.4 Developmental sequences of horizontal jumping.
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TABLE 12.8 Component Developmental Sequences of Jumping

Leg Component	Arm Component
L1 <i>One-footed take-off</i> —The jumper tries to jump but steps out with one foot. There is little preparatory knee flexion.	A1 <i>No action</i> —The arms are stationary or after take-off they may “wing” to the side.
L2 <i>Knees straight</i> —The jump begins with knee extension prior to heel lift from the surface.	A2 <i>Arm swing forward</i> —Arms start at the sides and swing forward (or sideways) at the shoulder.
L3 <i>Simultaneous extension</i> —The jumper extends the knees as the heels lift off the floor.	A3 <i>Arms extend, then partially flex</i> —Arms swing backwards together during knee flexion and then forward at take-off but never reach above the head.
L4 <i>Heels first, knees next</i> —The jump begins with the heels coming off the ground first, quickly followed by knee extension. This action occurs as the jumper falls or tips forward.	A4 <i>Arms extend, then fully flex</i> —Arms swing backwards during knee flexion and then forward at take-off with full arm extension above the head.

Constraints in Jumping

Jumping has been looked at from both a process (pattern of jumping) and product (e.g., distance jumped) perspective. Much of the jumping research has focused on product measures of jumping like distance jumped, as this is a fast and easy measure to undertake in large numbers of children. From an *individual constraints* standpoint, age, gender, and BMI are consistently reported as individual constraints influencing long-jump performance.

Environmental constraints associated with jumping include SES, non-English-speaking, and geographic region. *Task constraints* include the attentional focus of the task.

BMI appears consistently as a constraint in the jumping literature (Antunes et al., 2018; Fraser, et al., 2019; Hardy et al., 2018). Antunes et al. (2018) investigated the relationship between motor performance and body fatness among 3- to 5-year-olds taking into account gender, SES, and geographic region. As would be expected, BMI was negatively correlated with BMI (greater BMI, shorter jump) with this finding similar for boys and girls. Rural children jumped further than urban children. In children aged 3-6 years, Latorre-Román, García-Pinillos, & Mora-López (2017) reported better jumping distances in boys and in older children.

Williams et al. (2013) reported a difference between the vertical jumps of typically developing children and those children who had low motor proficiency. Children with low motor proficiency not only jumped lower but the coordination of their jumping mechanics was different and less effective. The authors suggest that the vertical jump may be a simple solution to identify children with low motor proficiency who are in need of additional support.

A number of researchers have looked at jumping from a product perspective and reported as children get older, they demonstrate improvements in product measures such as height or distance jumped (Branta, Haubenstricker, & Seefeldt, 1984; Haubenstricker & Branta, 1997; Isaacs & Pohlman, 2000; Isaacs, Pohlman, & Hall, 2003; Wickstrom, 1983). As with many of the other skills, caution needs to be exerted in seeing these changes as age-dependent (they naturally occur as a function of age); rather, they are more age-related (these trends are true for some children but not others). It is not age alone that manifests these improvements in jumping; rather as children get older they often have greater dynamic strength and balance, and better multi-limb coordination resulting from physical growth and neuromuscular development. For many of the nation's obese children, skills like jumping are extremely challenging as the child does not possess the necessary strength to propel her body off the ground.

Branta and colleagues (1984) tracked vertical and horizontal jumps for children longitudinally starting at age 5 through age 14 years. Across time, the mean jumping performance for girls and boys improved on both of these body projection skills. In the vertical jump, from age 5 to 10 years the average yearly incremental change was approximately 1 inch for both boys and girls. Both boys and girls nearly doubled their jumping heights during these ages. However, by age 12 years, the yearly change for girls was relatively constant while the boys began to improve their jumping scores more dramatically. From age 8–14, boys gained 7.56 inches compared to girls at 6.34 inches. Findings for the horizontal jump were similar. From ages 5–10 years children improved their jumps as much as 7 inches annually, but showed less than 2-inch yearly

gains by age 14. Horizontal distance gains represented a 75% improvement for girls and a 71% increase for boys from ages 5–10 years. In considering these findings we need to look at the changes in physical growth in children as potential individual constraints influencing the trends in jumping performance.

Klein et al. (2016) looked at differences in jumping among children from higher and lower SES environments. They found ($N = 1389$; first through tenth grade) students with higher SES had better jumping performance than lower SES, and higher than the reference population. The opposite was true for the lower SES students. This study has implications for those schools who have higher percentages of children from lower SES environments and means physical educators should consider their students' backgrounds in planning activities.

Similar to some manipulative skills, Marchant et al. (2018) looked at the focus of attention on standing long jump performance. In the first study, an external focus of attention (e.g., looking at a cone) resulted in better jumping outcomes than a control or internal attentional focus (focused on the body). In the second study, the researchers added what they called a proximal external

attentional focus (closer) versus a distal external attentional focus (further away). Jumping distance was better for the distal external focus condition although other constraints like instruction and task characteristics may have been influential. Coker (2018) found similar findings comparing the standing long jump in seventh graders in four conditions: no cues, focus on leg or arm technique (internal focus), and jumping to a cone (external focus). The external focus condition resulted in greater jumping distances and lower take-off angles. Of the internal focus conditions, the arm focus produced better results. These findings highlight how important task constraints and instructional constraints are in influencing FMS performance.

In summary, jumping is a complex skill requiring coordination, strength, and balance. It takes a very long time to develop to proficiency from the initial emergence of jumping behaviors. There are different kinds of jumping, and Wickstrom (1983) utilized a variety of sources to provide a developmental progression of jumping tasks. He suggested the following approach for two-footed jumping: (a) jumping down from a height, (b) jumping up, (c) jumping forward, and (d) jumping over an



DEVELOPMENTAL DILEMMA

Lesson Planning

You are an elementary school physical education teacher planning a 4-day locomotor unit for children in preschool through second grade. The unit will include hopping, skipping, galloping, running, and jumping, and each lesson period is 30 minutes long. Use the information you have learned about these skills and consider how you would arrange these skills in your unit. In each of the four lessons, what skills would you teach together? How much time would you spend on them? What progressions might you use? What individual constraints should you consider? How will you assess these skills to see if the children have learned? Write out your block plan like the following example:

Day 1

Day 2

Day 3

Day 4

List the skills you will teach here.

object. For the practitioner, it is important to recognize that children need lots of opportunity to practice the skill of jumping. However, jumping involves significant physical exertion and large blocks of time for jumping should not be planned into a lesson. Rather, jumping should be placed in several different lesson plans alongside other activities that are less strenuous in nature.



CONCEPT 12.3

There is a relationship between process and product measures in some locomotor skills (running and jumping). As performers move from initial to emerging to proficient patterns of performance (process), they are able to apply these biomechanical efficiencies to achieve greater outcomes (product) such as speed of run and distance jumped.

► Hopping

Hopping is a body projection locomotor skill that involves the child taking off and landing on the same foot. There is often some confusion as to the term. In children's stories, we typically read that "bunnies hop," but this is not true, and as we should know by now, bunnies jump! Although adults rarely hop in isolation, children need to develop this FMS in order to become proficient in the skill in order to apply it to different sports, games, and dances. Hopping is an integral part of childhood games, playground games such as hopscotch, and dances. Many folk dances, such as the schottische, incorporate the hop into the pattern of the dance. The International Perspective box on Morris dancing portrays a culturally relevant form of



Hopping is an important fundamental movement skill used in the traditional Indonesian game of engklek.

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hopping. However, elements of hopping are also found in sports skills such as the lay-up in basketball and the approach in triple jump. As such, it is important that young children learn how to hop.

Prerequisites to Hopping

Like jumping, hopping requires significant muscular strength, multi-limb coordination, and dynamic balance in order to be performed proficiently. However, hopping is more complex than jumping as the task demands for strength, coordination, and balance are significantly greater than in jumping. Hoppers have to take-off and absorb the forces of landing on one foot. For the younger child, physical growth constraints such as smaller feet and higher center of gravity make the balance part of hopping particularly challenging. For our heavier children, the strength-to-weight ratio needed to hop often means that hopping is a challenging task and one they struggle to perform.

Proficient Hoppers

Proficient hoppers have also learned to control their body dynamics as their center of gravity moves over their base of support while they hop. Proficient hoppers use their non-support leg to swing forward and back in a pendular action to contribute to the power production of the hop. During the hop the child's arms act in opposition to the swinging leg in order to control the biomechanical forces generated by the leg. As the body leaves the ground in the projection phase of the hop the support leg extends and the body leans forward. Proficient hoppers can often hop with considerable speed. **TABLE 12.9** illustrates the characteristics of a proficient hopper.

For the initial hopper, the task of hopping is exhausting, high in cognitive load (concentration), and often highly frustrating. Initial hoppers maintain more of a vertical body position. The foot of the swing

TABLE 12.9 The Characteristics of a Proficient Hopper

Balance effectively on the support foot
Support leg extends fully at take-off and flexes at landing
The thigh of the nonsupport leg pumps back and forth with the hop
Arms pump in opposition to the swing leg's pendular motion
Forward lean of the body

leg is held in front of the support leg to assist with the task of balancing and allows the child to step forward onto the non-support foot if he or she loses her balance. The beginning hopper relies on her arms to assist with the lift necessary to propel her off the ground. Distance hopped is small and almost all of the motion is vertical. Young hoppers often do not have requisite strength to get their body off the ground on one leg and may show extension and flexion of the support leg as they try to get off the ground, to no avail. This is particularly true for children who are heavier.

Development of Hopping

Hopping has been studied from a predominantly process perspective with both total body and component sequences identified. As with other skills, the total body and component sequences share many commonalities.

Total Body Developmental Sequence of Hopping

The total body approach has identified a four-stage sequence of hopping (Haubenstricker, Henn, & Seefeldt, 1975; Haubenstricker et al., 1989; Seefeldt & Haubenstricker, 1974). Table 12.1 and **FIGURE 12.5** depict information on the four stages of hopping. One of the keys to distinguishing between the four stages of hopping is the position of the swing leg and free foot. In the initial stage (stage 1) the foot of the swing leg is in front of the support leg and the thigh horizontal to the surface in order to provide greater balance. Children push off the surface with bent knees and hold their hands near the shoulders. As children progress, emerging hoppers begin to drop the foot of the swing leg alongside the support leg with the thigh at a 45-degree angle to the hip (stage 2). Arms are often used bilaterally. By stage 3, the foot of the swing leg is behind the support leg and the thighs are parallel in emerging hoppers. As described above, proficient (stage 4) hoppers use the swing leg as a means of force production and pump the swing leg in a pendular action. Hoppers in these latter two stages demonstrate better balance, leg strength, and multi-limb coordination. They also cover more horizontal distance in these stages as compared to stages 1 and 2. Their support leg extends fully at take-off and flexes upon landing to absorb the forces of the hop. Figure 11.4 shows the age at which 60% of children performed a specific stage of hopping.

Data show that the skill of hopping is initiated about 6 months to one year after the initial jumping pattern is begun (Seefeldt & Haubenstricker, 1982). Initial

hopping patterns occur around 30 months of age, and by around 42 months of age, girls and boys show a stage 2. This skill is one of the few skills in which girls move ahead of boys, and by around 58 months, girls show a stage 3 compared to boys, who do not reach this stage until around 64 months. By approximately 84 months (7 years) girls show a stage 4, and boys follow shortly after at around 90 months. The interskill sequence of running and hopping shows that the majority of children are at the stage 2 running pattern before they initiate the hopping skill. They have been jumping on two feet at least 6 months before mastering stage 1 of hopping. These interskill sequences are valuable to the elementary physical educator as he or she develops her annual plans and unit plans on locomotor skills.

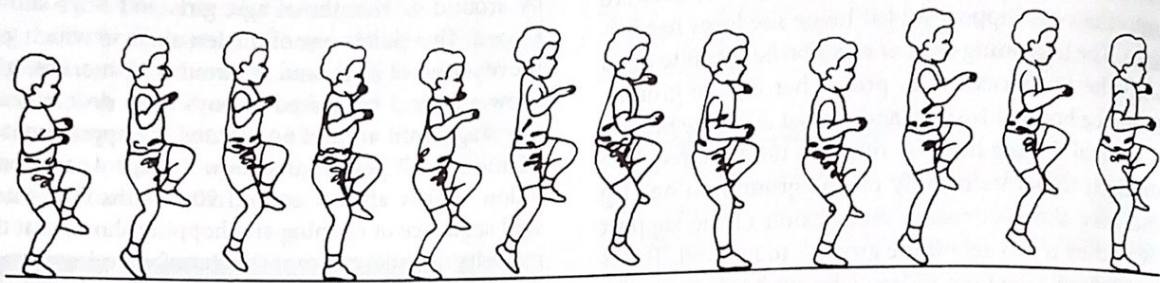
Component Developmental Sequence of Hopping

Hopping has also been described using a two-component (arms and legs) body component perspective (Halverson & Williams, 1985). **TABLE 12.10** identifies the four-level leg action and the five-level arms action.

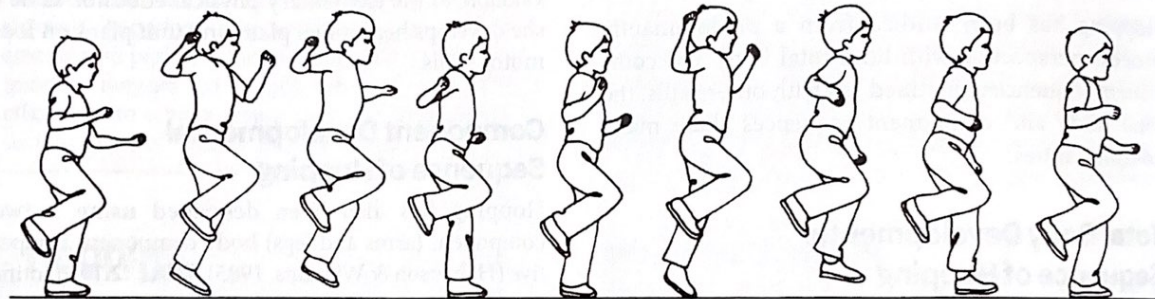
Overall the action of initial hoppers is awkward, energy demanding, and inefficient. Young hoppers often lose their balance easily and are only able to demonstrate a few hops at a time without stepping onto the nonsupport foot, with few children who are younger than 3 years being able to hop at initial levels or hop repeatedly (Bayley, 1969; Haubenstricker et al., 1989; McCaskill & Wellman, 1938; Seefeldt & Haubenstricker, 1982). In contrast, proficient hoppers can hop with mechanical efficiency and speed.

Hopping can be performed on the right and left legs. Typically children have a foot preference for hopping with hopping on the non-dominant side being inferior to the dominant side. Halverson and Williams (1985) reported that hopping on the non-dominant side lagged developmentally behind hopping on the dominant side. They also found few children ages 3–5 who could be classified at advanced levels of the hop. For the overweight child, hopping is specifically challenging, as this child's strength-to-weight ratio is low. The preschool and early elementary years are important years in which to give children practice and feedback on good hopping techniques. Having said that, hopping as a skill requires significant energy expenditure, and entire lessons on hopping are not recommended as they would be exhausting and not motivating for the young child. Like jumping, hopping should be built into opening activities, games, and dances; or placed alongside other less energy-demanding skills in a locomotor skill unit.

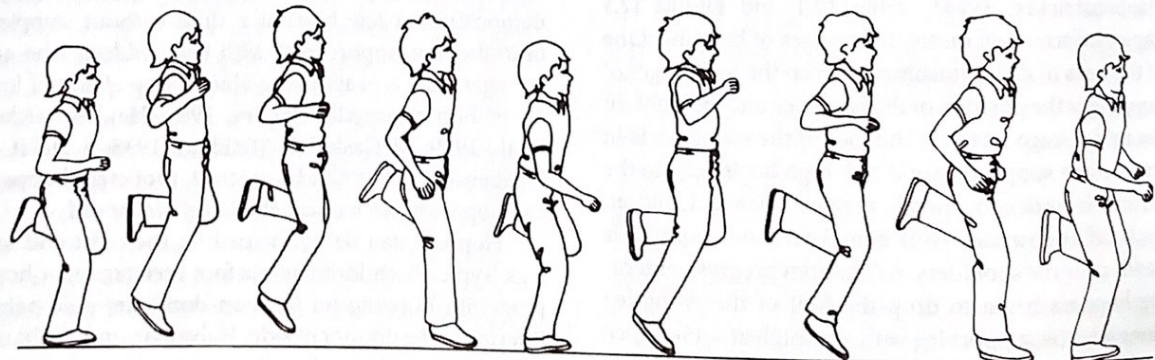
Stage 1



Stage 2



Stage 3



Stage 4

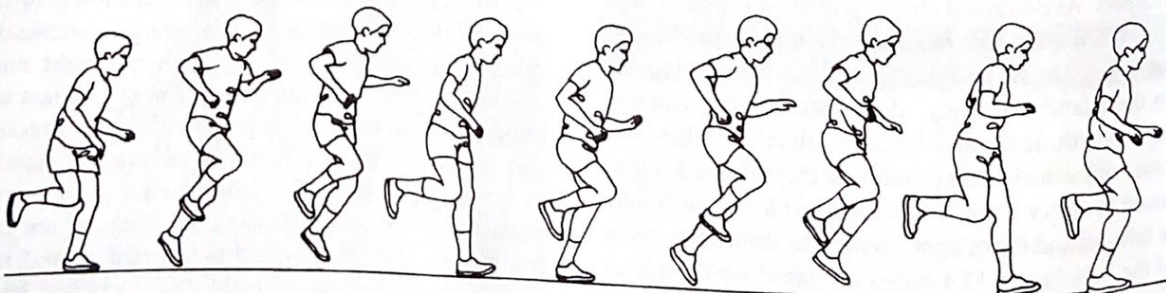


FIGURE 12.5 Developmental sequences of hopping.

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TABLE 12.10 Component Developmental Sequences of Hopping

Leg Component	Arm Component
L1 <i>Momentary flight</i> —Support leg and knee pull up with the swing leg held in front or to the side. Only 1–2 hops in a row possible.	A1 <i>Bilateral inactive</i> —Arms bilateral, high, and out to side.
L2 <i>Fall and catch with swing leg inactive</i> —Slight lean forward with small knee and ankle extension that helps body “fall” forward. Repeated hops possible.	A2 <i>Bilateral reactive</i> —Arms swing upward and out to side in a winging action.
L3 <i>Projected take-off, swing leg assist</i> —Support leg extends on take-off and flexes quickly on landing. Swing leg pumps slightly but little force production.	A3 <i>Bilateral assist</i> —Arms pump up and down together in front of body.
L4 <i>Projection delay, swing leg leads</i> —Weight transfer from landing to take-off on support foot is smooth. Strong pumping action in swing leg transmits power to support leg.	A4 <i>Semi-opposition</i> —The arm on the opposite side to the swing leg moves in opposition, the arm on the other side is variable.
	A5 <i>Opposite Assist</i> —The arms swing in opposition to the swing leg, especially during hopping for speed.

Constraints in Hopping

The majority of research in hopping has been biomechanical in nature and little research has investigated constraints in hopping. Hopping requires that children have greater lower leg strength and balance than other skills. One product measure of hopping that has been used in studies is hop length. This measures the distance from take-off to landing in a hop. Holm et al. (2009) found that hop length increased in children ages 7–12 years, even when normalized to height, and that hop length may be a good measure of motor performance in children. Kakebeeke et al. (2012) reported significant

differences in hopping between 3- and 5-year-olds with no gender differences in performance.

Tveter & Holm (2010) investigated the extent to which leg strength and balanced predicted hop length in children 7–12 years. They found that hop length and leg (thigh) muscular strength increased across age groups, whereas balance only showed minor fluctuations. Overall, thigh strength, static balance, age, and gender predicted 53.4% of the variance in hop length, but gender and balance were not significant predictors. There is still a lot we do not know about hopping, and there is particularly little evidence on how best to teach hopping to children and promote more proficient performance.



INTERNATIONAL PERSPECTIVES

Hop, Skip, and Jump: Morris Dancers at Work

Morris dancing is an ancient form of English folk dance dating back perhaps to pre-Christian days and the relics of Druid society. Morris dancing today is a ritualized form of folk dance performed to music in the open air in villages in rural England by groups of specially chosen and trained men and women. Morris dancers have bells on their legs, hankies (English for handkerchief) or sticks in their hands, and hats on their heads. Traditional Morris dances consist of all the locomotor skills in this chapter such as skipping, hopping, galloping, sliding, and jumping, and many of these dances are believed to be fertility dances. One of the earliest references to Morris dancing is in Shakespeare's *All's Well that Ends Well* (II.ii.21). Morris dancing was commonly performed on May Day (May 1). King James I's *Book of Sports* in the early 17th century also mentions Morris dancing in May Day celebrations.

I remember May Day celebrations from my childhood in a small rural English village called Waltham St. Lawrence. The local Morris dancing troop would perform in the center of the village in front of our 14th-century church and pub. The entire village community would gather to watch and celebrate the beginning of spring. The Morris troop would hop, skip, jump, and gallop in rhythm to music, generally played by an accordion. (Jackie Goodway).

See https://www.youtube.com/watch?v=sArAC2_ow2k or other examples of Morris Dancing on YouTube.

► National Guidelines and Fundamental Motor Skills

In Chapter 11 we examined the development of manipulative skills and in this chapter we have read about locomotor skills. As we have previously emphasized, the development of FMS is important for sports, games, and lifetime physical activities. These FMS should be developed in the early childhood and middle childhood years. For most children, school physical education is where children get opportunities to develop these important FMS. But what kinds of FMS should children be performing at different grades? And in what kinds of environments? The Society of Health and Physical Educators (SHAPE America) has identified grade-level outcomes for the performance of FMS as part of their K–12 physical education curriculum framework (SHAPE America, 2013). The goal of physical education is “to develop physically literate individuals who have the knowledge, skills and confidence to enjoy a lifetime of healthful physical activity” (SHAPE America, 2013). SHAPE America recognizes the importance of developing FMS in promoting a physically literate individual and FMS are built into the content of Standard 1.

Standard 1

The physically literate individual demonstrates competency in a variety of motor skills and movement patterns.

The elementary school years are where the child develops competence in FMS, combinations of FMS, and uses a variety of movement concepts in dance, gymnastics, and small-sided practice tasks. **TABLE 12.11** shows the grade level outcomes for locomotor and manipulative skills. As can be seen from examining the table, there is an increasing requirement for more proficient patterns of FMS as children go from kindergarten to fifth grade and also increasing complexity in the environment in which the skills are placed. However, like SHAPE America, we believe it is important to remember these grade-level outcomes are just recommendations and instructional activities should be aligned to the current developmental level of the child.

A while ago, physical activity guidelines were also developed for children ages 0–5 years. These SHAPE America’s *Active Start* physical activity guidelines (NASPE, 2009) guidelines were developed for infants, toddlers, and preschoolers and state, “All children birth to age 5 should engage in daily physical activity that promotes movement skillfulness and foundations of health-related fitness.” Specifically, Guideline 3 for

preschoolers highlights the importance of FMS and says preschoolers should “develop competence in fundamental motor skills that will serve as the building blocks for future motor skillfulness and physical activity” (NASPE, 2009).

These national standards for physical education and physical activity recognize that FMS are important and should be taught, practiced, and reinforced during the childhood years. In line with this perspective, assessing FMS is important in order that teachers, coaches and other practitioners can:

- Determine the developmental status of a child’s FMS performance and if he or she is demonstrating age-appropriate skills or in need of additional services such as adapted physical education.
- Ensure that there is a “goodness of fit” between the instructional activities and the children’s developmental level.
- Monitor a child’s progress across a unit of instruction or a motor skill program and report this progress to the child and parent.
- Examine the effectiveness of the motor skill program or physical education program to determine what needs to be changed about it.

► Assessment of Fundamental Motor Skills

Throughout this chapter, we have referred to both process and product perspectives on FMS development. Before we provide a brief overview of the major assessment instruments used to evaluate FMS, we need to define some terms that are important to the world of assessment and evaluation:

- **Product-oriented tests**—tests that look at the outcome of a skill, for example, how many out of 10 tosses can you catch or what distance you can throw.
- **Process-oriented tests**—tests that examine the pattern of the performance such as form, style, or mechanics of the movement, for example, the developmental sequences identified above.
- **Norm-referenced tests**—tests that compare the child’s skills to those of a similar age and gender (and sometimes race and socioeconomic status). A norm-referenced test will typically provide a percentile rank for a child. For example, a child at the 75th percentile is better than 75% of other children his age.
- **Criterion-referenced tests**—tests that examine the quality of a child’s movement compared to some predetermined criteria of performance. For

TABLE 12.11 Grade-Level Outcomes for Locomotor and Manipulative Skills

Grade	Locomotor Outcomes	Manipulative Outcomes
K	Maintains balance while performing: hop, gallop, run, slide, skip, horizontal/vertical jump.	Steps with opposite foot in underhand throw. Can catch a tossed ball and drop and catch a ball. Has beginning hand-dribbling skills (2 contacts). Kicks a stationary ball from a stationary position (2 of 5 critical elements) and taps a ball with inside of foot sending it forward. Strikes with a short-handled implement and hand.
1	Uses a proficient pattern to hop, gallop, jog, and slide. Performs 2 of 5 critical elements for jumping in horizontal/vertical plane.	Throws underhand (2 of 5 critical elements). Catches self-tossed and tossed balls of various sizes. Hand dribbles continuously in self space with dominant hand. Kicks a stationary ball from a moving approach (2 of 5 critical elements) and taps a ball with inside of foot walking. Strikes with a short-handled implement and hand sending it upward.
2	Demonstrates mature skip and run. Can jog and sprint. Performs 4 of 5 critical elements for jumping in horizontal/vertical plane (1- and 2-footed take-offs and landing).	Throws underhand with mature pattern and overhand (2 of 5 critical elements). Catches self-tossed and tossed balls of various sizes with hands. Hand dribbles with mature performance in self space with dominant hand and while walking. Kicks a moving ball from a running approach (3 of 5 critical elements) and foot dribbles in self and general space with control. Demonstrates a variety of striking patterns including a ball off a tee with sideways orientation and correct grip, underhand volleying an object upward with hand, and consecutive striking with a short-handled implement.
3	Demonstrates a mature leap. Travels by sprinting and running. Demonstrates a mature pattern in jumping in horizontal/vertical plane.	Throws underhand with mature pattern to a target and overhand for distance/force (3 of 5 critical elements). Hand catches partner-tossed small ball (3 of 5 critical elements). Hand dribbles with mature performance and control while jogging and traveling. Kicks a ball along the ground and into the air from a running approach, and kicks for accuracy to a target. Foot dribbles in general space while jogging with control, and passes and receives a ball with the instep. Voleys a ball with sidearm/underarm pattern (4 of 5 critical elements) over a net or to a partner. Strikes with a short-handled implement (3 of 5 critical elements) sending ball over net or to a wall. Strikes ball with a variety of long handled implements (e.g., bat, golf club, hockey stick) with proper grip.

(continues)

TABLE 12.11 Grade-Level Outcomes for Locomotor and Manipulative Skills*(continued)*

Grade	Locomotor Outcomes	Manipulative Outcomes
4	Can functionally use a variety of locomotor skills in different environments (e.g., games, dance, gymnastics). Runs across distance using a mature pattern. Can jump and land in a variety of gymnastics environments.	Applies underhand throwing. Throws overhand with mature pattern to a target (stationary and moving) with distance/force. Hand catches partner-tossed small ball above head and at waist with mature pattern. Hand dribbles with mature performance and control while increasing/decreasing speed. Dribbles with non-dominant hand in general space. Dribbles in combination with other skills. Kicks a ball along the ground and into the air and punts with mature pattern. Foot dribbles in general space with increasing/ decreasing speed, and passes and receives a ball with the inside/outside of feet to a stationary/moving partner. Volleys underhand in dynamic environment, and overhand (3 of 5 critical elements) sending it upward. Strikes with a short-handled implement with a mature pattern and in a rally with partner. Strikes ball with a variety of long-handled implements (e.g., bat, golf club, hockey stick) with 3 of 5 critical elements.
5	Demonstrates individual and combinations of locomotor skills in dynamic environments (e.g., dance, gymnastics) showing mature form. Combines locomotor skills and manipulative skills for execution to a target (e.g., scoring in soccer, hockey and basketball). Is able to run distances with appropriate pacing. Uses jumping and landing patterns with other locomotor and manipulative skills in dance, gymnastics, and games.	Throws underhand and overhand with a variety of balls with mature pattern and to a large target. Throws with accuracy (2 partners moving) and in small-sided game. Hand catches batted ball above head/waist/along ground with mature pattern. Catches (2 partners moving) and in small-sided game. Hand dribbles with other skills in 1-on-1 and in small-sided games. Kicks/punts with mature pattern in small-sided tasks. Foot dribbles with other skills in 1-on-1 and passes and receives a ball with feet with mature pattern while both partners travel and in small-sided games. Applies underhand volley and overhand volleys sending it upward to a target. Strikes with a short-handled implement in a rally with a partner in cooperative/competitive game. Strikes a pitched ball with a bat with mature pattern and combines with traveling skills in a game.

Data from SHAPE America. (2013). Grade-level outcomes for K-12 physical education. Reston, VA.

example, does the child step with a contralateral (opposition) pattern when throwing?

- **Reliability**—tests that provide consistent scores from one testing period to another.
- **Validity**—tests that measure what they claim to measure.
- **Objectivity**—tests that will give similar results when administered by different testers.



CONCEPT 12.4

Assessments can be categorized as norm-referenced, criterion-referenced, product-oriented, and/or process-oriented.

We will provide a brief overview of three main approaches to assessing fundamental motor skills during childhood.

Test of Gross Motor Development (TGMD)

At the present time there are two versions of the TGMD being used and seen in the literature. Both the TGMD 2 and 3 (Ulrich, 2000; Webster & Ulrich, 2017) are a norm-referenced and criterion-referenced test designed to assess 12 or 13 FMS in children ages 3 to 10 years. Both TGMD versions include two subscales:

- **TGMD-2**
 - 6 locomotor skills (run, gallop, hop, leap, jump, slide = 48 possible points)
 - 6 object control skills (strike, dribble, catch, kick, throw, roll = 48 possible points)
- **TGMD-3**
 - 6 locomotor skills (run, gallop, hop, skip, jump, slide = 46 possible points)
 - 7 ball skills (2-handed strike, 1-handed strike, dribble, catch, kick, overhand throw, underhand throw = 54 possible points)

Each fundamental motor skill in the TGMD has between 3 and 5 performance criteria (see Appendix for an example of the TGMD-3). Children are evaluated on whether they meet the performance criteria (1 is awarded) or do not meet the criteria (0 is awarded). Two trials for each of the FMS are attempted, and the total numbers of 1s and 0s are summed with a possible subscale range between 0 and 48 points (TGMD-2) and 0-45/0-54 (TGMD-3). From the raw score, standard scores that factor out age can be calculated in order to compare two children of different ages. Additionally, a percentile rank can be calculated based upon the child's age and gender. High skill scores and

percentile rank indicate children met performance criteria and are motor competent. A child with a percentile rank below the 25th percentile is considered developmentally delayed (Ulrich, 2000). This scale has documented reliability and validity. This test is one of the most commonly used assessment instruments for practitioners and also for researchers. The TGMD-2 is often used to identify children for Adapted Physical Education services and typically takes about 15 minutes per child to administer.

Movement Assessment Battery for Children 2

The Movement Assessment Battery for Children-Second Edition (Movement ABC-2) (Henderson, Sugden, & Barnett, 2007), a revision of the Movement Assessment Battery for Children, is used to identify students ages 3 years 0 months to 16 years 11 months who either have established movement difficulties, or are believed to have problems in the movement domain, or are significantly behind their peers. The Movement ABC-2 test is a standardized assessment tool that requires a child to perform a series of eight motor tasks grouped under three headings/subscales: (1) manual dexterity, (2) ball skills, and (3) static and dynamic balance. The tasks vary based upon the age of the child, and the test is divided into three age bands:

- Age band 1: 3–6 years
- Age band 2: 7–10 years
- Age band 3: 11–16 years

The Movement ABC-2 takes approximately 20–40 minutes to administer depending on the age of the child and degree of difficulty experienced, as well as the experience of the examiner. Total standard scores and percentiles can be calculated. This test is frequently used for identification, intervention planning, program evaluation, and as a research tool and has both reliability and validity.

Peabody Developmental Motor Scale-Second Edition (PDMS-2)

The PDMS-2 (Folio & Fewell, 1983, 2000). is a valid and reliable measure of gross and fine movement skills in children birth to 6 years. It focuses on assessing and intervening for children with disabilities and can be used clinically in physical/occupational therapy or in research. It consists of 6 subtests, 4 focused on gross motor skills and 2 fine movement skills. The gross movement subtests include: reflexes (8 items), stationary performances (30 items), locomotion (89 items), and object manipulation (24 items). The fine

movement subtests include: grasping (26 items) and visual-motor integration (72 items). The PDMS-2 uses a 3-point rating system where 2 = skill is attained, 1 = emerging skill, and 0 = skill is not acquired. The entire test takes between 45–60 minutes to implement. As the test is designed for 0 to age 6 years it includes motor milestones as well as FMS and motor abilities.

Bruininks-Oseretsky Test of Motor Proficiency (BOTMP, BOT-2)

The BOT (Bruininks & Bruininks, 2005) is another instrument that is used to clinically to measure motor competence. It assesses fine and gross movement skills in individuals ages 4–21 years, and has predominantly been used to identify children with motor coordination deficits. The entire BOT-2 has 53 items with 8 subtests in which later items in the subscale are harder than earlier items: fine motor precision (7 items), fine motor integration (8 items), manual dexterity (5 items), bilateral coordination (7 items), balance (9 items), running speed and agility (5 items), upper limb coordination (7 items), strength (5 items). As the BOT-2 is so extensive, it also has a BOT-2 Short Form consisting of 14 items from all subtests. There is a high correlation ($r = 0.80$) between the short and long form of the BOT-2. Subscale scoring ranges between 2- to 13-point scales. Standard scores can be calculated. The test implementation time is 45–60 minutes for the long form and 15–20 minutes for the short form.

Developmental Sequences

The developmental sequences (total body and component) described above can be used to assess the FMS of children. These assessments are fast, developmental, valid, and reliable. A variety of approaches can be used by the teacher to assess the FMS within a gymnasium environment. The teacher can set up a testing station and each child will rotate to that station where the child performs 3–5 trials of the skill and the teacher formally evaluates the stage. A less formal and perhaps more practical approach

for a physical educator is to use colored stickers. Each color represents a stage; for example, green is stage 1. As the teacher rotates around skill stations providing feedback, she places a colored sticker on the child after observing the child perform a skill. Upon exiting the gym, the child places his sticker on a chart by the door next to his name. When using developmental sequences in research, the researcher must be sure to standardize the testing equipment and environment as different tasks and equipment will vary the skill. The researcher should also videotape the performance in order to ensure interrater reliability (making sure that two different raters come up with the same stage). Videotape is particularly necessary with the component approach as it often takes multiple observations to be able to stage all of the components.

Which Assessment?

There are many different tests to measure FMS and the ones identified above are some of the most common ones. There is no single response to which assessment should be selected to evaluate FMS. It will depend on many factors. Two articles provide an overview of different assessment instruments and issues to consider when selecting an instrument (Cools et al., 2009; Bardid et al., 2019). Overall, practitioners and researchers should consider:

- Purpose of the assessment, for example, identification for adapted physical education, research, or tracking instructional effectiveness
- Number of children being tested and the time available for testing
- Conditions in which the child will be tested, for example, alone, within a class setting, or in a research design
- Reliability and validity of the test
- Objectivity and training needed to train the tester
- Whether a test has norms: do the norms represent a sample that is similar to your sample? and do you need norms for your assessment purpose?
- Characteristics of the population to be tested
- Cost of the test

► Summary

Locomotor skills consist of a group of FMS that allow individuals to navigate through space or move their body from one point to another. Developing basic competence in locomotor skills is essential for

engagement in meaningful physical activity for health and to move effectively in various sports, games, and dances. Running, galloping, hopping, skipping, jumping, leaping, and sliding are the most common forms

of locomotor skills. Developmental sequences (total body and component) describe how children acquire locomotor skills through mechanically inefficient *initial* movement patterns and onto increasingly efficient *emerging* patterns of movement. The goal is that children will develop *proficient* and biomechanically efficient patterns of movement. Research in locomotor skills shows how improving these *process* measures of locomotor skill performance will result in better

movement *product* such as faster run times or greater distance jumped. Knowledge of the developmental sequences and the constraints acting on the skills better prepare the teacher, coach, or clinician to design developmentally appropriate movement experiences for children. Assessments for FMS include process-oriented, criterion-referenced, and norm-referenced forms of tests. The selection of an appropriate assessment instrument depends on many different factors.

► Questions for Reflection

1. Why is it important for children to have a lot of experiences in attempting fundamental motor skills?
2. Can you write a definition in your own words for each of the five locomotor skills: run, skip, gallop, jump, and hop?
3. What do the terms *phylogenetic* and *ontogenetic* mean? What implications do these terms have for teachers and coaches?
4. Overall, for locomotor skills, what key features characterize initial, emerging, and proficient stages of development?
5. For the skill of jumping, what is the difference in process and product measures of assessment?
6. Which assessment is better to use for skill analyses in young children?
7. Describe how process and product measures of FMS are related.
8. Select a locomotor skill. What are some of the common quantitative, or product, measures of this skill?
9. Describe the interskill (between skill) sequences in locomotor skill development.
10. Explain the interrelationships among galloping, sliding, hopping, and skipping.
11. Select one assessment for FMS, describe it, and identify why you selected this assessment.

► Critical Readings

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