Development of Vision from Infancy to Early Adolescence

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Transdisciplinary approach in rehabilitation and integration

The goal of the continued education in visual functioning.

How can we together learn more about functioning of visually impaired children?
Transdisciplinary approach in rehabilitation and integration

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How can we together learn more about functioning of visually impaired children?
Processing of visual information

Early processing in the occipital lobe: Ventral stream
Dorsal stream
Mirror neuron system
Processing of visual information

Early processing in the occipital lobe:
- Ventral stream
- Dorsal stream
- Mirror neuron system
Visual communication

Eye contact, copying of expressions
At 6 weeks, 8 weeks at the latest

Social smile, active interaction
at the age of 12 weeks.
Communication – at 8 weeks
Early Interaction
Anne Nafstad & Inger Rødbroe

Emotional and motoric attunement
When an infant is functionally blind

Congenital glaucoma
Cloudy corneas
Flat anterior chambers

"Developmental emergency"
Patricia Sonksen
After corneal transplant

- Born blind
- clear cornea from 5th weeks of age
- **intensive activation**
- awareness of vision
- interdisciplinary early intervention
After corneal transplant

- Born blind
- clear cornea from 5th to 15 weeks of age
- early intervention
- normal milestones in motor development
- effective use of vision
- some form vision and colour perception
At 2 years

- born blind
- clear cornea from 5th to 15 weeks of age
- early intervention
- healthy child

Normal motor development
Fragile baby
Eye contact and social smile are important to the baby and the parents.

4-month-old baby refuses visual communication.

Insufficient accommodation? Mirror neuron system?
Accommodation

eye contact and social smile

Weak accommodation can be compensated with "reading glasses."
Penalisation + bifocal

Late development of accommodation may lead to esotropia.
Penalisation + bifocal
Amblyopia did not develop, binocularity remained

In school age
Clinical examination gives the foundation for the assessment of visual functioning

Orthoptists, therapists, nurses, optometrists, technicians, parents, teachers

Observations

Photo: Miguel G. Alvares, MD  Brazil
Clinical examination gives the foundation for the assessment of visual functioning.
Grating Acuity & Heidi Face

as detection acuity & communication distance

Preferential looking

Detection tests

2.5%
Hiding Heidi
low contrast pictures for assessment of communication distance

Facial expressions are fast moving low contrast shadows.
Figure-in-motion, Pepi-test

Near correction
Head support

Can be copied @
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Vision
in motor development
Head control

Foto: Patricia Sonksen
Low tonus and poor head control

Strong visual stimulus activates motor control
Infant artists using Mirror neuron functions

Photo: Päivi Setälä
Tactile, haptic and auditory confirmation is important!
Multimodal learning.
Periventricular leukomalasia
Delayed motor functions

Combined effect of visual and motor disorder delays the development of an infant in all functional areas.
Constricted visual field

Large illuminated ball used by child’s own therapist.
Assessment >> Early Intervention

1. Normal hand
2. Spastic hand

Awareness of hands ➞ Fixation
Accommodation
difficult to measure when the infant does not look at a target

Near correction is always worth trying.
Eye contact
when reading lenses give a clear image on the retina
Visually active infant
ten weeks later: improved visual and motor functions

RE: GrA less than in LE >> training
as a part of physiotherapy
Infants at risk

Accommodation in hypotonic infants is often very weak.
Compensating accommodation
Watching simple pictures
two years later
High myopia fully corrected
The child is happy to have +4 near correction.

Near vision is vision for learning. Spectacle corrections should be for the functionally important distances.
Decisions can be followed by observing infant’s fixations

Fixation in the communication with a 5-month old infant: what is the preferred object?
Object in hand helps fixation

Turning of gaze and turning of attention can be helped with simultaneous information from the hands: tactile, haptic, and kinesthetic.
Perception of space
"visual cliff"
Playmat

orientation in space

Light coloured surfaces rough, dark surfaces smooth - vision and touch coincide.
Structured play situation

Finnish version (needs to be modified for other countries)
Structured play situation
Siblings and grandparents training
"Little room"
made of a brown paper box

Vision, touch, echoes,
measuring space with his own body.
Tea break
Pathways
Retinocalcarine pathway
Changes in the information that can occur in the eye

Cornea
Lens
Vitreous
Retina
Optic nerve

Use of 3D eye to explain the structures that have been affected and how that changes the quality of information that flows into the brain for processing.
Visual Pathways
Primary and secondary visual cortex
Retinocolcalcarine and tectal pathway

LGN = Lateral Geniculate Nucleus; SC = Superior Colliculus; PU = Pulvinar
Ventral & dorsal stream
inferotemporal & parietal stream
Early processing in the occipital lobe: Ventral stream, Dorsal stream, Mirror neuron system
Arousal- Wakefulness
Early processing in occipital lobe
Ventral and dorsal stream/network

Early processing:
Colours
Contrast edges
Movement/ motion
Line directions & length
Stereo vision
Object/ background
Figure/ ground
Visual closure, filling-in
Visual illusions
Figure-in-motion
Visual closure, filling-in
Visual illusions
Binocularity tests - fusion

Worth 4-dot test
Stereovision

Lang test

9 months

TNO

Effron rectangles
Rectangles – Mailbox
Heidi Expressions– Colorama

26.2.2000; 3 years 8 (corr. 5) months

Testing early and higher visual processing
Vision for communication

- Real life situations, drawing/making pictures
- Photographs, colour and B&W
- Videos, tactile exploration, magnifying mirror
- **Intervener in communication situations**
Training facial expressions

- Drawing with the child
- Magnifying mirror
- Visuotactile pictures
Matching and recognition of pictures
Recognition of faces

**Re-cognition:**
- facial features are seen well enough
- a **template** is formed in memory
- the face is seen again
- template is found and matched
- the name of the person is remembered
- in normal development infants recognise faces at the age of 6-8 months, latest at 10 months
Discussion
Lunch break
Early Identification
Vision Screening
Assessment of Visual Functioning

1. OCULOMOTOR FUNCTIONS

2. QUALITY OF VISUAL INFORMATION
   CLINICAL TESTS

3. OBSERVATIONS
   ON
   VISUAL PROCESSING FUNCTIONS
Clinical examination

Foundation for Assessment of Visual Functioning

completed with

Tests and observations

at School/KG/Early Intervention

Children with other Functional Problems
Clinical examination gives the foundation for the assessment of visual functioning

orthoptists, therapists, nurses, optometrists, technicians, parents, teachers

OBSERVATIONS

Photo: Miguel G. Alvares, MD  Brazil
Clinical examination gives the foundation for the assessment of visual functioning.
Hospitals’/ophthalmologists’ role in early intervention and vision rehabilitation

- Early referral to ophthalmologists
- Immediate referral to early intervention
  - need of information and support is greatest on communication, interaction, future, motor development, social skills
- Early diagnosis
- Information to the EI and rehab teams
- Never say “Nothing can be done.”
- Remember visual ergonomics
  - spectacles, optical and nonoptical devices
Impaired Vision

in infants and children, risk groups

• 60-70 % of VI children have multidisability
• intellectual disability, Down syndrome: refraction, accommodation
• motor impairment, CP, strabismus, accommodation, NVI/CVI
• hearing impairment, cortical
  peripheral (Usher Syndrome)
• prematurely born infants, twins, difficult birth
• chronic illness
• 20% of VI children have ”CVI”, problems in processing of visual information due to brain damage
Vision loss affects development of following areas of functioning:

- communication
- interaction
- motor development
- spatial concepts
- orientation in space
- object permanence
- language
Prematurely born infants

retinopathy of prematurity & periventricular leukomalasia

ROP+PVL
Retinal changes +cerebral visual impairment
ROP
Retinopathy of prematurity

After laser treatment
Birth trauma, 3\textsuperscript{rd} nerve palsy > ptosis
right sided hemiplegic condition
Exotropia – Slow miosis
3rd nerve and Ehdinger-Westphal nucleus

After operation looks normal, but is severely impaired.
Symptoms of impaired vision

- exotropia, outward squint operated
- brought objects close to the eyes = geometric magnification
- looked at the hair line, not at the eyes = central scotoma
- explored carefully with hands and mouth
- recognised people first at 18 months of age
- moved freely and knew his way at home.

Usual story of children with brain damage in all countries.
Cognitive vision tests

- Hiding Heidi for communication
- LEA-Mailbox
- LEA-Rectangles
- Face pictures
- Heidi Expressions
- LEA Puzzle
- Crowding effect
- Pepi-test, Johansson’s Walking Man

**Reading tests**

**OBSERVATIONS**
Primary visual cortex, V1

Decoding – encoding:
- contrast edges
- lines, length, direction
- binocular fusion > stereo depth
- movement, also directly to V5
- ”filling-in” of scotomas
- hyperacuity
Looking for contrast edges
Mailbox Game
Mailbox Game – Orientation of lines in eye-hand coordination
Directions as purely visual task
Ventral stream function

One rod is fixed, the other can be rotated until parallel
Angles
Eye-hand coordination in assessment of awareness of directions
Stereovision

Children with severely impaired vision may have normal visual acuity and stereovision. VA does NOT depict disability.
Object-background, figure.ground
Other functions of visual cortex

Auditory space
Haptic space
Tactile information, Braille
Working memory

Transcranial Magnetic Stimulation
Copying
parietal, eye-hand-coordination task
Copying angle & cross

Tester draws the figure.
Parallel lines, angle, and cross
Picture perception

Composing picture of its parts

Communication pictures figure-ground problems
Ventral Stream
Inferotemporal Networks

Details in pictures, Noticing errors and missing details
Perception of textures and surface qualities
Recognition of familiar and unfamiliar faces
Facial expressions, Body language
Landmarks, Concrete objects, Pictures of concrete objects
Abstract pictures of objects of different categories
Abstract forms (letters, numbers), Sequencing
Reading words and lines of texts, Optimal reading strategy
Comparison with pictures in memory, ‘Reading’ series of pictures
Visual problems in copying pictures from blackboard and/or at near
Crowding effect, Scanning lines of text
Dorsal Stream
Parietal Networks

Awareness of surrounding space, directions and distances in space

Body awareness

Perception of near and far space

Orientation in space, map based, Memorising routes

Motion perception, Depth perception, Simultaneous perception

Eye-hand coordination, Grasping and throwing objects

Drawing, free hand, visual imagination

Copying from near/ from blackboard, motor planning and execution

Mathematics, Visual attention
Tea break
Vision Screening in Health Care Centres

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New Finnish Instruction Manual for follow-up and screening of functions and Functioning 2011
Recommended follow-up
in Finland 2011

• Birth: structure of the eyes, red reflex, strabismus
• 6th – 8th weeks: good eye contact
• 3rd – 4th month: - active visual communication, hands found
  - baby follows hand movements of children and adults
  - fixation, following movements, convergence
• 7th- 8th months: pincer grasp, face recognition, Hirschberg
• 18 months: face recognition, Hirschberg, cover test (H+c)
• 3\textsuperscript{rd} year: (H+c), near vision acuity
• 4\textsuperscript{th} year: (H+c), near and far vision acuity
• 5\textsuperscript{th} year: if visual perceptual problems >> ophthalmologist
• 7\textsuperscript{th} year: visual acuity as a part of general health, first grade in Finland
• 7\textsuperscript{th} grade, visual acuity and colour vision
Recommended assessments in Finland 2011

- Following functions should be assessed in all infants – stressed in the new recommendations:
  - eye contact and social smile
  - observation of hand functions and copying them
  - face recognition of family members
Visual communication

Eye contact, copying of expressions
At 6 weeks, 8 weeks at the latest

Social smile, active interaction
at the age of 12 weeks.
Accommodation

eye contact and social smile

Weak accommodation can be compensated with "reading glasses."
Infant artists using Mirror neuron functions

At the Art Museum
Pori, Finland

Photo: Päivi Setälä
Infants at risk

- Infants with delays/difficulties in communication
- All hypotonic infants: brain damage, Down
- All infants with Down syndrome, refraction
- Premature infants
- Infants with strabismus
- All deaf and hard of hearing infants
- All infants with syndrome based risk of VI
- Spectacle correction without delay
- Support for development of binocularity
Infants at risk

- Infants with delays/difficulties in communication
- All hypotonic infants: brain damage, Down
- All infants with Down syndrome, refraction
- Infants with strabismus
- All deaf and hard of hearing infants
- All infants with syndrome based risk of vision loss

Paediatricians, Paediatric neurologists, Audiologists
Paediatric geneticists, Psychologists, Therapists, Parents
Early Intervention should start EARLY
It should start during the assessment.
For Early Intervention
Observations at the age of 4 months

• Problems in early interaction are usually no more present if nothing was found in the assessment of vision and hearing and the family situation is stable.
• Eyes are symmetric and their structure is normal.
  Large eyes - glaukooma?
• Red reflex
• Fixation and convergence
• Following movements
• Hirschberg test
• Strabismus, also if reported by parents – is sometimes not present during the visit to the health care centre.
Strabismus – spectacles

good fitting, not too small

When spectacle frames are large enough, looking over is not possible.
Observations at the age of 8 months equal to observations at the age of 4 months +

- If the family has early intervention because of difficulties in interaction, is the situation developing positively.
- Eyes are symmetric and their structure is normal.
  
  **Large eyes - glaukooma?**
  
  - Red reflex
  - Fixation and convergence
  - Following movements
  - Hirschberg test
- Strabismus, also if reported by parents – is sometimes not present during the visit to the health care centre.
- The infant recognises parents’ faces before they talk.
- Tear pathway problems.
Cover test

Small accommodative fixation target should be at the level of the child’s eyes and the child fixates at a small detail. Ask for example ”Does giraff’s tail move?” at the moment when you place the cover on the other eye.
Training of direct cover test

- Following slides show findings during cover test. Observe:
- 1. What happens to the eye that is NOT covered
  a. - if it does not move = no strabismus in that eye
  b. – if it moves toward midline from the inner corner = constant esotropia;
     when the cover is removed, the eye moves back to the corner and the
coversed eye moves to the middle
  - if it moves toward midline from the outer corner = constant exotropia.
Observations at the age of 18 months

• As at the age of 8 months +
• If an eye that has been in normal position, has started to squint, remember the rare possibility of retinoblastoma and refer without delay.
• Direct cover test
At the age of 3, 4 and 5 years

- 3 years: Hirschberg + cover test, visual acuity with near card
- 4 years: Hitschberg + covertest, VA near an distance
- 5 years: if problems in visual perception => ophthalmologist and neurologist before therapies
Near vision test at 40 cm
binokular measurement first
Near vision test at 40 cm
binokular measurement without pointing
Near vision test
monocular measurement
Near vision test
## 50% & 25% spacing

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Developed by Laszlo Hyskowitz, M.D. FOR TESTING AT 16 INCHES (40 CM)
Near vision test with Numbers
Distance VA tests
LEA Symbols test in lightbox
standard illumination for VA and CS tests
LEA Numbers test in lightbox
CONSULTATION
ON DEVELOPMENT OF STANDARDS
FOR CHARACTERIZATION
OF VISION LOSS
AND VISUAL FUNCTIONING

Geneva, 4-5 September 2003
Vision Screening
in Health Care Centres

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