

Neurodevelopmental Delay

Dr Philip Snyman
Department of Paediatrics
13 March 2012

Content – ND delay

- Introduction
- What are we talking about?
- Warning signs?
- How do we screen/assess it?
- What may be causing delay?
- What is normal?
- What are the red flags?
- References

Introduction

- The *American Academy of Pediatrics* recommends routine developmental screening in well-child care.
- Health care providers cite time restraints as a limitation preventing its widespread adoption.
 - <15 minutes consultation time
- **In SA 70% of parents are not warned of longterm N/D outcomes** → litigation
 - “Neonatal litigation claims are now the highest claims in any category” (Dr Liz Meyer at Paediatric UPdate 2011)

Introduction...

- Neurodevelopment is the acquisition of skills to enable the child to:
 - assume an upright position and maintain posture and equilibrium while performing **activities**;
 - develop **thumb opposition** and bimanual manipulation;
 - **communicate**; and
 - interact **socially** in accordance with social expectations.

Introduction: Development

- Serial MRI scans (FLAIR images), PET scans
- Birth: Brain growth 0 → 3yrs: **370 → 1080 grams (1200 – 1400g)**
- Skull ↑ too: 35cm → 45(8mo) → 50(3yrs).
- Spurt in growth postnatal: elaboration of axons, dendrites, synapses and myelination (first 8 months fastest).
- Synapses - information pathways (1st 3 yrs)
 - form after birth, during 1st year, need stimulation to become permanent
 - frontal & occipital at 2-10yrs: 2x more than at birth/ adult
 - disorders impair the brain by disrupting these pathways
- Develops from brainstem up to cortex

Myelin

- Formed by: Schwann cells, oligodendroglia
- Myelin is the **insulating fatty material** around nerve processes and the main functions are:
 - prevention of the dispersion of electrical impulses,
 - speeding up the velocity of conduction (up to 100x) along the nerve structures
- Myelination already starts during pregnancy (12W)
- The first anatomical locations are:
 - brainstem, cerebellum, followed by
 - posterior limb of internal capsule,
 - optic pathway,
 - and parietal lobes.



Myelin...

- **At birth:** Structures predominantly myelinated are:
 - Bulbar structures
 - optic pathways
 - certain peripheral nerves.
- This enables the child to:
 - **suck, cry, swallow**
 - **see and visually fixate**
 - display **primitive reflexes**.
- Shaken baby syndrome: due to ↓ myelin

Principles of Development

- Development is a **continuous process** from conception to maturity
- The **sequence** of development is the same for all, but the **rate** differs
- Development = related to **maturation** of the CNS
- Generalized mass activity is replaced by **specific** individual responses
- Development is **cephalocaudal**
- Certain **primitive reflexes** have to be lost before the corresponding voluntary movement is acquired
- Illingworth, 1970

How is a developmental delay identified?

Developmental delay is identified through two types of play-based assessments:

- Developmental **Screening** – questionnaire
- Developmental **Evaluation** - in-depth assessment

What if a child does not meet a developmental milestone?

Each child is unique and will develop at his or her own pace.

However, **there are definitely blocks of time "windows" when most children will meet a milestone.**

For example:

- Children learn to walk anytime between 9 and 15 months of age.
- So, if your child is 13 months of age and not yet walking, there is no need to worry if he is crawling and pulling to a stand. He has acquired the skills he needs to learn to walk and may begin walking soon.
- However, if you have a child 15 months of age who is not yet walking, consult the paediatrician to make sure there aren't any medical or developmental problems. 15 months is outside of the normal "window" or time frame in which children learn to walk.

There are some **warning signs** or "red flags" to watch for that may mean your child is not meeting developmental milestones.

Ask a professional.

What are the warning signs of a developmental delay?

There are several general "warning signs" of possible delay.

- **Behavioural Warning Signs**
- **Gross Motor Warning Signs**
- **Vision Warning Signs**
- **Hearing Warning Signs**

Behavioural Warning Signs

- Does not pay attention or stay focused on an activity for as long a time as other children of the same age
- Focuses on unusual objects for long periods of time; enjoys this more than interacting with others
- Avoids or rarely makes eye contact with others
- Gets unusually frustrated when trying to do simple tasks that most children of the same age can do
- Shows aggressive behaviours and acting out and appears to be very stubborn compared with other children
- Displays violent behaviours on a daily basis
- Stares into space, rocks body, or talks to self more often than other children of the same age
- Does not seek love and approval from a caregiver or parent

Gross Motor Warning Signs

- Has stiff arms and/or legs
- Has a floppy or limp body posture compared to other children of the same age
- Uses one side of body more than the other
- Has a very clumsy manner compared with other children of the same age

Vision Warning Signs

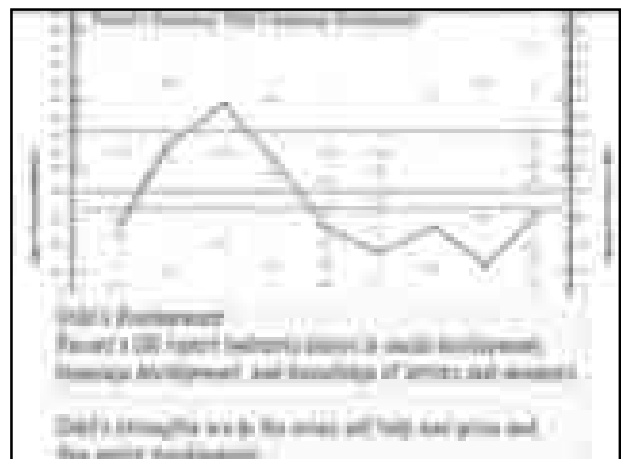
- Seems to have difficulty following objects or people with her eyes
- Rubs eyes frequently
- Turns, tilts or holds head in a strained or unusual position when trying to look at an object
- Seems to have difficulty finding or picking up small objects dropped on the floor (after the age of 12 months)
- Has difficulty focusing or making eye contact
- Closes one eye when trying to look at distant objects
- Eyes appear to be crossed or turned
- Brings objects too close to eyes to see
- One or both eyes appear abnormal in size or colouring


Hearing Warning Signs

- Talks in a very loud or very soft voice
- Seems to have difficulty responding when called from across the room, even when it is for something interesting
- Turns body so that the same ear is always turned toward sound
- Has difficulty understanding what has been said or following directions after once she has turned 3 years of age
- Doesn't startle to loud noises
- Ears appear small or deformed
- Fails to develop sounds or words that would be appropriate at her age

Areas of Developmental Screening

1. Gross motor function
2. Vision and fine manipulation
3. Hearing and language
4. Personal-Social skills
5. Emotional!
6. Performance (non-verbal problem solving)






by Raymond Tervo, M.D.

- Common reasons for global developmental delay include chromosomal anomalies such as **Down syndrome** — the most common identifiable cause of mental retardation.
- Global delays also are common in children with **fetal alcohol syndrome** — the most common preventable reason for mental retardation — and in children with **fragile X syndrome**, the most common known cause of inherited mental retardation.


This Child Development Inventory (CDI) profile shows **significant delays in all domains of development.** A developmental cognitive disability ought to be considered in this 2-year, 9-month-old girl.



Note that this child's social, self-help, expressive language and language comprehension skills lag behind his gross and fine motor skills. Expressive language is greater than language comprehension because of rote memory or echolalia. On more detailed evaluation, this 2-year, 5-month old boy was determined to have **autism**.

Table 1
Speech and Language Delay
Figure 2
Speech/Language Variant

- Hearing Loss
- Mental Retardation
- Autism
- Dysarthria
- Specific Learning Disabilities
- Developmental Language Disorder
- Landau-Kleffner Syndrome (LKS)
- Poor Language Environment



Note that gross motor skills are substantially below expected levels. All other domains of development are at or close to age-appropriate expectations. This 2 1/2 – year old boy has cerebral palsy and spastic diplegia.

Table 2
Motor Delay


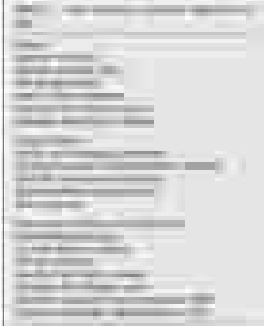
- In combination:
 - Mental Retardation
 - Visually Impaired
- Alone:
 - Cerebral Palsy
 - Ataxia
 - Spina Bifida
 - Spinal Muscular Atrophy
 - Myopathy

Causes for delays


1. Deprivation – emotional nurture, deafness
2. Genetic disorders – Down syndrome
3. Immune dysfunction – Sydenham's chorea
4. Infectious diseases – Measles, Rubella
5. Metabolic disorders – diabetes, phenylketonuria
6. Nutrition – folic acid, vit B
7. Trauma – asphyxia, birth trauma
8. Toxic and environmental factors – fetal alcohol sx
9.

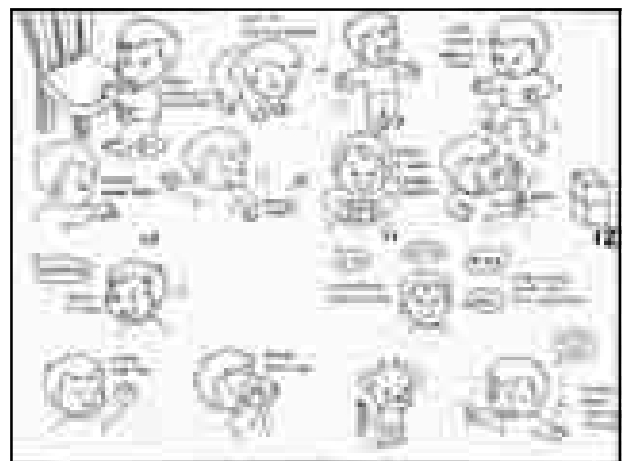
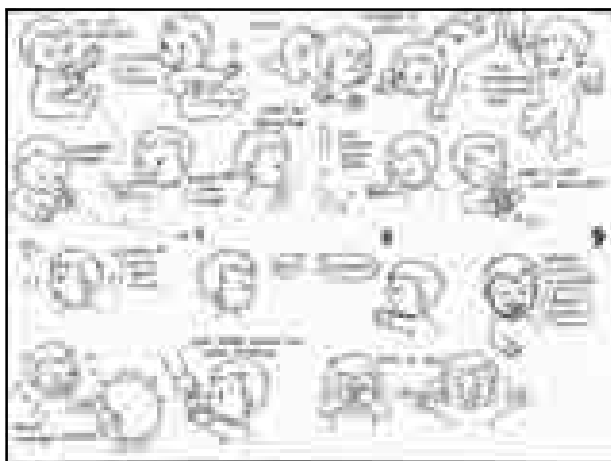
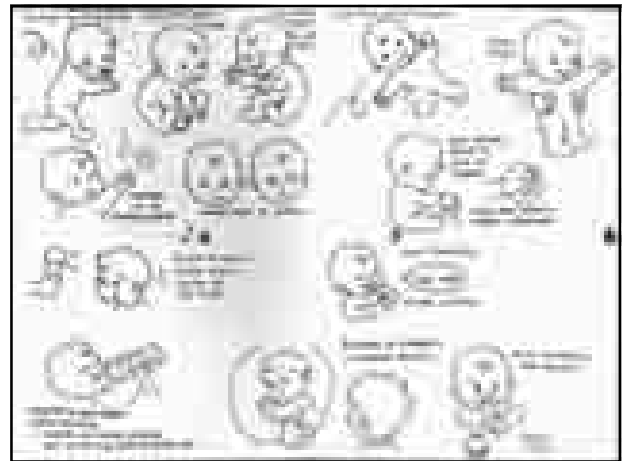
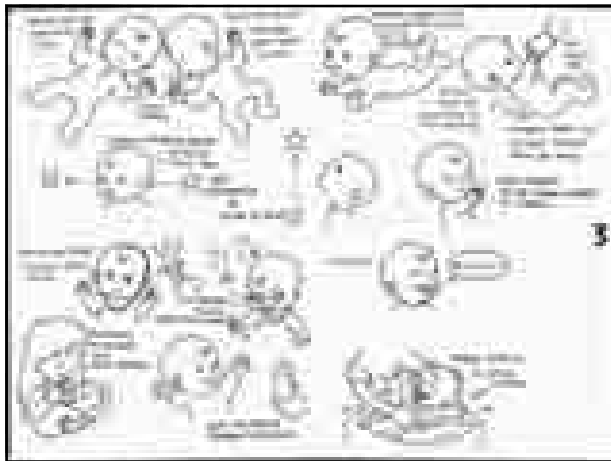
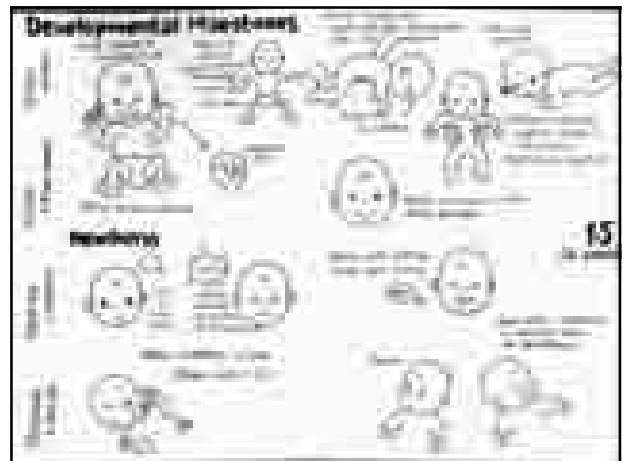
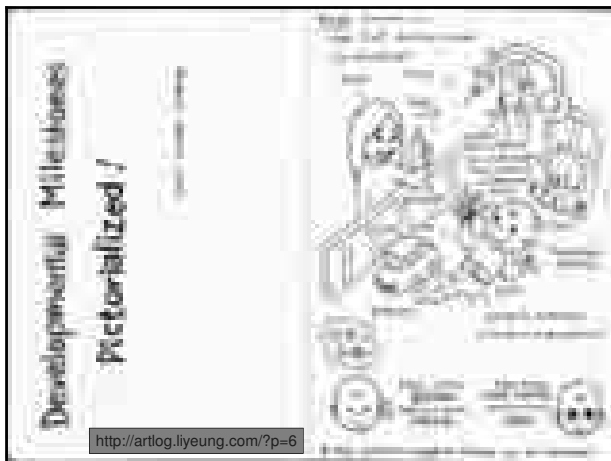
http://en.wikipedia.org/wiki/Neurodevelopmental_disorder

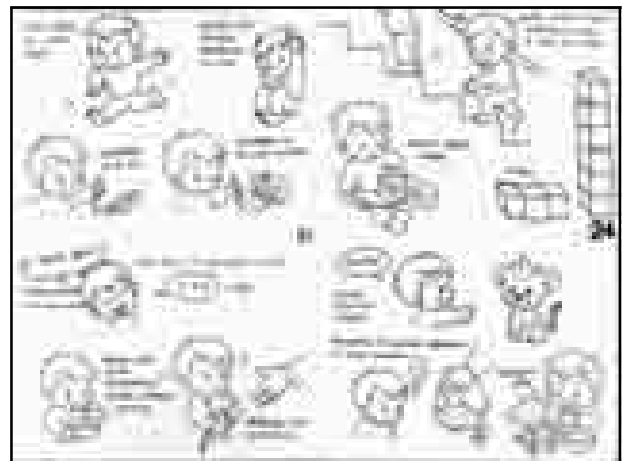
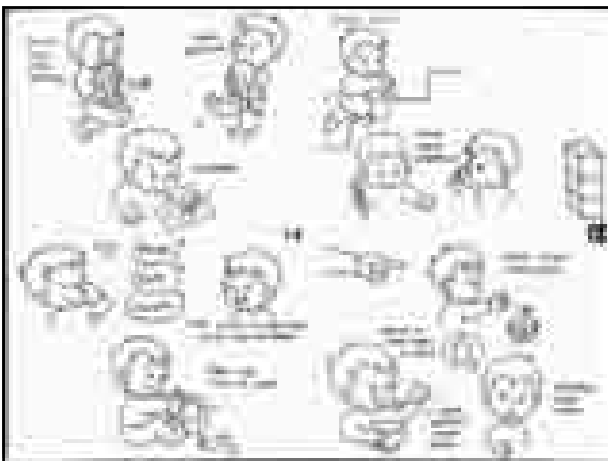
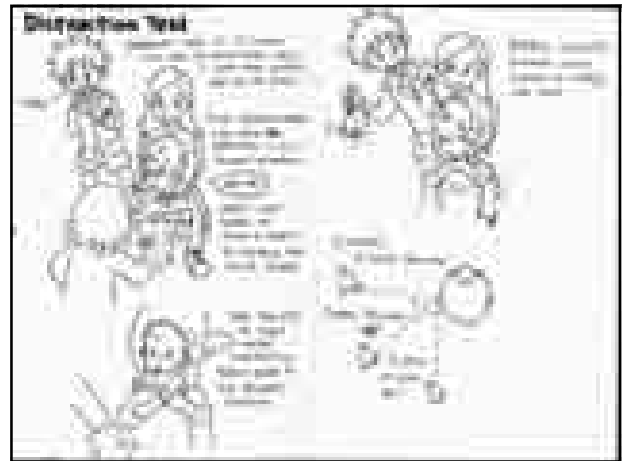
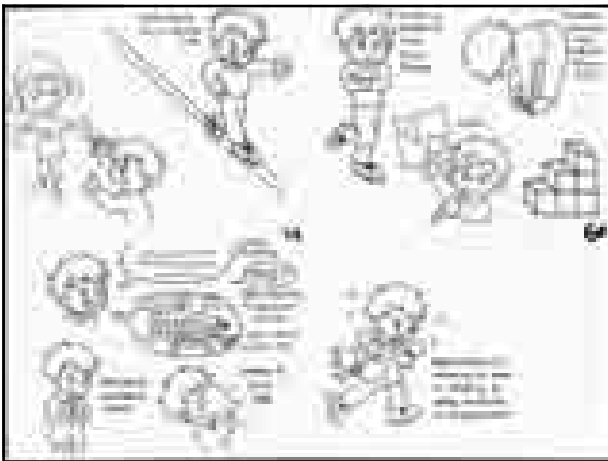
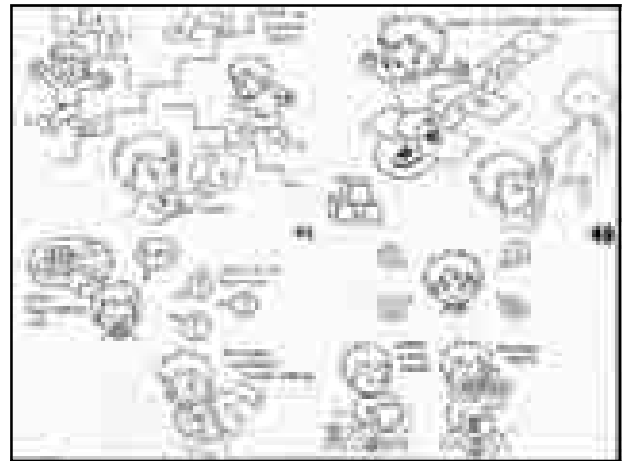
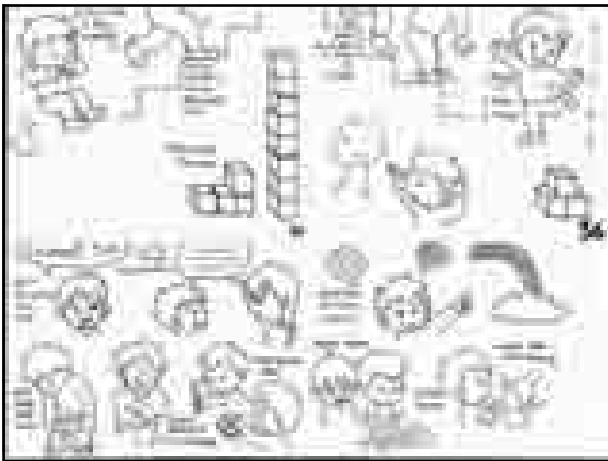
Regression

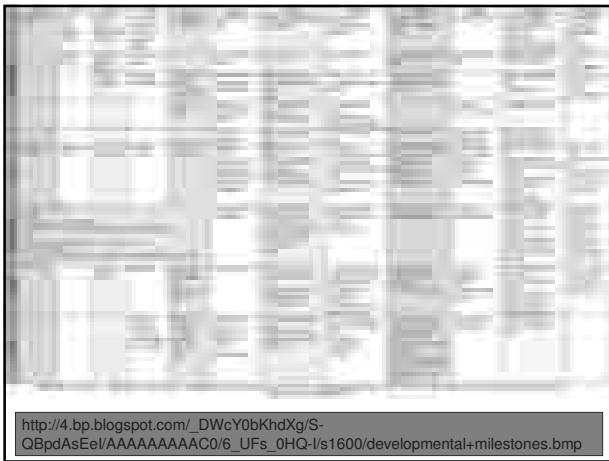
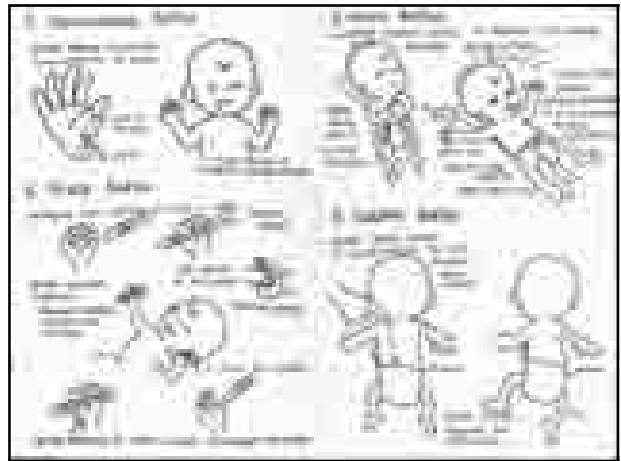
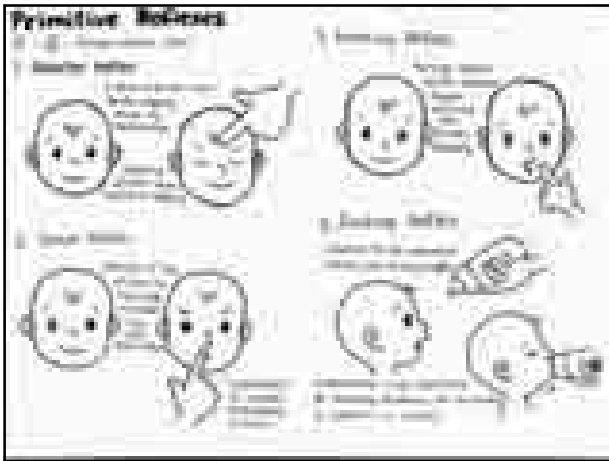



What is normal?









Normal Milestones (25-90% of children can do it)					
Age	Gross Motor	Fine Motor and Vision	Hearing and Speech	Social Behaviour	Warning Signs
0-1 month	Head control(1-3) Moro response Visual response(0-1) Prone position	None Follows horizontally 90°	None or not 10 or ear level Startle response	Directed (0-1 month) Turns to regard observer	No visual fixation or following Failure to respond to sound Excessive startle Failure to smile Abnormal or no social reflexes
2-4 months	Rolls over on right(2-3) Transfers and reaches(4-6) Sit with support(4-6) Sit without support(5-6) Pull to sit(5-6) Crawl(6-9)	Reaches to grasp(2-4) Transfers and reaches(4-6) Pokes an small object(5-6) Follows when toy(4-6)	Vocalized(4) Polyphasic babbling(5) Laugh(5-6) Responds to own name(4-6) Directional hearing(4)	Looks everything to mouth(4-6) Head and foot right(4-6) Persistence of primitive reflexes Plays 'pat-a-cake'(8-13) 'Where good' play(8-13)	Hand preference being learnt Persistence of hand reflexes Persistence of foot reflexes Absence of babbling or cooing Absence of waving responses - spontaneous
5-7 months	Can sit up unsupported(5-7) Pull up standing(6-11) Pull up standing(6-11) Walk holding on(7-13) Walk alone(9-15)	Points with index finger Can hold pencil(7-11) Pincer grasp(8-10) Holds 2 cubes together(11)	Turns to sound of name Uses nonverbal gesture(1-10)	Drinks from cup(8-10) Indicates need(10-15) Plays 'pat-a-cake'(8-13) 'Where good' play(8-13)	Unable to sit or bear weight Persistence of hand reflexes Absence of babbling or cooing Absence of waving responses - spontaneous
8-10 months	Walks backward(8-12) Can step on and off a step Climb stairs(8-12) Walks alone clear	Deletes pencil grasp(8-10) Scribbles(8-10) Turns paper of 3-4 bricks(10-14) Builds tower of 3-4 bricks(10-14)	Speaks continuously 1-2 words(10-12) understood Points to eye, nose and mouth(10-12) Obeyes nonverbal(10-15)	Holds spoon(10-15) Indicates environmental(1-10)	Unable to stand without support Unable to understand simple commands No spontaneous vocalization Cooing/awakening present
12-18 months	Walks forward(12-18) Climbs stairs with holding Jumps(18-24) Kicks ball(18-24)	Places up 1000(1000) Builds tower of 8 bricks(18-24)	Uses pencil(18-24) Gives name Speech discrimination	Plays alone Eats with spoon and fork Plays on tables Dry throughout day	Unable to speak without gestures - 2 yrs Unable to understand speech
18-24 months	Runs fast Climbs stairs with holding Pushes toy(18-24) Stands on one foot(21-24)	Copies drawing(18-24) Thread beads with Matches 2 colours	Uses prepositions(18-24) Uses sentences of 2 words Gives full name, sex and age(24-48)	Eats with knife and fork Goes to toilet alone Dresses(24-42) Washes, dries hands(23-30) Separates from mother(24-48)	Speech difficult to understand Spoken articulation or omission or substitution of consonants
24-30 months	Hops on one foot for 20 seconds(24-30) Climbs stairs Stands on one foot- 30s(33-54)	Copies cross and square Indicates length of 3 bricks Draws a man with 3 parts	Labels geometric(24-30) Counts up to 10 Gives full name, sex and address Recognizes colour(36-57)	Draws line Rubs wheel Dresses without supervision(40-60)	
30-36 months	Walks backward with feet per step Walks backward(30-36) Walks backward(30-36)	Clips 6 buttons Draws man with all features(54-72) Copies 3 shapes from 6 bricks	Labels familiar and alien Hearing/age - automatic	Scissors(36-48) Chooses own friends Drives own toy car	

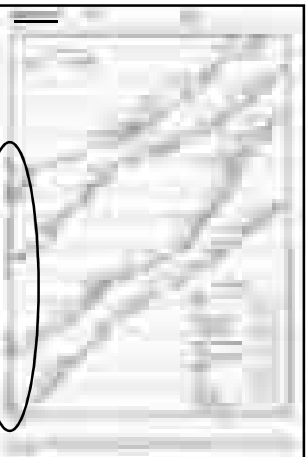
See also: <http://www.howkidsdevelop.com/developSkills.html#typicalMilestone>

Development - Screening

- Stycar sequences - Mary D. Sheridan
- Gesell shapes
- Goodenough 'Draw-a-Man' (..person)
- Peabody Picture vocabulary Test - PPVT
- Denver
- Ages and Stages Questionnaire
- Parents' Evaluation of Developmental Status














Assessment - Denver

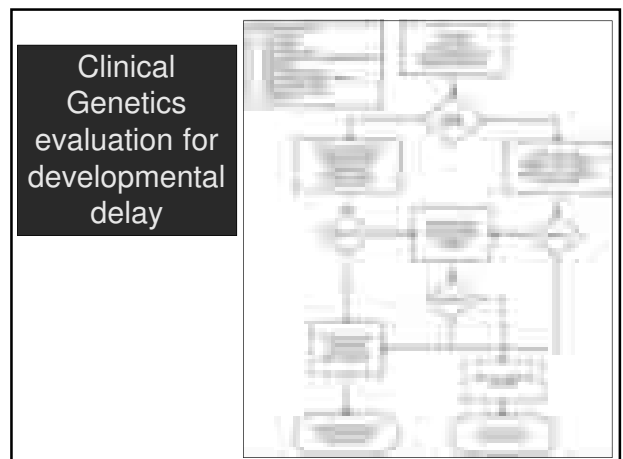
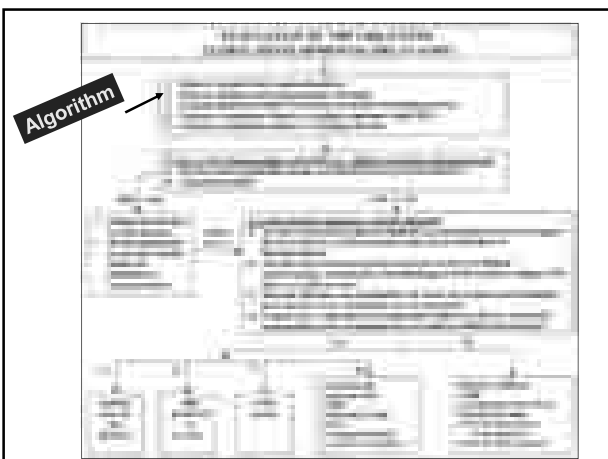
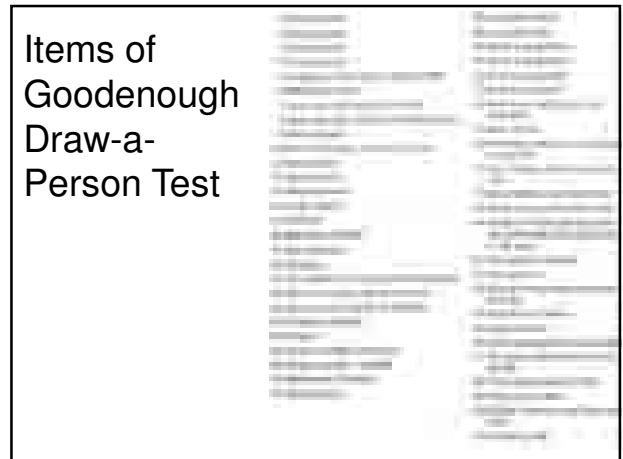
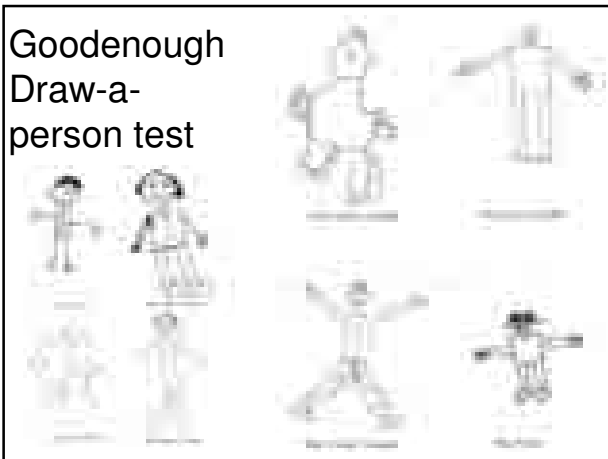


Gesell Developmental Chart

A grid chart showing developmental milestones. A circled '1' is in the top left corner.

Gesell figures

	3 yrs		7 yrs
	4 yrs		7 yrs
	4 1/2 yrs		8 yrs
	5 yrs		9 yrs
	6 yrs		11 yrs
	6 yrs		



What are early intervention services?

Early intervention services include a variety of different resources and programmes that provide **support to families to enhance a child's development**.

These services are specifically tailored to meet a child's individual needs. Services include:

- Assistive technology (devices a child might need)
- **Audiology and speech therapy**
- Counselling and training for a family
- Educational programs
- Medical services
- Nursing services
- Nutrition services
- **Occupational therapy**
- **Physiotherapy**
- Psychological services
- Respite services = A short period of rest or relief from something difficult or unpleasant
- **Speech/Language**

Red Flags!

- **6 w:**
 - no visual fixation/ following
 - sound: no response
 - head lag++
 - **no smile**
 - asymmetrical neonatal reflexes
- **6-8 mo:**
 - hand preference, **fisting**, squint
 - persistent primitive **reflexes** - Moro, stepping, ATN
- **12 mo:**
 - **not sitting**, bears no weight, abnormal grasp
 - persistent hand regard
 - no babbling/ cooing/ **no speech**
 - no parachute reflex

Red Flags!

- **18 mo:**
 - *not walking*, **not standing alone**
 - no pincer grasp
 - still throwing
 - not understanding simple commands
 - no spontaneous vocalization
 - mouthing, drooling

References

- Developmental milestones pictorialized <http://artlog.liveung.com/?p=6>
- UNICEF_Developmental milestones in children (video).
- Downloads: <http://www.cdc.gov/ncbddd/actearly/downloads.html>
- *The Physician's Guide to Caring for Children with Disabilities and Chronic Conditions*, edited by Robert E. Nickel and Larry W. Desch, copyright © 2000 Paul H. Brookes Publishing Co.
- Shevell, M. *Global Developmental Delay and Mental Retardation or Intellectual Disability: Conceptualization, Evaluation, and Etiology*. *Pediatr Clin N Am* 55;2008:1071-1084.
- Shevell MI, Ashwal S, Donley D, et al. *Practice parameter: evaluation of the child who has a global developmental delay*. *Neurology* 2003;60:376.
- Herschkowitz, N. *Neurological bases of behavioral development in infancy*. *Brain & Development* 22;2000:411-416.
- Inge Fleming. *Normal Infant Development and Borderline Deviations*. 1992. ISBN 3-13-777301 6 (Thieme) / ISBN 0-86577-428-5 (TMP).
- Mary D. Sheridan. *From Birth to Five Years*. 1997. ISBN 0-415-16458-3.
- <http://www.howkidsdevelop.com/developSkills.html#typicalMilestone>