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Assessment of Gross Motor Development

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Motor development can be defined as the gradual acquisition of control and/or use of the large and small muscle masses of the body (neuromuscular coordination). Motor development is also often referred to as “perceptual-motor development” and/or “physical or motor coordination” in part because both the brain/nervous system and the muscles interact in intricate ways to allow the child to move the body skillfully in manipulating objects and exploring the physical world around him/her. Motor development is known to be an important dimension of child development and is a universally recognized means for assessing the overall rate and level of development of the child during the early months and years after birth (Butcher & Eaton, 1989; Dewey, Kaplan, Crawford & Wilson, 2002; Gesell, 1973; Illingworth, 1975). The years from 2 to 6 are considered the “golden years” of motor development (Hayes, 1994; Williams, 1983). During this period, most children acquire a basic repertoire of manipulative and locomotor skills, develop goal-directed motor behaviors, and learn to put together two or three movement sequences to accomplish specific end goals (Bruininks, 1978; Piaget, 1963; Sporns & Edelman, 1993). All of these behavioral achievements are forerunners of important aspects of adult functioning and are contingent upon the child’s acquiring an adequate base of motor development. The early years of motor development set the foundation for neuromuscular coordination that will be used by the individual throughout life to deal with a multitude of mental, social, emotional, and recreational dimensions of living.

The learning process in the early years is a physically active one, which often centers around play, physical activity, and the use of a variety of motor skills (Butcher & Eaton, 1989; Keough & Sudgen, 1990; Martin, 2002). Most children have a natural tendency to seek stimulation and to learn about themselves and their environment. They spend hours upon hours actively exploring and examining both their bodies and the physical environment that surrounds them. Such activities necessarily involve and rely upon the use of fundamental motor skills. Adequate motor development is important in optimizing this early concrete and sensorimotor-based learning. A process instrumental in the child’s progress from early primitive levels of thinking to those of higher abstraction is that of the symbolization of objects and events and the relationship between the two (Piaget, 1963). Physi-

cal activity provides the basis for carrying out important symbolic activities such as imitation (use of the body to represent objects and events), symbolic play (use of objects to represent other objects), and modeling, drawing, and cutting (construction of objects in two and three dimensions). Motor development and the physical activity associated with it, thus, are integral to promoting selected aspects of the early, active learning process.

A major function of the human nervous system is the coordinated control of movement. Evidence is clear that the acquisition of coordinated movements is inextricably linked to the development of the brain and that perception and action are intricately interrelated both early and throughout life (Sporns & Edelman, 1993). Coordinated motor responses enable the young child to explore his or her environment and to sample and process a variety of different sensory stimuli. This promotes brain development and perceptual function. Thus, movement appears to be crucial to the optimum development of perceptual development and to the development of fundamental concepts such as unity, boundedness, persistence of objects, construction of spatial maps of the environment, and so on (Spelke, 1990; Sporns & Edelman, 1993). It is a widely held belief that motor development may, in part, determine the nature and sequence in which certain perceptual and cognitive abilities unfold. If a child is unable to engage in a motor behavior that is prerequisite to the acquisition or practice of certain perceptual or cognitive abilities, that lack of motor competence may block or interfere with the natural emergence of those abilities (Bushnell & Boudreau, 1993).

Motor development also is linked during the early years to general psychological health, to social and emotional adjustment, and to educational achievement (Cantell, Smyth, & Ahonen, 1994; Henderson, Knight, Losse, & Jongmans, 1990; Losquadro-Little & Yorke, 2003; Piek & Dyck, In Press). Underachievement in school, lack of concentration, low self-esteem, poor social competence, and behavioral problems have all been linked to or associated with deficits in motor development in early and later years of childhood (Bauman, Loffler, Curie, Schmid & von Aster, 2004; Dewey et al., 2002; Geuze & Borger, 1993; Lyytinen & Ahonen, 1989; Rose & Larkin, 2002). For example, there is a greater incidence of difficulty in making appropriate social and emotional adjustments to both play and learning situations in children whose motor skills are less well developed than those of other children of similar chronological age. Lack of physical or motor skill often prevents children from joining in group games and other sports that encourage social interaction and personal growth.

Successful motor development is important not only in early development but also has important implications for development in adolescence (Cantell et al., 1994; Skinner & Piek, 2001). For example, Cantell et al. (1994), in a 10-year follow-up study, reported that, when compared to a group of age-matched peers, children who exhibited motor development problems at age 5 were still significantly poorer in performance of physical and motor skills at age 15. These children, now adolescents, also had less social interaction with peers, participated less often in team games, and had lower academic ambitions and future goals than other children. Losse et al. (1991) also reported that in addition to continuing motor problems at age 16, children with motor difficulties early in life (6 years) also had a variety of educational, social, and emotional problems. The inability to perform basic motor skills, thus, can have long-term negative effects on the individual; the potential implications for adult behavior, although not well studied, seem clear.

Motor development delays frequently accompany a number of potentially serious health conditions such as childhood obesity, etc. (Graf et al., 2004; Okely, Booth & Chey 2004) and are often associated with lack of integrity of neurological functioning (e.g., prematurity, mental subnormality, emotional disturbances, cerebral palsy, etc.). These are all

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conditions that may require medical and/or other special professional attention, and motor development needs or difficulties accompanying these conditions need to be identified early. Recent evidence suggests that some 57% of children born prematurely and who showed some minor neurological impairment early in life continue to show deficits in motor functions (balance, gross motor coordination, etc.), as well as in other school-related behaviors far into the preschool years (Lane, Attanasio, & Huselid, 1994; Losch & Damman, 2004). Assessment of motor development in these cases may be integral to help circumvent potential problems that may accompany school-related stresses.

Most tests of mental development in infants and young children include a large number of items that essentially are neuromuscular coordination or motor development tasks (Bayley, 1965; Cratty, 1972). Gesell (1973) grouped such items into a separate "motor category" in his developmental schedules. Pediatric neurologists often use, as a part of their assessment of the neurological status of the young child, items that directly involve neuromuscular coordination (e.g., evaluation of muscle tone, posture, gait, balance, alternating movements of the limbs, etc.). In general, a child whose motor development is considerably poorer than that observed in children of similar chronological age is more likely than others to exhibit soft and/or hard neurological signs, an indication that systems that provide support for the growth and refinement of neuromuscular coordination are not functioning appropriately (Capute & Accardo, 1996; Paine & Oppe, 1966; Precht, 1977; Precht & Beintema, 1964; Touwen, 1976). Still, many children do not show classical neurological signs and their difficulties cannot be linked to any identifiable neurological disease; yet they exhibit significant difficulty performing tasks that require coordination (e.g., writing, catching a ball, riding a bicycle). Several terms have been used to describe this condition; these include *developmental agnosia* and *apraxia* (Gubbay, 1975), *developmental dyspraxia* (Denckla, 1984), and most recently, *developmental coordination disorder* (DSM-IV, 1993). Most simply refer to this condition as the "clumsy child syndrome." The motor problems of these children are of concern not only because they are stressful to the children themselves, but also because they are often associated with higher incidences of learning difficulties, school failure, and psychological problems (Losse et al., 1991). For these reasons, assessment of gross motor development in the preschool-age child is an essential component in planning and providing for optimal conditions for growth and development during one of the most significant periods in the life of the child.

Gross motor development may be defined simply as the acquisition of control and use of the large muscle masses of the body. The preschool years are characterized by the appearance and mastery of a number of gross motor skills also known as "the fundamental motor skills." These fundamental motor skills include body projection (locomotor skills), body manipulation (nonlocomotor actions), and object control or ball handling skills. Body projection or locomotor skills include running, jumping, hopping, skipping, galloping, leaping, and sliding (e.g., Gallahue & Ozmun, 2002; Ulrich 2002; Williams, 1983). These skills all focus on the use of the large muscle masses of the body in moving the total body horizontally through space. Body manipulation skills, on the other hand, are concerned with moving the body and/or body parts within a well-defined, small area of space, and include stretching, curling, twisting, rolling, bending, and balancing skills. Universally recognized object control skills include throwing, catching, striking, kicking, and ball bouncing (Robertson & Halverson, 1984). Gross motor development includes both the adaptive or functional changes that take place in these motor skill behaviors across time, as well as the processes or factors that underlie or promote these changes (e.g., growth, development, experience, environmental issues, etc.)

A simple description of some proposed steps in motor skill development can help us to understand the complexity of the processes and factors involved in this aspect of the child's development. The following discussion describes some broad categories or steps involved in motor skill development (Burton & Miller, 1998). Generally, the child first develops or acquires the foundational processes necessary for the development of motor skills. The child then acquires the so-called motor development milestones; this is followed by the development of fundamental gross motor skills. Ultimately these skills and/or behaviors are manifested in a variety of specialized movement skills typical of the older child and young adult.

Motor Skill Foundations. This aspect of motor skill development includes those factors and processes that are important to the development and performance of all motor skills. These factors include, among others, gender, body size and composition, cardiovascular endurance, flexibility/range of motion, muscular strength, neurological integrity, adequate sensory system function, perception, cognition, etc. These are all underlying factors that contribute to the pattern of gross motor development and play a critical role in what the nature of that pattern will be.

Early Motor Development. The term *milestone* is often used to describe early motor skill development and highlights the significance of the impact that the motor skills acquired during this early period of development have on the social, perceptual, and cognitive development of the infant and young child. These milestones include the locomotor and object control skills that appear before the child achieves an easy upright stance and locomotion; they include rolling, crawling, creeping, sitting, standing, walking, object manipulation, etc. The onset of walking, which occurs, on average, at 12–13 months, is the last of the early motor development milestones. Lags or issues in the appearance of these milestones often signal potential difficulty with continued development and/or acquisition of the fundamental motor skills.

Fundamental Motor Skills. These gross motor skills are ones that are universally observed in the development of the young child during the period from 2 to 7 years of age. They appear in a fairly orderly sequence during this developmental period and include the locomotor and object control skills described previously. Balance skills also undergo rapid development during this period.

Functional Motor Skills. Functional motor skills are skills performed in natural and/or meaningful contexts and make up the primary activities that we perform on a daily basis. These movement skills are manifested in the form of specific sports skills and/or other specialized, complex movement behaviors. Various combinations of one or more of the earlier motor skills are integrated in a variety of ways and manifested in a wide variety of behaviors such as "shooting a free throw," "serving in tennis," "getting into and out of a car," "performing surgery," "driving a car," etc. Ultimately it is critical that an individual's motor skills become an integrated and spontaneous part of his/her educational, professional, recreational, and overall life activities. The pathway to this level is nurtured during the preschool period.

WHY SHOULD WE ASSESS GROSS MOTOR DEVELOPMENT?

The development and assessment of the young child's use of the large muscle masses of the body is the primary focus of this chapter. Not all of the skills included under the heading of

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fundamental motor skills will be addressed. Rather, major attention will be given to the locomotor skills of running, jumping, galloping, hopping, and skipping, and to the object control skills of throwing, kicking, catching, and striking. Balance and postural control are also mentioned.

Because motor skill development is a critical dimension of the overall development of the young child, it is important to have information about the present level of motor skill development of the child to establish a baseline against which to monitor the growth and development of the child. In this respect, assessment of gross motor development is integral to screening out and/or identifying those children who may not be developing or progressing as expected, e.g., those children who are or may be at risk for future problems. In general, screening or preliminary assessment of gross motor development is necessary for identifying the nature and extent of children's needs, in determining if additional diagnostic testing is needed, in deciding if and what type of enrichment may be appropriate for promoting optimum development, and in predicting potential neurodevelopmental outcomes at a later age. In the school setting, outcomes of motor development assessment are especially important for planning for and developing appropriate instructional strategies so that appropriate experiences for individual children can be implemented. It is also important to provide assessment information on the child's gross motor skills to parents and other concerned individuals, particularly those who are or may be involved in providing for adequate follow-up support for the child with special needs. Results or outcomes of any evaluation of gross motor development should identify strengths and weaknesses and highlight those skills that are lagging or deficient along with the nature and extent of the deficit.

THE DEVELOPMENT OF GROSS MOTOR SKILLS: AN OVERVIEW

The general sequence in which locomotor, object control, and balance skills develop is shown in Figure 17.1. Although locomotor skills tend to develop slightly in advance of object control skills, there is considerable overlap in the development of these skills. Balance is an important element in the mastery of both locomotor and ball handling skills (Williams, 1983). All of the fundamental motor skills develop during the preschool years and have

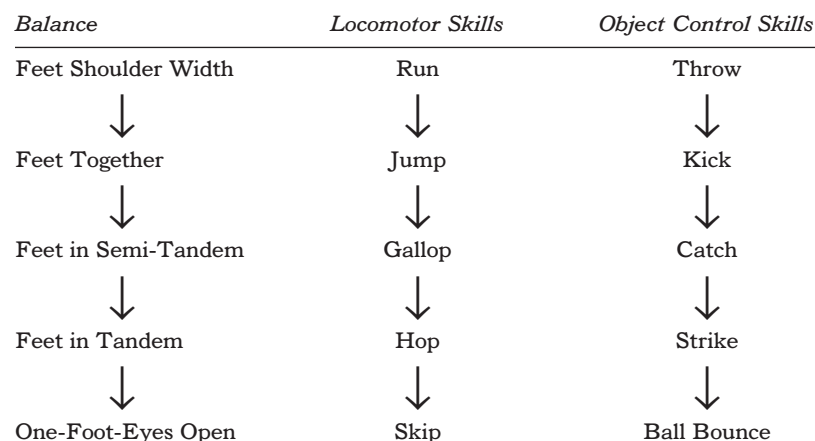


FIGURE 17.1. General Sequence of Development of Gross Motor Skills

many of the characteristics of mature patterns. Typically, balance progresses from balancing with the feet shoulder width apart to balancing with the feet together, with the feet in semi-tandem and tandem positions, and finally to balancing on one foot with the eyes open. Balance with eyes closed develops later. Children typically run, jump, and gallop in that order; most children gallop by age 3. The hop and skip tend to be the last of the locomotor skills to appear. Most children skip by age 6. Although there is considerable overlap in the development of object control skills, the typical order of mastery is throw, kick, catch, strike, ball bounce.

The preschool years are a period of rapid and important changes in the development of large muscle or gross motor coordination. Developmental sequences, often referred to as steps or stages, help identify the qualitative changes that occur as children acquire or master gross motor skills. General progressions or changes in and developmental characteristics of selected locomotor and object control skills are given in Tables 17.1 and 17.2, respectively. The information in these tables provides a brief overview and succinct summary of recognized changes in the development of these skills. Selected aspects of developmental changes in the skills included in the tables are discussed below. Balance is also described. Most aspects of the following discussion of motor skill development are generally supported by a number of authors and scientists including Branta, 1992; Espenschade and Eckert, 1980; Gallahue and Ozmun, 2002; Haywood and Getchell, 2005; Keough and Sudgen, 1990; Payne and Issacs, 2002; Wickstrom, 1977; Williams, 1983, Williams and Breihan, 2001, etc.

Running. In general the early running pattern resembles a fast walk. The base of support is wide (feet are shoulder-width apart) and there is little or no use of the arms. The feet tend to toe-out, and the child receives the body's weight on a flat foot (foot control is still developing). As control and coordination increase, the base of support narrows (feet are placed one in front of the other), rhythmical arm/foot opposition is integrated into the run, and the body weight is received on the heel and rolled to the toe (slow-paced running). Quantitatively, the length of stride steadily increases as does speed and versatility of the running pattern; the child starts, stops, turns, and runs at a variety of speeds and in multiple directions. The running action is ultimately used skillfully in games and sports.

Jumping. Jumping proceeds developmentally from a one-foot step-down from a low object to a skillful execution of a standing broad (long) jump that covers a distance of approximately 44 inches. In the beginning, the arms are used very little, if at all. When they are used, they are used ineffectively (the arms may be moved, but not in conjunction with the legs). Skillful jumping is manifested most clearly in the smooth coordination of arm and leg movements. In early jumping patterns, leg movements are characterized by incomplete flexion and extension. That is, the young or inexperienced jumper fails to assume a semi-crouched position in preparing to jump, fails to fully extend the body at take-off, and also often lands "stiff legged." That is, in landing they fail to flex to absorb the momentum of the body as it comes into contact with the ground. The accomplished 6-year-old jumper assumes a flexed (semi-crouched) position prior to jumping and fully extends the ankles, knees, and hips at take-off and flexes (most obviously at the knees) in landing. Last but not least, young jumpers tend to lose balance and take steps or fall on landing. The skillful jumper flexes (most obviously at the knees) to absorb the momentum of the body and rarely loses balance. Quantitatively, the distance of the jump (vertical, running broad, or standing broad) increases in a nonlinear fashion.

TABLE 17.1.
General Developmental Characteristics and Progressions in Gross Motor
Development: Locomotor Skills in the Preschool Years

Locomotor/body Projection Skills
<i>Walking and Running</i>
General Progressions Children walk before they run. Children walk or run a straight path before a circular or curved one. Children walk or run a straight path before they walk or run around obstacles. Early vs Later Characteristics The early run resembles a fast walk; it is a series of hurried steps with a wide base of support and no period of suspension. Later the run involves a period of suspension; the base of support is narrower, the feet are placed one in front of the other. Initially the weight is received on a flat foot; Later the weight is received on the heel and shifted to the ball of the foot (slow pace) In a faster run, the weight is often received on the ball of the foot. Initially the child runs with short strides (there is minimal flexion/extension of the legs); they also run at a slow pace; Later the child runs with longer strides (there is greater flexion/extension of the legs) and they run at a faster rate. Initially, the arms are used minimally if at all and often are out for balance; Later the arms move smoothly in opposition to the legs. With practice the running action becomes more automatic; the child can start, stop, and turn easily; running is incorporated readily into games and other activities.
<i>Jumping</i>
General Progressions Children exhibit a series of 'bunny hops' before they perform a true standing broad jump. Children jump down from an object before they jump up onto or over an object. Children execute jumps from lower heights before higher heights. When jumping down from obstacles, children progress from aided jumping, to jumping alone with a one foot step down, to jumping alone with a simultaneous two-foot propulsion. Children pass through the same progression described above at each height from which a jump is attempted. Early vs Later Characteristics Initially the jump covers short distances (there is minimal flexion/extension of the legs); Later the jump covers longer and longer distances (there is more complete flexion/extension of the legs). Initially the arms are not used or are used awkwardly; Later the arms initiate the jumping action and are coordinated with the action of the legs. Initially balance is often lost upon landing; Later the child maintains balance on landing.
<i>Galloping</i>
General Progressions Children gallop before they hop or skip. Children gallop with the preferred foot leading before they gallop with the opposite foot in the lead. Children usually gallop in rudimentary form by age 3.

(continued)

TABLE 17.1.
(Continued)

Early vs Later Characteristics

Initially children gallop with the body in a sideways position (a sliding action);

Later children gallop with the body facing forward.

Initially the arms are not used;

Later the two arms are used together (bilaterally) to support the leg action.

Early on, children execute 3–4 cycles of the gallop and then lose the pattern;

Later they gallop through a 50' distance without losing the pattern.

*Hopping***General Progressions**

Children 'hop' on both feet prior to developing a true hopping action on one foot.

Children hop in place before they perform a moving hop.

Children hop first on the foot on the preferred side;

Later they hop on the foot on the opposite side.

Children usually hop by age 3–4 years and complete 3–5 hops on the preferred side.

Early vs Later Characteristics

Initially the path of the hop is erratic;

Later the child hops in a straight path.

Initially there is minimal suspension in the hop (minimal flexion/extension of the legs);

Later there is good suspension in the hop (flexion/extension of the legs are more complete).

Initially the weight is received on the whole/flat foot;

Later the weight is received on the ball of the foot.

Initially the arms flail or are used awkwardly;

Later the arms are used together in a bilateral action and are coordinated with the leg action.

*Skipping***General Progressions**

Skipping is usually the last locomotor skill to appear.

Children may not skip until 6 years or later.

Skipping consists of a step and a hop on alternating sides.

Skipping progresses from a shuffle step to a skip on one side to a skip on alternating sides.

Early vs Later Characteristics

Initially the child may execute 2–3 cycles of the skipping pattern and then begin to gallop;

Later the skipping action is maintained for 50+ feet without loss of the pattern.

Initially the arms are not used; later they move in opposition to the legs.

Stair Climbing

Marking time (both feet placed on rung or step before next step is attempted) precedes alternation of feet in climbing.

Use of alternating feet appears first in ascending steps and later in descending stairs.

Children typically ascend a set of stairs before they descend.

Initially children develop proficiency in climbing a short flight of stairs or a ladder with rungs close together;

Later they gain proficiency in climbing a longer flight of stairs or a ladder with rungs farther apart.

Children alternate feet to climb short flights of stairs but still mark time on longer flights of stairs.

TABLE 17.2.
Some Developmental Changes in Gross Motor Development:
Object Control Skills in the Preschool Years

Ball-Handling/Object Control Skills
<i>Throwing</i>
General Progressions Children throw a smaller ball farther than a large one. Children develop a better throwing pattern if they throw forcefully. Throwing at a target develops later than throwing for distance. Targets should be large and at close distances initially; later they can be smaller in size and farther away. There is a progression toward shorter periods of acceleration; that is, the necessary joint actions occur in shorter periods of time, thus creating increased force of the throw. Early vs Later Characteristics Initially the ball is held in the palm of the hand; Later the ball is held in the tips of the fingers. Initially the action is largely arm action in the vertical plane; Later the whole body is involved in initiating the throwing action; Still later arm action involves lateral and medial rotation of the shoulder and elbow extension. Initially there is no trunk rotation; Later there is block trunk rotation; still later there is differentiated trunk rotation. Initially there is no shift of weight; Later the weight is shifted onto the foot on the same side as the throwing arm; still later the weight is shifted onto the foot opposite the throwing arm.
<i>Kicking</i>
General Progressions Children kick stationary balls successfully before they kick rolling balls. Large, light balls are contacted more easily than smaller, heavier balls. Children kick a rolling ball with greater success if it is rolled slowly and directly toward him/her. Children progress from kicking stationary balls to kicking balls rolled to him/her and then to kicking balls rolled to the right and left. Early vs Later Characteristics Initially the leg action stops at ball contact; Later the child kicks through the ball. Initially the leg is swung forward only; Later the child swings the leg backward and then forward and through the ball. Initially ball contact is often inconsistent; it may be with the toes, the top of the foot/leg, or with the side of the foot; Later contact is more consistent and appropriate for different types of kicks. Initially the arms are not involved in the kicking action; later the arm opposite the kicking leg swings forward and upward as the ball is contacted.
<i>Catching</i>
General Progressions The child intercepts (stops) a rolling ball before they catch or intercept a bounced or aerial ball. Bounced balls are caught more easily than aerial balls. Balls bounced or tossed from shorter distances are easier to catch than balls bounced or tossed from greater distances. Children successfully intercept a large ball before they successfully intercept a small ball.

(continued)

TABLE 17.2.
(Continued)

Early vs Later Characteristics

Initially children use the hands/arms as a single unit;

Later they trap the ball against the body; occasionally children contact the ball and then immediately drop it;

Still later they contact and control the ball with the hands/fingers.

Children revert to using the hands and arms as a single unit when they initially attempt to intercept a small ball; at the same time they easily coordinate the use of hands and fingers in catching a larger ball.

Initially children fixate and track the oncoming ball minimally or with little consistency and do not judge the speed or direction of a moving ball accurately and consistently; they often do not get to the ball in time to intercept or catch it.

Later they track the ball more effectively and judge the speed and direction of the moving ball more accurately and consistently; they are more likely to get to the ball in time to make effective contact.

Initially children may show an 'avoidance reaction' to the oncoming ball; they close the eyes and/or turn the head away as the ball approaches; with increasing skill and confidence, this reaction disappears.

Striking

General Progressions

Children initially use a one-arm striking pattern and gradually develop a two-arm striking pattern.

Children are successful in hitting a stationary ball before a moving ball.

Children are more successful using a large, light bat/implement than a small, heavy bat/implement.

Early vs Later Characteristics

Initially the bat is held against the shoulder;

Later the bat is held out away from the body.

Initially the child faces the oncoming ball;

Later they stand with the side of the body toward the ball.

Initially the arm action is a vertical chopping action;

Later the action is in the horizontal plane.

Initially the arm action stops at ball contact;

Later the child swings the implement through the ball.

Initially there is no shift of weight;

Later children step onto the foot on the same side as the preferred hand;

Still later they shift weight onto the foot on the side opposite the preferred hand.

The weight shift initiates the striking action in a kind of 'step and swing' pattern.

Ball Bouncing

General Progressions

Children attempt a two-hand bounce before a one-hand bounce.

Children bounce a smaller ball (one that fits the hand) before a larger ball.

Children perform a series of "bounces-and-catches" before they perform a continuous bounce.

Children bounce a ball in a stationary position before they bounce a ball while moving.

Early vs Later Characteristics

Initially children bounce a ball with whole body action;

Later they use the arm/hand independently of body action.

Initially children 'slap' at the ball with a flat/whole hand;

Later they use the fingers/wrist to bounce the ball.

Galloping. The skill of galloping usually appears around the age of 3. Initially, children “gallop” with the body in a sideways position; this is often referred to as a “sliding” action. This is followed by a true gallop action in which the body faces forward and the leg action is in the sagittal plane. It is not uncommon for children to complete 2–3 cycles of the gallop action and then lose the pattern. Later, the child gallops a 50’ distance without a loss or disruption of the gallop action. Early in development, the arms are frequently not involved in the action or they flail awkwardly. Later, the arms move in a bilateral action to assist the action of the legs. The gallop typically appears on the dominant side first; later, the child executes the gallop with the foot on the nondominant side leading.

Hopping. Early hopping patterns are characterized by little or no elevation of the body (the child doesn’t get very high off the ground, if at all), little or no arm usage, limited use of the nonsupport leg, and landing on a “whole” or “flat foot.” Early hopping patterns are often jerky, staccato, and arrhythmic. Gradually the arms and nonsupport leg are used to add to force production, and, thus, to the elevation of the body; the nonsupport leg actually “pumps” (flexes and extends rapidly) to aid in the forward momentum of the hopping action. Last, but not least, the body weight is received on the ball of the foot. The hopping action becomes smoother with practice, and the child advances from being unable to execute a hop, to hopping in place, to carrying out a short series of coordinated hopping movements, to hopping a 25-foot distance skillfully in approximately 5 seconds. The versatility of the hopping pattern also increases; the child can hop backward and sideward and alternate hops between right and left feet.

Skipping. The early skip is a shuffle step. The shuffle step is followed by a one-sided skip; the final step in skipping is a step-hop on alternate sides of the body (a true skip). Early skipping patterns are characterized by a lack of use of the arms, a toeing out of the feet, and a lack of ability to maintain a continuous skipping sequence. Skillful skipping involves smooth and consistent arm/leg opposition (the arms move in opposition to the legs). The toes point forward and the body’s weight is received on the ball of the foot. Mastery of a continuous skipping action is seen in the growing capacity of the child to skip longer distances in less time. The more skillful 6-year-old skipper can cover a distance of 25 feet in approximately 4 seconds.

Throwing. The earliest beginning of a throwing pattern is simply the release of an object from the hand. The early over arm throwing pattern consists largely of flexion and extension of the trunk and arm (elbow). There is little or no weight shift or trunk rotation. Gradually, a shift of weight and trunk rotation appear and help to increase the force or velocity of the throw. The weight shift is first seen as a shift of weight forward onto the foot on the same side as the throwing arm; later, the skillful thrower steps onto the foot opposite the throwing arm. Trunk rotation first occurs in block form, that is the lower and upper trunk, e.g., pelvis and spine rotate together as a single unit. Later, trunk rotation is differentiated (the lower trunk or pelvis rotates first, followed by upper trunk or spinal rotation). Quantitatively, developmental changes are seen primarily in increases in the distance and velocity of the throw. Increases in both distance and velocity during development are nonlinear in nature.

Kicking. Kicking is the least studied of gross motor object control skills. Available data suggest that early kicking pattern consists of a single forward action of the kicking leg; the

child stands close to the ball and simply pushes or punches the ball forward from a stationary position. Typically the leg action stops at ball contact with a step backward to maintain balance. Later, the child swings the kicking leg backward and then forward and through the ball (full range of motion). At this time there is evidence of arm-leg opposition. Another important step in kicking is seen in the child's ability to execute a moving approach to the ball; this is often accompanied by a forward or side step and a hop after ball contact is made. An important step in the developmental process is evident in the child's successful kicking of rolling balls and the capacity to time the kicking action to the speed and direction of the oncoming ball. Proficient kickers also often exhibit a leap before kicking the ball.

Catching. Early and/or immature catching patterns are characterized by lack of skillful use of the arms, hands, and fingers. Initially, the arms and hands are held stiffly in front of the body with the elbows extended. The ball often rebounds off the outstretched arms. Later, the arms are held at the sides with the hands relaxed and cupped. The arms, hands, and fingers of more accomplished catchers are positioned according to the flight of the oncoming object. The fingers and hands are pointed toward the ball. For balls above the waist, the fingers and hands point upward; for balls below the waist, the fingers and hands point downward. When ball contact is made, the fingers close around the ball. Young or inefficient catchers rarely display this fingertip control in making contact with the ball and often trap, touch and drop, or fail to make contact with the ball. Another aspect of the child's early catching response is a fear reaction in which the child turns the head, closes the eyes, and fails to track the ball as it comes toward him or her. This reaction disappears as skill and confidence increase; the child watches the ball intently as it approaches. The major characteristic of the highly proficient catcher is his or her ability to adjust the total movement of the body to receive balls bounced or thrown at different speeds and from varying distances and directions. Young catchers are unable to do this. Quantitatively, the number of successful catches (balls skillfully contacted with hands and fingers) slowly increases. Changes in catching skills have not been quantified to any great extent in children of preschool age.

Striking. The development of striking skills is an important part of early gross motor development. Although there is little normative or descriptive data available on developmental changes in striking skill in young children, the little that is available suggests that striking patterns proceed from one-arm attempts at contacting stationary objects to skillful two-arm striking patterns made in an effort to contact objects moving at different speeds and in different directions. Initially, the striking movement is a vertical chopping motion; later, it becomes a sidearm motion executed in the horizontal plane (the swing is flat). Early in the development of the striking pattern (as in throwing), the trunk rotates as a single unit; later, differentiated or two-part trunk rotation occurs. Another important developmental change in striking is the appearance of a definite shift of weight onto the forward (opposite) foot prior to initiation of the swing. The child also gradually changes from standing in a position facing the oncoming ball to one in which the body is perpendicular to the ball (e.g. the side of the body is placed toward the ball). Quantitatively, with advancing development the bat is swung with greater force (the range and timing of the movement of the body are improved), and the ball is projected with increasingly greater velocity.

Balance. Early balance development is manifested in the child's ability to maintain equilibrium in a variety of positions (e.g., on all fours, on the knees, in a standing position). This is followed by attempts to stand, to walk, and to navigate around objects in the envi-

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ronment. Once some success is achieved in these behaviors, the child will attempt to walk on narrow objects (e.g., balance beams, rails, lines) and shows some beginning ability to maintain balance on one foot. By 6 years of age, most children can balance for fairly long periods of time on the preferred foot with the eyes open (Mean = 22 sec). Balancing on the nonpreferred foot is more difficult (Mean = 14 sec), and balancing with the eyes closed is just beginning to be mastered (Mean = 7 sec). Most children can, at this age, walk a balance beam (2½ inches wide) in a controlled heel-toe manner in 23 seconds.

It is important to note that although the early versus later changes described for each skill can be loosely associated with chronological age, the relationship between these changes and chronological age per se is at best a tenuous one. One of the most dramatic characteristics of gross motor development in the preschool child is its great variability (Keogh & Sudgen, 1990). Some children fall nicely into a rather traditional “change with age” association, but many do not. Thus, ages have been intentionally de-emphasized in the discussion of developmental changes in gross motor skills in this chapter. The reader also should be aware that the changes described for individual skills are not mutually exclusive; children typically display changes in more than one skill at any given time (Robertson & Langendorfer, 1980).

Gender Differences. Figure 17.2 shows the age in months of the emergence of several gross motor skills and the approximate age at which 60% of boys and girls performed these skills proficiently (Seefeldt & Haubenstricker, 1982). The numbers in the figure refer to the changes or *stages* that have identified characteristics and are part of the process of mastering or showing proficiency in the skill (1 = beginning or early characteristics of skill performance; 4 = proficiency and/or more mature characteristics). Observed gender differences indicate that boys acquire proficiency before girls in running, jumping, throwing, kicking, and striking. Gender differences in running and jumping are minimal (6–8 months); differences are greater for kicking and striking (12–16 months). Interestingly, differences are even more evident in throwing; boys tend to demonstrate proficiency at about 69 months, while girls show proficiency at about 102 months, some 33 months later. In contrast, girls have an advantage over boys in hopping, skipping, and catching and demonstrate proficiency

Author please supply art for figure 17.2

FIGURE 17.2. Author please provide caption

some 6–10 months before boys (Seefeldt & Haubenstricker, 1982). Garcia (1994) and Greendorfer and Ewing (1981) also document gender differences in the development of fundamental motor skills.

It is important to note that in addition to gender differences, there is also considerable variability in the timing of the changes that occur in motor skill development for all children. For example, both girls and boys show some arm-foot opposition and heel-toe contact in running at about 3 years of age (Stage 3). However boys show full proficiency (Stage 4) in running just 10 months later, while girls do not exhibit proficiency until some 20 months later. Although some developmentalists have attributed differences between boys and girls to physical differences, it is generally the case that boys and girls do not differ substantially in physical size or muscular strength prior to puberty. Thus, cultural differences associated with opportunities for practice and encouragement may play a greater role in skill development than once was thought to be the case (Thomas & French, 1985).

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In deciding how to approach the assessment of gross motor development, it is important to consider a number of factors that may affect the child's motor skill performance. A contemporary approach to understanding motor performance is referred to as *dynamical systems*. We will describe this systems approach using the work of Newell (1986) who identifies three major factors that need to be considered in evaluating motor skill development. These factors include characteristics of the individual performing the skill (referred to as individual constraints), the nature and demands of the task itself or task constraints, and the environment or context in which the skill is performed (environmental constraints). *Individual constraints* refer to the physical characteristics of the child or what are known as *structural* and *functional* factors. Structural factors include such things as height, weight, strength, limb length, hand size, gender, etc. *Functional constraints* refer to the mental characteristics of the child and include such things as the child's level of cognitive function, their perceptual abilities, motivation, self-confidence, etc. How do individual characteristics affect children's motor skill performance? Briefly, for example, with regard to structural constraints, if a child has a lower center of gravity (due to shorter relative leg length), he/she may have a slight advantage in maintaining or performing balance tasks. Still, physical characteristics of young children do not vary greatly and thus often are not a major factor in skill development (Malina, Bouchard & Bar-Or, 2004). Functional constraints affect motor skill acquisition and performance in other ways. For example, a child who has developed control of one-foot balance is likely to be more confident, motivated, and successful in hopping simply because they have developed one of the important preliminary skills—one foot balance. This promotes interest and self-confidence.

Task constraints refer to the demands of the skill or task to be performed and include the rules for performing the task, the choice of equipment, etc. It is important to consider the properties or requirements of the task and how they relate to the characteristics of the child. By considering both, the teacher or examiner can better determine what equipment to select and how to structure a task so that the child demonstrates his/her true level of development. For example, if a child is having difficulty catching a small ball, because of small hands and/or limited eye-hand coordination, the teacher/examiner might use a larger ball and/or toss the ball from a closer distance. This would match individual characteristics more closely to task requirements, help to maximize success, and give a truer picture of the

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child's developmental level. Descriptions of early versus later accomplishments given in Tables 1 and 2 provide some simple examples of matching task requirements to individual characteristics.

The environment in which the skill is performed and/or assessed is also important to consider. These are the so-called *environmental constraints*; they include characteristics of both the physical and socio-cultural environments. Physical environmental constraints include such things as the surface on which the skill is performed (gym floor versus grass versus pavement, etc.), time of day, nature of the space available, etc. Socio-cultural environmental constraints refer to social and/or cultural factors that impact development and/or performance of motor skills. These include such things as the opportunity for socialization, as well as the freedom to select to participate or not participate in certain activities and experiences, etc.

It is also important to consider how individual, task, and environmental constraints interact to give rise to the motor skill performance observed. For example, a growth spurt that results in increased height can affect the performance of a number of motor skills. Jumping is a good example. Children usually grow taller before their muscular strength changes enough to accommodate the change in height (e.g., longer and heavier limbs, etc). This increase in height relative to muscular strength can affect both the distance jumped and the way in which the jumping action is carried out. At this time the child may look less skillful than he/she has previously. Usually once muscular development catches up to the changes in height, most children exhibit dramatic gains in the jumping action and jump longer distances and look more skillful and coordinated.

The interaction of these factors and how they affect motor skill development and performance is particularly relevant to pre-school children because of the dynamic, fast-paced changes that take place in growth and development and the variety of environmental experiences children undergo during this period. Although identifying an individual's motor development relative to normative data is an inherent feature of assessment, it is important that teachers and parents be aware that individual performances may differ from a stated norm and still be age and/or developmentally appropriate. Knowing something about the various constraints that affect motor skill development and performance can help teachers to interpret more effectively a child's motor performance data and develop appropriate experiences to promote skill development (Haywood & Getchell, 2004).

(Author: the reference is 2005.)

Process versus Product Assessment. Gross motor development is most effectively evaluated by considering both process and product characteristics of the child's movement (Ulrich, 2002; Williams, 1983). *Process characteristics* address qualitative aspects of movement and have to do with how a child moves the body in performing a motor task. Thus, evaluation of process characteristics is concerned with assessing the form or quality of the movement itself (e.g., observing how the body is positioned, which limbs are moved, how they move, etc.). *Product characteristics*, in contrast, have to do with the end product or outcome of the movement and usually are more quantitative in nature. Evaluation of product characteristics of movement answer such questions as: How far did the child run? How high did he jump? How fast did she move? Techniques used for assessing gross motor development often incorporate measures of both process and product aspects of movement performance. Most motor development scales or tests available for use with younger children tend to emphasize process characteristics; tests for older children tend to emphasize product measures. Both types of information are needed at all ages if a complete and comprehensive assessment of the motor development of the child is to be made. An exam-

ple of a simple checklist that includes both process and product characteristic items can be found in Cratty's Perceptual-Motor Behaviors Checklist (Cratty, 1972; see Table 17.3). Examples of items that emphasize process characteristics are: "can walk rhythmically at an even pace" (2 to 3 years), "can step off low objects, one foot ahead of the other" (2 to 3 years), and "walks and runs with arm action coordinated with leg action" (4 to 4½ years). Items that are more product-oriented include: "can walk a 2-inch-wide line for 10 feet" (2 to 3 years), "can jump 8 inches or higher" (5 to 5½ years), and "can run 50 feet in 5 seconds" (6 to 6½ years). The following sections address (1) screening for gross motor development problems, (2) process assessment of motor development, and (3) product assessment of gross motor development.

Screening for Gross Motor Development Problems. Screening for potential motor development needs can be easily accomplished by (1) having basic knowledge about the characteristics of typical motor development, (2) being aware of some signs and symptoms of potential delays or slowness in motor development, and (3) using a checklist designed to guide the observer in things to look for in the child's movements. Basic information about typical characteristics and accomplishments in gross motor development in young children is provided in the previous section on Gross Motor Skill Development: An Overview. Regardless of the approach used in screening the young child's gross motor development, there are some general indicators of potential slowness in motor development that may be helpful to teachers and parents alike and that will help make the initial screening process more complete and informative. Many of these behaviors are included and described in different ways in various screening tools.

Some Signs of Potential Delays in Gross Motor Development. What are some of the signs that may indicate slowness or the possibility of a delay in the young child's gross motor development (Williams, 2001a)? Some of the more universally recognized signs to look for in

TABLE 17.3.
Process and Product Assessment Examples:
Cratty's Perceptual-Motor Behaviors Checklist

2–3 Years

- Can walk rhythmically at an even pace (**process**)
- Can step off low object, one foot ahead of the other (**process**)
- Can walk a line on the ground (2 in wide/10 ft long) (**product**)

4–4½ Years

- Can broad jump with both feet together and clear the ground (**process**)
- Can walk and run with arm action coordinated with leg action (**process**)
- Can walk a circular line a short distance (**product**)
- Can hop 2 or 3 times on one foot without precision (**product**)

5–5½ Years

- Can high jump with simultaneous two-foot take-off and landing (**process**)
 - Can high jump over a bar 8 inches high (**product**)
 - Can run 30 yds in just over 8 sec (**product**)
 - Balances on one foot: girls 6–8 sec, boys 4–6 sec (**product**)
-

Source: From B. J. Cratty. *Perceptual and Motor Development in Infants and Young Children*. Copyright 1986 by Allyn & Bacon.

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observing the child's motor development are described next. Whether or not these signs are good indicators of potential problems in the child's gross motor development depend on a variety of factors including the age, gender, physical characteristics, and previous experience of the child. Even more important, many of these same characteristics are a natural and integral part of the process of achieving proficiency in various gross motor skills.

1. Is there **EXCESS TENSION** in the hands, face, or body?
 - Does the tongue protrude when the child performs the task?
 - Are the hands fisted as they run, jump, hop, etc.?
 - Are the fingers extended and stiff or contorted?
2. Is there **EXTRANEIOUS MOVEMENT** of parts of the body not involved in the task?
 - Do the arms flail as the child runs, hops, or skips?
 - Does the head move from side to side or up and down?
3. Does the child have **DIFFICULTY BALANCING**?
 - Does the child trip and/or fall easily and often?
 - Does the child have difficulty jumping over an obstacle and landing?
 - Does the child touch the foot down or lose balance frequently when hopping?
4. Are the **FEET** used **AWKWARDLY**?
 - Do the feet toe in or out when the child runs, etc.
 - Does the child run flat-footed?
 - Does the child have difficulty placing the feet when walking on a line or beam?
5. Are the **ARMS/HANDS** used **AWKWARDLY**?
 - Are the arms held stiffly and not used?
 - Are the arms moved awkwardly or jerkily?
6. Are **EYE MOVEMENT PATTERNS** immature?
 - Does the child have difficulty fixating and tracking moving objects?
 - Does the child look away from or close the eyes as a ball approaches?

Screening Tools. There are a few tools and techniques that have been developed for screening fundamental motor skills in young children. Four common approaches (two formal, two informal) are described below. All involve checklists of various lengths and content; one is designed for use by parents, but is also useful in the preschool setting.

The Movement ABC Checklist. The Movement Assessment Battery for Children Checklist (Henderson & Sudgen, 1992) is a universally recognized tool for screening motor development in young preschool and school-age children. Although the checklist can be used flexibly by teachers, parents and other professionals working with children, it is designed primarily for use by teachers. The Checklist should be completed over a period of 1–2 weeks as the child is observed in different settings including the classroom and the playground. The checklist consists of four major parts; the child is observed in each of the following types of conditions:

1. When the child is stationary and the environment is stable or unchanging; a typical observation for this condition is “can the child stand on one leg in a stable position” or “does the child have good posture in sitting or standing”;

2. When the child is moving and the environment is unchanging; some examples of observations to be made here include: “can the child hop on one or both feet,” “can the child jump across or over obstacles (blocks, ropes, etc.),” and “can the child run to kick a large stationary ball”;
3. When the child is stationary and the environment is changing; some observations to be made here include: “can the child catch a large, approaching ball using two hands,” “can the child keep time to a musical beat by clapping hands or tapping the foot,” and “can the child kick a rolling ball using the foot rather than the shin;” and
4. When the child is moving and the environment is changing; observations to be made here include “can the child participate in chasing games,” “can the child run to catch a moving ball,” “can the child run to hit a moving ball using a bat or racket,” and “can the child use the skills of kicking, catching, throwing to participate in a game.”

(Author: do you want to use question marks for all of the above questions?)

Each set of conditions becomes increasingly more difficult or complex so that tasks in Condition 4 are more demanding and require more skill than those in previous conditions. In observing the child, the teacher/parent rates each task/skill on a scale of 0–3; zero indicates the child performs the task “very well” and 3 indicates that the child does not/cannot perform the task (e.g., is “not close”). Higher scores indicate slower or greater deficits in gross motor development. Scores are totaled and some data are provided for older children for cut-off performance levels at the lowest 5th and 15th percentiles. The Checklist can be used flexibly to help identify potential needs in specific motor skills based on observations of performances on different tasks. Normative data for the checklist are based on 1,200 children from 4 to 12 years of age; the sample in the age range from 4 to 6 years was 493 children. Boys and girls of different ethnic origins and from diverse regions of the United States were included.

Denver Developmental Screening Test. The Denver test (Frankenburg & Dodds, 1967; Frankenburg, Dodds, Archer, Bresnick, & Shapiro, 1990) is one of the most universally recognized and widely used standardized procedures for screening/assessing gross and fine motor development in young children. It includes 32 simple gross motor tasks that are essentially product measures. Items are scored pass/fail; performances on each item are classified as “normal,” “suspect,” or “delayed.” The items in this battery are helpful to the educator and clinician in that they provide information about whether certain common gross motor skills are within the behavioral repertoire of a child at a given age. They do not, however, provide information about why a given motor skill is not a part of the child’s set of behavioral skills. This tool is most properly used as part of a more comprehensive and ongoing assessment of motor development. The Denver Developmental Screening Test can be very useful in outlining the general nature and/or level of motor skill development in children from birth to 6 years. Standards for passing items are described in simple language and are based on normative data from 1,036 children. Examples of gross motor items included in the test and the age at which 90% of children pass these items are given in Table 17.4. A prescreening developmental questionnaire is available for parents to help them determine if their child may need further assessment.

Williams’ Preschool Motor Development Check List. Williams’ checklist (Williams, 2001c) is an informal screening tool that asks questions about the movement or process characteristics of motor skill performance in children 3 to 6 years of age. This checklist focuses on basic motor development immaturities in six important gross motor skills; it includes four lo-

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TABLE 17.4.
Selected Gross Motor Items: Denver Development Screening Test

<i>Item</i>	<i>Age*</i>
Walks backward	21 mo
Walks up steps	22 mo
Kicks ball forward	2 yrs
Throws ball overhand	2½ yrs
Jumps in place	3 yrs
Pedals tricycle	3 yrs
Performs broad jump	3½ yrs
Balances on 1 foot for 1 sec	3½ yrs
Balances on 1 foot for 5 sec	4½ yrs
2 of 3 times	
Hops on 1 foot	4½ yrs
Performs heel-toe walk	5 yrs
2 of 3 times	
Catches bounced ball 2 of 3 times	5½ yrs
Balances on 1 foot for 10 sec	5½ yrs
2 of 3 times	
Performs backward heel-toe walk	6 yrs
2 of 3 times	

Source: Adapted from "The Denver Developmental Screening Test," W. K. Frankenburg and J. B. Dodds, 1967, *Journal of Pediatrics*, 71, p. 181.

* Age at which 90 percent of children pass individual items.

comotor skills (running, jumping, hopping, skipping) and two ball-handling or object control skills (throwing, catching). Williams' checklist uses a question format and provides some simple guidelines for determining the presence or absence of developmental needs in each skill area. Information provided by this checklist can indicate whether the child has isolated motor control problems (e.g., difficulty hopping, but not in skipping, jumping, or running), more general locomotor skill difficulties (e.g., immaturities in the movements involved in several locomotor skills) and/or ball-handling problems (e.g., poor or deficient skills in throwing and catching). Data from the checklist provide an overview of the nature and extent of the child's gross motor skill development and thus is helpful in deciding whether or not additional assessment or diagnosis is needed or appropriate. Information from the checklist is detailed enough that beginning enrichment programs and instructional strategies can be planned. The checklist was developed from published research as well as from data on clinical observations of motor development characteristics of some 300 preschool age children with and without gross motor development needs. It can be used in both clinical and educational settings. The checklist items and score sheet are given in Table 17.5 and guidelines for interpreting the information gathered are given in Table 17.6.

Motor Development Checklist for Parents. The Motor Development Checklist for Parents (Williams, 2001b) was developed to help parents recognize potential motor development needs in their preschool child. It consists of 12 questions which are answered *yes* or *no*. If the response to the majority of the questions (6 or more) is *yes*, the parent is encouraged

TABLE 17.5.
Williams Preschool Motor Development Checklist

Directions: Carefully observe the child perform each skill several times and if possible in different settings. Ask the following questions about the 'way' the child performs each motor skill. Try to answer 'yes' or 'no' to each question.

Running

1. Does the child have difficulty starting, stopping or making quick turns?
2. Does the child run using a flat foot; is the weight received on the whole foot?
3. Does the child run with the toes pointing outward?
4. Do the arms move back and forth across the body?

Jumping

1. Does the child fail to assume a crouched or flexed position in preparing to jump?
2. Does the child fail to extend the hips, knees, ankles in initiating the jump?
3. Does the child fail to use a two-footed take-off and landing?
4. Are the arms not used or used awkwardly in jumping?
5. Does the child land stiff legged, e.g., with hips/knees extended?
6. Does the child lose balance on landing?

Hopping

1. Does the child hop two or three steps and lose control?
2. Are the hopping movements staccato and/or stiff and arrhythmic?
3. Are the hands and fingers stiff, extended and/or tense?
4. Do the arms flail?
5. Is there no period of suspension, e.g., does the child fail to get up off on the ground?

Skiping

1. Does the child skip 2–3 cycles and then lose the pattern?
2. Does the child skip on one foot and walk or step with the other?
3. Does the child skip using a flatfoot?
4. Is there little or no arm-foot opposition?

Throwing

1. Is the arm moved primarily in the vertical or anteroposterior plane?
2. Is the ball held in the palm of the hand?
3. Does the child throw without any transfer of weight?
4. Does the child throw by stepping onto the same foot as the throwing arm?
5. Is there little or no trunk rotation?
6. Does the child fail to follow-through after ball release?

Catching

1. Does the child prepare to catch with the arms extended in front of the body?
2. Does the child use the arms, hands and body to 'trap' the ball?
3. Does the child turn the head away from the ball as they contact it?
4. Does the ball bounce off the outstretched arms?
5. Does the child only catch balls bounced from close distances (5 ft or less)?
6. Does the child fail to watch or track the ball?

Source: Williams' Preschool Motor Development Checklist, by H. Williams. Revised 2001. The Perceptual-Motor Development Laboratory Protocols-Revised, University of South Carolina-Columbia.

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TABLE 17.6.
Interpretation of Williams' Preschool Motor Development Checklist

<i>Skill</i>	<i>Guidelines</i>
Running	If three of the four questions are answered yes, there may be a developmental lag in running.
Running	If four of the six questions are answered yes, there may be a development lag in jumping.
Hopping	If four of the five questions are answered yes, there may be a developmental lag in hopping.
Skipping	If the child is 5 to 6 years old and the answer to all five questions is yes, there may be a developmental lag in skipping.
Throwing	If a child is 4 or 5 years old and the answer to five of the six questions is yes, there may be a developmental lag in throwing.
Catching	If the child is 3 years old, and the answer to questions 2, 3, 4, and 5 is yes, keep a watchful eye on this aspect of motor development. If the child is 5 years old, and the answer to any question is yes, there may be a developmental lag in catching.

Source: Williams' Preschool Motor Development Checklist; H. Williams, 2001, The Perceptual-Motor Development Laboratory Protocols-Revised, University of South Carolina-Columbia

to pursue further, more detailed evaluation of the child's gross motor development. The checklist is based on clinical and educational observations of some 200 preschool children and is meant to be used only as an informal guideline for parents who suspect that their child's motor development may not be progressing normally. The checklist includes the following questions:

1. Does the child avoid physical activity and play with other children?
2. Does the child often stumble over objects?
3. Does the child have difficulty balancing?
4. Does the child seem clumsy in running, jumping or galloping?
5. Does the child have difficulty tracking a ball?
6. Does the child seem awkward in throwing or catching balls?
7. Does the child seem to fatigue or tire easily?
8. Does the child have difficulty using crayons and/or pencils?
9. Does the child have difficulty cutting out shapes?
10. Does the child have poor attention or is easily distracted?
11. Does the child routinely spill or drop things?
12. Does the child move frequently and/or act impulsively?

Process Assessment of Gross Motor Development. A popular, useful, and highly recommended approach to the assessment of gross motor development in young children focuses on observing and evaluating process characteristics of movement skills. This involves assessing the quality, form, and/or action sequence of the movement involved in performing fundamental motor skills. This approach focuses on how the child moves his or her body to per-

form a given motor skill. Process evaluation instruments are often informal in nature and rely on the skill and experience of the observer. They are rarely based on large standardization populations. Despite this, the process approach to motor skill assessment is widely recognized and endorsed. The process approach to the assessment of gross motor skill in young children is frequently used in clinical settings to examine children's movement problems as process measures provide critical information about and insight into the nature of the child's movement problems as well as possible factors that may be contributing to the problems observed. Most of these instruments require some understanding of the developmental characteristics associated with the acquisition of motor skills in young children, as well as some experience in observing children's movement behavior in play or other naturalistic environments. Most process assessment techniques consist of a series of descriptive statements designed to identify important aspects of the child's movement performance. The interpretation of the information from these instruments is usually straightforward, but may vary from one instrument to another. Several of the most common instruments are discussed next.

Ulrich Test of Gross Motor Development. The Ulrich Test of Gross Motor Development (Ulrich, 2002) is one of the most widely recognized and used motor skills process assessment tools. It is an excellent example of a battery that focuses solely on assessing process characteristics of children's gross motor skills that is both norm and criterion referenced. Importantly it is one of a very few standardized tests that use a quantitative approach to evaluating process aspects of gross motor skill development in young children. Data are provided on children between the ages of 3 and 10 years. The battery has a multidimensional purpose; it is designed to identify children who would benefit from special services or enrichment, to assist in the development of appropriate instructional programming strategies, to assess the progress of individual children, and/or to evaluate the effectiveness of specially designed gross motor development programs. It also has the potential, because of its quantitative approach, to be an excellent research tool for individuals interested in the scientific study of motor skill acquisition in young children.

Two areas of gross motor development are evaluated: locomotion (body projection) and object control (ball handling). Locomotor skills that are evaluated include running, hopping, leaping, jumping, and sliding. Object control skills include two-hand striking, stationary ball bouncing, catching, kicking, throwing, and an underhand roll. Each skill is scored according to the presence or absence of selected movement process characteristics. An example of the specific locomotor and object control skill process characteristics are described in Table 17.7. If the process characteristic is present, a score of 1 is given; if it is absent, a score of 0 is given. Scores are summed for each skill and can be converted into percentile ranks (recommended for parental use) or standard scores (recommended for educational or clinical program planning). A scale is provided for arranging individual subtest standard scores into seven steps, ranging from very poor to very superior performance. Standard scores for each of the areas of locomotion and object control can be summed to arrive at a Gross Motor Development Quotient. This quotient provides an estimate of the child's overall gross motor development and is interpreted in the same way (very poor to very superior) as individual subtest standard scores. Raw scores can also be directly converted into *age equivalents*. These values provide a possible indication of the developmental age of the individual child. Caution should be exerted in using age equivalents in interpreting children's levels of motor development as development is age-related not age-specific. Normative data for the battery are based on some 1200 children from a vari-

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TABLE 17.7.
Locomotor and Object Control Examples from Ulrich's Test
of Gross Motor Development

<i>Skill</i>	<i>Description</i>	<i>Skill Characteristics (PC)*/**</i>
Locomotor		
Run	Child runs through a 50' distance	Arms move in opposition (5) Lands on heel or toe (3)
Jump	Child jumps as far as possible	Knees flexed/arms extended behind (6) Takes off/lands on two feet (3) Arms extend fully above head (9)
Hop	Child hops 3 times on each foot	Foot of nonsupport behind body (6) Nonsupport legs swings in pendular fashion (7) Arms bent at elbows; swing forward to produce force (7) Able to hop 3 times on right/left feet (5)
Object Control		
Throw	Child throws ball against wall-20'	Hips/shoulders rotate so that non throwing side faces wall (9) Transfers weight onto foot opposite throwing arm (8) Follow-through beyond ball release (7)
Catch	Child catches ball tossed-15'	Hands in front of body to prepare (5) Ball caught with hands/fingers (8)
Bounce	Child bounces ball 4 consecutive times without moving feet	Contacts ball, 1 hand, hip height (8) Pushes ball with fingers (7) Ball contacts floor in front of foot on side of hand used for bouncing (6)

*Performance characteristics modified from original.

**Age at which 70+% of children exhibit the process characteristic.

ety of racial backgrounds from eight states; data on 332 children ages 3–5 years are included. A careful analysis of reliability and validity issues also is provided.

Motor Control Process Checklists. In the recently revised Motor Control Process Checklists, Williams and Breihan (2001) have attempted to create a standardized approach to the assessment of process characteristics of movement control in young children. The 16 checklists in the battery describe, in simple language, movement characteristics of selected gross and fine motor skills and are based on data from 350 children ages 4, 6, and 8 years. The statements in each checklist are descriptions of the actions required for mastery of the skill. Typically, full mastery of most of the tasks included in this battery is not expected until sometime after 6 years of age. Ten of the gross motor skill checklists are presented in Table 17.8. Each checklist consists of 4–8 statements about important process characteristics to look for in the movement behavior of the child during task performance. The statements in these checklists are more detailed than those discussed earlier and allow the evaluator to assess more precisely the nature and quality of the child's movement, as well as to determine whether or not a motor skill problem is present. The child performs each skill at least four times, preferably in a naturalistic setting. While the child moves, the evaluator circles the

TABLE 17.8.
Examples of Process Characteristics of Selected Object Control Skills:
Motor Control Process Checklists

Object Control Skills	(Circle the number if the characteristics present)*			
Overarm Throw				
1. Trunk is rotated backward; weight is shifted to back foot	1	2	3	4
2. Throwing arm is moved backward with rotation occurring at the shoulder joint	1	2	3	4
3. Step is taken toward the intended target on the foot opposite the throwing arm	1	2	3	4
4. Body weight is shifted forward: the arm lags behind, the elbow leads	1	2	3	4
5. Arm begins moving in the horizontal plane	1	2	3	4
6. Medial rotation of the shoulder and elbow extension occur; the elbow is close to complete extension at the time of release	1	2	3	4
7. Wrist is flexed rapidly just before ball is released	1	2	3	4
8. On the follow-through the body and arm continue to rotate or move forward	1	2	3	4
Kick				
1. A preliminary step is taken on the support leg and toward the ball	1	2	3	4
2. The kicking leg swings backward and then forward with flexion at the knee	1	2	3	4
3. Body is inclined slightly backward	1	2	3	4
4. As the upper leg becomes perpendicular to the floor, lower leg extends (at knee)	1	2	3	4
5. The kicking leg extends and makes contact with the ball	1	2	3	4
6. Contact is made with the toes or instep	1	2	3	4
7. The ankle is slightly flexed	1	2	3	4
8. The opposite arm swings forward/upward in the follow-through	1	2	3	4
9. Trunk becomes slightly more vertical after contact	1	2	3	4
Catch				
1. Arms move to a position in front of the body	1	2	3	4
2. Hands are juxtaposed, the palms of the hands facing each other	1	2	3	4
3. Hands turn to accommodate the high or low trajectory of ball	1	2	3	4
4. Hands and fingers are “loose” but slightly cupped and pointed in direction of the oncoming ball	1	2	3	4
5. Eyes pick up and follow the flight of the ball until ball contact is made	1	2	3	4
6. Initially, the ball contact is made with both hands simultaneously	1	2	3	4
7. Adjustments in the elbow and shoulder joint positions are made to accommodate changes in the flight of the ball	1	2	3	4
8. Fingers close immediately around the ball and the arms “give” to absorb momentum of ball	1	2	3	4
One-Arm Strike				
1. Feet are positioned approximately shoulder width apart	1	2	3	4
2. Trunk is rotated backward and the weight is shifted onto the back foot	1	2	3	4
3. Lead elbow is held up and out from the body with bat off the shoulder	1	2	3	4
4. Eyes follow the flight of the ball until just before contact	1	2	3	4
5. Body weight is shifted forward onto the opposite foot in the direction of the intended hit	1	2	3	4
6. Hips and trunk rotate in the direction of intended hit; hips lead	1	2	3	4
7. Arms move forward independent of hips	1	2	3	4

* To be considered a consistent process characteristic, the characteristic should be present on 3 of 4 trials.

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numbers of those statements that typify or characterize the movement behavior of the child. The general rule of thumb is that the child should display a given process characteristic 75% of the time if that characteristic is to be considered typical of his or her movement behavior. In addition, if the child does not exhibit three or more of the process characteristics that 70% of children the same age display, he or she might be experiencing some motor development delays. This child should be considered for additional monitoring of their motor development; some thought should also be given to providing enrichment activities to support the child's development in the area(s) of delay. Percentages of children 3–6 years of age exhibiting selected process characteristics are shown in Tables 17.9 and 17.10.

Product Assessment of Gross Motor Skill. The most common approach to the evaluation of motor development is the use of product assessment techniques. Normative data for such test batteries usually are given in standard scores, percentiles, or some other quantitative form derived from means, standard deviations, and/or standard errors. Normative data generally are used for comparing individual children to standards typical for children of comparable chronological ages. There are no comprehensive, published test batteries of this type for very young children (2- to 3-year-olds); several are available for assessing 4, 5, and 6-year-old children. Several of the more widely used product-oriented motor performance test batteries are reviewed here; all are formal, standardized measures of motor development.

Movement Assessment Battery for Children. The Movement Assessment Battery for Children is one of the more recent, most comprehensive, and widely-used test batteries for assessing motor development in children. It is generally referred to as the Movement ABC (Henderson & Sudgen, 1992; Schoemaker, Smits-Englesman, & Jongmans, 2003) and was designed to provide both process and product information about children's motor development. It consists of an objective *test*, which includes both a product and process component and a *checklist* (described earlier). The objective test is appropriate for use in arriving at a more detailed description of motor development needs. The test component of the Movement ABC is divided into different age bands; the youngest age band spans the years from 4 to 6. Each age band consists of eight tasks. Tasks in each age band are categorized as follows: manual dexterity (fine motor tasks), ball skills, and static and dynamic balance. The latter three categories assess gross motor development. For each task there is a quantitative or product score (e.g., time in balance, number of steps, etc.) and a series of process characteristics to be checked. Some selected examples of process characteristics for each of the gross motor tasks are given in Table 17.4. The process characteristics listed in the table are, for the most part, paraphrased and do not represent the verbatim wording found in the battery. Demonstration of and practice on all tasks is required; after practice, children are given 1 or more trials to perform the task. The number of trials varies from task to task and range from 2–10. Tasks in the age band for 4, 5, and 6 year olds include:

1. putting coins through a slot in a box
2. threading beads
3. drawing a single continuous line within a boundary
4. catching a bean bag tossed from 6'
5. rolling a ball into a goal 6' away
6. one-leg balance

TABLE 17.9.
Percentages of 3–6 year olds Exhibiting Selected Process Characteristics:
Locomotor Skills

Run

60–68% of 3 year olds

70–74% of 4 year olds

73–78% of 5 year olds

80–85% of 6 year olds exhibit some or all of the following characteristics:

- Arms and legs move in opposition
- Brief period of suspension
- Weight is received on either heel or toes of foot
- Head is up/facing forward

Jump

16–30% of 3 year olds

32–40% of 4 year olds

44–50% of 5 year olds

50–80% of 6 year olds exhibit some or all of the following characteristics:

- Flexes, e.g., assumes a crouched position
- Extends legs at take-off
- Uses 2-foot take-off/landing
- Arms are coordinated with legs
- Maintains balance on landing

Gallop

10–30% of 3 year olds

23–66% of 4 year olds

32–89% of 5 year olds

49–81% of 6 year olds exhibit some or all of the following characteristics:

- Steps (or leaps) with lead foot; follows with step on trail foot
- Brief period of suspension
- Arms pump/lifted to waist at take-off
- Continually leads with same foot

Hop

10–49% of 3 year olds

36–61% of 4 year olds

50–85% of 5 year olds

62–90% of 6 year olds exhibit some or all of the following characteristics:

- Arms pump to produce force
- Weight received on ball of foot
- Hips/knees flex on landing
- Performs 3 consecutive hops/preferred foot

Skip

6–20% of 3 year olds

8–42% of 4 year olds

50–63% of 5 year olds

68–86% of 6 year olds exhibit some or all of the following characteristics:

- Arms/legs move in opposition
- Performs a step-hop on alternating sides
- Brief period of suspension

TABLE 17.10.
Percentages of 3–6 year olds Exhibiting Selected Process Characteristics:
Object Control Skills

Throw

11–20% of 3 year olds

29–42% of 4 year olds

33–56% of 5 year olds

52–65% of 6 year olds exhibit some or all of the following characteristics:

- Whole trunk rotates backward and forward
- Weight is shifted onto the foot opposite the throwing arm
- Ball is held in the fingertips
- Side is toward the target

Kick

16–50% of 3 year olds

20–68% of 4 year olds

28–84% of 5 year olds

54–89% of 6 year olds exhibit some or all of the following characteristics:

- Takes preliminary step to ball
- Kicking leg extends to make contact
- Kicks through the ball
- Contact is with instep or toe of preferred foot

Stationary Catch

5–33% of 3 year olds

14–62% of 4 year olds

51–84% of 5 year olds

35–90% of 6 year olds exhibit some or all of the following characteristics:

- Arms are flexed at elbows and in front of the body
- Eyes fixate and track ball to contact
- Ball is caught with hands/fingers

Two Arm Strike

26–40% of 3 year olds

32–56% of 4 year olds

38–65% of 5 year olds

52–68% of 6 year olds exhibit some or all of the following characteristics:

- Feet are parallel and shoulder width apart
 - Side of body is toward the target
 - Hips/trunk/shoulders rotate during swing
 - Swing is horizontal
 - Weight is shifted onto opposite foot
-

7. jumping over a cord knee high

8. walking 15 steps on a line with the heels raised.

Directions for administering and scoring each item are provided in simple, straightforward language. Means and standard deviations are given for total impairment scores by age and by gender. Cut-off scores for the 5th and 15th percentiles are provided. Scores below the 5th percentile are indicative of a definite motor development lag, while scores be-

tween the 5th and 15th percentiles suggest borderline motor development difficulties. Sample case studies are described in detail. Normative data for both the test and checklist components are based on 1,200 children from 4 to 12 years of age; the sample in the age range from 4 to 6 years was 493 children. Boys and girls of different ethnic origins and from diverse regions of the United States were included. The battery has been used throughout the world for assessing motor skill development in children.

Peabody Developmental Motor Scales-II. A very widely used tool for assessing motor development in young children is the Peabody Developmental Motor Scales (Folio & Fewell, 2000). The scales were designed to evaluate gross and fine motor skills in children both with and without disabilities from birth to 6 years. The Gross Motor Scale consists of a total of 170 items, 10 items at each of 17 age levels. Items are grouped at 6-month intervals beginning at 2 years. The areas of gross motor development that are considered include reflexes (in children up to 1 year of age), balance/nonlocomotor behaviors, locomotor skills, and object manipulation skills. The gross motor development scale requires approximately 30 minutes to administer and is straightforward in administration, scoring, and interpretation. All items are scored 0 (the child cannot or does not perform the task), 1, or 2 (the child performs the task according to the differential criteria listed). Basal and ceiling ages are determined, and raw scores can be converted into percentile ranks, standard scores, and a gross and fine motor quotient. Normative data on 2,003 children (85.1% Caucasian) from a wide variety of geographical locations (northeastern, northern, central, southern and western United States) are provided. Of the total number of children in the standardization sample, there were at least 92 2-year-olds, 103 3-year-olds, 50 4-year-olds, and 55 5 year olds. Examples of each of the skill areas and the criteria for passing (for 4-year-olds) are described in Table 17.11. The Peabody Motor Activities Program is available for use by teachers.

Bruininks-Oseretsky Test of Motor Proficiency. The Bruininks-Oseretsky Test (Bruininks, 1978) is designed for use with children 4½ through 14½ years of age. It consists of eight subtests (46 separate items) that provide a broad index of the child's proficiency in both gross and fine motor skills. A short form of the test (14 items) provides a brief overview of

TABLE 17.11.
Examples of Items from the Peabody Gross Motor Scale (4-year olds)

<i>Skill Area</i>	<i>Item</i>	<i>Criterion for Passing</i>
Balance (Stationary)	Walks a 4-in balance beam	Completes 4 steps without support
	Stands on tiptoes with hands	Maintains position for 8 sec with good stability over head
Locomotor	Jumps up with hands overhead	Jumps 3 ft beyond normal reach as high as possible
	Jumps down from 32 in	Jumps without support, leading with one foot
	Jumps forward as far as possible	Jumps forward 16 in on one foot
	Rolls forward (somersault)	Jumps forward 12 in on opposite foot
Object Manipulation	Throws ball	Rolls forward over head without turning head 15 degrees to either side
		Throws ball 10 ft on 1 of 2 trials

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the child's general motor proficiency. Four of the subtests measure gross motor skills; these include running speed and agility, balance, bilateral coordination, and upper limb coordination. Selected items used to assess these four aspects of gross motor development are described in Table 17.12. Raw scores on gross motor items are converted to point scores that are then converted to standard scores. The standard scores are summed to give a gross motor composite; this is converted into a composite standard score. The standard score is used to determine a percentile rank for the individual child. Some age-equivalent data are provided, and norms are established at 6-month intervals. The standardization sample was based on 68 children for the 4 year 6 month to 5 year 5 month range and 82 children for the 5 year 6 month to 6 year 5 month range. The test is currently undergoing revision.

Cashin Test of Motor Development. The Cashin Test (Cashin, 2001) was designed for use with 4- and 5-year-olds and its database is approximately 1,000 children. This test assesses five different gross motor skills: static balance, dynamic balance, agility, over arm throw, and catch. General task descriptions, testing procedures, and a sample of normative data are given in Table 17.13. The Cashin Test was developed with ease of administration and minimal space requirements as important considerations. On average, a child can com-

TABLE 17.12.
Items from Gross Motor Skills Subtest:
Bruininks-Oseretsky Test of Motor Proficiency

Running Speed/Agility (Time to nearest .2 sec)

Child runs a distance of 15 yds, picks up a block, runs back across the start line

Balance (Time or number of steps)

Child stands on preferred leg on floor; holds for 10 sec

Child stands on preferred leg on balance beam; holds for 10 sec

Child stands on preferred leg on balance beam with eyes closed

Child walks line on floor with normal stride for 6 steps

Child walks forward on balance beam in normal stride for 6 steps

Child walks forward in heel-toe fashion on line on floor for 6 steps

Child walks forward in heel-toe fashion on balance beam for 6 steps

Child walks forward on balance beam and steps over a stick held at knee height; hands on hips

Bilateral Coordination (Completes 10 cycles in 90 sec)

Child taps feet alternately while making circles with index fingers

Child simultaneously taps foot and index finger on one side of body and then the other

Child simultaneously taps right foot & left index finger and the left foot and right index finger

Child jumps in place with leg and arm on opposite sides of body and alternates sides

Child jumps as high as possible and touches heels (while in the air)

Upper Limb Coordination (Number in 5 attempts)

Child bounces tennis ball on floor and catches with both hands

Child uses preferred hand and bounces tennis ball on floor and catches it

Child catches tennis ball tossed from 10 ft using two hands

Child catches tennis ball tossed from 10 ft with preferred hand

Child throws ball overarm at target 4 feet away

Child attempts to touch a ball swung horizontally in front of them with the index finger

Source: Adapted from *Bruininks-Oseretsky Test of Motor Proficiency: Examiner's manual*, by Robert H. Bruininks, 1978, Circle Pines, MN: American Guidance Service, Inc.

TABLE 17.13.
Cashin Test of Motor Development

<i>Task*</i>	<i>Scoring</i>	<i>Age/sex</i>	<i>Average</i>	<i>Accelerated</i>	<i>Lag</i>
Agility (Obstacle Course)	1 practice trial	4 M/F	9.5–10.2	Below 9.0	Above 11.0
	Average of 3	5 M	8.1–8.6	Below 7.9	Above 9.0
		5 F	9.0–10.2	Below 8.5	Above 11.0
Static Balance	1 practice trail	4 M	13.7–16.9	Above 19.0	Below 12.0
	Average of 3	4 F	17.6–21.1	Above 23.0	Below 15.0
	30 sec max	5 M/F	20.3–22.5	Above 24.0	Below 19.0
Dynamic Balance	3 trials/av steps	4 M	5.8–7.9	Above 9.0	Below 4.7
	2 trips of 10 steps	4 F	11.9–14.2	Above 15.0	Below 10.7
	2 errors per trip	5 M/F	13.2–14.8	Above 16.0	Below 12.0
Throwing	2 trials/10 throws	4 M	55–59	Above 59	Below 53
	Total points	4 F	45–48	Above 49	Below 43
	5 pts per trial	5 M	56–58	Above 59	Below 55
		5 F	46–49	Above 51	Below 45
Catch	2 trials/12 tosses	4 M/F	30–32	Above 33	Below 29
	Av pts/2 trials	5 M	34–36	Above 37	Below 30
	5 pts per toss	5 F	34–35	Above 36	Below 30

Agility: On signal go, child follows the laid out path. **Static Balance:** Child places hands on hips and foot of choice against the inside of support leg just below the knee. **Dynamic Balance:** Child places hands on hips and steps onto beam 2-inches wide and walks 10 steps (heel-toe), stops, returns to end of beam and repeats task. **Throwing:** child stands behind a line 12 ft from a wall and throws ball, overarm, as hard as possible against the wall; a rating scale is used to determine points. **Catching:** Child stands on an 'x' 13 ft from the examiner and attempts to catch an 8½ inch playground ball; 4 tosses to child, 4 tosses to child's right and 4 tosses to child's left are given in random order in each of the 2 trials; a rating scale is used to determine points.

plete the entire test in 20 minutes. Since the test includes product measures of some skills and process assessment of others, some minimal training or experience in observing process characteristics of the over arm throw and catching skills in young children is necessary to use the battery successfully. Young children often have difficulty understanding exactly what to do on the agility task, and several practice trials may be needed if an accurate assessment of the child's agility is to be made. The normative data available provide a rough standard for assessing the level of motor development of individual children. Three categories of development are identified: *average*, *accelerated*, and *developmental lag*. The score(s) corresponding to these levels of motor development are based on group means and standard deviations (average level of development is within 1+/- standard deviations; accelerated development is at least 2 standard deviations above the mean; developmental lag is at least 2 standard deviations below the mean). Important female-male differences are also noted in Table 17.13.

McCarthy Scales of Children's Abilities. Another example of a product approach to the evaluation of young children's motor development is the McCarthy Scales of Children's Abilities. This test battery was designed to help fulfill the need for a single instrument to evaluate strengths and weaknesses of young children's abilities (McCarthy, 1972). The McCarthy scales involve systematic observation of a variety of cognitive and motor be-

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haviors that are subdivided into six scales. The Motor Development Scale assesses gross and fine motor skills through the following subtests: Leg Coordination, Arm Coordination, Imitative Action, Draw-A-Design, and Draw-A-Child. The latter two tasks are fine motor tasks and are included in the Perceptual-Performance and General Cognitive Scales. Leg Coordination is examined using the following tasks: walk backward, walk on tiptoes, walk on a straight line, stand on one foot, and skip. Arm Coordination involves three tasks: bouncing a ball, catching a bean bag, and throwing a bean bag at a target. Four tasks are included in the Imitative Action sequence: crossing feet at the ankles, folding hands, twiddling thumbs, and sighting through a tube. In the Draw-A-Design task, the child is asked to reproduce various geometric designs including a circle, vertical and horizontal lines, a parallelogram, and so on. In the Draw-A-Child task, the child is asked to draw a picture of a boy or girl according to the gender of the child. During performance of the motor items, observations concerning hand usage and eye preferences also are made. For each of the scales, including the Motor Scale, the child's raw scores are converted into T-scores based on the child's chronological age. Percentile ranks are also presented for purposes of interpretation. The scales are based on normative data gathered on 1,032 children ages 2½ through 8½ years.

The Vulpe Assessment Battery. The Vulpe Assessment Battery (Vulpe, 1994) was developed by physical and occupational therapists to assess a wide variety of behaviors using a clinical approach. Among the areas of behavior that are evaluated are gross and fine motor development, language, cognitive processes, adaptive behaviors, and activities of daily living. The test, which is a product-oriented assessment tool, also includes tests of muscle strength, motor planning, reflex development, and balance. These are useful tools for conducting a comprehensive analysis of the young child's gross motor development. With regard to specific gross motor skill development, significant individual motor development achievements are identified for different ages beginning at 1 month and extending to 8 years of age. Skills are organized in an age-based sequence, and criteria for assessing mastery of each skill at each age are provided. The gross motor skills assessed by the Vulpe include sitting, kneeling, standing, walking, stair climbing, running, jumping, kicking, throwing, and balancing. A number of different tasks (usually 1–3) are used to assess each motor skill; performance is judged on a number of dimensions ranging from whether the child requires physical or verbal assistance to perform the tasks to whether the child can perform the skill alone and/or can transfer the skill to a different task or environmental context. Overall, the test is most useful as a source of information about age-related motor development and other behavioral achievements in young children. There is a direct link between scoring and an accompanying curriculum.

Gross Motor Function Measure (GMFM). The GMFM (Russell, Rosenbaum, Avery & Lane, 2002) is a clinical assessment tool designed to evaluate change in gross motor function in children with cerebral palsy, but can also be used to evaluate motor development in children with Down syndrome or with other children whose skills are at or below those typically observed in 5-year-olds. The original test consists of 88 items; a more recent version consists of a subset of 66 items. The tasks included span a range of skills from lying and rolling through walking, running, and jumping skills; the 88-item battery takes approximately 45–60 minutes to administer. Data are on children from 5 months to 16 years. A 4-point scale is used to evaluate each item; detailed standards for scoring are provided. The GMFM–88 scores can be summed to determine raw scores and percentile scores for

the child's overall performance. There is a GMFM self-instructional CD ROM that can be used for training and experience prior to administering the test.

Multidomain Tests. Zittel (1994) reviews important considerations in selecting an instrument for assessing gross motor development in preschool children with special needs. This work provides an excellent overview of several test batteries that could be used with preschoolers with special motor development needs. Other multidomain tests of potential interest include the I CAN Preprimary Motor and Play Skills (Wessel, 1980), Battelle Developmental Inventory-II (2004), Brigance Diagnostic Inventory of Early Development (Brigance, 1991), Miller Assessment for Preschoolers (Miller, 1988), and Developmental Indicators for the Assessment of Learning-Revised (Mardell-Czudnowski & Goldenberg, 1998). These are all multidomain tests and, thus, do not focus primarily on assessment of gross motor development.

USE OF ASSESSMENT RESULTS

Because we know that children who experience lags in motor development are more likely than their peers to display difficulties in adapting to both school and play environments, information about the level and nature of motor skill development is of major importance to the parent, the teacher, the school psychologist, and the family physician. It may be easy to note that a child moves awkwardly; however, it is another matter to describe or determine more precisely what was missing from or contributed to the lack of skillful performance. Poor or underdeveloped motor skills may be the product of a complex set of factors that include not only poor coordination and control, but also lack of appropriate spatial/body awareness, underdeveloped sensory function, lack of self-confidence, fear of failure, etc. Thus, a scientifically sound and insightful description and diagnosis of gross motor development should be based on information from formal and informal product and process assessments of the child's gross motor behaviors along with outcomes of a variety of other developmental measures. With regard to motor development, formal measures of gross motor development are needed to support, clarify, and extend observations of motor behavior made with informal instruments. Formal product measures of motor development are valuable because they provide a frame of reference for interpreting the current status of the child's motor development. It is important to note, however, that it is imprudent and unfair to act as though figures or descriptions in a table or on a chart are an irrefutable indication of whether or not a child is normal or typical.

Process information is used to elaborate on the product frame of reference. Process information is especially important because it considers directly how the body is moved and attempts to identify what is missing from or contributing to the child's lack of adequate motor control. Process assessment techniques are particularly important for gaining insight into how the child attempts to solve the problem of performing a motor task. This type of information is integral to an accurate description and/or ultimate diagnosis of the level of gross motor development because lags in motor development can be as much a function of the young child's understanding of the what and how of a task as they are of the child's ability to perform the task. The most significant, direct, and immediate uses that can be made of information from gross motor development screening and evaluation include the following:

1. *Planning and evaluating effective gross motor curricula for young children.* To individualize early sensory and motor learning experiences for young children, profes-

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sionals need to be able to group or identify children according to motor development levels. When specific aspects of the gross motor behavior of the child are known, basic tasks can be modified in a variety of ways to encourage individual refinement of and success in motor skill performance at the child's present level of development, as well as to promote growth toward higher levels of skill mastery.

2. *Early identification of motor dysfunctions.* Motor dysfunctions can impede the child's physical, mental, social, and emotional development. Information about gross motor development can be valuable to the teacher of the young child for maximizing early learning potential and for educational counseling. Such information is vital when making decisions about whether the child possesses the basic skills needed to succeed in simple classroom activities. The child who devotes a major share of his or her energy to assuming and maintaining basic postures or to controlling movements of the body will have much less energy to devote to other important activities that are integral to optimal development. Data about the child's level of gross motor development are important in determining when and/or if a child should enter school, or whether he or she should be placed in a developmental enrichment environment.
3. *Design of individual programs of enrichment activities.* Motor skill deficiencies often accompany and contribute to other learning, behavior, and attention problems of the young child. When this is the case, some attention almost always is required to improve the motor capacities of the child before other learning and behavior problems can be effectively addressed. If, on the other hand, the young child has learning, memory, and/or attentional problems but no accompanying motor development difficulties, gross motor activities may be used in creative ways to help stimulate improvement in other dimensions of development.

Results of gross motor skill screening and evaluation of the preschool child are most useful as a part of a comprehensive, multidimensional assessment of the young child. At a minimum, information about the child's fine motor control or eye-hand coordination (e.g., cutting, peg manipulation, pencil or crayon usage), simple perceptual skills (e.g., identification of colors, color matching, visual, verbal, and tactile-kinesthetic discrimination of shapes and sizes, as well as figure ground perception), and general characteristics of cognitive function ought to accompany the child's motor development record. It is only when information from gross motor development testing is used or viewed in conjunction with information about these other aspects of sensory and motor development that appropriate prognostic statements and remediation techniques for gross motor and other dimensions of development can be established or prescribed.

If the child has gross motor deficiencies only (e.g., no accompanying deficits in other sensory and motor behaviors), it is more likely that the motor development problems observed are temporary and simply reflect an uneven growth process that will self-correct with time. If, on the other hand, gross motor deficits are accompanied by fine motor and/or other sensory-perceptual or cognitive difficulties, there may be underlying neurological problems. In this case, referral to a pediatric neurologist and/or other appropriate medical personnel for further evaluation is appropriate. The motor system (including the control of eye muscles) is more likely than other systems to show deficits when something has gone awry with basic central and/or peripheral neurophysiological processes. At a behavioral level, information-gathering behaviors (e.g., the way children use their eyes to pick up information from the environment) and information-interpretation skills (e.g., figure-ground perception) can contribute significantly to the lack of refined fine and gross motor skills.

Gross motor deficits are often, at least in part, a reflection of inadequate support skills in visual perception. Therefore, remediation and enrichment programs for children with both gross motor and simple perceptual deficits need to focus on improving support behaviors as well as the movement behaviors themselves. Professionals working in educational settings with preschool children should use the following guide to gross motor development:

- Screen all children in gross motor development prior to or early in their entry into the preschool program.
- For initial screening, use a simple motor development screening tool such as the Denver Developmental Screening test or the Williams Preschool Checklist.
- Observe the children in naturalistic play settings.
- Use this information to determine which children need closer observation.
- Use a formal instrument to screen more carefully the children identified as potentially having gross motor process and product deficiencies.
- Examiners who must choose one measure over another should be sure to include some evaluation of the process characteristics of the child's motor skill performance.
- Children with questionable abilities should be referred to a motor development specialist, physical education teacher, or school psychologist for a more formal and comprehensive evaluation that includes a broad base of developmental information.
- Based on the total developmental profile, develop and implement appropriate instructional strategies and experiences to promote the motor development of the young child.
- When in doubt about the child's motor development difficulties, talk to or refer the child to the appropriate personnel within or outside the school setting.
- Remember that scores, percentiles, and other outcomes do not always tell the whole story about the child's overall motor development status and/or needs.

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