



NCC Pediatrics Continuity Clinic Curriculum: Development I-V Faculty Guide

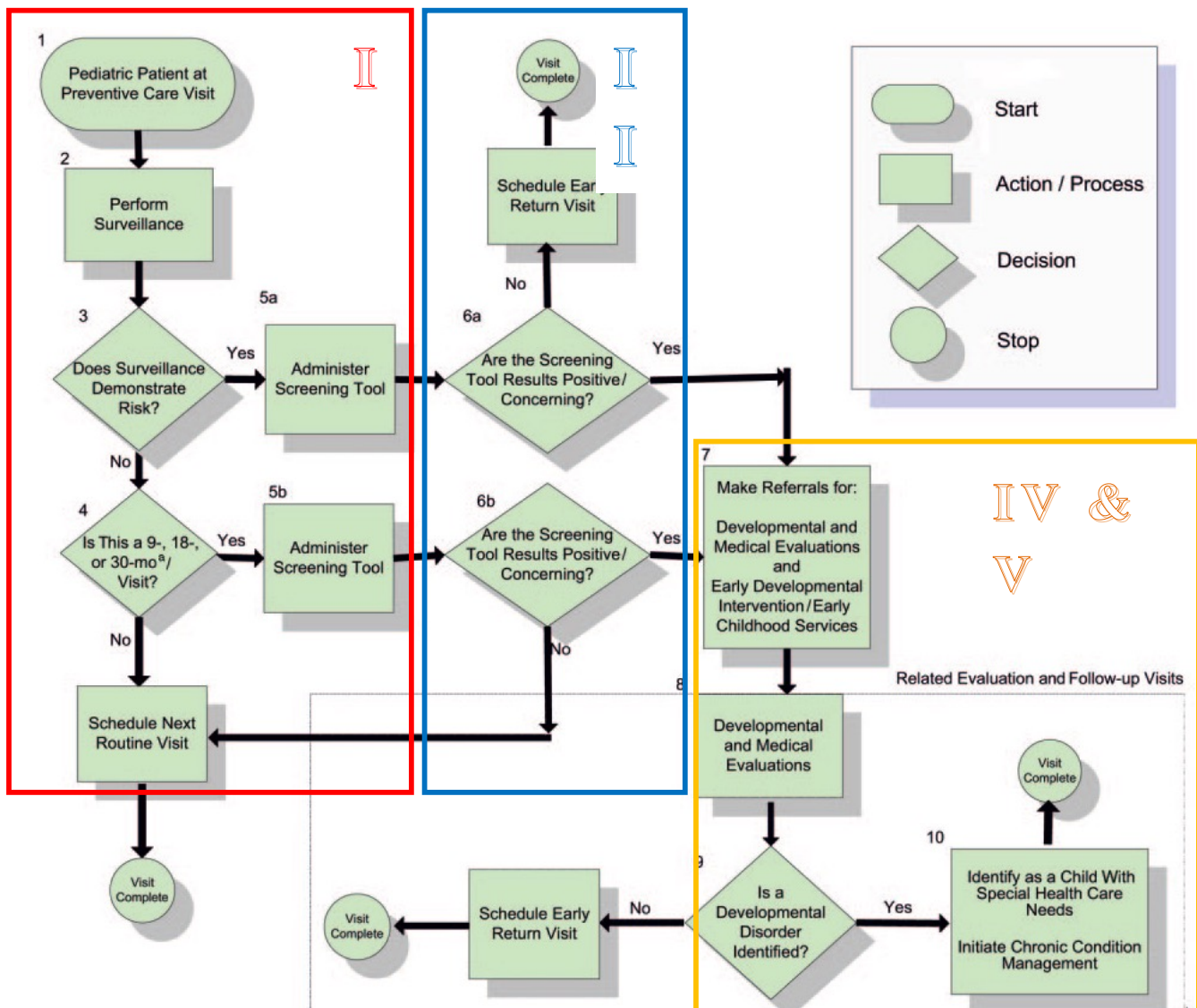


Overall Goal:

Understand the proper use of developmental surveillance in the pediatric office, to include developmental screening, school readiness, & use of community resources. (*Graphic from AAP Policy Statement on Developmental Screening & Surveillance— See Extra Credit*).

Overall Objectives:

- **Devo I: Typical Development**
- Devo II: Atypical Development
- Devo III: “K.I.D.S. Game”
- Devo IV: Psycho-educational Testing
- Devo V: Developmental Interventions & Services





NCC Pediatrics Continuity Clinic Curriculum: **Development I: Typical Development** Faculty Guide



Pre-Meeting Preparation:

Please read the following enclosures:

- Developmental Milestones: Motor Development (*PIR 2010*)
- Developmental Milestones: Cognitive Development (*PIR 2010*)
- Developmental Milestones: Social-Emotional Development (*PIR 2011*)

Skim the following links:

- [Developmental Milestones \(*PIR 2016*\)](#) and [Birth to 5-Watch Me Thrive](#)

NOTE: in your reading for this module, focus on developmental norms (rather than red flags)

Conference Agenda

- Complete Development I Cases
- **“Guess the SWYC”:** Divide yourselves into groups of 1-3 residents. There will be completed SWYC tools on the table, with the ages blacked-out. **Determine the age-range of your SWYQ, the score of your example patient, and your A&P based on that score.** Present your findings to the entire continuity group.
- [SWYC Main Page](#) (includes questionnaires for all ages, tutorials, scoring "cheat sheet")

Our clinic has shifted from the ASQ tool to the SWYC tool in the past year. Briefly compare/contrast tools.

Extra-Credit:

- Articles:
 - [Comparative Accuracy of Developmental Screening Questionnaires](#) (*JAMA Peds, April 2020*)
 - [Select Articles On Child Developmental During the COVID Pandemic](#)
- Parent Resources:
 - [Zero to Three](#): website, with links to 9 age-based parent handouts
 - [Promoting Child Development \(Chapter from Bright Futures Guidelines\)](#) (*Overview of Devo, Behavior, and Adolescent modules*)
 - [Birth to 5 - Watch Me Thrive - Families](#)
- AAP Resources:
 - [AAP Policy Statement on Developmental Screening & Surveillance](#)
 - [AAP Bright Futures](#) (homepage, includes digital Bright Futures Pocket Guide)

Developmental Milestones: Motor Development

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Author Disclosure
 Drs Gerber, Wilks, and
 Erdie-Lalena have
 disclosed no financial
 relationships relevant
 to this article. This
 commentary does not
 contain a discussion
 of an unapproved/
 investigative use of a
 commercial
 product/device.

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 • Fussies 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-

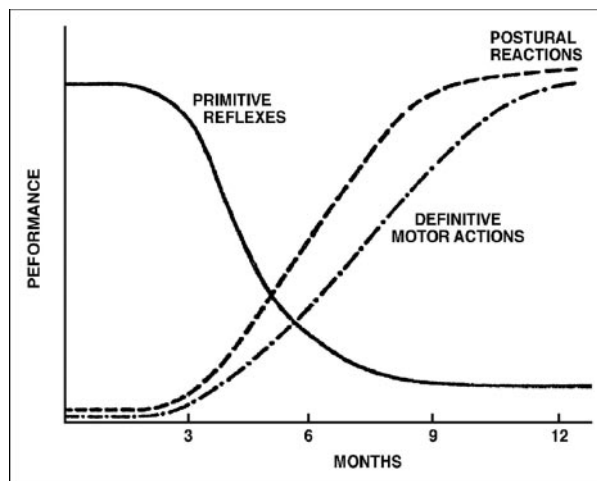


Figure 4. The declining intensity of primitive reflexes and the increasing role of postural reactions represent at least permissive, and possibly necessary, conditions for the development of definitive motor reactions. Reproduced with permission from Johnson CP, Blasco PA. Infant growth and development.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

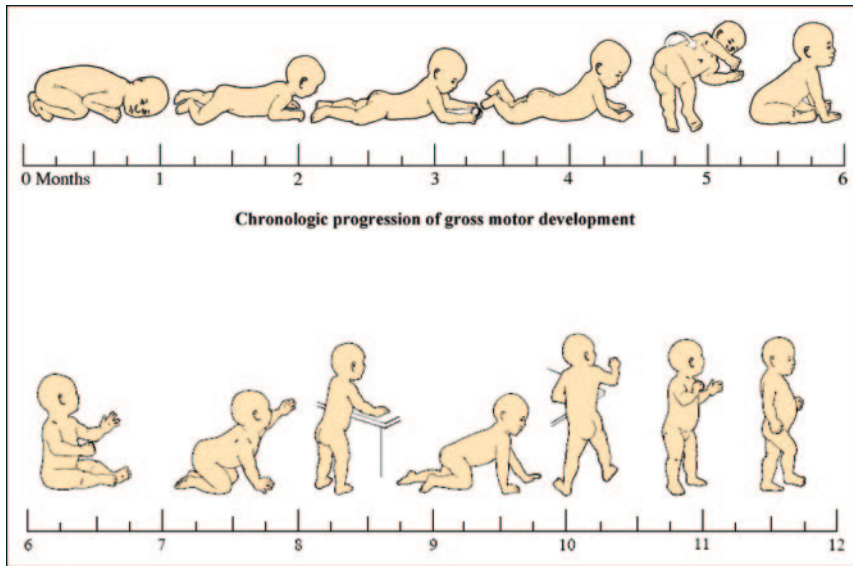


Figure 6. Chronologic progression of gross motor development during the first 12 postnatal months. Reproduced with permission from Johnson CP, Blasco PA. Infant growth and development. *Pediatr Rev.* 1997;18:224–242.

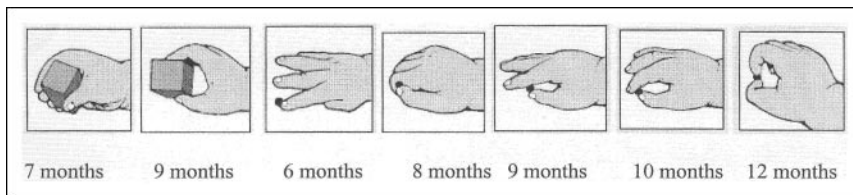


Figure 7. Development of pincer grasp. Illustrations from the Erhardt developmental prehension. In Erhardt RP. *Developmental Hand Dysfunction: Theory Assessment, Treatment.* 2nd ed. San Antonio, Tex: Therapy Skill Builders; 1994. Reprinted with permission.

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 devel-

opmental 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.

Developmental Milestones: Cognitive Development

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Drs Wilks, Gerber, and
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disclosed no financial
relationships relevant
to this article. This
commentary does not
contain a discussion
of an unapproved/
investigative use of a
commercial
product/device.

Objectives After completing this article, readers should be able to:

1. List the foundational aspects of cognitive development.
2. Characterize object permanence, causality, and symbolic thinking.
3. Discuss the steps of problem-solving development.
4. Describe methods of assessing language development.
5. Review language milestones.

This is the second in a series of three articles on normal infant and child development. The previous article covered the acquisition of motor milestones. This article focuses on cognitive development. Social-emotional development will be discussed in the final article.

Introduction

Infant and child development relies on significant interdependence of the developmental streams. The infant who is concentrating on gross motor control while sitting is unlikely to be able to explore an object's detail or advance his or her manipulation of objects. The clinician must appreciate the total developmental progression of a child while also understanding the patterns of development expected within individual developmental streams. Such improved understanding of development can assist in the pediatrician's surveillance of a child's progress but will not substitute for a systematic developmental screening program, as outlined in recent American Academy of Pediatrics (AAP) Practice Guidelines. The complete table of developmental milestones is included in the online version of this article for reference (Table 1). The table is printed in the previous article of this series (*Pediatrics in Review*. 2010;31:267–277).

Cognitive Development

Cognitive development is the foundation of intelligence. The dictionary defines intelligence as the ability to learn or understand or to deal with new situations. In reality, intelligence is a broad concept that involves multiple factors and is incompletely understood. The best efforts to quantify this concept come through use of standardized intelligence tests that attempt to measure multiple areas, such as problem-solving, language, attention, memory, and information processing. Scores in these domains are used to determine specific subset strengths and weaknesses in addition to a composite score. The subset scores and composite score do not represent the individual in isolation accurately and require careful analysis. Accurate interpretation of intelligence testing requires more than a casual understanding of normal ranges.

Standardized intelligence testing is not available for infants. Therefore, the assessment of infant and child intelligence depends on progression through two developmental domains: problem-solving and language. Children advance through these domains by learning. Learning requires the ability to direct and to sustain attention as well as the ability to manipulate information.

The foundational aspects of cognitive development include memory, representational competence, attention, and processing speed. Successful cognitive development requires progress in all these domains. Memory involves the proper encoding, storing, and

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retrieving of information. Representational competence is the ability to create and manipulate a mental image of an object or idea that is not seen. Appropriate advancement in the control of attention—learning how to focus and shift focus—also is important. Processing speed may be the central limiting factor of intelligence because it links the other functions together.

Developmental Theory

Many theorists have tried to create a framework to understand better the cognitive development of infants and children. No categorization of developmental stages has been able to describe accurately what parents have been observing for centuries. The current overarching construct is that infants are not merely passive learners; they are very active in the observation and modification of their environment. Learning is a product of this observation and occurs when there is disequilibrium of assimilation (taking in information) and accommodation (revising existing mental structures). The cognitive development of an infant is no less predictable than the motor development described in the first article of this series. The progression, however, is more subtle, and child behavior often is mistaken as abnormal rather than evidence of advancement to a new developmental stage.

Object permanence is one of the subtle developments and is not an all-or-nothing phenomenon. It may be most noticeable around 9 to 10 months of age, when the infant understands that his mother still exists even when she is not visible. The object permanence is not yet mature enough, however, to allow the infant to make a judgment about where the mother might be when she is not visible, so he cries and demonstrates separation anxiety. By 15 to 18 months, the toddler's understanding has matured, and he will be able to make predictions regarding the mother's location. Rather than crying when separated, the child will use advancing motor skills to seek her out. Object permanence allows him to form concepts and ideas about things, even if the items themselves cannot be seen, and then to create schemes for relating to objects encountered in the future. For example, successfully interacting with a cup involves use of different skills than throwing a ball. The toddler's early organizational ability also allows him to separate objects into language-specific categories.

Causality refers to the infant's gradual understanding of her role in changing or acting on her environment. The infant discovers that she can use objects to her benefit; she even can use her voice to make objects (eg, her parents) respond in ways that directly meet her needs or wants (eg, being picked up). Her actions become

increasingly more intentional. Between 4 and 8 months of age, she purposefully begins to repeat effects that were discovered accidentally. For example, a random kick causes toys hanging over her activity mat to move, so she kicks again. Eventually, she will try different interactions to see what effects she can create.

Symbolic thinking allows for expansion of play by using one object to represent another object. The toddler may use blocks as cars and often reenacts past events. The toddler may “cook” his favorite food in a toy kitchen and use paper to represent his “food.” Imitation of the actions of others is an important part of play, and his food preparation reflects what he sees his caregivers do for him.

Object permanence, causality, and symbolic thinking are fundamental concepts in the current understanding of cognitive development. Such foundational skills combine with a toddler's gross and fine motor advancement to permit the ability to problem-solve and develop language.

Problem-solving

Problem-solving involves the manipulation of objects to achieve a specific goal. An infant's first exploration of her environment is performed visually. At first, the infant is able to follow a face and then objects. Tracking starts with horizontal and vertical movements but soon advances to tracking circular motion. Three-dimensional awareness and response is seen at 3 months, when an infant reacts to a visual threat. Initially, the infant only regards and stares intently, but as she gains improved control of her arms and hands, she begins batting at and reaching for objects. She begins to inspect items placed in her hand visually and by mouthing as a means of environmental exploration. As hand control improves, she is able to hold an object in one hand while manipulating it with the other. At around 5 months of age, her vision has matured to allow her to focus on smaller objects. Her attempts to pick them up help develop a pincer grasp and eventually lead to isolation of her index finger, which allows her to explore objects by poking.

With maturation of object permanence and causality, the toddler begins to play in earnest. She bangs objects and delights in the sound they make as well as in the reactions from her caregivers. When she drops something from her high chair, she is able to look down for it. Her attention span continues to increase, and she is able to work on obtaining objects that initially are partially hidden and then hidden completely. She works on removing lids and formulating different strategies for obtaining objects out of her reach. She soon begins to learn

through her manipulation instead of merely learning how to manipulate.

Language Development

Language is a broad concept that involves the representation of thoughts and ideas using culturally agreed-upon arbitrary signals for the exchange of ideas. Language encompasses both expressive and receptive processes. Language skills are the single best indication of intellectual ability, and evidence exists that early language skills are related to later reading skills. In fact, among school-age children who have specific language impairments, up to 50% also have a learning disorder involving reading.

Clinicians often assess language development incompletely by asking how many words a child knows, but speech, or vocal communication, is only one form of expressive language. Other forms include the use of gestures, manual signs, facial expressions, body postures, pictures, diagrams, and written symbols. Each of these has a strong cultural overlay, although some, such as facial expressions, can be understood more universally. The production of speech is a specific motor skill and requires complex control of air flow, mouth shape, and tongue position. Impairments in motor planning and execution or anatomic abnormalities can impair speech yet spare other language abilities. A hearing-impaired child using manual sign language can demonstrate normal expressive language without the use of speech. Rather than asking parents how many words their child uses, an alternative question is, “How does your child communicate with you?” The question can be clarified to ask how the child shows displeasure or happiness or requests a want or a need.

Receptive language is the ability to understand communication. It is evaluated most often by a response to a request or question. However, a request to perform a gross motor task by the child who has gross motor impairment, such as cerebral palsy, may give a false impression of a child’s receptive language skills. A more useful method of assessing receptive language is to ask how the child responds to parental communication. Language and social development are largely intertwined, and conversations regarding communication help the clinician survey both developmental domains.

Language development is molded by the type of interactions the infant has with his environment. Although the ability to learn language is innate, environmental exposure to language is essential. For example, an infant who has a significant hearing impairment can startle to sound, laugh, and even babble. The hearing

impairment would be easily missed by using observational measures alone, highlighting the importance of systematic hearing screening programs. With intervention by 6 months of age (eg, with hearing aids), language outcomes in children who have hearing impairments are similar to children who have no hearing deficits, emphasizing that exposure to language is the key to language development. The importance of language exposure is demonstrated most strongly and simply by children beginning to speak the language they hear, despite being born with the ability to learn any language. Children in Spanish-speaking homes learn to speak Spanish, not Russian. Ideally, the language to which they are exposed should be as rich and diverse as possible. Multiple studies have demonstrated that a robust linguistic environment is critical to language development. It is estimated that by the time a child starts kindergarten, the difference in word exposure between socioeconomic groups may be as much as 32 million words, making low socioeconomic status a risk factor for poor language development.

Interventional approaches, such as reading to infants and children, try to counter this risk by promoting increased frequency and complexity of linguistic exposure. Other, less successful strategies have involved “educational” videos. These videos fail to understand the interdependence of language and social development. Conversational turn-taking and appropriate communicative interaction is not provided through video or television media; these crucial aspects can be provided only by interactions with people who are present and responsive.

Language Milestones

Infants communicate long before they speak their first words or phrases. At birth, crying is the primary form of communication. It is nonspecific but very effective in initiating a response from a caregiver. Expressive communication then progresses through cooing and babbling. In a trial-and-error process, the infant begins making vowel and consonant sounds that she can put together into “mama” and “dada” by 9 months of age. Although she is not using the words discriminately, if her caregivers respond to the sounds she makes, she will continue to use them. As her attempts to communicate become more precise and the outcome more predictable, by her first birthday she can say her first word and can point to communicate a request. The first words attained often are labels for things with which the infant commonly interacts. There is great variety among children of the same age as to what words they use, emphasizing the importance that environmental stimulus plays in language development.

By 15 months, the toddler is able to give a clear “no” with a headshake. His ability to imitate sounds increases, and he can repeat an entire word and even mimic environmental sounds. By 18 to 24 months of age, he is starting to use pronouns such as “me,” and his vocabulary has expanded to 50 words. New words are learned quickly, and he begins to combine them into two-word phrases (noun + verb). He now is able to communicate basic wants (“more drink”) and social interest (“bye, mama”). Between 2 and 3 years of age, his vocabulary continues to increase, and the phrases he uses increase to 3 to 4 words in length. He begins asking “what” questions frequently. His ability to pronounce words also has improved, and by 2 years of age, at least 50% of his speech is understandable to a stranger. At 3 years of age, 75% is understandable, and the beginning of the “why” questioning occurs. He is able to tell others what he did while they were apart. His sentence structure continues to gain complexity, and by 4 to 5 years of age, his speech is completely understandable to strangers.

Although the infant’s expressive communication is more observable, receptive language skills also are present at birth. A neonate shows preference for voices and interest in faces. She will begin to turn toward sound. Early evidence of receptive language ability is her response to “no” and to her name. Once she can isolate her index finger she can work on pointing. By 12 to 15 months, she can point to body parts and familiar objects when named. Her understanding of grammar increases, and she is able to understand pronouns by 18 to 24 months. By 2 to 3 years of age, she can answer questions, understands the concept of “one,” and follows two-step commands. Her natural ability to categorize has matured, and by 3 to 4 years, she can point to an object in a requested category rather than just by name. She understands much of what is said, including negatives. Her ability to follow complex instructions continues to improve as she begins to prepare for early school experiences.

Developmental Red Flags

At every pediatric encounter, some form of developmental surveillance occurs. The interaction of the child with the caregiver or examiner often is measured against what is expected. Such surveillance may include questions regarding specific developmental milestones, but it does not substitute for developmental screening using standardized instruments. Recognition of certain key developmental red flags is important, however. Table 2 lists red flags specific to the cognitive domain. If a red flag is

Table 2. Cognitive Red Flags

Age	Red Flag
2 months	Lack of fixation
4 months	Lack of visual tracking
6 months	Failure to turn to sound or voice
9 months	Lack of babbling consonant sounds
24 months	Failure to use single words
36 months	Failure to speak in three-word sentences

discovered during an examination, a developmental and medical evaluation is indicated. Early developmental intervention services also may be warranted. Although it may be appropriate to use developmental screening tools to uncover additional areas of concern, these tools should not take the place of a developmental and medical evaluation. Additional information on using screening instruments and performing developmental surveillance can be found in the Recommended Reading (AAP Policy Statement: Identifying Infants and Young Children with Developmental Disorders in the Medical Home: An Algorithm for Developmental Surveillance and Screening).

Conclusion

The cognitive development of a child is an exciting process for both the child and the parents. The child demonstrates remarkable skills in communication and problem-solving. Such skills are not isolated and are demonstrated best in the context of the child’s social and emotional development. The next article in this series will describe that domain, completing the picture of normal development.

Suggested Reading

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Developmental Milestones 3: Social-Emotional Development

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Author Disclosure
 Drs Gerber, Wilks, and
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 disclosed no financial
 relationships relevant
 to this article. This
 commentary does not
 contain a discussion
 of an unapproved/
 investigative use of a
 commercial
 product/device.

Objectives After completing this article, readers should be able to:

1. Know the sequence through which social abilities develop in the infant and young child.
2. Understand the concept of joint attention.
3. Be aware of the ways in which infants and young children mature in their emotional development.
4. Recognize when a child is not achieving the appropriate social or emotional milestones and requires further evaluation.

This is the third and final article in a series on developmental milestones. Previous articles have focused on motor and cognitive aspects of development. As has been mentioned, developmental skills are interrelated and do not evolve in isolation. Problem-solving, language, and fine motor skills all are required for an infant to develop normal social-emotional skills.

Social Milestones

Most children are born with an inherent drive to connect with others and share feelings, thoughts, and actions. The earliest social milestone is the bonding of a caregiver with the infant, characterized by the caregiver's feelings for the child. The infant learns to discriminate his mother's voice during the first month after birth. He cries to express distress from hunger, fatigue, or a wet diaper. Attachment theory suggests that as the caregiver responds to these cries and other behaviors, the infant gains confidence in the caregiver's accessibility and responsiveness. This behavior system promotes the parent-child relationship that some researchers believe facilitates parental protection, and thus infant survival. From this relationship comes the first measureable social milestone: the smile.

The infant smiles at first in response to high pitched vocalizations ("baby talk") and a smile from his caregiver; but over time, less and less stimulation is required. Ultimately, just seeing the caregiver elicits a smile. The infant learns that he can manipulate the environment to satisfy personal needs by flashing a toothless grin or, alternatively, by crying. His interactions then begin to involve to-and-fro vocalizations by 4 months. Visual skills develop as well, and he can recognize his caregivers by sight at 5 months. Stranger anxiety, or the ability to distinguish between familiar and unfamiliar people, emerges by 6 months. Whereas the 4-month-old infant smiles at any adult, the slightly older infant cries and looks nervously between his caregiver and other adults.

Joint attention is the quintessential social milestone that develops towards the end of the first year after birth. Joint attention is the process whereby an infant and caregiver share an experience and recognize that the experience is being shared. The earliest demonstration of joint attention occurs around 8 months of age, when an infant follows a caregiver's gaze and looks in the same direction. In a few months, the infant looks back at the caregiver as an indication of a shared interaction. The infant consistently turns her head to the speaker when her name is called by 10 months, further demonstrating a connectedness with her environment.

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Between 12 and 14 months, children begin to point to request something (proto-imperative pointing), and they usually integrate this pointing with eye contact directed between the object of interest and the caregiver, sometimes accompanied by a verbal utterance. Proto-imperative pointing then proceeds to proto-declarative pointing by 16 months of age, characterized by the child pointing at something merely to indicate interest. Again, the pointing is accompanied by eye contact directed between the object and the caregiver. By 18 months, he brings objects or toys to his caregivers to show them or to share the experience. The online version of this article has several [video clips](#) that demonstrate these core joint attention skills.

Play skills also follow a specific developmental course. Initially, an infant holds blocks and bangs them against each other or on the table, drops them, and eventually throws them. Object permanence allows her to realize that the blocks are still present, even if she cannot see them. She learns that dropping the blocks from her highchair will cause her caregiver to pick them up and return them to her; so she repeats this “game” over and over. As fine motor and cognitive skills develop, she starts to use objects for more specific purposes, such as using those blocks to build a tower. By 18 months, she engages in simple pretend play, such as using miniature representative items in a correct fashion. For example, she pretends to talk on a toy phone or “feeds” a doll by using a toy spoon or bottle.

After his second birthday, the child begins to play with others his own age. A rule of thumb is that a child can play effectively only in groups of children in the same number as his age in years. Thus, a 2-year-old can play well only with one other child. Two-year-old play often is described as “parallel” because a child of this age often plays next *to* another child but not with him. However, the 2-year-old frequently looks at his playmate and imitates his actions. He has not yet mastered the skill of cooperation; so aggression often is the tool of choice to obtain a desired object.

By 30 months, the child uses complex pretend play, such as using generic items to represent other objects. A block may be used as a telephone in one scenario or used as a bottle to feed a doll in another. The scenarios themselves also increase in complexity, from merely feeding the doll to dressing the doll and putting her to “sleep.”

By age 3 years, a child has mastered her aggression to some extent, and she is able to initiate a cooperative play experience with one or two peers. Most of the time, they are able to have joint goals and take turns. She also moves

into simple fantasy or imaginative play. She may pretend to be a dog or an airplane. However, she cannot yet distinguish between what is real and what is make-believe; so fear of imaginary things is common at this time.

Four-year-olds usually have mastered the difference between real and imaginary. They become interested in tricking others and concerned about being tricked themselves. They are able to play effectively with up to three other children, although some may have a preferred friend. Imaginary scenarios increase in complexity: a cardboard box may become a sailboat, and toilet paper rolls may become binoculars.

By age 5, children have learned many adult social skills, such as giving a positive comment in response to another’s good fortune, apologizing for unintentional mistakes, and relating to a group of friends. Their imaginative play is increasingly more complex, and they love to dress up and act out their fantasies. Kindergarten classrooms usually are well-equipped with toys that promote this imaginative play.

Emotional Milestones

Coinciding with the development of social skills is a child’s emotional development. As early as birth, all children demonstrate individual characteristics and patterns of behavior that constitute that individual child’s temperament. Temperament influences how an infant responds to routine activities, such as feeding, dressing, playing, and going to sleep. There seems to be a biologic basis to these characteristics, although how a child learns to regulate her emotional state also depends on the interactions between child and caregiver. For a more detailed discussion of temperament, please see the Suggested Reading list.

Emotional development involves three specific elements: neural processes to relay information about the environment to the brain, mental processes that generate feelings, and motor actions that include facial expressions, speech, and purposeful movements. The limbic system is responsible primarily for receiving, processing, and interpreting environmental stimuli that produce emotional responses. During development, the repertoire of specific emotions remains constant, but the stimuli that produce them become more abstract.

Studies have demonstrated that three distinct emotions are present from birth: anger, joy, and fear. All infants demonstrate universal facial expressions that reveal these emotions, although they do not use these

Table. **Social-Emotional Red Flags**

Age	Red Flag
6 mo	Lack of smiles or other joyful expressions
9 mo	Lack of reciprocal (back-and-forth sharing of) vocalizations, smiles, or other facial expressions
12 mo	Failure to respond to name when called Absence of babbling
15 mo	Lack of reciprocal gestures (showing, reaching, waving) Lack of proto-declarative pointing or other showing gestures Lack of single words
18 mo	Lack of simple pretend play Lack of spoken language/gesture combinations
24 mo	Lack of two-word meaningful phrases (without imitating or repeating)
Any age	Loss of previously acquired babbling, speech, or social skills

expressions discriminately before the age of 3 months. Cognitive input is not a requirement; anencephalic infants may show disgust with sour flavors and pleasure with sweet flavors, just as normocephalic infants do.

Eventually, however, cognitive skills play a role as emotional expressions become connected to specific occurrences. For example, an 8-month-old infant can let his parents know that he is upset about being left alone in his crib or happy about playing with a toy. Because he now has object permanence, he demonstrates fear in new situations due to the ability to shift attention and recognize “familiar” from “unfamiliar.”

Emotional development continues as the toddler learns to identify different emotions in other people. At 15 months, a child demonstrates empathy by looking sad when she sees someone else cry. She also develops self-conscious emotions (embarrassment, shame, pride) as she evaluates her own behavior in the context of the social environment. Having once performed cute tricks on demand, she suddenly seems embarrassed and refuses to perform when she realizes that others are watching. She may hide behind a chair to have a bowel movement and become upset if someone catches her in the act.

As language skills develop, the child can label different emotional states in others and even associate language with emotions and memory. For example, if he had a tantrum when he didn’t get a toy from the store, he may have an identical emotional outburst when he hears a verbal reminder of the situation. By age 2 years, he starts to mask emotions for social etiquette.

During the preschool years, children learn more and more behavioral strategies to manage their emotions, depending on a given situation. They begin to under-

stand that their expressed emotion—whether a facial, vocal, or behavioral expression—does not necessarily need to match their subjective emotional experience. They demonstrate an increased understanding and use of “display rules.” These are “culturally defined rules that guide a person’s decision to alter emotional behavior consistent with the demands of the social context.” (1)

Children learn to substitute their expressions (smile and say “thank you” even though they are disappointed in the birthday present), amplify expressions (exaggerate a painful response to get sympathy), neutralize expression (put on a “poker face” to hide true feelings), or minimize emotion (look mildly upset when feeling extremely angry). By the time they enter kindergarten, children have started to master many of the emotional nuances of social interactions.

Developmental Red Flags

As in other streams of development, failure to achieve specific milestones in the social-emotional domain should prompt the pediatrician to evaluate a child more thoroughly. The Table lists the developmental red flags specific to the social-emotional domain, although there is some overlap with language and cognitive skills. A lack of age-appropriate joint-attention skills or any loss of previously gained skills warrants screening by using a validated instrument. If abnormal, simultaneous referral to early intervention services as well as to a developmental specialist for a thorough evaluation should be the next step. The Suggested Reading list includes several references to specific autism screening tools, as well as several websites with video clips highlighting the differences in children with autism.

In addition, pediatricians need to be aware of behavioral abnormalities that may stem from temperament and psychosocial factors or may signal the early stages of a behavior disorder. A discussion of these behavior problems is beyond the scope of this article. Please see the Suggested Reading list for more information.

A comprehensive table (Table 2) of developmental milestones in all domains is printed in the first of these three articles (Pediatr Rev. Jul 2010; 31: 267-277) and as a data supplement to this article in the online edition.

Summary

- The development of a child from infancy to preschool years is truly remarkable. As with physical growth, neurodevelopment proceeds in a sequential and predictable fashion that can be observed, measured, and followed over time.
- In a few short years, human beings change from completely helpless creatures who depend entirely on their caregivers, to small beings with independent movement, complex language and problem-solving skills, as well as the ability to interact in positive and productive ways with others.
- Children thus become well-suited for the next phase of development, characterized by academic achievement and more complex problem-solving and thinking skills.
- Developmental milestones provide a valuable framework with which the pediatrician can appropriately evaluate and observe children over time.

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Suggested Websites

- www.firstsigns.org
www.autismspeaks.org

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Development I Cases:

Case 1:

You are seeing 9 month-old Nick in clinic today. He was the product of a full-term uncomplicated vaginal delivery and has, thus far, been developing normally.

What motor skills do you expect him to have at this age?

Gross Motor: “stands” on feet and hands, begins creeping, pulls to stand, bear walks

Fine Motor: radial-digital grasp of cube, brings two cubes together

How would your answers change if he were a 26-week preemie?

Corrected age:

Prematurity: 40 weeks-26 weeks = 14 weeks early (3 mo 2 weeks) →

Chronologic age: 9 mo = 8 mo 4 weeks – 3 mo 2 weeks = **5 mo 2 weeks**

Gross motor: sits with pelvic support, rolls back to front, sits with arms supporting trunk

Fine motor: palmar grasps cube, transfers objects: hand-mouth-hand, reaches for dangling ring

There is no consensus among professionals regarding correcting a child’s age for prematurity, but most pediatricians **correct through 2 years**.

Guided by the prompts on the Tri-Service Work-flow (TSWF) templates, you learn that he sits without support and commando crawls, but does not pull to stand or creep on hands and knees. For fine motor milestones, he has a mature pincer grasp and can point with his index finger.

Other than by parental recall/screening questionnaires, how else can you assess motor development in clinic?

Neurologic exam: tone, strength (weight-bearing in sitting or standing as surrogate marker), DTRs, coordination, station, gait

“Neuromaturational markers”: primitive reflexes (present at birth, disappear btwn 3-6 mo), postural reactions (develop btwn 3-10 mo, persist)

Red flags (will focus on in future modules): persistent fisting @3 mo; frog-legs (hypotonia), scissoring (spastic hypertonia), early rolling at 1-2 mo, etc

Please describe/demonstrate for the group the following primitive reflexes and postural reactions, and fill in the approximate ages of appearance and disappearance (check Harriet Lane):

	Description	Appears	Disappears
Primitive Reflexes	Sudden neck extension	at birth	3-6 months
Moro	→ extension, adduction,		

	and then abduction of UEs		
Asymmetric tonic neck reflex	Rotate head laterally 45-60 degrees → extension of limbs on chin-side; flexion on occiput side	at birth	4-9 months
Postural Reactions		5-6 months	persists
Parachute	Arm extension when falling = facial protection		
Lateral propping	Arm extension laterally in protective response = independent sitting	6-7 months	persists

Flashback: What immunizations should he have received so far?

3 HepB, 3 DTaP, 3 IPV, 3 Rota, 3 Prevnar, 2 Hib

Case 2:

You are seeing 30-month-old Elise in clinic today for a preschool physical. She has an unremarkable past medical history, and normal growth and development thus far. She will be starting a Montessori school, and her mother is concerned about her “pre-academic skills”.

According to the AAP Periodicity Table, what type of developmental assessment should be performed at the 30-month visit? *Are you routinely seeing patients for 30-month visits?*

Developmental screening (vs. surveillance). The AAP recommends that – in absence of established risk factors or parental or provider concern – developmental screening be performed at the 9, 18, and 30 month visits with a standardized tool.

Which developmental milestones best estimate IQ and, in turn, predict school success?

“Language skills are the single best indication of intellectual ability, and evidence exists that early language skills are related to later reading skills.”

What intellectual abilities & language skills do you expect her to have at this age?

Self-help: washes hands, puts things away, brushes teeth with assistance

Problem-solving: replaces circle in foam board, points to small details in pictures

Social/Emotional: imitates adult activities

Receptive language: follows two prepositions, understands action words

Expressive language: echolalia gone, names objects by use, refers to self with correct pronoun

In taking a developmental history, you learn that a French-speaking nanny has cared for your patient since 6 weeks old. **How do your answers for language skills change? (hint: can find answer on UpToDate)**

“Questions often arise about the language development of children reared in bilingual environments. Bilingualism is the ability to speak two languages [54]. Early research that suggested bilingual children were less intelligent than were monolingual children is incorrect. Learning two languages at once does not harm a child's cognitive abilities [55-57]; rather, it enhances them [58-61]. An initial stage of confusion, code-mixing, and comprehension-building for young bilinguals may occur but resolves [62]. At 24 to 30 months of age, bilingual children may intermix vocabulary and syntax from both languages, but vocabulary size, intelligibility, and length of utterance are normal. By 36 months of age, they become fluent bilingual speakers [44]. One should note that single-language scores in one language may not accurately reflect the child's abilities, and direct comparisons across languages and different writing systems are precarious.”

Elise’s mother informs you that Montessori schools emphasize “purposeful play” and “free discovery” within a “prepared environment”. **Assuming your patient is developing normally, what might their play look like at this age?**

“By 30 months, the child uses complex pretend play, such as using generic items to represent other objects. A block may be used as a telephone in one scenario and used as a bottle to feed a doll in another. The scenarios themselves also increase in complexity, from merely feeding the doll to dressing the doll and putting her to “sleep.”

Please define/ demonstrate for the group the following language terms, and their ages:

Language Term	Definition/Example	Age
Razzing	“raspberries”: baby sticks tongue out and blows	5 mo
Babbling	Reduplicative → “bababababa”, variegated → “kadabubamidoy”	6 mo
Immature jargoning	Unintelligible vocalizations, with the same intonations, inflections, and rhythms of speech. “Foreign language”	13 mo
Proto-imperative pointing	Goal = desired object	12 mo
Proto-declarative pointing	Goal = parent’s attention (a “social action” – red flag for autism if absent)	14 mo
Mature jargoning	One or more intelligible words mixed in the gibberish	15 mo
Giant words	“Thank-you”, “Stop it”, “Let’s go”	18 mo
Holophrases	Single-word has sentence-like meaning (“mommy” = “these keys belong to mommy.”)	20 mo
Telegraphic speech	2-3 word phrases with prepositions, pluralization, and adjectives omitted	24 mo

Flashback: What is a major theme in affective development for toddlers and how does this affect their nutrition?

Autonomy and independence. “Struggles over autonomy may occur daily. The toddler may refuse to eat unless allowed to feed him- or herself. In addition, the child no longer may be willing to try new foods, despite parental coaxing.