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Developmental Milestones: Motor Development

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Erdie-Lalena have
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Objectives After completing this article, readers should be able to:

1. Identify the milestones for gross and fine motor development.
2. Recognize the child whose development falls outside of the expected range.
3. Describe the sequences involved in gross and fine motor development.

This is the first of three articles on developmental milestones; the second and third articles will appear in the September and November 2010 issues of Pediatrics in Review, respectively.

Introduction

Infancy and childhood are dynamic periods of growth and change. Neurodevelopmental and physical growth proceed in a sequential and predictable pattern that is intrinsically determined. Skills progress from cephalic to caudal; from proximal to distal; and from generalized, stimulus-based reflexes to specific, goal-oriented reactions that become increasingly precise. As one clinician has stated, “infants [and children] are very orderly in their ways; they actually behave [and develop] according to laws that can be explored, discovered, confirmed, reconfirmed, and celebrated.” (1) By convention, these neurodevelopmental “laws” or sequences often are described in terms of the traditional developmental milestones.

Milestones provide a framework for observing and monitoring a child over time. According to recent American Academy of Pediatrics and *Bright Futures* guidelines, pediatricians should incorporate developmental surveillance at every health supervision visit. Surveillance involves analyzing the milestones in the context of a child’s history, growth, and physical examination findings to recognize those who may be at risk for developmental delay. A thorough understanding of the normal or typical sequence of development in all domains (gross motor, fine motor, problem-solving, receptive language, expressive language, and social-emotional) allows the clinician to formulate a correct overall impression of a child’s true developmental status. However, it must be emphasized that even experienced pediatricians cannot rely solely on their knowledge of the milestones to identify children who have developmental concerns. Developmental screening using validated and standardized tools should occur at the 9-month, 18-month, and 30-month (or 24-month) health supervision visits or whenever surveillance uncovers a concern.

Although neurodevelopment follows a predictable course, it is important to understand that intrinsic and extrinsic forces produce individual variation, making each child’s developmental path unique. Intrinsic influences include genetically determined attributes (eg, physical characteristics, temperament) as well as the child’s overall state of wellness. Extrinsic influences during infancy and childhood originate primarily from the family. Parent and sibling personalities, the nurturing methods used by caregivers, the cultural environment, and the family’s socioeconomic status with its effect on resources of time and money all play a role in the development of children. Developmental theory has, itself, developed as clinicians have tried to grapple with which influence is more predominant.

The focus of this series of articles is to help the clinician frame general concepts of development according to the developmental streams rather than highlight developmental

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abnormalities. The milestones cited are, on average, those at the 50th percentile for age. By understanding what is “normal” or typical, the clinician can appreciate more keenly what is abnormal or delayed. This article concentrates on normal motor development, with a brief mention about specific “red flags” that should alert clinicians to potential motor developmental problems. The second article in the series discusses cognitive and language development. The final article addresses the development of social-emotional skills. An all-inclusive table of milestones is provided in this first article as a reference (Table 1) both in print and online; Table 1 appears online only in the September and November articles.

Gross Motor Milestones

The ultimate goal of gross motor development is to gain independent and volitional movement. During gestation, primitive reflexes develop and persist for several months after birth to prepare the infant for the acquisition of specific skills. These brainstem and spinal reflexes are stereotypic movements generated in response to specific sensory stimuli. Examples include the Moro (Fig. 1), asymmetric tonic neck (ATNR) (Fig. 2), and positive support reflexes (Fig. 3). As the central nervous system matures, the reflexes are inhibited to allow the infant to make purposeful movements. For example, during the time when the ATNR persists, an infant is unable to roll from back to front, bring the hands to midline, or reach for objects. This reflex disappears between 4 and 6 months of age, the same time that these skills begin to emerge. The Moro reflex interferes with head control and sitting equilibrium. As this reflex lessens and disappears by 6 months of age, the infant gains progressive stability in a seated position (Fig. 4).

In addition to primitive reflexes, postural reactions, such as righting and protection responses, also begin to develop after birth. These reactions, mediated at the midbrain level, interact with each other and work toward the establishment of normal head and body relationship in space. Protective extension, for example, allows the infant to catch him- or herself when falling forward, sideways, or backwards (Fig. 5). These reactions develop between 6 and 9 months, the same time that an infant learns to move into a seated position and then to hands and knees. Soon afterward, higher cortical centers mediate the development of equilibrium responses and permit the infant to pull to stand by 9 months of age and begin walking by 12 months. Additional equilibrium responses develop during the second year after birth to allow for more complex bipedal movements, such as moving backward, running, and jumping.

During the first postnatal year, an infant thus moves from lying prone, to rolling over, to getting to hands and knees, and ultimately to coming to a seated position or pulling to stand (Fig. 6). Within the framework of Back to Sleep guidelines, infants must have age-appropriate and safe opportunities for “tummy time” to promote the development of these important prone-specific milestones. It is important to note that crawling is not a prerequisite to walking; pulling to stand is the skill infants must develop before they take their first steps. The ultimate goal of this timeframe is to develop skills that allow for independent movement and freedom to use the hands to explore, manipulate, and learn from the environment.

Gross motor development in subsequent years consists of refinements in balance, coordination, speed, and strength. The wide-based, slightly crouched, staccato gait of a 12-month-old evolves into a smooth, upright, and narrow-based style. The arms change from being held abducted and slightly elevated for balance to swinging in a reciprocal fashion as the gait reaches an adult pattern by age 3 years. Similarly, running develops soon after walking, starting as a stiff-legged approximation and changing into a well-coordinated movement that includes rapid change of direction and speed by 18 months of age.

Simultaneous use of both arms or legs occurs after successful use of each limb independently. At age 2 years, a child can kick a ball, jump with two feet off the floor, and throw a big ball overhand. Milestones for succeeding ages reflect progress in the length of time, number of repetitions, or the distance each task can be performed successfully. By the time a child starts school, he or she is able to perform multiple complex gross motor tasks simultaneously (such as pedaling, maintaining balance, and steering while on a bicycle).

Fine Motor Milestones

Fine motor skills relate to the use of the upper extremities to engage and manipulate the environment. They are necessary for a person to perform self-help tasks, to play, and to accomplish work. Like all developmental streams, fine motor milestones do not proceed in isolation but depend on other areas of development, including gross motor, cognitive, and visual perceptual skills. At first, the upper extremities play an important role in balance and mobility. Hands are used for support, first in the prone position and then in sitting. Arms help with rolling over, then crawling, then pulling to stand. Infants begin to use their hands to explore, even when in the supine position. When gross motor skills have developed such that the

Table 1. **Developmental Milestones**

Age	Gross Motor	Fine Motor	Self-Help	Problem-solving	Social/Emotional	Receptive Language	Expressive Language
1 month	<ul style="list-style-type: none"> Chin up in prone position Turns head in supine position 	<ul style="list-style-type: none"> Hands fisted near face 	<ul style="list-style-type: none"> Sucks well 	<ul style="list-style-type: none"> Gazes at black-white objects Follows face 	<ul style="list-style-type: none"> Discriminates mother's voice Cries out of distress 	<ul style="list-style-type: none"> Startles to voice/sound 	<ul style="list-style-type: none"> Throaty noises
2 months	<ul style="list-style-type: none"> Chest up in prone position Head bobs when held in sitting position 	<ul style="list-style-type: none"> Hands unfisted 50% Retains rattle if placed in hand Holds hands together 	<ul style="list-style-type: none"> Opens mouth at sight of breast or bottle 	<ul style="list-style-type: none"> Visual threat present Follows large, highly contrasting objects Recognizes mother 	<ul style="list-style-type: none"> Reciprocal smiling: responds to adult voice and smile 	<ul style="list-style-type: none"> Alerts to voice/sound 	<ul style="list-style-type: none"> Coos Social smile (6 weeks) Vowel-like noises
3 months	<ul style="list-style-type: none"> Props on forearms in prone position Rolls to side 	<ul style="list-style-type: none"> Hands unfisted 50% Inspects fingers Bats at objects 	<ul style="list-style-type: none"> Brings hands to mouth 	<ul style="list-style-type: none"> Reaches for face Follows objects in circle (in supine position) Regards toys 	<ul style="list-style-type: none"> Expression of disgust (sour taste, loud sound) Visually follows person who is moving across a room 	<ul style="list-style-type: none"> Regards speaker 	<ul style="list-style-type: none"> Chuckles Vocalizes when talked to
4 months	<ul style="list-style-type: none"> Sits with trunk support No head lag when pulled to sit Props on wrists Rolls front to back 	<ul style="list-style-type: none"> Hands held predominately open Clutches at clothes Reaches persistently Plays with rattle 	<ul style="list-style-type: none"> Briefly holds onto breast or bottle 	<ul style="list-style-type: none"> Mouths objects Stares longer at novel faces than familiar Shakes rattle Reaches for ring/rattle 	<ul style="list-style-type: none"> Smiles spontaneously at pleasurable sight/sound Stops crying at parent voice To and fro alternating vocalizations 	<ul style="list-style-type: none"> Orients head in direction of a voice Stops crying to soothing voice 	<ul style="list-style-type: none"> Laughs out loud Vocalizes when alone
5 months	<ul style="list-style-type: none"> Sits with pelvic support Rolls back to front Anterior protection Sits with arms supporting trunk 	<ul style="list-style-type: none"> Palmar grasps cube Transfers objects: hand-mouth-hand Holds hands together Reaches/grasps dangling ring 	<ul style="list-style-type: none"> Gums/mouths pureed food 	<ul style="list-style-type: none"> Turns head to look for dropped spoon Regards pellet or small cracker 	<ul style="list-style-type: none"> Recognizes caregiver visually Forms attachment relationship to caregiver 	<ul style="list-style-type: none"> Begins to respond to name 	<ul style="list-style-type: none"> Says "Ah-goo" Razzes, squeals Expresses anger with sounds other than crying
6 months	<ul style="list-style-type: none"> Sits momentarily propped on hands Pivots in prone In prone position, bears weight on 1 hand 	<ul style="list-style-type: none"> Transfers hand-hand Rakes pellet Takes second cube and holds on to first Reaches with one hand 	<ul style="list-style-type: none"> Feeds self crackers Places hands on bottle 	<ul style="list-style-type: none"> Touches reflection and vocalizes Removes cloth on face Bangs and shakes toys 	<ul style="list-style-type: none"> Stranger anxiety (familiar versus unfamiliar people) 	<ul style="list-style-type: none"> Stops momentarily to "no" Gestures for "up" 	<ul style="list-style-type: none"> Reduplicative babble with consonants Listens, then vocalizes when adult stops Smiles/vocalizes to mirror
7 months	<ul style="list-style-type: none"> Bounces when held Sits without support steadily Lateral protection Puts arms out to sides for balance 	<ul style="list-style-type: none"> Radial-palmar grasp 	<ul style="list-style-type: none"> Refuses excess food 	<ul style="list-style-type: none"> Explores different aspects of toy Observes cube in each hand Finds partially hidden object 	<ul style="list-style-type: none"> Looks from object to parent and back when wanting help (eg, with a wind-up toy) 	<ul style="list-style-type: none"> Looks toward familiar object when named Attends to music 	<ul style="list-style-type: none"> Increasing variety of syllables
8 months	<ul style="list-style-type: none"> Gets into sitting position Commando crawls Pulls to sitting/kneeling position 	<ul style="list-style-type: none"> Bangs spoon after demonstration Scissor grasp of cube Takes cube out of cup Pulls out large peg 	<ul style="list-style-type: none"> Holds own bottle Finger feeds Cheerios® or string beans 	<ul style="list-style-type: none"> Seeks object after it falls silently to the floor 	<ul style="list-style-type: none"> Lets parents know when happy versus upset Engages in gaze monitoring: adult looks away and child follows adult glance with own eyes 	<ul style="list-style-type: none"> Responds to "Come here" Looks for family members, "Where's mama?"... etc 	<ul style="list-style-type: none"> Says "Dada" (nonspecific) Echolalia (8 to 30 months) Shakes head for "no"

(continued)

Table 1. Developmental Milestones—continued

Age	Gross Motor	Fine Motor	Self-Help	Problem-solving	Social/Emotional	Receptive Language	Expressive Language
9 months	<ul style="list-style-type: none"> • "Stands" on feet and hands • Begins creeping • Pulls to stand • Bear walks (all four limbs straight) 	<ul style="list-style-type: none"> • Radial-digital grasp of cube • Bangs two cubes together 	<ul style="list-style-type: none"> • Bites, chews cookie 	<ul style="list-style-type: none"> • Inspects bell • Rings bell • Pulls string to obtain ring 	<ul style="list-style-type: none"> • Uses sounds to get attention • Separation anxiety • Follows a point, "Oh look at..." • Recognizes familiar people visually 	<ul style="list-style-type: none"> • Enjoys gesture games • Orients to name well • Orients to bell 	<ul style="list-style-type: none"> • Says "Mama" (nonspecific) • Nonreduplicative babble • Imitates sounds
10 months	<ul style="list-style-type: none"> • Creeps well • Cruises around furniture using two hands • Stands with one hand held • Walks with two hands held 	<ul style="list-style-type: none"> • Clumsy release of cube • Inferior pincer grasp of pellet • Isolates index finger and pokes 	<ul style="list-style-type: none"> • Drinks from cup held for child 	<ul style="list-style-type: none"> • Uncovers toy under cloth • Pokes at pellet in bottle • Tries to put cube in cup, but may not be able to let go 	<ul style="list-style-type: none"> • Experiences fear • Looks preferentially when name is called 	<ul style="list-style-type: none"> • Enjoys peek-a-boo • Waves "bye-bye" back 	<ul style="list-style-type: none"> • Says "Dada" (specific) • Waves "bye-bye"
11 months	<ul style="list-style-type: none"> • Pivots in sitting position • Cruises furniture using one hand • Stands for a few seconds • Walks with one hand held 	<ul style="list-style-type: none"> • Throws objects • Stirs with spoon 	<ul style="list-style-type: none"> • Cooperates with dressing 	<ul style="list-style-type: none"> • Finds toy under cup • Looks at pictures in book 	<ul style="list-style-type: none"> • Gives objects to adult for action after demonstration (lets adult know he or she needs help) 	<ul style="list-style-type: none"> • Stops activity when told "no" • Bounces to music 	<ul style="list-style-type: none"> • Says first word • Vocalizes to songs
12 months	<ul style="list-style-type: none"> • Stands well with arms high, legs splayed • Posterior protection • Independent steps 	<ul style="list-style-type: none"> • Scribbles after demonstration • Fine pincer grasp of pellet • Holds crayon • Attempts tower of two cubes 	<ul style="list-style-type: none"> • Finger feeds part of meal • Takes off hat 	<ul style="list-style-type: none"> • Rattles spoon in cup • Lifts box lid to find toy 	<ul style="list-style-type: none"> • Shows objects to parent to share interest • Points to get desired object (proto-imperative pointing) 	<ul style="list-style-type: none"> • Follows one-step command with gesture • Recognizes names of two objects and looks when named 	<ul style="list-style-type: none"> • Points to get desired object (proto-imperative pointing) • Uses several gestures with vocalizing (eg, waving, reaching)
13 months	<ul style="list-style-type: none"> • Walks with arms high and out (high guard) 	<ul style="list-style-type: none"> • Attempts to release pellet in bottle 	<ul style="list-style-type: none"> • Drinks from cup with some spilling 	<ul style="list-style-type: none"> • Dangles ring by string • Reaches around clear barrier to obtain object • Unwraps toy in cloth 	<ul style="list-style-type: none"> • Shows desire to please caregiver • Solitary play • Functional play 	<ul style="list-style-type: none"> • Looks appropriately when asked, "Where's the ball?" 	<ul style="list-style-type: none"> • Uses three words • Immature jargonizing: inflection without real words
14 months	<ul style="list-style-type: none"> • Stands without pulling up • Falls by collapse • Walks well 	<ul style="list-style-type: none"> • Imitates back and forth scribble • Adds third cube to a two-cube tower • Puts round peg in and out of hole 	<ul style="list-style-type: none"> • Removes socks/shoes • Chews well • Puts spoon in mouth (turns over) 	<ul style="list-style-type: none"> • Dumps pellet out of bottle after demonstration 	<ul style="list-style-type: none"> • Points at object to express interest (proto-declarative pointing) • Purposeful exploration of toys through trial and error 	<ul style="list-style-type: none"> • Follows one-step command without gesture 	<ul style="list-style-type: none"> • Names one object • Points at object to express interest (proto-declarative pointing)
15 months	<ul style="list-style-type: none"> • Stoops to pick up toy • Creeps up stairs • Runs stiff-legged • Walks carrying toy • Climbs on furniture 	<ul style="list-style-type: none"> • Builds three- to four-cube tower • Places 10 cubes in cup • Releases pellet into bottle 	<ul style="list-style-type: none"> • Uses spoon with some spilling • Attempts to brush own hair • Fusses to be changed 	<ul style="list-style-type: none"> • Turns pages in book • Places circle in single-shape puzzle 	<ul style="list-style-type: none"> • Shows empathy (someone else cries, child looks sad) • Hugs adult in reciprocation • Recognizes without a demonstration that a toy requires activation; hands it to adult if can't operate 	<ul style="list-style-type: none"> • Points to one body part • Points to one object of three when named • Gets object from another room upon demand 	<ul style="list-style-type: none"> • Uses three to five words • Mature jargonizing with real words
16 months	<ul style="list-style-type: none"> • Stands on one foot with slight support • Walks backwards • Walks up stairs with one hand held 	<ul style="list-style-type: none"> • Puts several round pegs in board with urging • Scribbles spontaneously 	<ul style="list-style-type: none"> • Picks up and drinks from cup • Fetches and carries objects (same room) 	<ul style="list-style-type: none"> • Dumps pellet out without demonstration • Finds toy observed to be hidden under layers of covers • Places circle in form board 	<ul style="list-style-type: none"> • Kisses by touching lips to skin • Periodically visually relocates caregiver • Self-conscious; embarrassed when aware of people observing 	<ul style="list-style-type: none"> • Understands simple commands, "Bring to mommy" • Points to one picture when named 	<ul style="list-style-type: none"> • Uses 5 to 10 words

(continued)

Table 1. **Developmental Milestones—continued**

Age	Gross Motor	Fine Motor	Self-Help	Problem-solving	Social/Emotional	Receptive Language	Expressive Language
18 months	<ul style="list-style-type: none"> • Creeps down stairs • Runs well • Seats self in small chair • Throws ball while standing 	<ul style="list-style-type: none"> • Makes four-cube tower • Crudely imitates vertical stroke 	<ul style="list-style-type: none"> • Removes garment • Gets onto adult chair unaided • Moves about house without adult 	<ul style="list-style-type: none"> • Matches pairs of objects • Replaces circle in form board after it has been turned around (usually with trial and error) 	<ul style="list-style-type: none"> • Passes M-CHAT • Engages in pretend play with other people (eg, tea party, birthday party) • Begins to show shame (when does wrong) and possessiveness 	<ul style="list-style-type: none"> • Points to two of three objects when named • Points to three body parts • Points to self • Understands "mine" • Points to familiar people when named 	<ul style="list-style-type: none"> • Uses 10 to 25 words • Uses giant words (all gone, stop that) • Imitates environmental sounds (eg, animals) • Names one picture on demand
20 months	<ul style="list-style-type: none"> • Squats in play • Carries large object • Walks downstairs with one hand held 	<ul style="list-style-type: none"> • Completes round peg board without urging • Makes five- to six-cube tower • Completes square peg board 	<ul style="list-style-type: none"> • Places only edibles in mouth • Feeds self with spoon entire meal 	<ul style="list-style-type: none"> • Deduces location of hidden object • Places square in form board 	<ul style="list-style-type: none"> • Begins to have thoughts about feelings • Engages in tea party with stuffed animals • Kisses with pucker 	<ul style="list-style-type: none"> • Points to three pictures • Begins to understand her/him/me 	<ul style="list-style-type: none"> • Holophrases ("Mommy?" and points to keys, meaning: "These are Mommy's keys.") • Two-word combinations • Answers requests with "no"
22 months	<ul style="list-style-type: none"> • Walks up stairs holding rail, putting both feet on each step • Kicks ball with demonstration • Walks with one foot on walking board 	<ul style="list-style-type: none"> • Closes box with lid • Imitates vertical line • Imitates circular scribble 	<ul style="list-style-type: none"> • Uses spoon well • Drinks from cup well • Unzips zippers • Puts shoes on partway 	<ul style="list-style-type: none"> • Completes form board 	<ul style="list-style-type: none"> • Watches other children intensely • Begins to show defiant behavior 	<ul style="list-style-type: none"> • Points to four to five pictures when named • Points to five to six body parts • Points to four pieces of clothing when named 	<ul style="list-style-type: none"> • Uses 25 to 50 words • Asks for more • Adds one to two words/week
24 months	<ul style="list-style-type: none"> • Walks down stairs holding rail, both feet on each step • Kicks ball without demonstration • Throws overhand 	<ul style="list-style-type: none"> • Makes a single-line "train" of cubes • Imitates circle • Imitates horizontal line 	<ul style="list-style-type: none"> • Opens door using knob • Sucks through a straw • Takes off clothes without buttons • Pulls off pants 	<ul style="list-style-type: none"> • Sorts objects • Matches objects to pictures • Shows use of familiar objects 	<ul style="list-style-type: none"> • Parallel play • Begins to mask emotions for social etiquette 	<ul style="list-style-type: none"> • Follows two-step command • Understands me/you • Points to 5 to 10 pictures 	<ul style="list-style-type: none"> • Two-word sentence (noun + verb) • Telegraphic speech • Uses 50+ words • 50% intelligibility • Refers to self by name • Names three pictures
28 months	<ul style="list-style-type: none"> • Jumps from bottom step with one foot leading • Walks on toes after demonstration • Walks backward 10 steps 	<ul style="list-style-type: none"> • Strings large beads awkwardly • Unscrews jar lid • Turns paper pages (often several at once) 	<ul style="list-style-type: none"> • Holds self and verbalizes toilet needs • Pulls pants up with assistance 	<ul style="list-style-type: none"> • Matches shapes • Matches colors 	<ul style="list-style-type: none"> • Reduction in separation anxiety 	<ul style="list-style-type: none"> • Understands "just one" 	<ul style="list-style-type: none"> • Repeats two digits • Begins to use pronouns (I, me, you) • Names 10 to 15 pictures
30 months	<ul style="list-style-type: none"> • Walks up stairs with rail, alternating feet • Jumps in place • Stands with both feet on balance beam • Walks with one foot on balance beam 	<ul style="list-style-type: none"> • Makes eight-cube tower • Makes a "train" of cubes and includes a stack 	<ul style="list-style-type: none"> • Washes hands • Puts things away • Brushes teeth with assistance 	<ul style="list-style-type: none"> • Replaces circle in form board after it has been turned around (little or no trial and error) • Points to small details in pictures 	<ul style="list-style-type: none"> • Imitates adult activities (eg, sweeping, talking on phone) 	<ul style="list-style-type: none"> • Follows two prepositions: "put block in . . . on box" • Understands actions words: "playing . . . washing . . . blowing" 	<ul style="list-style-type: none"> • Echolalia and jargonizing gone • Names objects by use • Refers to self with correct pronoun • Recites parts of well-known story/fills in words
33 months	<ul style="list-style-type: none"> • Walks swinging arms opposite of legs (synchronous gait) 	<ul style="list-style-type: none"> • Makes 9- to 10-cube tower • Puts six square pegs in pegboard • Imitates cross 	<ul style="list-style-type: none"> • Toilet trained • Puts on coat unassisted 	<ul style="list-style-type: none"> • Points to self in photos • Points to body parts based on function ("What do you hear with?") 	<ul style="list-style-type: none"> • Begins to take turns • Tries to help with household tasks 	<ul style="list-style-type: none"> • Understands three prepositions • Understands dirty, wet • Points to objects by use: "ride in . . . put on feet . . . write with" 	<ul style="list-style-type: none"> • Gives first and last name • Counts to 3 • Begins to use past tense • Enjoys being read to (short books)

(continued)

Table 1. Developmental Milestones—continued

Age	Gross Motor	Fine Motor	Self-Help	Problem-solving	Social/Emotional	Receptive Language	Expressive Language
3 years	<ul style="list-style-type: none"> Balances on one foot for 3 seconds Goes up stairs, alternating feet, no rail Pedals tricycle Walks heel to toe Catches ball with stiff arms 	<ul style="list-style-type: none"> Copies circle Cuts with scissors: side-to-side (awkwardly) Strings small beads well Imitates bridge of cubes 	<ul style="list-style-type: none"> Independent eating Pours liquid from one container to another Puts on shoes without laces Unbuttons 	<ul style="list-style-type: none"> Draws a two- to three-part person Understands long/short, big/small, more/less Knows own gender Knows own age Matches letters/numerals 	<ul style="list-style-type: none"> Starts to share with/without prompt Fears imaginary things Imaginative play Uses words to describe what someone else is thinking ("Mom thought I was asleep") 	<ul style="list-style-type: none"> Points to parts of pictures (nose of cow, door of car) Names body parts with function Understands negatives Groups objects (foods, toys) 	<ul style="list-style-type: none"> Uses 200+ words Three-word sentences Uses pronouns correctly 75% intelligibility Uses plurals Names body parts by use Asks to be read to
4 years	<ul style="list-style-type: none"> Balances on one foot 4 to 8 seconds Hops on one foot two to three times Standing broad jump: 1 to 2 feet Gallops Throws ball overhand 10 feet Catches bounced ball (4½ yrs) 	<ul style="list-style-type: none"> Copies square Ties single knot Cuts 5-inch circle Uses tongs to transfer Writes part of first name Imitates gate with cubes 	<ul style="list-style-type: none"> Goes to toilet alone Wipes after bowel movement Washes face/hands Brushes teeth alone Buttons Uses fork well 	<ul style="list-style-type: none"> Draws a four- to six-part person Can give amounts (usually less than 5) correctly Simple analogies: <ul style="list-style-type: none"> dad/boy: mother/??? ice/cold: fire/??? ceiling/up: floor/??? Points to five to six colors Points to letters/numerals when named Rote counts to 4 "Reads" several common signs/store names 	<ul style="list-style-type: none"> Deception: interested in "tricking" others and concerned about being tricked by others Has a preferred friend Labels happiness, sadness, fear, and anger in self Group play 	<ul style="list-style-type: none"> Follows three-step commands Points to things that are the same versus different Names things when actions are described (eg, swims in water, you cut with it, it's something you read, it tells time . . .) Understands adjectives: bushy, long, thin, pointed 	<ul style="list-style-type: none"> Uses 300 to 1,000 words Tells stories 100% intelligibility Uses "feeling" words Uses words that tell about time
5 years	<ul style="list-style-type: none"> Walks down stairs with rail, alternating feet Balances on one foot >8 seconds Hops on one foot 15 times Skips Running broad jump 2 to 3 feet Walks backward heel-toe Jumps backward 	<ul style="list-style-type: none"> Copies triangle Puts paper clip on paper Can use clothespins to transfer small objects Cuts with scissors Writes first name Builds stairs from model 	<ul style="list-style-type: none"> Spreads with knife Independent dressing Bathes independently 	<ul style="list-style-type: none"> Draws an 8- to 10-part person Gives amounts (<10) Identifies coins Names letters/numerals out of order Rote counts to 10 Names 10 colors Uses letter names as sounds to invent spelling Knows sounds of consonants and short vowels by end of kindergarten Reads 25 words 	<ul style="list-style-type: none"> Has group of friends Apologizes for mistakes Responds verbally to good fortune of others 	<ul style="list-style-type: none"> Knows right and left on self Points to different one in a series Understands "er" endings (eg, batter, skater) Understands adjectives: busy, long, thin, pointed Enjoys rhyming words and alliterations Produces words that rhyme Points correctly to "side," "middle," "corner" 	<ul style="list-style-type: none"> Repeats six- to eight-word sentence Defines simple words Uses 2,000 words Knows telephone number Responds to "why" questions Retells story with clear beginning, middle, end
6 years	<ul style="list-style-type: none"> Tandem walks 	<ul style="list-style-type: none"> Builds stairs from memory Draws diamond Writes first and last name Creates and writes short sentences Forms letters with down-going and counterclockwise strokes Copies flag 	<ul style="list-style-type: none"> Ties shoes Combs hair Looks both ways at street Remembers to bring belongings 	<ul style="list-style-type: none"> Draws a 12- to 14-part person Number concepts to 20 Simple addition/subtraction Understands seasons Sounds out regularly spelled words Reads 250 words by end of first grade 	<ul style="list-style-type: none"> Has best friend of same sex Plays board games Distinguishes fantasy from reality Wants to be like friends and please them Enjoys school 	<ul style="list-style-type: none"> Asks what unfamiliar words mean Can tell which words do not belong in a group 	<ul style="list-style-type: none"> Repeats 8- to 10-word sentences Describes events in order Knows days of the week 10,000 word vocabulary

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Figure 1. Moro reflex. This reflex occurs spontaneously to loud noises or by simply holding the supine infant's hand and releasing the hand suddenly. Classically, the reflex is elicited while holding the infant supine, with the head dropped slightly backward. This produces sudden extension and abduction of the upper extremities with hands open, followed by flexion of the upper extremities to midline (the "startle reflex").

infant is more stable in upright positions and can move into them easily, the hands are free for more purposeful exploration.

At birth, infants do not have any apparent voluntary use of their hands. They open and close them in response to touch and other stimuli, but movement otherwise is dominated by a primitive grasp reflex. Because of this, infants spend the first 3 months after birth "contacting" objects with their eyes rather than their hands, fixating on faces and objects and then visually tracking objects. Gradually, they start to reach clumsily and bring their hands together. As the primitive reflexes decrease, infants begin to prehend objects voluntarily, first using the entire palm toward the ulnar side (5 months) and then predominantly using the radial aspect of the palm (7 months). At the same time, infants learn to release objects voluntarily. In the presence of a strong grasp reflex, objects must be removed forcibly from an infant's grasp or drop involuntarily from the hand. Voluntary release is seen as the infant learns to transfer objects from one hand to the other, first using the mouth as an intermediate stage (5 months) and then directly hand-to-hand (6 months).

Between 6 months and 12 months of age, the grasp evolves to allow for prehension of objects of different shapes and sizes (Fig. 7). The thumb becomes more involved to grasp objects, using all four fingers against the thumb (a "scissors" grasp) at 8 months, and eventually to just two fingers and thumb (radial digital grasp) at



Figure 2. Asymmetric tonic neck reflex (ATNR). The sensory limb of the ATNR involves proprioceptors in the cervical vertebrae. With active or passive head rotation, the baby extends the arm and leg on the face side and flexes the extremities on the contralateral side (the "fencer posture"). There also is some subtle trunk curvature on the contralateral side produced by mild paraspinous muscle contraction.

9 months. A pincer grasp emerges as the ulnar fingers are inhibited while slightly extending and supinating the wrist. Voluntary release is awkward at first, with all fingers extended. By 10 months of age, infants can release a cube into a container or drop things onto the floor. Object permanence reinforces the desire to practice this skill over and over. Intrinsic muscle control develops to allow the isolation of the index finger, and infants will poke their fingers into small holes for exploration. By 12 months of age, most infants enjoy putting things into containers and dumping them out repeatedly. They also can pick up small pieces of food with a mature pincer grasp and bring them to their mouths.

As infants move into their second year, their mastery of the reach, grasp, and release allows them to start using objects as tools. Fine motor development becomes more closely associated with cognitive and adaptive development, with the infant knowing both what he or she wants to



Figure 3. Positive support reflex. With support around the trunk, the infant is suspended, then lowered to touch the feet gently on a flat surface. This produces reflex extension at the hips, knees, and ankles so the infant stands up, completely or partially bearing weight. Mature weight-bearing lacks the rigid quality of this primitive reflex.

do and how he or she can accomplish it. Intrinsic muscle refinement allows for holding flat objects, such as crackers or cookies. By 15 months of age, voluntary release has developed further to enable stacking of three to four blocks and releasing small objects into containers. The child starts to adjust objects after grasping to use them properly, such as picking up a crayon and adjusting it to scribble spontaneously (18 months of age) and adjusting a spoon to use it consistently for eating (20 months of age).

In subsequent years, fine motor skills are refined further to draw, explore, problem-solve, create, and perform self-help tasks. By age 2 years, children can create a six-block tower, feed themselves with a spoon and fork, re-

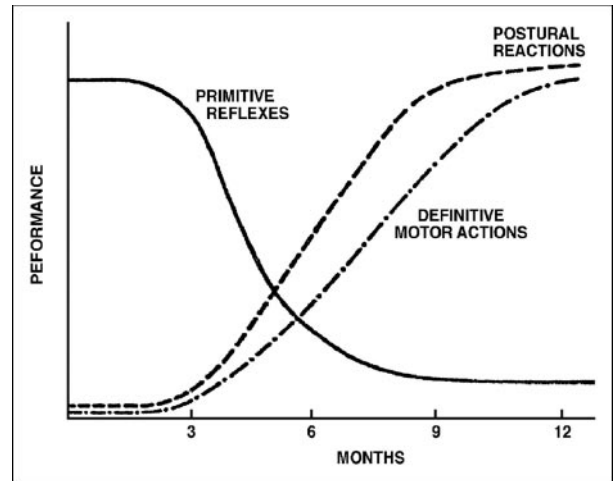


Figure 4. The declining intensity of primitive reflexes and the increasing role of postural reactions represent at least permissive, and possibly necessary, conditions for the development of definitive motor reactions. Reproduced with permission from Johnson CP, Blasco PA. Infant growth and development. *Pediatr Rev.* 1997;18:225–242.



Figure 5. Lateral protection. In the seated position, the child is pushed gently but rapidly to one side. The reaction is present if the child puts out his or her hand to prevent a fall.

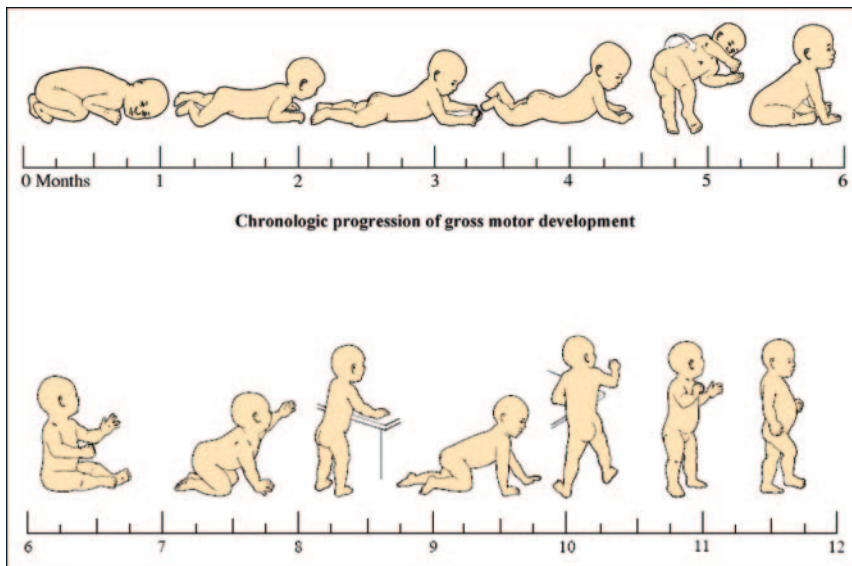


Figure 6. Chronologic progression of gross motor development during the first 12 postnatal months. Reproduced with permission from Johnson CP, Blasco PA. Infant growth and development. *Pediatr Rev.* 1997;18:224–242.

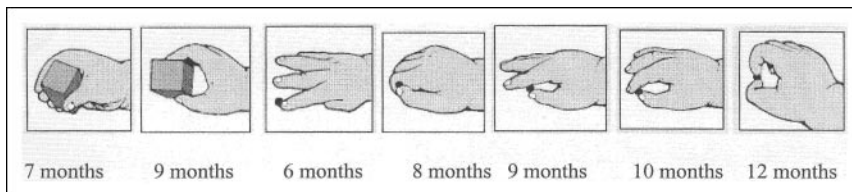


Figure 7. Development of pincer grasp. Illustrations from the Erhardt developmental prehension. In Erhardt RP. *Developmental Hand Dysfunction: Theory Assessment, Treatment.* 2nd ed. San Antonio, Tex: Therapy Skill Builders; 1994. Reprinted with permission.

Table 2. **Motor Red Flags**

Age	Red Flag
4 months	Lack of steady head control while sitting
9 months	Inability to sit
18 months	Inability to walk independently

move clothing, and grasp and turn a door knob. They have sufficient control of a crayon to imitate both vertical and horizontal lines. In-hand manipulation skills permit them to rotate objects, such as unscrewing a small bottle cap or reorienting a puzzle piece before putting it in place. They are able to wash and dry their hands. By 36 months of age, they can draw a circle, put on shoes, and stack 10 blocks. They make snips with scissors by alternating between full-finger extension and

flexion. Their grasp and in-hand manipulation skills allow them to string small beads and unbutton clothes.

At age 4 years, a palmar tripod grasp allows for finer control of pencil movements, and the child can copy a cross, a square, and some letters and numerals and can draw a figure of a person (the head and a few other body parts). Scissor skills have progressed to permit the cutting of a circle. When a child reaches the age of 5 years, he or she can dress and undress independently, brush the teeth well, and spread with a knife. More precise in-hand manipulation skills enable the child to cut a square with mature scissor movements (independent finger use) and to print his or her own name and copy a triangle using a mature tripod pencil grasp (using the fingers to move the pencil rather than the forearm and wrist).

Developmental Red Flags

As the clinician performs developmental surveillance, the absence of certain key milestones in a patient should raise the level of concern. Table 2 lists the developmental red flags specific to the motor domain. If one of these red flags is discovered, a medical and more thorough developmental evaluation is warranted.

Although reported in this article in isolation, motor

skills development overlaps significantly with the other streams of development.

Summary

- The development of motor skills is critical for a child to move independently and to interact with his or her environment meaningfully and usefully. Skills develop in a cephalic-to-caudal progression and from proximal to distal. Thus, consistent head support occurs before voluntary control of arms and legs, and large muscle control of the upper arms occurs before small, intrinsic muscle control in the hands.
- Skills also progress from generalized responses to stimuli (primitive reflexes) to goal-oriented, purposeful actions with ever-increasing precision and dexterity.

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Suggested Reading

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PIR Quiz

Quiz also available online at <http://pedsinreview.aappublications.org>.

1. An 18-month-old girl is seen for a health supervision visit. Her mother has no concerns regarding her daughter's development. Her growth parameters are at the 25th percentile. She walks well, climbs onto her mother's lap, and whispers a few words to her mother. The *best* next step in the evaluation of this child's development is:
 - A. Full developmental surveillance.
 - B. Further evaluation of language skills.
 - C. Implementation of a developmental screening tool.
 - D. Review of developmental milestones with the mother.
 - E. Scheduling of a visit for full developmental assessment.
2. A 6-month-old infant is unable to roll from back to front or bring hands to midline. The *most* likely cause of this infant's difficulty is:
 - A. Absence of lateral protection postural reaction.
 - B. Absence of protective extension reaction.
 - C. Persistence of asymmetric tonic neck reflex.
 - D. Persistence of Moro reflex.
 - E. Persistence of positive support reflex.
3. A 15-month-old typically developing girl is able to release cubes into a cup and has a mature fine pincer grasp. She *most* likely also is able to:
 - A. Build a tower of three blocks.
 - B. Copy a vertical line.
 - C. Feed herself with a spoon and fork.
 - D. Put on her shoes.
 - E. Turn a doorknob.
4. An 18-month-old typically developing boy can walk well and run. He *most* likely also is able to:
 - A. Jump with two feet off the ground.
 - B. Kick a ball.
 - C. Pedal a tricycle.
 - D. Stoop and pick up a toy.
 - E. Toe-walk.

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