



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 ch<u>ildren</u> 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



Raninen AN, Näsänen RE and Hyvärinen L. (1999) Rehabilitation of vision in the hemianopic field. Invest Ophthalmol & Vis Sci 40, 737.

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



Constricted visual field

tested by her own therapist in order not to frighten the infant



Illuminated ball used by child's own therapist.

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





Hand as an activating grating



Activation of visual functions increases flexibility in directing attention.

Cortical Visual Functions



Cortical Visual Functions



Cortical Visual Functions



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



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







Special instrument

for observation of reading strategies



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.

Reading text upside down



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) at 60cm (2') (LEA Symbols line test on lightbox)



JNK 2008



Oculomotor functions



- N=50 FUNCTIONS
- Fixation
- Following movements Saccades
- Strabismus Nystagmus Head control Accommodation

All functions were normal in 2/50 cases

Normal in **30** cases

Fast, exact in 26 cases

Normal 16, slow, insufficient in 19 cases, not measurable in 18 cases >> 22 near corrections prescribed

Early Cortical Visual Functions



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



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



Bimanual demanding eye-hand coordination

Rectangles Game

Length of Rectangles, purely visually and eye-hand co-ordination



Mailbox Game Eye (Vision) – Hand coordination



Simultaneous Forms and Colours



Facial expressions



Face recognition



Nov.2001, 4¹/₂ years

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

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



"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

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





Ventral and dorsal streams Mirror neuron system







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