- **Psychomotor development**
- **Mental retardation**

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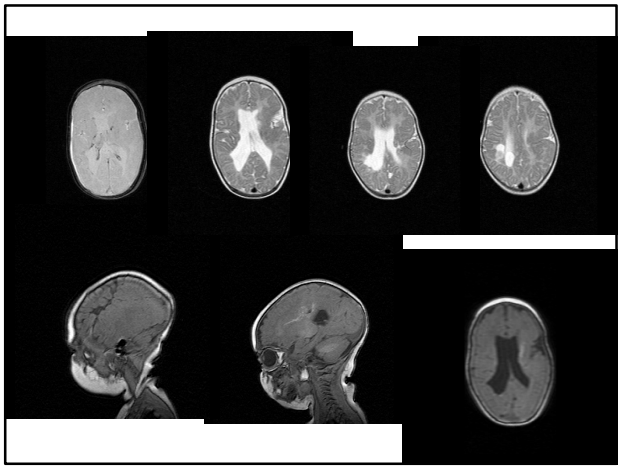
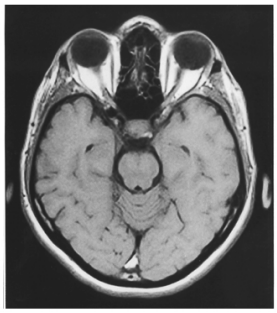
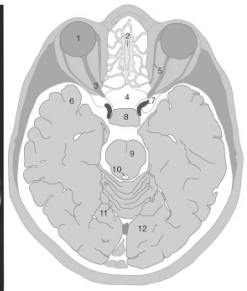


T1 súlyozott axialis MRI felvétel

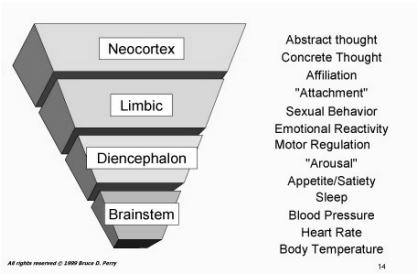




H61

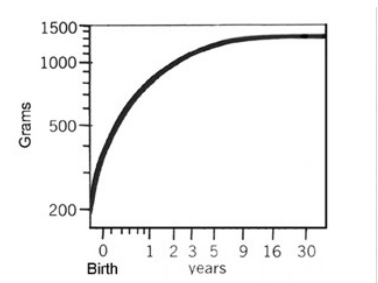
1. Bulbus oculi
2. Cavum nasi
3. N. opticus
4. Sinus sphenoidalis
5. M. rectus med
6. Lobus temporalis
7. Art. ophthalmica
8. Sella turcica
9. Pons
10. Ventriculus quartus
11. Vermis cerebelli
12. Lobus occipitalis

Csillag A., Atlas of Medical Imaging, Koenemann, Cologne, 1999

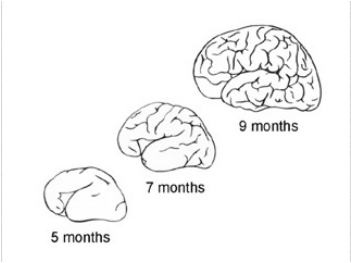


Functional Division	Constituent Parts	Developmental Division	Age of Functional Maturity	Functions
Neocortex	**Cerebral cortex** *Frontal Lobes* *Temporal Lobes* *Parietal Lobes* *Occipital Lobes* *Corpus Callosum*	Telencephalon	Puberty	Abstraction Self-image Socialization
			Childhood	Affiliation Attachment
Limbic *Cingulate Cortex* *Amygdala* *Hippocampus* *Septum*	**Amygdala**			Mood regulation
	Hippocampus			
	Basal ganglia *Caudate Nucleus* *Putamen* *Globus Pallidus*		Early childhood	Fine motor Large motor Complex state regulation *(e.g., sleep, appetite)*
Diencephalon	**Thalamus**	Diencephalon	Infancy	
	Hypothalamus			
Brainstem	**Midbrain** *Superior Colliculus* *Inferior Colliculus*	Mesencephalon	Six months	Primary state regulation
	Cerebellum	Metencephalon	Third trimester	Core physiological reflexes and regulatory functions
	Pons			
	Medulla Oblongata	Myelencephalon		
Spinal Cord	Spinal Cord		Third trimester	

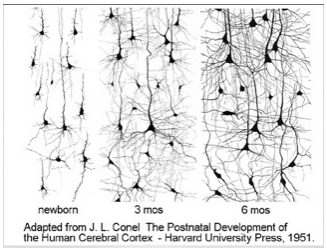
Development of the Human Brain



Development of the Human Brain



Development of Human Brain

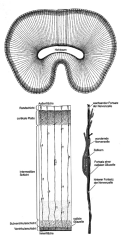


Adapted from J. L. Conel The Postnatal Development of the Human Cerebral Cortex - Harvard University Press, 1951.

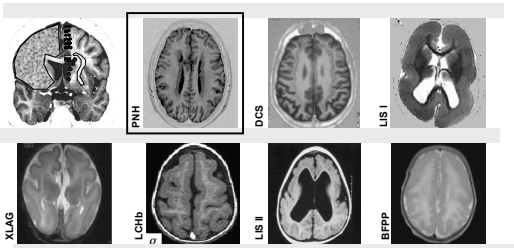
Development of Human Brain Myelinisation

Key Processes	Age beginning*	Greatest period of activity**	Age of equilibrium**	Other
Neurogenesis	First trimester	*In utero*	99 % of 100 billion neurons born by birth	Evidence of hippocampal cell birth in adult life
Migration	First trimester	*In utero* through first year	Regional specific: majority of migration complete by age three	Some suggestion of migration following brain injury
Differentiation	First-second trimester	Third trimester through year one	Region specific: primary differentiation complete by age three	Continues in some fashion throughout life
Apoptosis	Third trimester	First year	Age one	Majority of programmed death complete by age three
Arborization	Third trimester	First year	Primary dendritic arborization present by age three	Very experience dependent - continued sensitivity throughout life
Synaptogenesis	Third trimester	8 months	Region specific: with most cortical areas by age 10, other areas earlier	Continuous activity-dependent process through life
Synaptic sculpting	Birth	First four years	Region specific: cortical areas by age six	Second phase of activity during puberty
Myelination	Birth	First four years	Region specific: majority complete by 10	Continuing important myelination through adolescence

Genes involved in neuronal migration

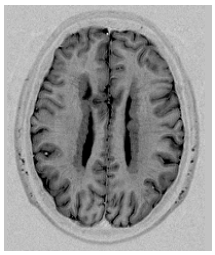


FLNA	X-linked periventricular nodular heterotopia
ARFGEF2	a.-r. periventricular nodular heterotopia
LIS1	isolated lissencepahly (lissencephaly **type** I)
DCX	X-linked isolated lissencephaly (lissencephaly **type** I)
ARX	X-linked lissencepahly with abnormal genitalia (XLAG)
Reelin	lissencephaly with cerebellar hypoplasia (LCHb)
VLDLR	simplified gyration with cerebellar hypoplasia
POMT1	Walker-Warburg-Syndrome (lissencephaly **type II**)
POMT2	Walker-Warburg-Syndrome (lissencephaly **type II**)
POMGnT1	Muscle-Eye-Brain Disease (lissencephaly **type II**)
Fukutin	Fukuyama Congenital Muscular Dystrophy (liss. **type II**)
FKRP	congenital muscular dystrophy with cerebellar cysts
LARGE	congenital muscular dystrophy with cortical malformation
GPR56	bilateral frontoparietal polymicrogyria



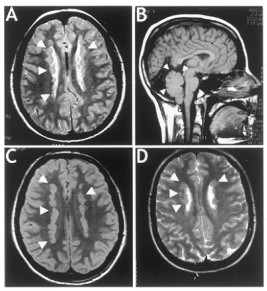
- subependymal / periventricular nodular heterotopia (PNH)
- lissencephaly type I (LIS I) / Double Cortex Syndrome (DCS)
- lissencephaly with abnormal genitalia (XLAG)
- lissencephaly with cerebellar hypoplasia (LCHb)
- lissencephaly type II (LIS II)
- bilateral frontoparietal polymicrogyria (BFPP)

Periventricular Nodular Heterotopia (PNH)



- associated with epilepsy
  - up to 80%
  - freq. begin after age 20
  - mostly focal seizures
- cognitive impairment
- coagulopathy / vasculopathy (stroke / patent ductus art. Botalli)
- abortions

Periventricular heterotopia: a disorder at the start of migration

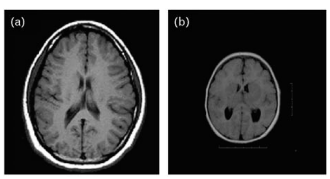


- Subsets of neurons fail to migrate from the periventricular region during corticogenesis
- PV**N**H due to mainly loss-of-function mutations in *FLNA* on Xq28
- FLNA is an actin-binding protein

Microlissencephalia

Gul et al., Neurogenetics 2006

Autosomal recessive primary microcephaly



Normal brain Patient with microcephaly

- Primary / true microcephaly is a subclass of microcephaly:
  - significant reductions in cerebral cortical size without displaying other gross abnormalities
- Affected individuals can have mild to moderate mental retardation and infrequently, epilepsy

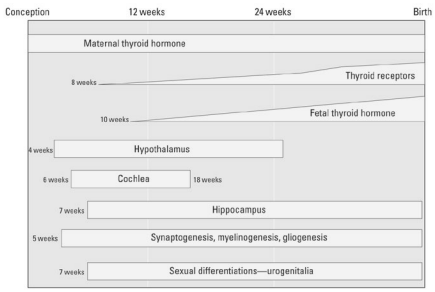


Figure 1. Role of thyroid hormones in fetal neurologic development in relation to timing of several landmark stages of development. Figure adapted from Howdeshell (2002).

Development of locomotion

- Mothers are usually (but not always) right
- Social, cultural and ethnic factors
- Normal variations in development

Development of locomotion

- A, ventral suspension
- B, prone position
- C, sitting
- D. standing and walking
- E. manipulation (evolution of graps)
- F. sphincter control

Development of locomotion

- Moro reflex
- Parachute reaction
- .....

Moro reflex:

Development of locomotion

Ventral suspension

A, normal

B, pathological

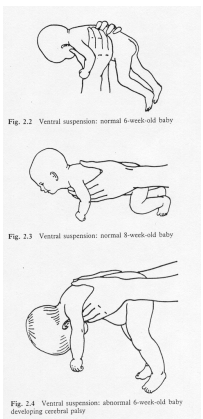


Fig. 2.2 Ventral suspension: normal 6-week-old baby

Fig. 2.3 Ventral suspension: normal 8-week-old baby

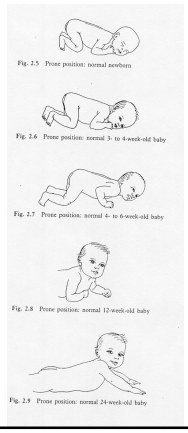
Fig. 2.4 Ventral suspension: abnormal 6-week-old baby developing cerebral palsy

Ventral position: Abnormal newborn

Abnormal newborn

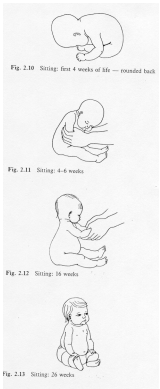
Development of locomotion

Prone position



Development of locomotion

- Sitting



Sitting: normal newborn

Primitive Reflexes – Stepping
normal newborn

Primitive Reflexes - Stepping

- **Primitive Reflexes - Stepping**
  With the baby held in vertical suspension and his feet touching the mat, he does not have the expected reciprocal flexion and extension of the legs. The stepping or walking reflex is **absent in this baby**.

Development of locomotion

I:

Standing
and walking

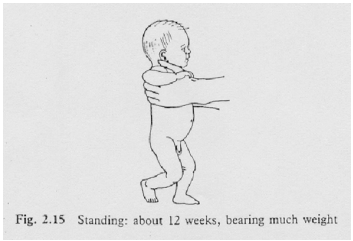
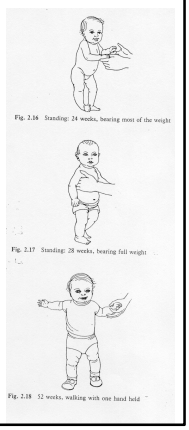


Fig. 2.15 Standing: about 12 weeks, bearing much weight

Development of locomotion

II:

Standing
and walking

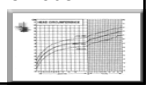


Development of locomotion

- Manipulation (evolutaion of grasp)

Head Circumference

- Another very important part of assessing brain development is measuring the growth of the brain. This is accomplished by measuring the head circumference, which is an accurate **reflection of brain size**. **The brain grows to 80% of its adult volume during the first 2 years** of life so many neurological diseases that occur early in life will impact the growth of the brain. A small head (**microcephaly**) or a large head (**macrocephaly** or **hydrocephalus**) can be key findings in explaining the neurological abnormalities of a child.
- It is essential to plot head circumference on a standardized head growth chart such as the Nellhaus chart.



Head Circumference

SPECIAL PROGRAMS Neurodevelopment Assessment

- Attentional based disorders
- Dyslexia and language related learning difficulties
- Study and organizational problems
- Non-verbal learning disabilities
- Emotional/Behavioral problems
- Written Expression problems

Developmental Milestones

- The neurological examination of the pediatric patient must be couched in the context of neurodevelopmental milestones. The normal neurological findings one would expect for a newborn are certainly different than a 2, 6 or 12-month-old infant. Obtaining developmental milestones is an important reflection of the maturation of the child's nervous system and assessing development is an essential part of the pediatric neurological examination. Delay in obtaining developmental milestones and abnormal patterns of development are important indicators of underlying neurological disease.

Diseases - Therapies

- **Speech Therapy**
- **Occupational Therapy or Physical Therapy**
- **Vision Therapy**
- **Applied Behavioral Analysis Therapy**
- **Neurodevelopment Therapy**
- **Specific Educational Therapy**
- **ADD/ADHD**
- ***The Ritalin-Free Child: Managing Hyperactivity & Attention Deficits Without Drugs*** **by Diana Hunter (ISBN 0962833681**

- **Autism (also PDD)**
- **Asperger Syndrome**
- **Auditory Processing Dysfunction**
- **Dysgraphia**
- **Dyslexia**
- **Mental Retardation**
- **Sensory Processing Dysfunction**
- **Speech Disorders**
- **Vision Impaired**

Cerebral Palsy

a persistent disorder of

- movement and
- posture

Risk factors for CP

- multifactorial

preterm birth
multiple gestation
intrauterine growth restriction
male sex
low Apgar scores
intrauterine infections
maternal thyroid abnormalities
prenatal strokes
birth asphyxia
maternal methyl mercury exposure
maternal iodine deficiency

Risk factors for CP

- prenatal factors result in 70-80% of cases of CP
- In most cases:
  the exact cause is unknown but is most likely multifactorial

Clinical course of CP

CP generally is considered to be

static encephalopathy or

nonprogressive in nature !!!!

Practice Parameter: Diagnostic Assessment of the Child with Cerebral Palsy (CP)

Neurology 2004; 62:851-863

Prevalence

- Worldwide incidence of CP is approximately 2 to 2.5 per 1000 live births.
- Each year about 10,000 babies born in the US develop CP.
- Data from the Northern Ireland Cerebral Palsy Registry revealed that ½ the children with CP were of low birth weight (i.e., less than 2500 grams

Practice Parameter: Diagnostic Assessment of the Child with Cerebral Palsy (CP)

Neurology 2004; 62:851-863

Economic Impact:

A California study (1992) of the extra economic costs associated with CP and 17 other congenital disorders (e.g., Down syndrome, spina bifida) showed that CP had the highest lifetime costs per new case, averaging $503,000 in 1992 dollars

Rate of Cerebral Palsy

- **Rate of cerebral palsy per 1000 live births across Europe by year and severity**