Visual Functioning in Children with Brain Damage

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”Provide concrete information to educators and rehabilitation specialists as they work to address ABI issues in their students and clients.”
ICF-CY

International Classification of Functioning, Disability and Health

9 DOMAINS to be assessed

same as in the ICF-2001 for adults

2007
ICF-CY
Children with visual, motor, intellectual and/or hearing impairment

2007
9 domains, 5 suitable for young children

1993
4 domains, main functional areas.
Brain damage related vision loss
in children

1) Close to adult type vision loss after 2 years of age.

2) Early brain damage: before, during or soon after birth, asphyxia related; infections, accidents, near-drowning

CVI – ”Cortical/cerebral visual impairment”, 20%
- usually also other than cortical lesions
- lesions without cognitive losses are not accepted as CVI, for example uncomplicated hemianopia
- some places require visual acuity values $< 0.3$, 20/60
- typically: losses in recognition functions (ventral stream functions) and/or in vision for action (dorsal stream functions)
- losses in the function of mirror neuron system often not considered
Lessons from adult neurology
hemianopia with motion perception in the ”blind” hemifield

Motion perception to V/4-stimulus in the hemianopic side of the visual field in 1991, good performance in test driving, allowed to keep driver’s licence. 1997 measurement of flicker sensitivity in the blind field at 30 deg eccentricity (Antti Raninen).
Luminance flicker measurements
13 sessions within a year

Infarct in left Radiatio optica

>> right hemianopia
Visual information from the blind side is now processed in the right hemisphere.

Visual information from the ”blind” right side is now processed in the right side of the brain close to the processing of information from the left normal side of the visual field.
Early visual field changes and disorders of processing in children have been taken as permanent. They may change, even improve.
Improvement of visual fields
in a man at the age of 22 years

Improved flexibility of ATTENTION during Orthopaedic manual therapy and *intrathecal (into the liquor)* Baclofen therapy since JAN 2004.
Constricted visual field
tested by her own therapist in order not to frighten the infant

At school 2010:
Nystagmus, head turn to block
Ocular motor functions
compensated by head movements
VA 0.3 (10/30), at 10% 0.1 (10/100)
GrA 24cpd, 10% contrast: 7cpd
Visual field with 10Hz flicker

Illuminated ball used by child’s own therapist.
Hand as an activating grating

Activation of visual functions increases flexibility in directing attention.
Cortical Visual Functions

- Inferotemporal recognition
- Eye-hand coordination
- Spatial awareness
Cortical Visual Functions

- Eye-hand coordination
- Spatial awareness

- Inferotemporal recognition
- Parietal
- Posterior
- Frontal

DIAGRAM: Brain regions and their functions.
Cortical Visual Functions

- Eye-hand coordination
- Spatial awareness

Brain regions:
- Frontal
- Parietal
- Inferotemporal

Visual areas:
- V1
- V2
- V3
- V4
- VP
- LO
Assessment of Visual Functioning

1. OCULOMOTOR FUNCTIONS

2. QUALITY OF THE INCOMING VISUAL INFORMATION CLINICAL TESTS

3. OBSERVATIONS and TESTS ON VISUAL PROCESSING FUNCTIONS
Assessment of Visual Functioning

OCULAR MOTOR FUNCTIONS

- Fixation
- Following
- Saccades
- Strabismus
- Nystagmus
- Head position
- Accommodation
Ocular motor functions

Fixation difficulties

Fixation + accommodation >>
loss of head control
Accommodation

dynamic retinoscopy
Ocular motor functions

**Accommodation** (CP, Down)

Dynamic Retinoscopy

**Observe**, whether convergence and miosis (pupils become smaller) occur when the child looks at interesting details. - Effect of near correction lenses. Which values?

**Compare visual acuity values** at near and at distance; does near addition make the values better?
Accommodation
compensation of poor accommodation with near correction

• 4 month old infant
• Dg: Infantile autism
• ”Avoids eye contact”
Corrective lenses
for esotropia; prevention of amblyopia

Optical penalisation = near correction RE blurs the image at distance.

Prevents diplopia, prevents amblyopia
Oculomotor functions
Saccades, short and long

Fixation, fixation nystagmus
Following - tracking
**Saccades & Scanning**
Strabismus
Nystagmus
Accommodation
Differentiation from head movements
Effect of head posture
Effect of posture and tonus of the body
Reading saccade

ELEPHANT IS WALKING

saccade
Special instrument for observation of reading strategies

Child’s face and the text are reflected to the camera.

Text on clear film.
Oculomotor functions recorded with a special camera system

This boy learned to speak 6 months before this video was taken; letter ”V” is difficult and blocks the use of vision and control of eyes and head movements.
Saccades L to R poor, VA 0.01 (50% crowding)
Saccades R to L good, VA 0.05 (50% crowding)
Insufficient accommodation, myopia
0.01 = 1/100 = 10/1000
0.05 = 10/200
visual acuity later 0.1 = 10/100
0.01 = 1/100
Visual acuity later 0.1 = 10/100
0.05 = 10/200
visual acuity later 0.1 = 10/100
(LEA Symbols line test on lightbox)

Reading text upside down
Oculomotor functions

N=50

FUNCTIONS

Fixation
Normal in 30 cases

Following movements

Saccades
Fast, exact in 26 cases

Strabismus
Nystagmus
Head control

Accommodation
Normal 16, slow, insufficient in 19 cases, not measurable in 18 cases

>> 22 near corrections prescribed

All functions were normal in 2/50 cases
Early Cortical Visual Functions

- **Posterior Parietal (PP)**
- **Inferotemporal (IT)**
- **Frontal**

- Eye-hand coordination
- Spatial awareness

Recognition
Components of images

Direction of lines

Mailbox Game
Purely visual tasks of direction
Mailbox Game
Mailbox Game
Eye (vision) - hand coordination
Direction of lines

In this test picture the lines may be seen moving – a coding problem.
Training for testing
Testing
Length & parallel lines
purely visual --- eye/vision-hand coordination
Angle & cross
Parallel v. crossing lines
LEA Rectangles Game
Visual Processing

- Inferotemporal recognition functions
- Face blindness, prosopagnosia agnosias
- Spatial awareness and orientation (eye) vision – hand coordination
VISUAL PROCESSING FUNCTIONS

VENTRAL STREAM

Perception and recognition
Length of lines, Orientation of lines, Figure-ground, Visual closure,
Details in pictures, Pictures of concrete objects, Noticing errors, Noticing missing details, Comparison with
pictures in memory, ‘Reading’ series of pictures, Visual problems in copying pictures
Recognition of Faces, Facial expressions, Body language, Concrete objects, Landmarks
Numbers, Letters, Words, Crowding effect, Scanning lines of text

DORSAL STREAM

Spatial awareness and orientation in space
Perception of near and far space, Orientation in space
Memorising routes, Perception of textures and surface qualities

Motion perception
Motion perception and moving
Motion perception and communication

Depth perception
Simultan perception and simultanagnosia

Eye-hand coordination
Grasping and throwing objects, Drawing, free hand,
Copying from near/ from blackboard

Mathematical space
Integration of sensory information
Visual, auditory, tactual overload
Visual processing and its problems – Check List

VENTRAL STREAM
Direction and length of lines and objects
Object-background
Crowding – increased crowding

RECOGNITION FUNCTIONS:
Concrete objects
Pictures of concrete objects
Visual closure – Filling in
Order of 3-4 pictures
Copying basic drawings, lines, cross, angle
used for planning motor functions
Perception of textures, surface qualities

Reading as a visual task
Recognition of letters and words
Saccades in reading, reading without saccades

Recognition of numbers and numerals

Recognition of landmarks

Recognition of facial features
Recognition of facial expressions
Perception/recognition of body language

DORSAL STREAM
Awareness of space
Map based orientation in space
Orientation based on routes

Visual imagination; mathematical abstract space

Detection and discrimination of motion

Perception of distances and depth

Simultan perception, - agnosia

Neglect

Eye-hand- co-ordination
Copying from near space, from far
Use of egocentric near space
Use of allocentric space

Integration problems, sensory, sensomotor

Hypersensitivity to noise, visual, auditory
Inhibitory functions, their insufficiencies
A child with several typical disorders

Dg: Periventricular leucomalasia

”Mild” CP
Early intervention at the age of 2 years 9 months, face blindness as the first dg

Body awareness

Spatial relationships

Bimanual demanding eye-hand coordination
Rectangles Game
Length of Rectangles, purely visually and eye-hand co-ordination

26.2.2000; 3 years 8 (corr. 5) months
Mailbox Game
Eye (Vision) – Hand coordination

26.2.2000
Simultaneous Forms and Colours

no difficulty

26.2.2000
Facial expressions

26.2.2000
Face recognition

In communication on guard, looking carefully. Does not perceive lip movements. Looks “autistic”.

Nov.2001, 4½ years
Finding the correct piece of the 3D puzzle

good picture perception & parts of a whole picture
Orientation in space
after a winter in a special school

based on a few routes
“Normal” visual functions at school beginning

- Normal eyes, small angle inward squint, treated
- Visual acuity 1.0 (10/10) o.u with line test, contrast sensitivity normal (at 37 months 0.6 (10/15) with single and 0.2 (10/50) with line test)
- Colour vision normal, perception of figure-in-motion (Pepi-test) and biological motion (Johansson’s Walking Man) at low speeds normal, high speeds (traffic, bouncing balls) were not perceived.
- Visual fields normal at 6 years of age (reflex technique).
Visual processing and its problems

**VENTRAL STREAM**
- Direction and length of lines and objects
- Object-background X
- Crowding – increased crowding X

**RECOGNITION FUNCTIONS:**
- Concrete objects
- Pictures of concrete objects
- Visual closure – Filling in
- Order of 3-4 pictures
- Copying basic drawings, lines, cross, angle Y
  used for planning motor functions
- Perception of textures, surface qualities Y

**Reading as a visual task**
- Recognition of letters and words Y small
- Saccades in reading, good

**Recognition of numbers and numerals**
- Y

**Recognition of landmarks**
- Y

**Recognition of facial features**
- Y

**Recognition of facial expressions**
- Y

**Perception/recognition of body language**
- Y

**DORSAL STREAM**
- Awareness of space Y
- Map based orientation in space Y
- Orientation based on routes Y

**Visual imagination; abstract space** X

**Detection and discrimination of motion** Y

**Perception of distances and depth** Y

**Simultan perception, - agnosia** Y

**Neglect** X

**Eye-hand- co-ordination**
- Copying from near space, from far Y
- Use of egocentric near space
- Use of allocentric space Y

**Integration problems**, sensory, sensomotor

**Hypersensitivity to noise**, visual, auditory Y

Inhibitory functions, their insufficiencies Y
At school

- Most of the teaching is audio-visual.
- Therefore we need to know WHAT and **HOW** children perceive through vision...
- ...to create the IEPs/ILPs so that they meet the needs of each child,
- …to observe in teaching and therapy situations **HOW** the child uses his sensory information.
- **When testing reading or mathematic abilities we SHOULD NOT** test visual functioning but give the tasks in a way that matches the child’s strategies.
Assessment
for schools and for early intervention

- Oculomotor functions
- Quality of the image
- Processing of the image
  - ventral stream
  - dorsal stream
Ventral & dorsal stream connections to directing of attention
Visual Pathways
to and from visual cortices, a two-way street

Modified from Virsu 1982
Lateral Geniculate Nucleus

JH 1982

Hyvärinen J 1982
Ventral and dorsal streams
Mirror neuron system
Visual Functioning
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