Normal & Abnormal Infant and Child Development

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Objectives

1. To review some basic principles of child development
2. To discuss major developmental “red flag” milestones in the different “streams” of development
3. Focus on the first 5 years, recognizing that development is lifelong
4. Discuss management of child not reaching milestones

Internal Environment (Nature)

Healthy, Normal Development needs:

- Intact, rapidly growing & developing CNS
  - Cerebral cortex, subcortical structures, cerebellum, spinal cord
- Sensory system
- Muscles

Genetic/Biologic capacity

External Environment

- Family
- Culture
- Language

} we grow up in

- Nature vs Nurture debate
  - Agreement that there is a continuous interplay of genetic capacity and external environment
  - Ongoing discovery re: relative contributions
  - Epigenetics - environment can influence gene expression

Other Environmental Considerations

- Nutrition
- In-utero environment
- +/- toxins, infections, trauma, etc

Developmental Principles

- Individuality
- Developmental Direction
- Continuity & Discontinuity

Individuality

- Each child is unique & develops in his or her own way
- Considerable individual variability in attainment of milestones

Developmental Direction

Physical & motor development follow two patterns:

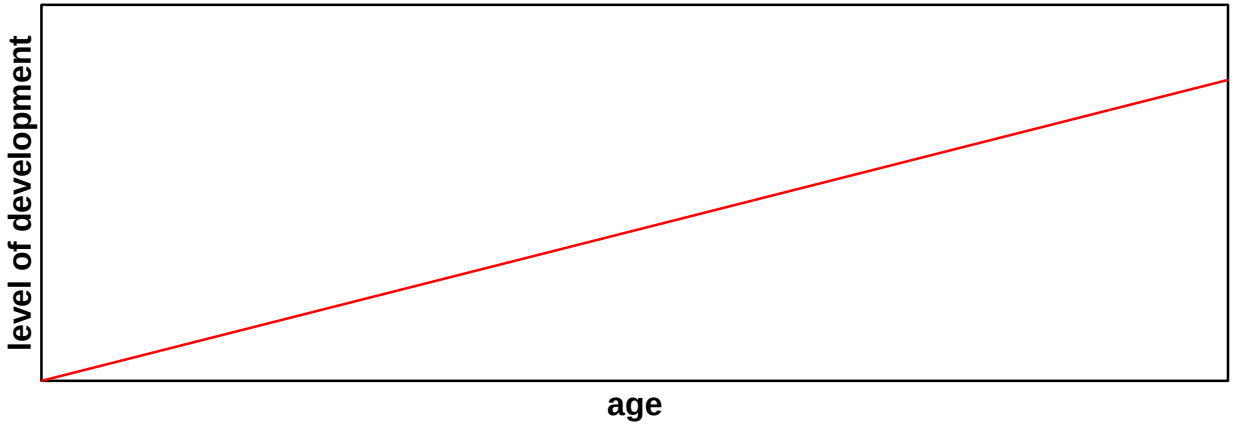
1. Cephalocaudal
2. Proximodistal

Development progresses from simple → complex

Continuity and Discontinuity

Continuous or Quantitative Change

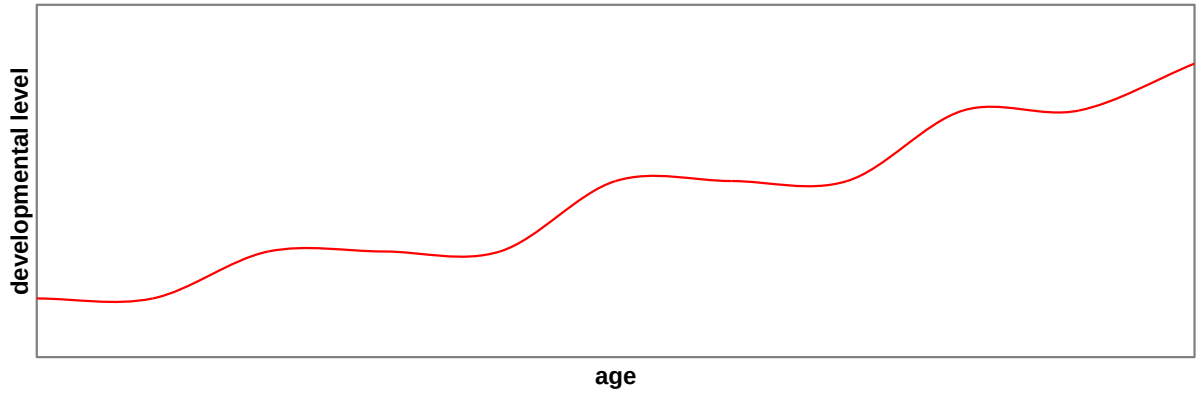
- Gradual accumulation of small changes
- Changes in amount, frequency or degree
  - Eg. Older children can remember more items than younger children



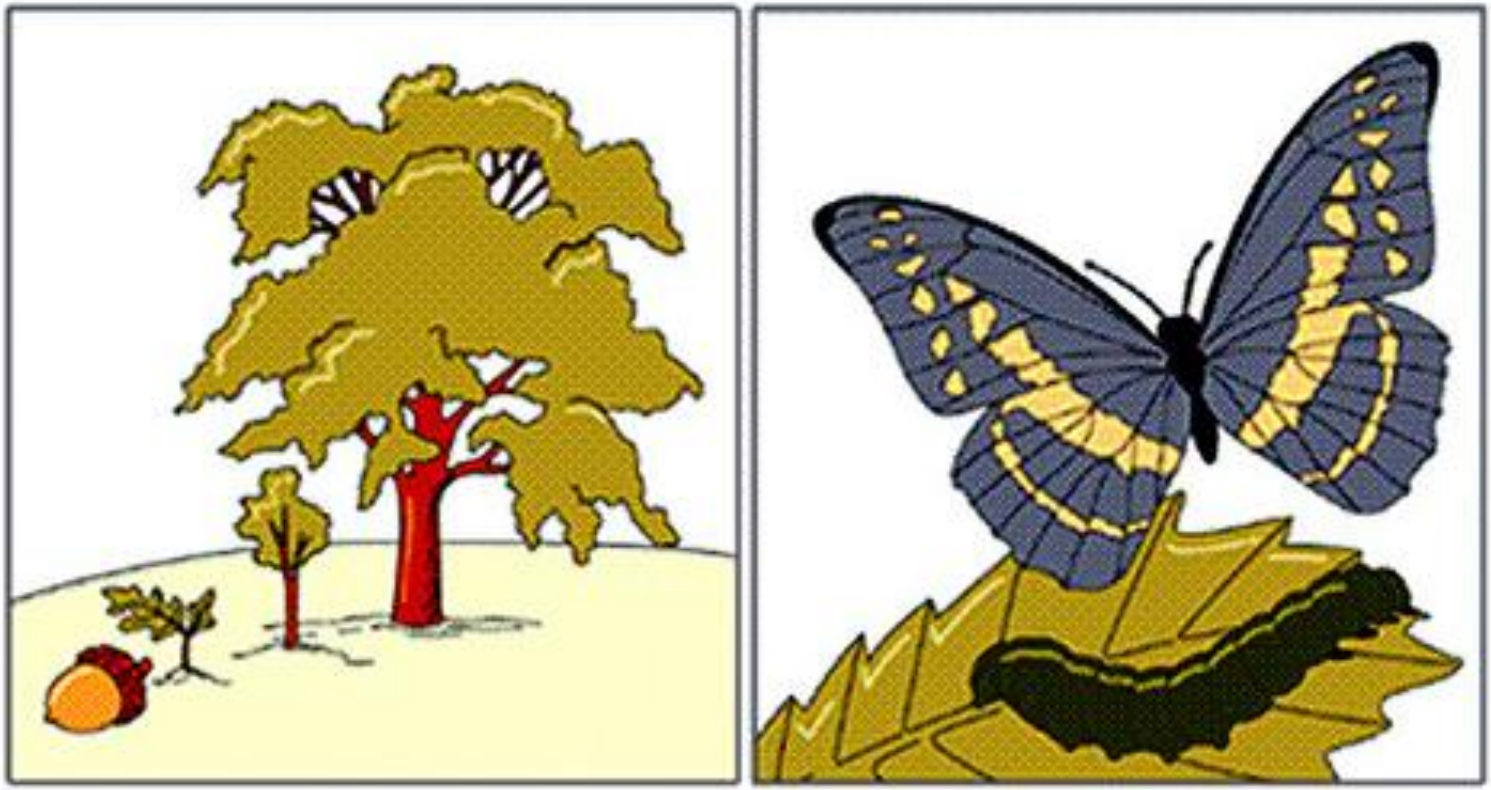
Continuity and Discontinuity

Discontinuous or Qualitative Changes

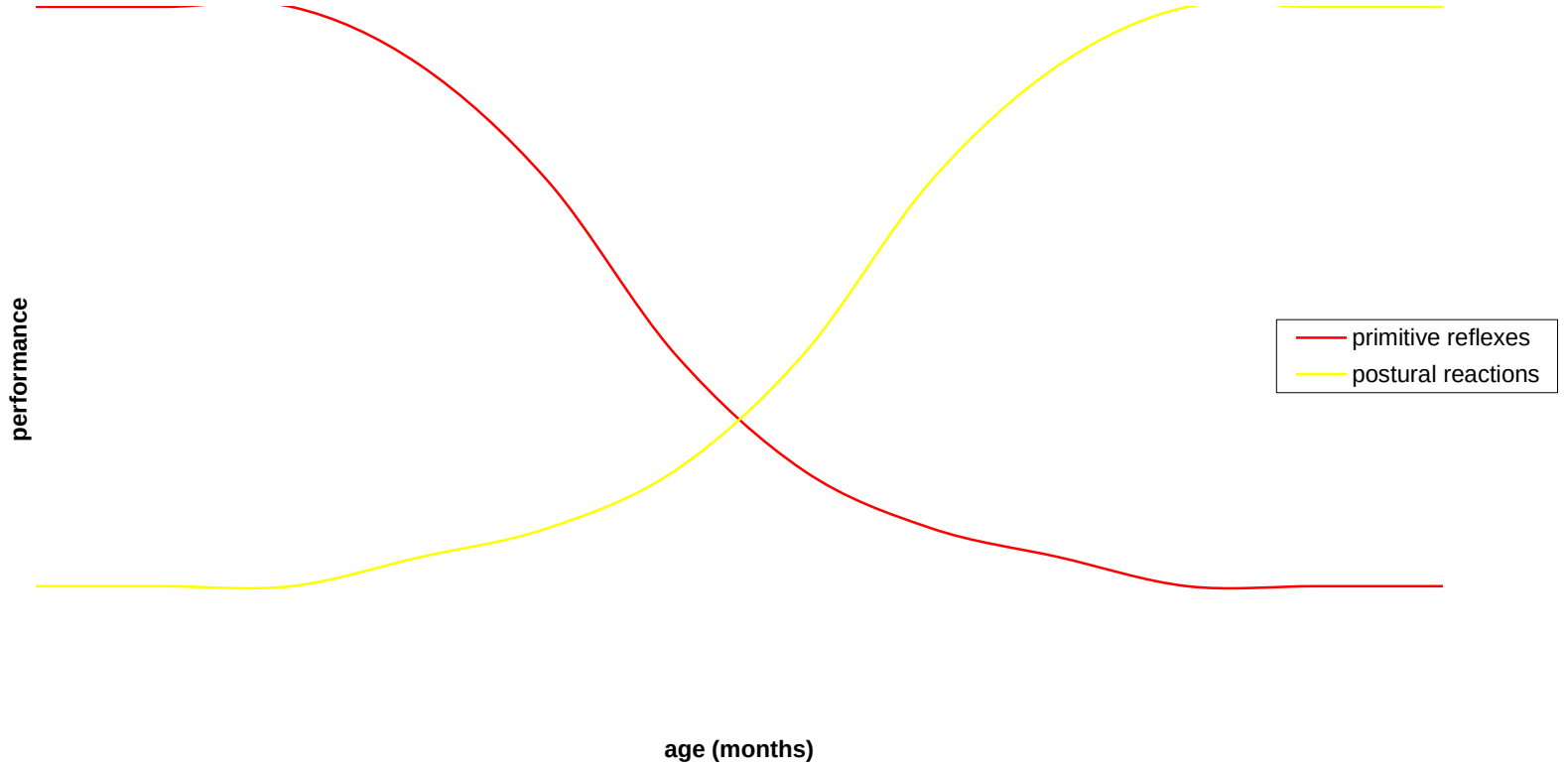
- Abrupt changes that result in qualitative changes in the pattern of development
- Stage-like transformations
- Changes in structure or organization
- Eg. Older children use memory strategies like rehearsal & organization to remember list of items



Continuity and Discontinuity in Development



Primitive Reflexes & Postural Reactions



Primitive Reflexes & Postural Reactions

If a child's primitive reflexes do not disappear, or if postural reactions do not develop → points to abnormality in CNS functioning.

Primitive Reflexes

- Brainstem mediated
- Complex
- Automatic & stereotypical
- Elicited by specific sensory stimuli
- Present at birth in term infants (begin as early as 25wks GA)

Palmar Grasp Reflex

Position: supine

Method: place index finger in infant's palm

Response: flexion of fingers

Disappears:6 months

Plantar Grasp Reflex

Position: supine

Method: press thumb against sole just behind the toes

Response: flexion of toes

Disappears: 10-15 months

Gallant Reflex

Position: prone

Method: scratch the skin of the back from the shoulders downward, 2-3 cm lateral to spinous processes

Response: incurvation of the trunk, concavity on the stimulated side

Disappears: 4 months

Moro

Position: supine

Method: sudden head extension produced by a light drop of the head

Response: abduction followed by adduction and flexion of arms

Disappears:6 months

ATNR

Position: supine

Method: rotation of head to one side for 15s

Response: extension of extremities on chin side & flexion of those on occipital side

Disappears: 3 months

Positive Support Reflex

- *Onset*- birth
- *Method*- contact to the ball of the feet in upright standing position.
- *Response*- Rigid extension , coactions of the lower extremity.
- *Disappears*- 6 months

Others

- Stepping

Suck-root

Plantar Response

Position: supine/sitting

Method: stroke lateral aspect of sole

Response: extension of great toe, fanning of other toes

Disappears: 12 months (often earlier)

Symmetric Tonic Neck Reflex

Position: suspended in prone

Method: passively extension of neck; passive flexion of neck

Response: neck extension results in extension of arms and flexion of legs; neck flexion produces arm flexion & leg extension

Disappears: 6 months

Postural Reactions

- Characterized by stereotyped posture of the trunk, head and extremities
- Occur in response to a strictly defined sudden change in position
- Response at each chronological age is different & reflects the maturational stage of the CNS

Head & Trunk Righting

Emergence: head – 3 months, trunk – 5 months

Position: supine or suspended

Method: tilt body to one side

Response: head & trunk adjust to retain vertical position

Lateral Prop

Emergence: 7 months

Position: sitting

Method: tilt to one side

Response: arm extends to support weight

Landau

Emergence: 6 months

Position: suspended horizontal

Method:

Response: neck & trunk extend, arms extend, legs partially flex

Parachute

Emergence: 8 months

Position: suspended vertically

Method: tilt forward

Response: arm & legs extend to support weight

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  Neurologic Exam Website: http://library.med.utah.edu/neurologicexam

  Pediatric Neurologic Exam Website: http://library.med.utah.edu/pedineurologicexam

Identification of Developmental Problems

Developmental Surveillance: elicitation of parental concerns combined with direct observations/examination

- Pediatric care providers correctly identify <54% of children with problems

Identification

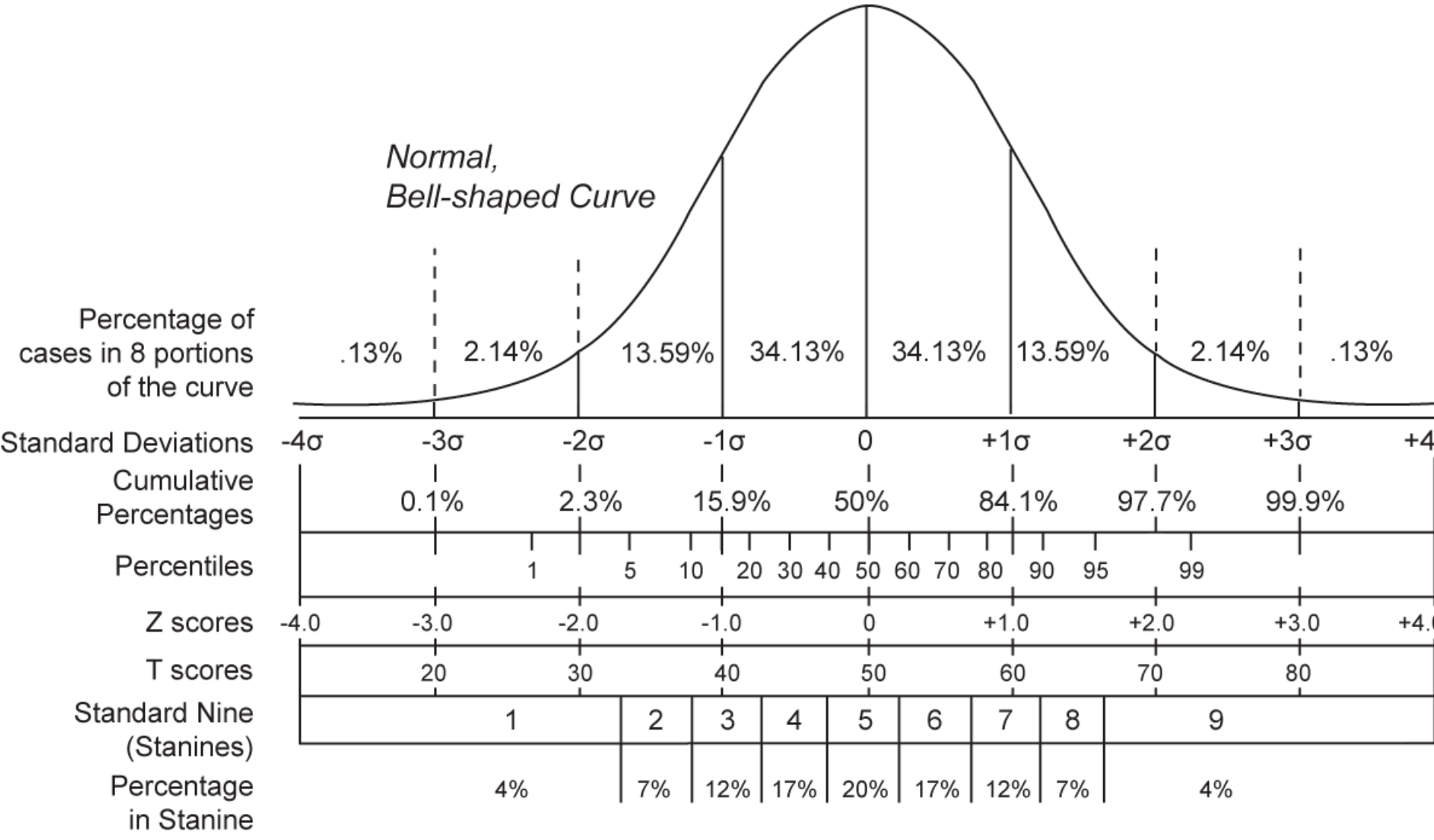
Developmental Screening: brief assessment using a standardized measure which has the purpose of discriminating those who are likely to have problems from those who likely do not.

- Good screening instruments correctly identify 75% of children with problems

Developmental Milestones

Problems with Milestone data from Pediatric texts:

- Original sources are from samples that lacked diversity or were small in size
- Most utilize the mean age of acquisition (50th %ile)
  - Large variability in normal acquisition of skills makes the 50th percentile inadequate in determining if a child's skills are typical or fall outside the range of normal
  - May cause undue parental anxiety if child's skills fall below 50th %ile.


Normal,
Bell-shaped Curve
Percentage of cases in 8 portions of the curve
.13%
2.14%
13.59%
34.13%
34.13%
13.59%
2.14%
.13%
Standard Deviations
-4σ
-3σ
-2σ
-1σ
0
+1σ
+2σ
+3σ
+4
Cumulative Percentages
0.1%
2.3%
15.9%
50%
84.1%
97.7%
99.9%
Percentiles
1
5
10
20
30
40
50
60
70
80
90
95
99
Z scores
-4.0
-3.0
-2.0
-1.0
0
+1.0
+2.0
+3.0
+4.
T scores
20
30
40
50
60
70
80
Standard Nine (Stanines)
1
2
3
4
5
6
7
8
9
Percentage in Stanine
4%
7%
12%
17%
20%
17%
12%
7%
4%

Developmental Milestones

- Need to know more than 50th%ile

10th %ile	Promotion of safety/anticipatory guidance	Eg. Discuss rolling over at 1-2 mo visit
50th %ile	Explanation & normalization Developmental promotion	Eg. Temper tantrums in 2 yr olds
90th %ile (or -1.5SD)	Identification of delays	Eg. Absence of 2 wd phrases at 24 mo.

Developmental Domains

- **G**ross motor
- **F**ine/Visual-Motor
- **S**peech/Language
- **C**ognitive
- **S**ocial/Emotional

*"**G**otta **F**ind **S**trong **C**offee **S**oon"*

Mneumonic created by Peter MacPherson, medical student, U of A

Red Flag Milestones

- Please refer to the following references for typical (ie 50th percentile) milestones:
  - Pediatrics in Review 2010:31;267
  - Pediatrics in Review 2010:31;364
  - Pediatrics in Review 2011:33;533
- Knowing the 90th percentile (upper limit of the normal range) has more utility for surveillance.
- The milestones presented represent the ages at which those skills should have been achieved. Therefore, if not achieved there is cause for concern

Dosman CF, Andrews DA, Goulden KJ. Evidence-based milestone ages as a framework for developmental surveillance. Paediatr Child Health 2012;17(10):561-568

- High quality evidence for gross motor, fine motor and self-help skills.
- Low quality evidence for communication, cognitive and social-emotional milestone ages

Newborn – Gross Motor

- Moro reflex
- Positive support primitive reflex
- Flexed posture

Newborn – Fine Motor

- Hand grasp primitive reflex

Newborn – Speech-Language

- Root, suck primitive reflexes
- Orients to sound
- (Smiles to voice)
- Variable cries

Newborn - Cognitive

- Visual focus length ~ 10 in
- Turns to visual stimuli
- Prefers human face (eyes), contrast, colours, high-pitched voice

Newborn – Social Emotional

- Cries when infant cries

Two Months – Gross Motor

- Head up 45° in prone

Two Months – Fine Motor

- Holds placed rattle

Two Months – Speech-Language

- Gurgles

Two Months - Cognitive

- Follows horizontal arc

Two Months – Social Emotional

- Awake more during day

Four Months – Gross Motor

- Asymmetrical Tonic-Neck primitive reflex**
  - Should have been present and then disappeared
- Lifts chest in prone

Four Months – Fine Motor

- Brings hands together in midline
- Extends straight arms towards rattle – supine
- Reaches and grasps rattle

Four Months – Speech-Language

- Coos

Four Months - Cognitive

- Watches hands
- Explores environment by looking around
- Anticipates routines
- Looks to find caregiver

Four Months – Social Emotional

- Calms when spoken to, picked up
- Looks to find caregiver

Six Months – Gross Motor

- Primitive Reflexes gone
- Pulls to sit
- Sits tripod

Six Months – Fine Motor

- Shakes rattle
- Holds cube between two hands,
- Holds one cube in each hand
- Ulnar palmar grasp (4th and 5th fingers)

Six Months – Speech-Language

- Looks toward person talking to him
- Vocalizes to answer
- Laughs

Six Months - Cognitive

- Bangs objects together
- Trial and error problem solving
- Looks for dropped object

Six Months – Social Emotional

- Predictable schedule
- Smiles to initiate engagement and respond
- Back and forth engagement through facial expressions and eye contact
- Shares enjoyment
- Prefers familiar people
- Shows interest in other infants

Nine Months – Gross Motor

- Postural reflexes present
- Rolls both ways
- Sits well

Nine Months – Fine Motor

- Transfers
- Radial-digital grasp (thumb with 1st and 2nd fingers, no palm)
- Touches cheerio with finger
- Raking pincer grasp

Nine Months – Speech-Language

- Looks to familiar object (or family member) when named
- Inhibits to “no”
- Vocalizes to initiate

Nine Months - Cognitive

- Object permanence
- Explores caregivers face
- Searches for hidden toy

Nine Months – Social Emotional

- Attachment development established

12 Months – Gross Motor

- Gets to sit
- Crawls
- Pulls to stand
- Walks with one hand held
- Catches rolling ball

12 Months – Fine Motor

- Pincer grasp

- Voluntary cube release, into cup

- Holds bottle

12 Months – Speech-Language

- Turns to name
- Understand routine commands
- Babbles or gestures intentionally for behaviour regulation
  - request: reach, point up
  - Refusal: push away, arch away
- and social interaction
  - Attention seeking: move arms and legs
  - Social game: imitate clapping
  - Representational: wave bye

12 Months - Cognitive

- Looks for object not seen hidden
- Trial and error exploration
- Cause and effect toys

12 Months – Social Emotional

- Plays pat-a-cake
- Peek-a-boo (initiates by putting blanket over head)
- Gives to infants
- Joint attention: Gives or shows by extending object to comment

18 Months – Gross Motor

- Gets to standing
- Walks alone
- Walks up and down stairs with railing

18 Months – Fine Motor

- Inserts shapes
- Stacks two to three cubes
- Scribbles, fisted
- Self-feeds (fingers)

18 Months – Speech-Language

- Follows 1-step commands
- Points to 6 body parts
- 15 words: labels, requests combined with gesture
- Claps from excitement
- Hugs stuffed animal (representational)
- Shakes head “no” (refusal)

18 Months - Cognitive

- Follows visible displacements
- Imitates using real props (sweeps with broom, bangs with hammer) “domestic mimicry”
- Functional use of objects (brushes own hair with brush, pushes toy car)

18 Months – Social Emotional

- Imitates peers
- Joint attention: points to comment, seek information
- Uses transitional object to self-calm
- Temper tantrums

24 Months – Gross Motor

- Runs, jumps, kicks
- Throw ball overhand three feet forward
- Walks up stairs marking time, no railing

24 Months – Fine Motor

- Copies vertical line
- Stacks six cubes
- Uses spoon
- Helps dress

24 Months – Speech-Language

- 50 words
- Two word phrases
- Talks instead of gestures
- Nods “yes”, blows kisses, “shh”, “high fives”
- Speech 50 percent intelligible to strangers

24 Months - Cognitive

- Symbolic representation,
- Simple pretend (toy broom, toy cup to self/doll)
- Strategies without rehearsal
- Tries to make toys work

24 Months – Social Emotional

- Social referencing
- Comforts others
- Joint attention: points to clarify word approximations
- Parallel play
- “no” , “mine”

ASD red flags

- No big smiles or other warm, joyful expressions by six months or thereafter
- No back-and-forth sharing of sounds, smiles or other facial expressions by nine months
- No babbling by 12 months
- No back-and-forth gestures such as pointing, showing, reaching or waving by 12 months
- No words by 16 months
- No meaningful, two-word phrases (not including imitating or repeating) by 24 months
- Any loss of speech, babbling or social skills at any age

36 Months – Gross Motor

- Pedals tricycle
- Walks down stairs marking time, no railing
- Walks up stairs alternating feet, no railing

36 Months – Fine Motor

- Copies horizontal line
- Stacks 10 cubes
- Uses spoon well and fork
- Drinks from open cup
- Removes socks and shoes, undresses
- Indicates voided

36 Months – Speech-Language

- Follows 2-step commands
- Three to four-word sentences
- Sequential narratives
- What, who, where, why?
- speech 75 % intelligible

36 Months - Cognitive

- Object constancy (≠ object permanence)
- Symbolic pretend play (stick as a broom, feeds doll invisible object, doll feeds self)
- Two step pretend play (car goes to garage to get gas and then windows washed)
- Names one colour
- Counts two objects
- Sorts shapes
- Completes 3-4 piece puzzle
- Compares two objects (‘bigger’)

36 Months – Social Emotional

- Separates easily
- Initiates peer interactions
- Shares
- Role play (eg “house”, “doctor”)
- Understands rules

48 Months – Gross Motor

- Hops
- Walks down stairs alternating feet, no railing
- Walks backwards in line

48 Months – Fine Motor

- Copies cross
- Draws 2-4 part person
- Cuts paper in half
- Dresses, no buttons
- Indicates need to void

48 Months – Speech-Language

- Follows 3-step commands
- Complex sentences
- Reports on past events, creates imaginary roles
- Word play, jokes, teasing

48 Months - Cognitive

- Theory of mind, time concept
- Generalizes rules
- Self-talks to problem solve
- Counts four objects
- Understands opposites

48 Months – Social Emotional

- Preferred friend
- Offers sympathy to peers
- Elaborate fantasy play (eg superhero)
- Usually compliant

60 Months – Gross Motor

- Catches ball
- Balances one foot 10 sec
- Sit-ups
- skips

60 Months – Fine Motor

- Copies square
- Draws 10 part person
- Colours between lines
- Tripod pencil grasp
- Washes and dries hands thoroughly

60 Months – Speech-Language

- Recalls parts of a story
- Narratives have a plot
- Future tense
- Speech 100% intelligible

60 Months - Cognitive

- Names four colours
- Preliteracy/numeracy/writing skills:
  - Rhymes
  - Counts 10 objects
  - Writes name

60 Months – Social Emotional

- Plays away from parent
- More elaborate discussion of emotions
- Insists on group rules

Red Flags Identified

- Consider administration of a developmental screening test to increase sensitivity and specificity thresholds for referral

Management of Concerns

Red Flag in any sector:

- Hearing, Vision screens
- Lead screen if mouthing/pica
- ECIP or specialized preschool
- General Pediatrician referral

Communications skills

(Consider speech-language impairment)

- Referral to speech-language pathologist, audiologist

Multiple Sectors

(consider intellectual disability, GDD, cerebral palsy)

- Psychologist
- Speech-language pathologist
- And/or Occupational therapist and physical therapist
- *Consider* developmental pediatrician, neurologist, pediatric physiatry

Communication and Social Emotional

(consider ASD or language impairment with mental health difficulties

- Psychologist
- Speech-language pathologist
- Mental health therapist
- Consider developmental pediatrician/multidisciplinary assessment

Motor Skills

(consider movement disorder)

- Physical or occupational therapist
- Developmental pediatrician/pediatric physiatrist
- neurologist

Self-Help Skills

- Parent training
- Consider social worker

Academic Skills

Consider learning disabilities, eg. reading, math in context of average intellectual disabilities

- Psychologist for tests of intellectual abilities and academic achievement

Social Emotional

Consider mental health condition

- Mental health therapist
- psychologist

Strengths in multiple areas

(consider intellectual giftedness, academic talent)

- psychologist

Useful Websites

- http://www.dbpeds.org/articles/detail.cfm?TextID=701
- http://www.cdc.gov/ncbddd/actearly/milestones/
- www.autismspeaks.org (video library)