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 we grow up in
- Language

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
Individually

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

[Diagram showing a line graph with age on the x-axis and level of development on the y-axis, illustrating a linear increase.]
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

Performance

age (months)

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 (50\textsuperscript{th} %ile)
  - Large variability in normal acquisition of skills makes the 50\textsuperscript{th} 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 50\textsuperscript{th} %ile.
Normal, Bell-shaped Curve

Percentage of cases in 8 portions of the curve

Standard Deviations
-4σ -3σ -2σ -1σ 0 +1σ +2σ +3σ +4σ

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 +4.0

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**

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

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

“**Gotta Find Strong Coffee Soon**”

Mneumonic created by Peter MacPherson, medical student, U of A
Red Flag Milestones

• Please refer to the following references for typical (ie 50\textsuperscript{th} percentile) milestones:
  Pediatrics in Review 2010:31;267
  Pediatrics in Review 2010:31;364
  Pediatrics in Review 2011:33;533

• Knowing the 90\textsuperscript{th} 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

- 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 (4\textsuperscript{th} and 5\textsuperscript{th} 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 1\textsuperscript{st} and 2\textsuperscript{nd} 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)