

Physical Development in Infancy



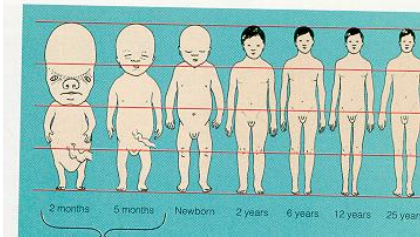
Questions

- What is neoteny?
- What are the basic patterns of physical growth in infancy?
- How do genes and environment influence growth?
- What are the differences between individual and group growth curves?
- List some major milestones and range of age of acquisition
- What are some differences in the ordering of these milestones

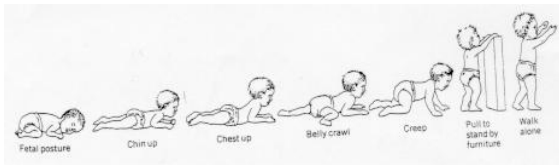
Principles of Physical Development

- Directionality: follows several characteristic directions
- Cephalocaudal

Cephalocaudal



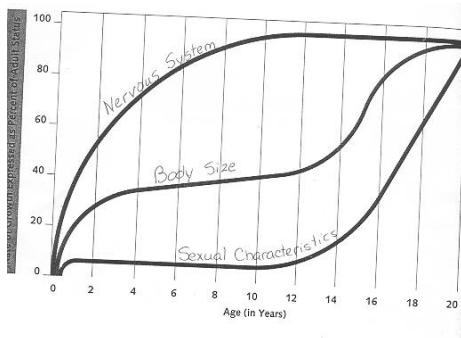
Cephalocaudal development



Principles of Physical Development

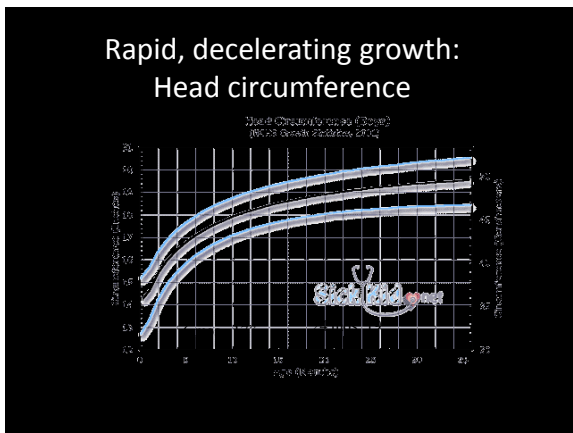
- Proximodistal: development from inside out
- Mass-to-specific: gross motor skills (large muscles) develops first followed by fine motor (small muscles) skills
- Principle of Hierarchical Integration: simple skills develop independently and are later integrated into more complex skills.
- Independence of Systems

Principle of Independence of Systems



Infancy is a period of rapid, decelerating physical growth.

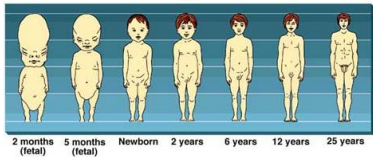
- Rapid, decelerating growth characterizes
 - **Head circumference**
 - Body length
 - Weight



Head circumference

- An index of brain size
 - but not necessarily meaningful for individuals
 - **concern** below 3rd percentile or above 97th
- Can be used as a predictor of early outcome in premature infants
 - at birth and at one month or later corrected age
- Its staying the course that its important
 - allowing for catch-up growth
 - reach growth channel by 12 - 14 months

Babies have big heads



- Newborn head is 25% of own body length
- Head length is 40% of mature length at birth
- Adult head is only ~15% of body length

Why?

- Why such large heads?
- Why such rapid, early growth in head size?

Neonteny: Mickey has a baby face

- Flat with small nose and cheekbones
- Small lower jaw
- Big cranium and forehead



Neoteny: Holding on to infant-like characteristics

- Neoteny characterizes human body form
 - Big heads and faces
 - Large eyes
 - Smaller muzzle
 - Spine attached at base of skull
 - Brain continues growth after birth
 - Essential constraint in human evolution

Neoteny characterizes human behavior

- Late sexual reproduction
- Play and curiosity throughout life span
- Cultural flexibility

Head growth allows brain growth

- Rapid, decelerating growth
- At birth,
 - 1 lb.
 - 15% of total body birthweight
 - 25% of final (adult's) brain weight
- At 6 months
 - 50% of final (adult's) brain weight

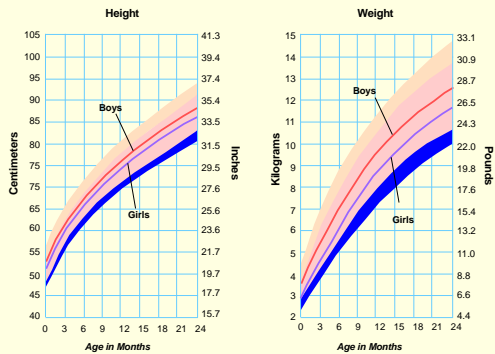
At the same time - Myelinization

- Fatty sheaths develop and insulate neurons
- Dramatically speeding up neural conduction
- Allowing neural control of body
 - General increase in first 3 years is likely related to speedier motor and cognitive functioning
 - allowing activities like standing and walking
- Endangered by prenatal lead exposure

Infancy is a period of rapid, decelerating physical growth.

- Rapid, decelerating growth characterizes
 - Head circumference
 - **Body length**
 - **Weight**

Height and Weight Growth During the First Two Years



Genes and environment

- Body size influenced by multiple genes
 - each has a small effect
 - some do not function until after birth
 - when individual differences emerge
- Body size influenced by environment
 - nutrition
 - uterus can also constrain or promote growth

Genes and environment example

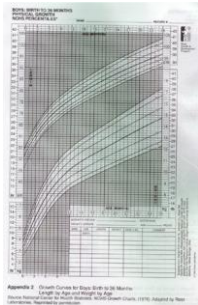
- Japanese-American infants
 - Smaller than European-American infants
 - genetics
 - But larger than Japanese national infants
 - dietary differences
 - Higher socioeconomic status
 - Taller, heavier kids who grow faster
 - Professional 3 year olds: 1/2" taller
 - » In England

Historical increase in body size

- Mean height of schoolchildren increased by 0.70 cm per decade
 - independent of race, sex, and age.
 - decrease in short children (<10th percentile)

Rapid, decelerating growth: Length

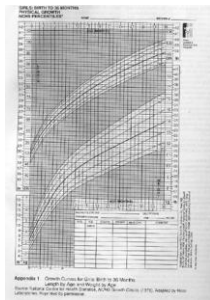
- Birth length 20"
 - add 10" by one year
 - add 5" more by 2 years
- Two year height approximately 1/2 adult height



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Rapid, decelerating growth: Weight

- Newborn girl (7.25 lbs.)
 - Gain 1.3 pounds per month for the first 6 months
 - 100% bigger
 - Double birth weight
 - Then 1 pound per month through 12 months
 - 50% bigger
 - Triple birth weight
 - Then less than a half a pound per month through 36 months



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Group curves

- Large samples
 - Many children at a given age (e.g., 3 months)
 - Find median (50th %ile), %s
 - e.g. at 17 months, only 5% < 75 cm.
 - Longitudinal data may have been collected
 - but at monthly intervals
- What does individual growth in length look like?

Common view

- Individual follows continuous growth curves
 - Portrait of group is portrait of individual
- But parents report of
 - growing by leaps and bounds
 - growth spurts
 - growing overnight

were dismissed

One child's growth

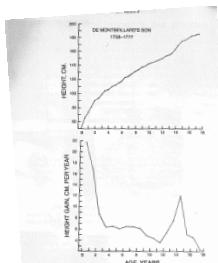


FIGURE 4.14
The growth of Curt Philippe de Marbottin's son from birth to the age of 11 years. The upper graph shows the height reached at each age; the lower graph shows the actual increments in weight. (After Stevens, 1975, © 1989 by Open Books Publishing Ltd. Reprinted by permission.)

Saltatory growth

- Lampl measures length/height
 - 3 samples of babies
 - every two weeks, weekly, daily
 - same pattern in all groups
 - re-measures for reliability

Individual growth – not a curve

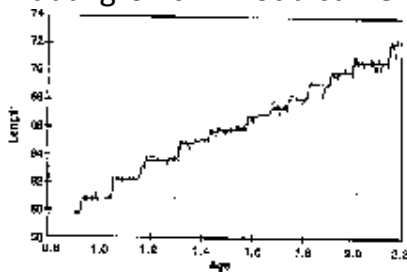


Fig. 1. Daily length measurements of an individual from 0 to 218 days of age and the resulting mean (solid) and standard deviation (dashed) curves. The mean curve is a smooth curve, but the individual data points show a step-like pattern. The mean curve is a smooth curve, but the individual data points show a step-like pattern. The mean curve is a smooth curve, but the individual data points show a step-like pattern.

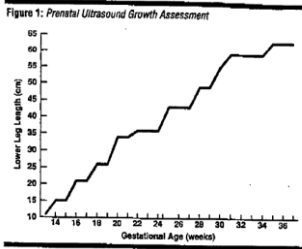
Growth jumps or spurts

- Growth occurs in spurts,
 - jumps of almost a cm. (.9)
- separated by periods of no growth [stasis]
 - of 2 to 15 days
- Total growth is sum of spurts
- Longer stasis continues, more likelihood of a spurt
 - but spurts aperiodic

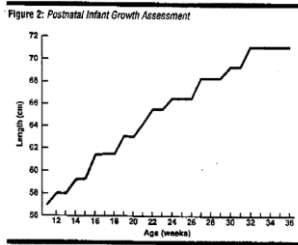
Saltatory growth is the rule

- prenatal
- infant
- child
- adolescent

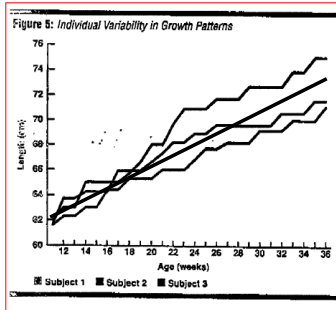
Prenatal growth



Postnatal growth

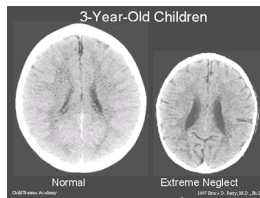


Individual differences



Practical consequences

- Fussiness and hunger during growth periods
- Sleep patterns
 - less before, more during?



Growth in height and weight follows a very predictable trend – unless there are extenuating factors, such as nutritional deficiencies, extreme stress, neglect, etc. Extreme neglect also affects brain development, as shown on right above.

There is an interaction of biological factors and environmental factors in producing physical development—for example, effects of extremes on growth.

Motor Development

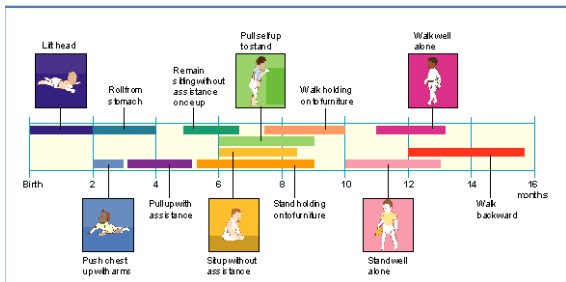
- Motor development influences and is influenced by other components of development
 - Intelligence is dependent on sensorimotor activities, Piaget
 - Institutionalized infants – delayed motor skills
 - Motor activities impact emotional development, fear of heights

Motor development

- Overall patterns
- Individual differences
- Individual development

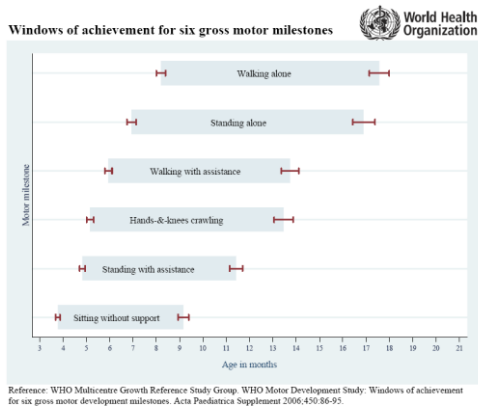
Norms versus Individual Differences

Motor Milestones



Motor Development is Orderly

- Occurs in a specific sequence
 - Reflexive movements (First 3-4 months): involuntary, undirected movements
 - Postural Reaction (approximately 2-3 months): the higher brain centers (cortex) begin functioning
 - inhibits lower brain centers
 - causes primitive reflexes to disappear
 - coordinate movements of head, trunk and limbs so body can adjust its posture to environment
 - Voluntary Motor Milestones
 - Controlled by higher brain centers (cortex)



Individual differences

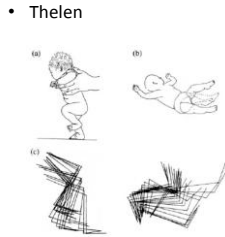
Pattern observed	N (%)
1 → 2 → 3 → 4 → 5 → 6	340 (41.7)
1 → 3 → 2 → 4 → 5 → 6	295 (36.1)
1 → 3 → 4 → 2 → 5 → 6	69 (8.5)
Other patterns	77 (9.4)
Non-crawlers	35 (4.3)
Total	816 (100)

Milestone: 1 = sitting without support; 2 = hands-and-knees crawling;
3 = standing with assistance; 4 = walking with assistance;
5 = standing alone; 6 = walking alone

WHO Motor Development Study: Windows of achievement for six gross motor development milestones. WHO MULTICENTRE GROWTHREFERENCE STUDY GROUP. *Acta Paediatrica*, 2006; Suppl 450: 86-95

Individual variability in locomotion

- Bimodality
 - http://www.youtube.com/watch?v=bh_ABVxpBsQ
- First Walk
 - <http://www.youtube.com/watch?v=q0arqxWU7R8>



Stages in Infant Development and Feeding

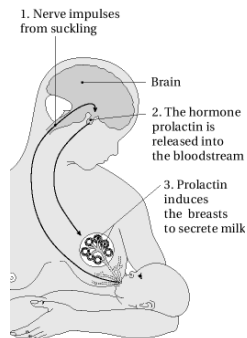
Birth through 3 months

- **Breast milk**
- OR**
- **Iron-Fortified infant formula**



Breastfeeding

- Infant Reflexes
- Maternal Reflexes



The mechanisms that occur during breast feeding

Breastfeeding

- Colostrum
- Oxytocin

The Advantages of Breastfeeding



Advantages for Child

- (1) Protects against infection—less diarrhea
- (2) Enhances vaccine response
- (3) Reduced risk of otitis media and respiratory infections
- (4) Decreased risk of SIDS
- (5) Protection from allergies; less eczema
- (6) Higher IQs
- (7) Less risk of childhood cancer, diabetes, etc.

Breastfeeding Advantages for Mother

- (1) Delays fertility and menstruation
- (2) Reduces risk of breast cancer (Am J. of Epidemiology, 1986) Breast cancer could be reduced by up to 25% through breastfeeding.
- (3) Reduced risk of uterine, ovarian and endometrial cancers.
- (4) Greater emotional health (less anxiety; more mutuality)
- (5) Decreased osteoporosis (4 x greater in non-breastfeeders)
- (6) Promotes postpartum weight loss (especially in lower body fat)

So, if the benefits of breastfeeding outweigh formula, why aren't all children breastfed?

- Inconvenient
- Some medications can be passed in breast milk
- Sleep patterns
- Exhaustion for mom
- Can be painful
- Social taboo
- Pumping

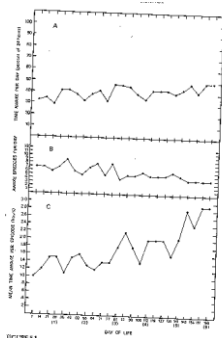


FIGURE 5.1 The sleep-wake cycle of a baby's infant changes week by week over the first 6 months of life. (A) Continuous time awake per day increases from about one hour at the start of the day to more than four hours by 6 months. (B) The number of episodes a possible episode for one hour. (C) The average duration of awake periods begins.

Sleep Patterns

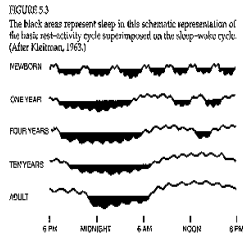


FIGURE 5.3 The black areas represent sleep in this schematic representation of the basic rest-activity cycle superimposed on the sleep-wake cycle. (After Kleitman, 1963.)
