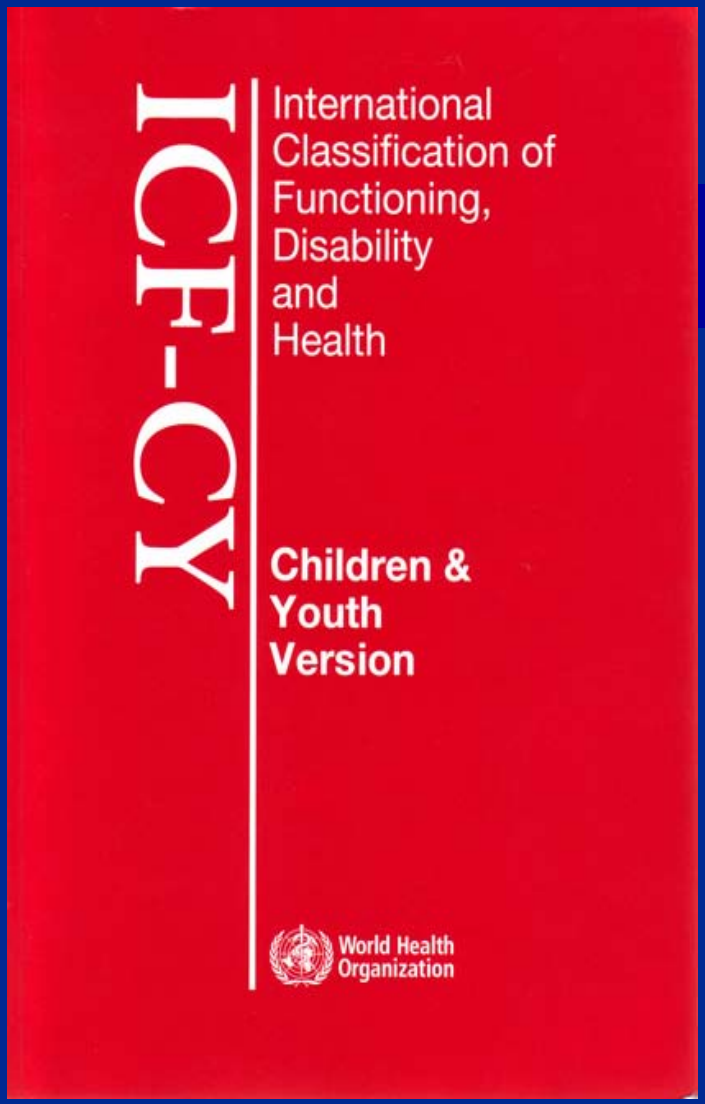
Assessment of Functional Vision

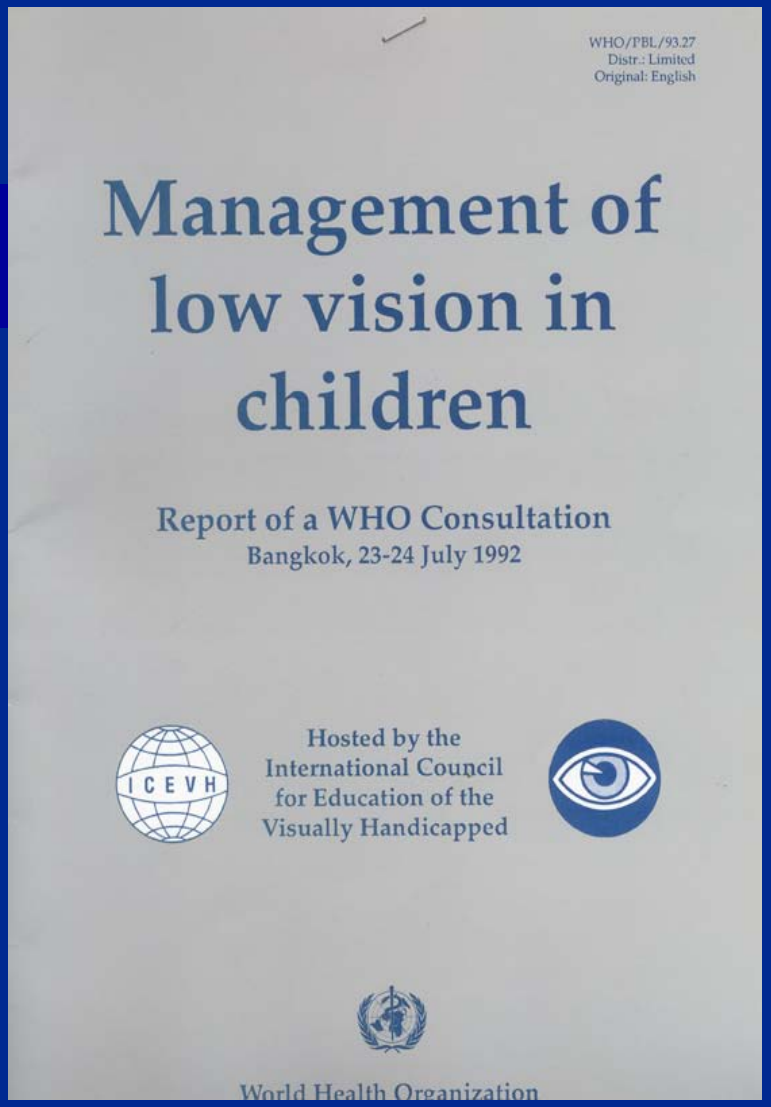
for Early Intervention and Rehabilitation

Lea Hyvärinen, MD
www.lea-test.fi

ICF-CY 2007



9 activites/domains



4 activites/domains

International Classification of Functioning, Disability and Health, Child and Youth Version

For early intervention and rehabilitation
we need to assess vision
more carefully than for
population based surveys.
We need to understand how vision is used:
in communication, orientation, ADL, and
sustained near vision tasks (reading, writing).

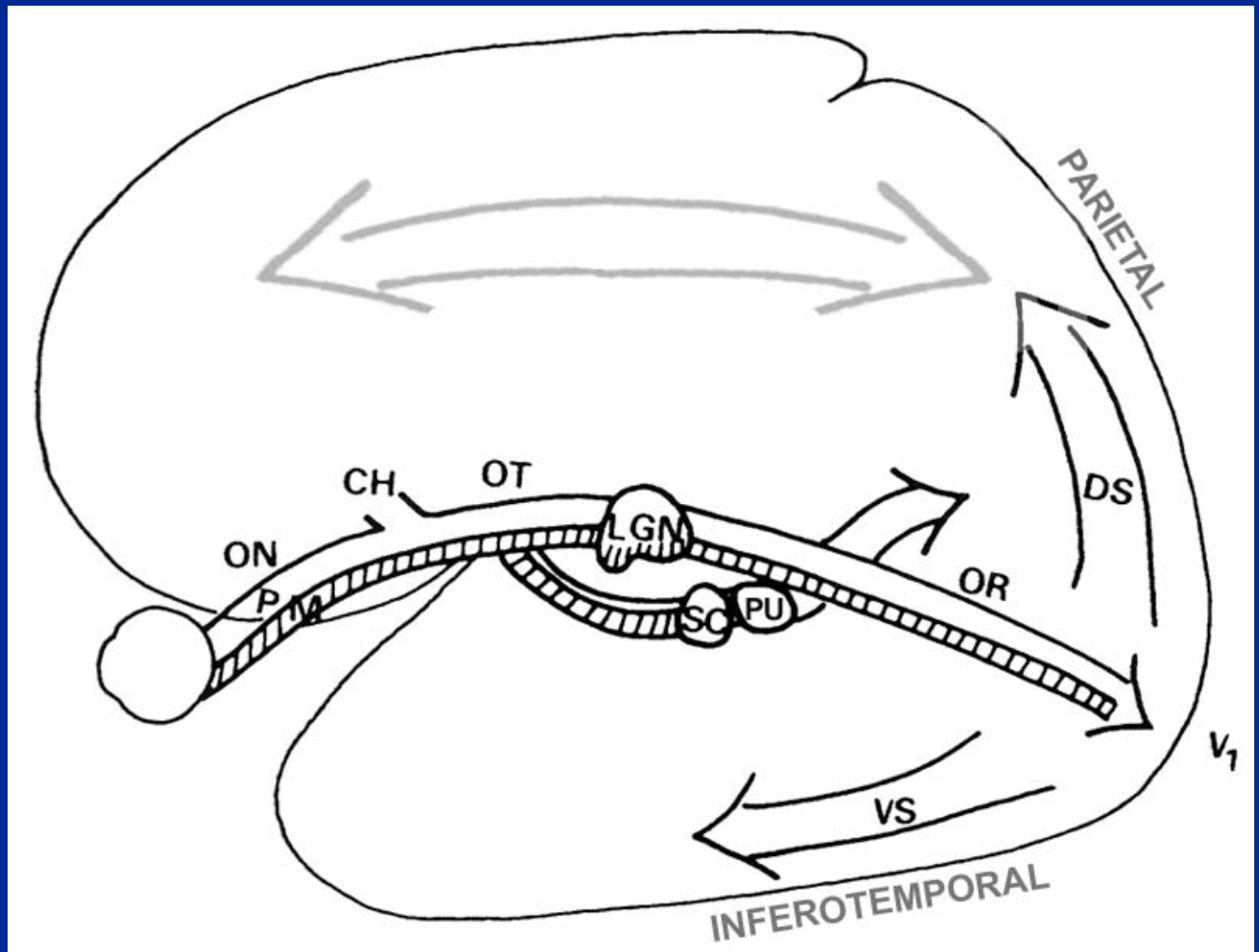
Assessment of functional vision

- basic information from the eye hospital
  structure of the pathways, **refraction, glasses** (under- or overcorrection?)
  VA, VF, CS, CV, VAd, motor functions

Assessment of functional vision

- basic information from the eye hospital
  structure of the pathways, refraction,
  glasses (under- or overcorrection?)
  VA, VF, CS, CV, VAd, motor functions
- testing of all visual functions in
  play and teaching situations

Temporal, parietal, frontal
mirror neuron functions



dorsal stream

ventral stream

Visual functioning

- Quality of the image
- Processing of visual information in brain functions
- Oculomotor functions

Binocularity - Fusion of images

Stereovision

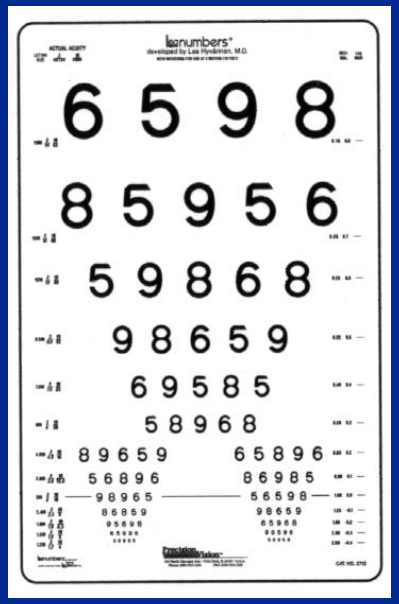
Structure of Images

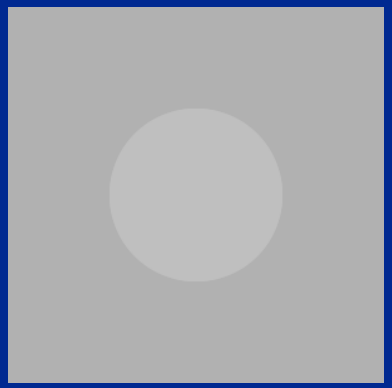
Forms

Colours

Movement

Forms, Colours, Movement





Visual acuity

- Measurement of visual acuity using optimal refractive correction that can be used
- in standard luminance + optimal luminance
- using varying postures when needed

Visual acuity

Detection acuity – small objects, ”where”function

– response to grating ” ”

[Resolving orientation of long lines (gratings)]

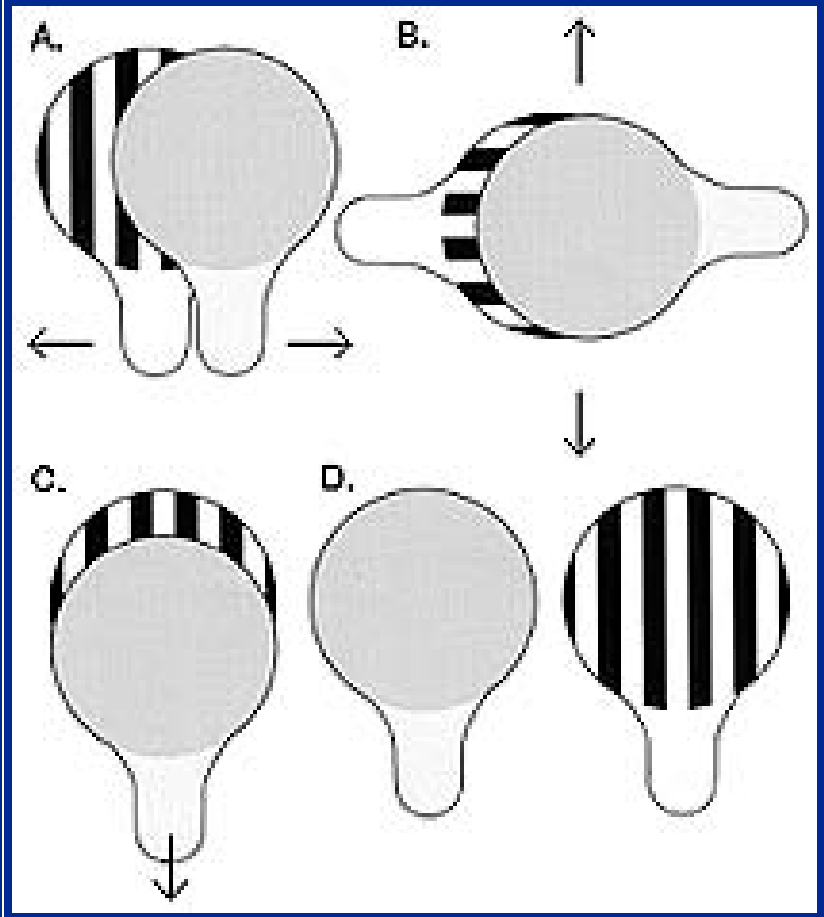
Recognition acuity – optotype acuity

Hand movements, light perception/ projection

(no ”counting fingers”, fingers are not standardized)

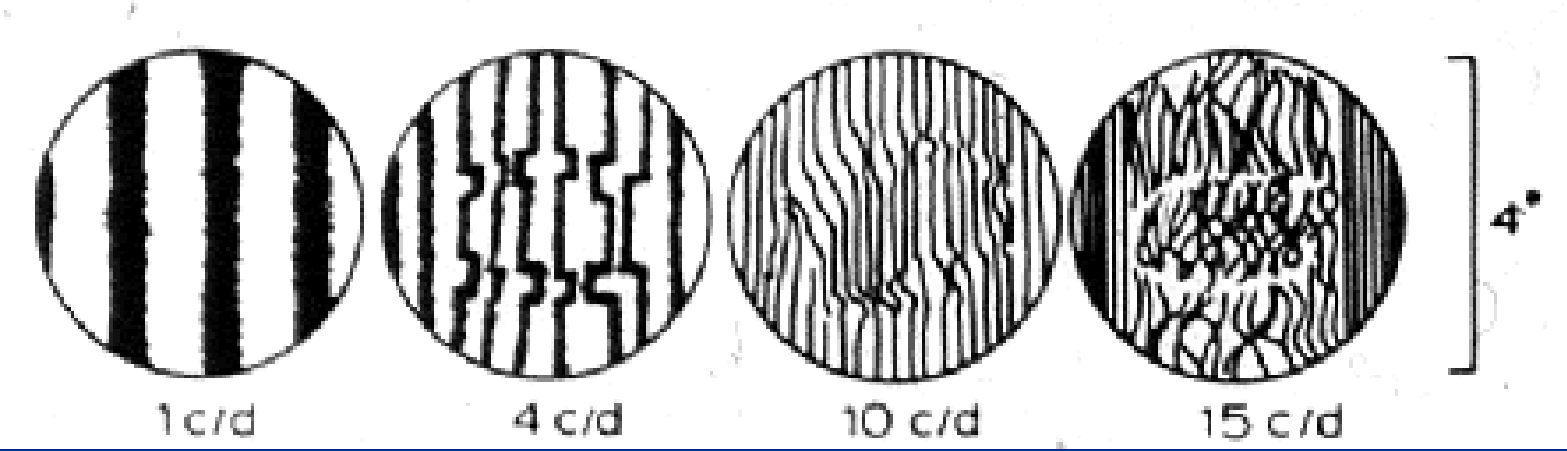
Teller Acuity Cards

LEA Gratings and Hiding Heidi



Grating tests

in preferential looking situation



Detection test

Grating acuity values

MUST NOT

be converted

to

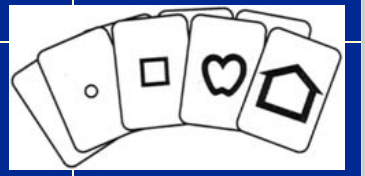
optotype acuity values

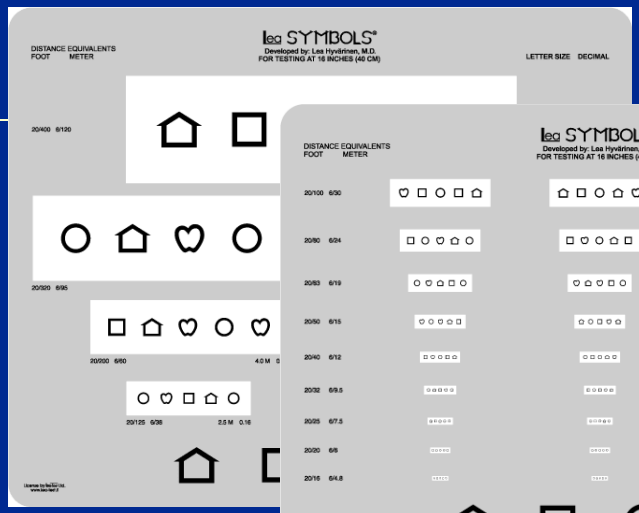
or reported as cycles per degree (cpd)

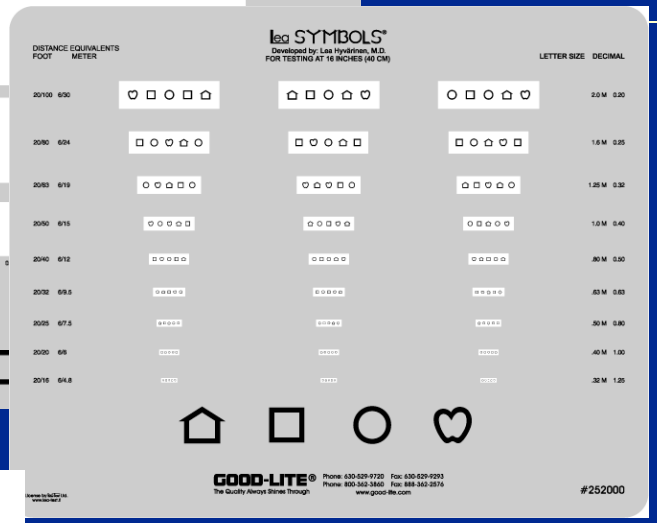
but as response to a grating with _ cpcm lines.

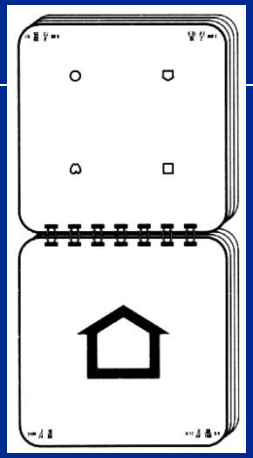
Training before testing

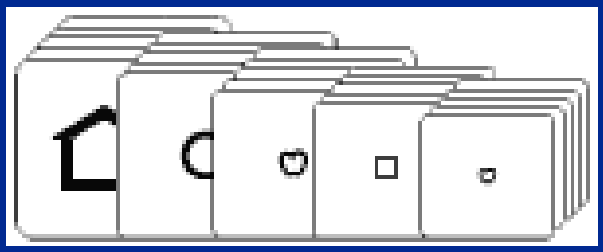
VA

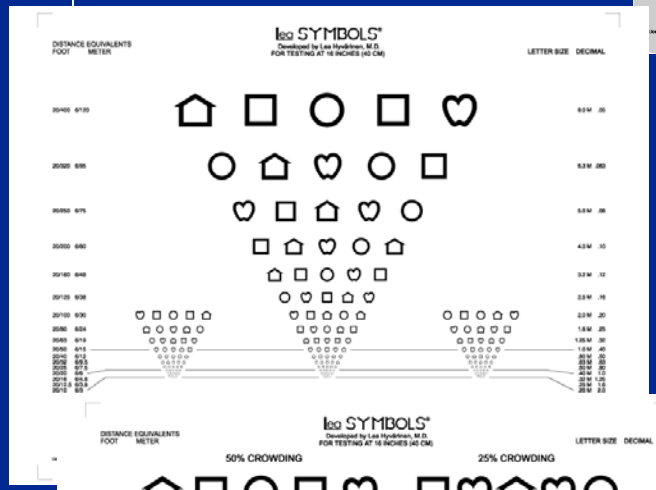


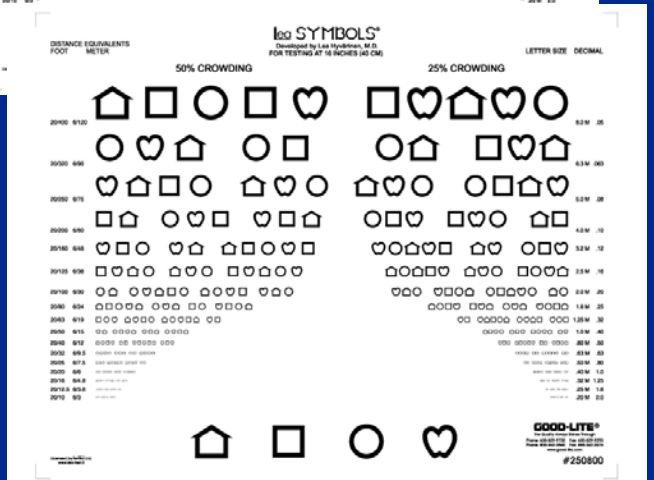


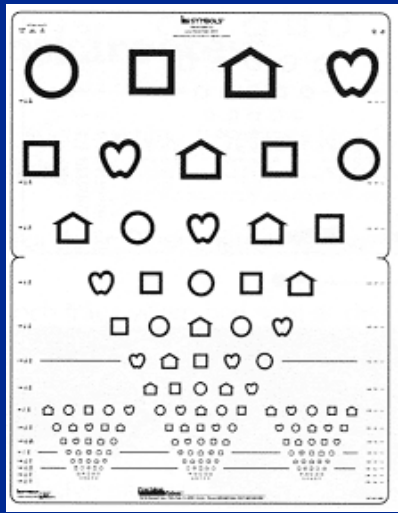


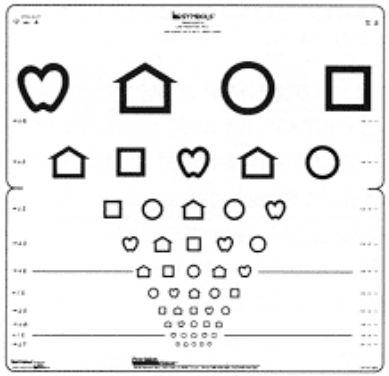


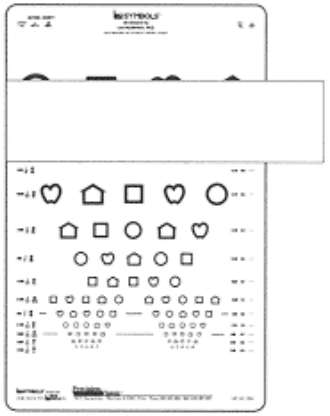












non-translucent charts & charts in lightbox

Increased Crowding

Distance	– single	**1.6, 6/4, 20/12**
	– line 3m/4M =	**0.8, 6/9, 20/25**
Near	– single symbols	**0.40, 6/15, 20/50**
	– screening test	**0.25, 6/24, 20/80**
	– standard test	**0.20, 6/30, 20/100**
	– 50% spacing	**0.16, 6/40, 20/120**
	– 25% spacing	**0.12, 6/50, 20/160**

WORLD HEALTH ORGANIZATION

WHO/PBL/03.91

Prevention of Blindness & Deafness

CONSULTATION ON DEVELOPMENT OF STANDARDS FOR CHARACTERIZATION OF VISION LOSS AND VISUAL FUNCTIONING

Geneva, 4-5 September 2003

WHO/PBL/03.91

Logarithmic design

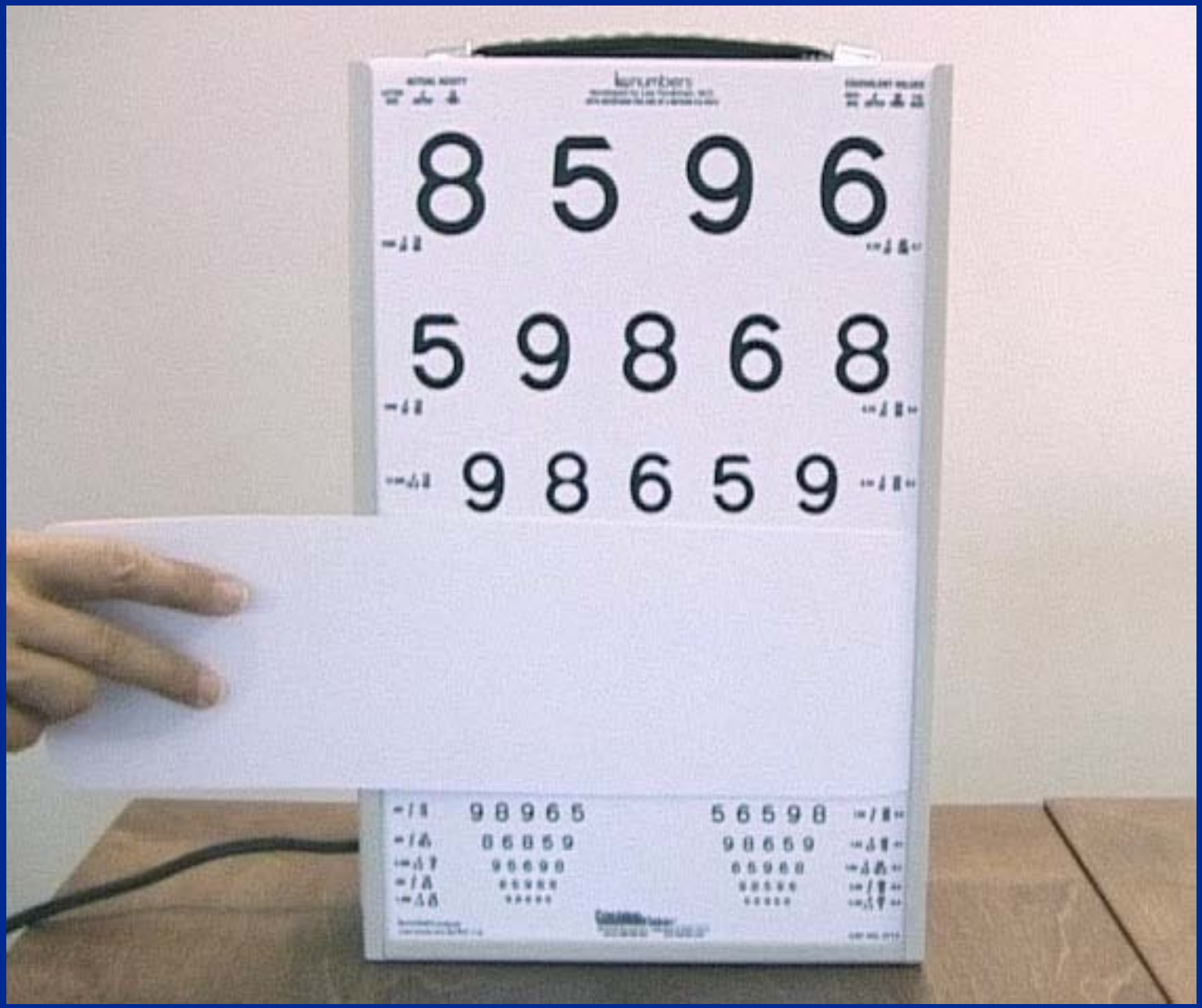
Distance & near VA, same optotypes

Distance 6m-4m; children 3m and 40cm,

adjust the distance and angle to fit the needs of the child

NOT to point at the optotypes.

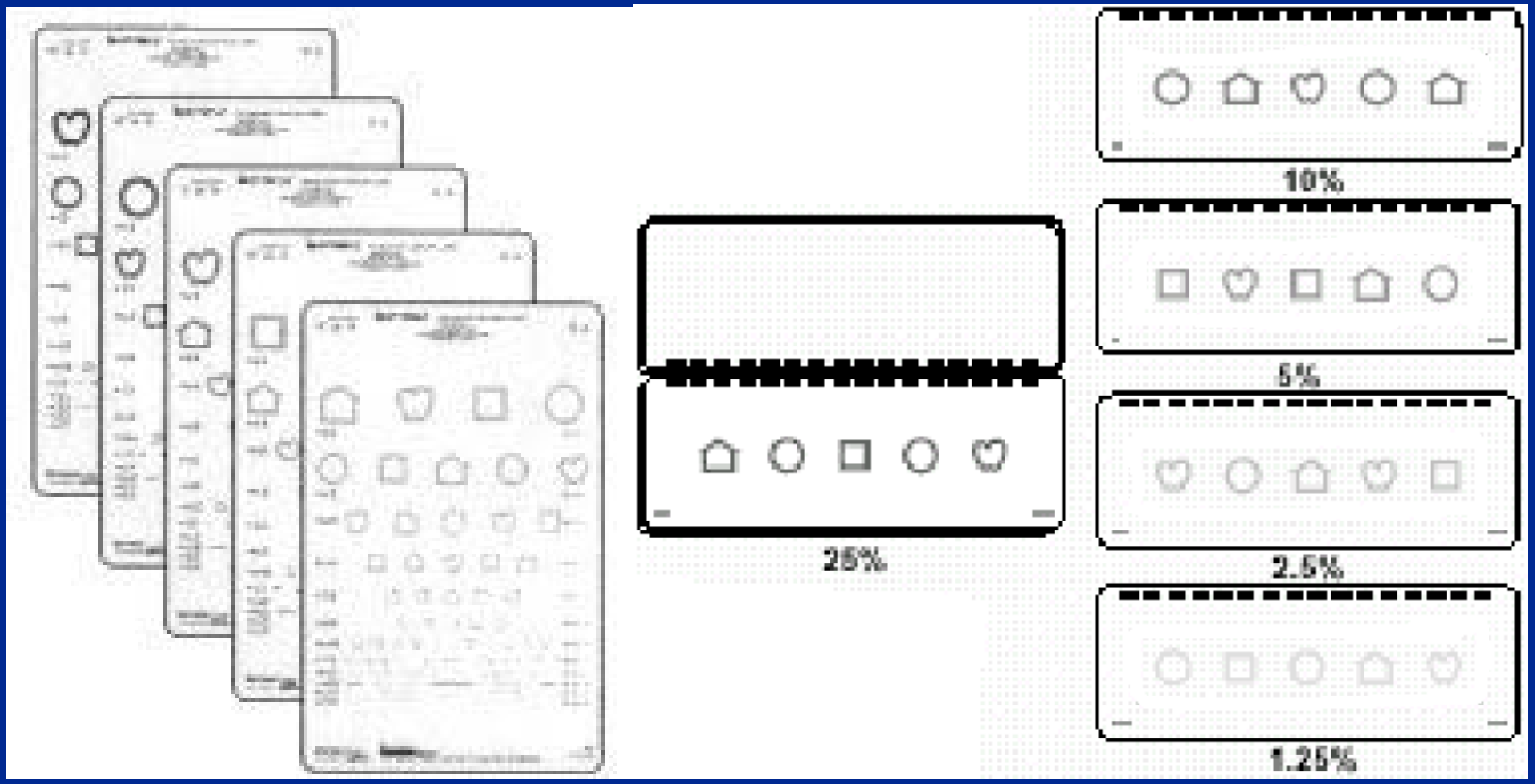
Luminance between 80 and 160 cd/m^2

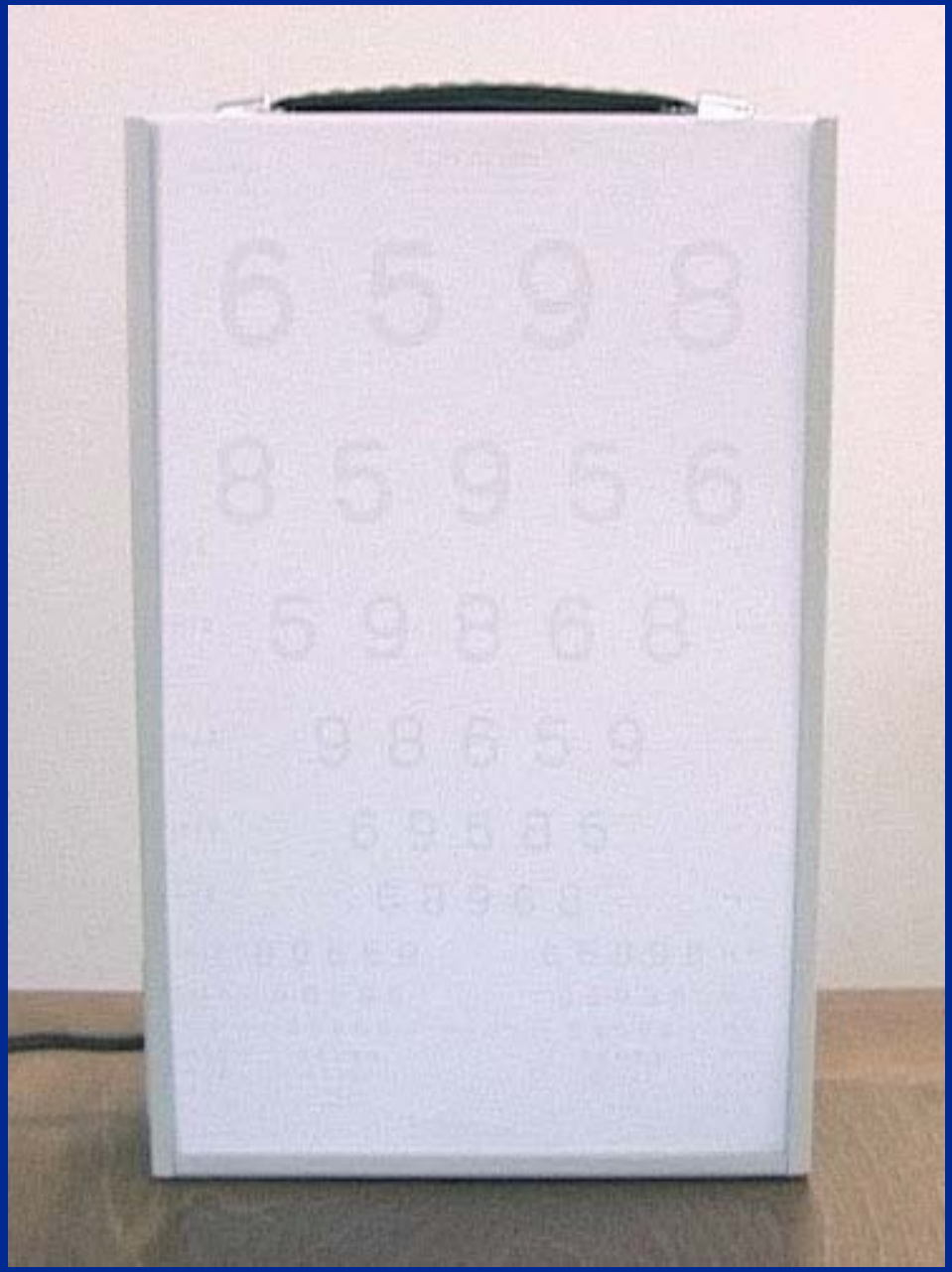

8 5 9 6
5 9 8 6 8
9 8 6 5 9

Low contrast pictures of smiling face

to assess communication distance

Contrast sensitivity



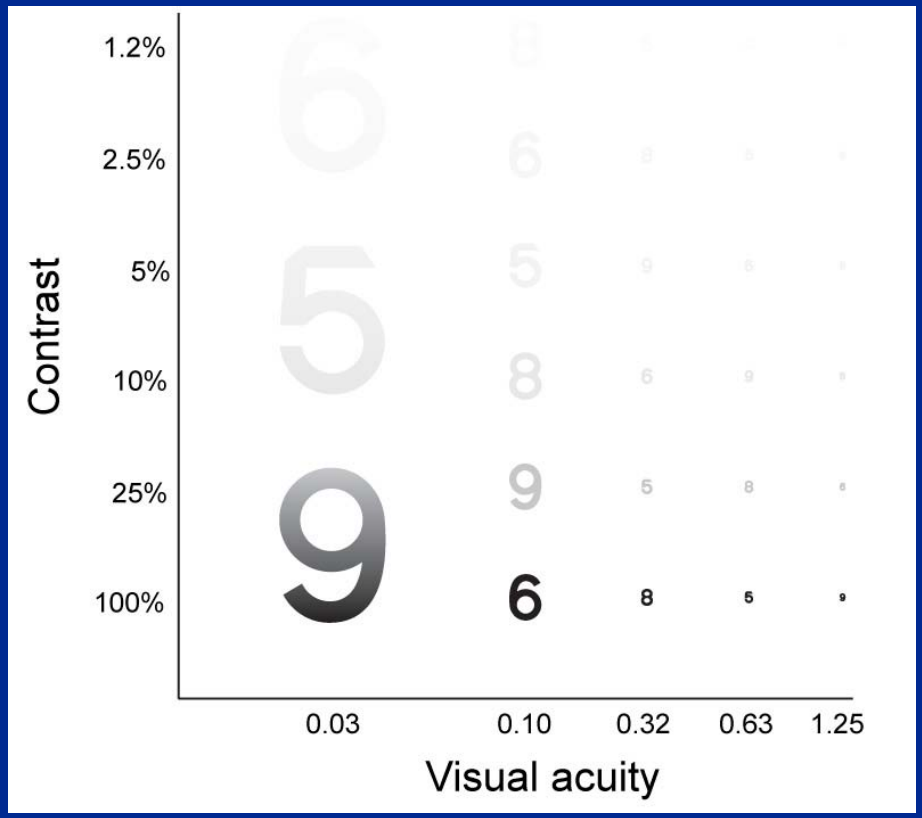


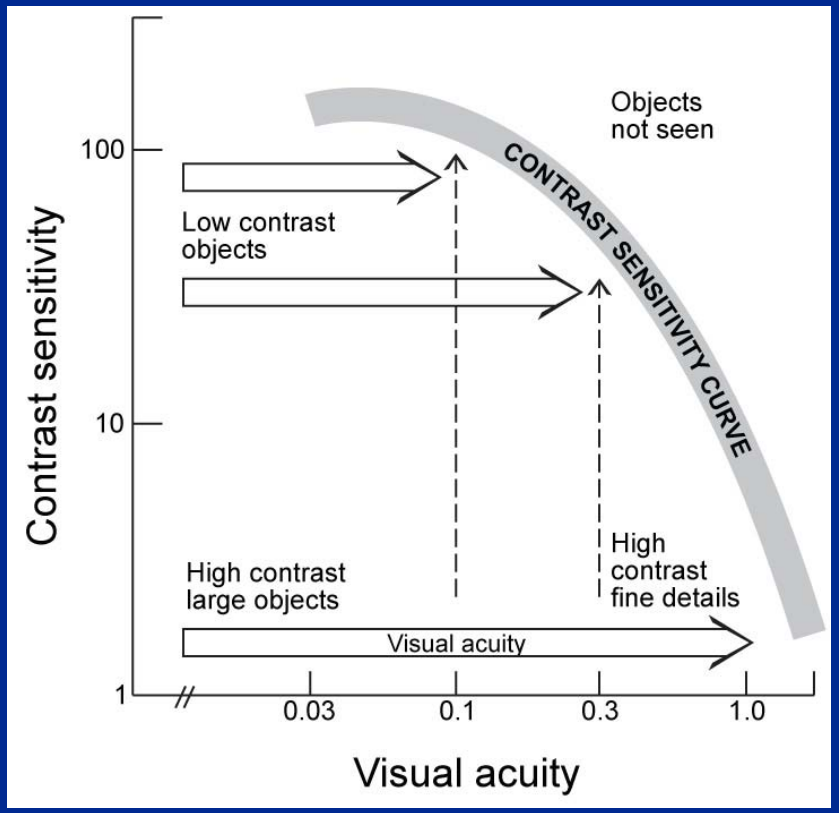
Cambridge Low Contrast Gratings

Detection test

Contrast sensitivity

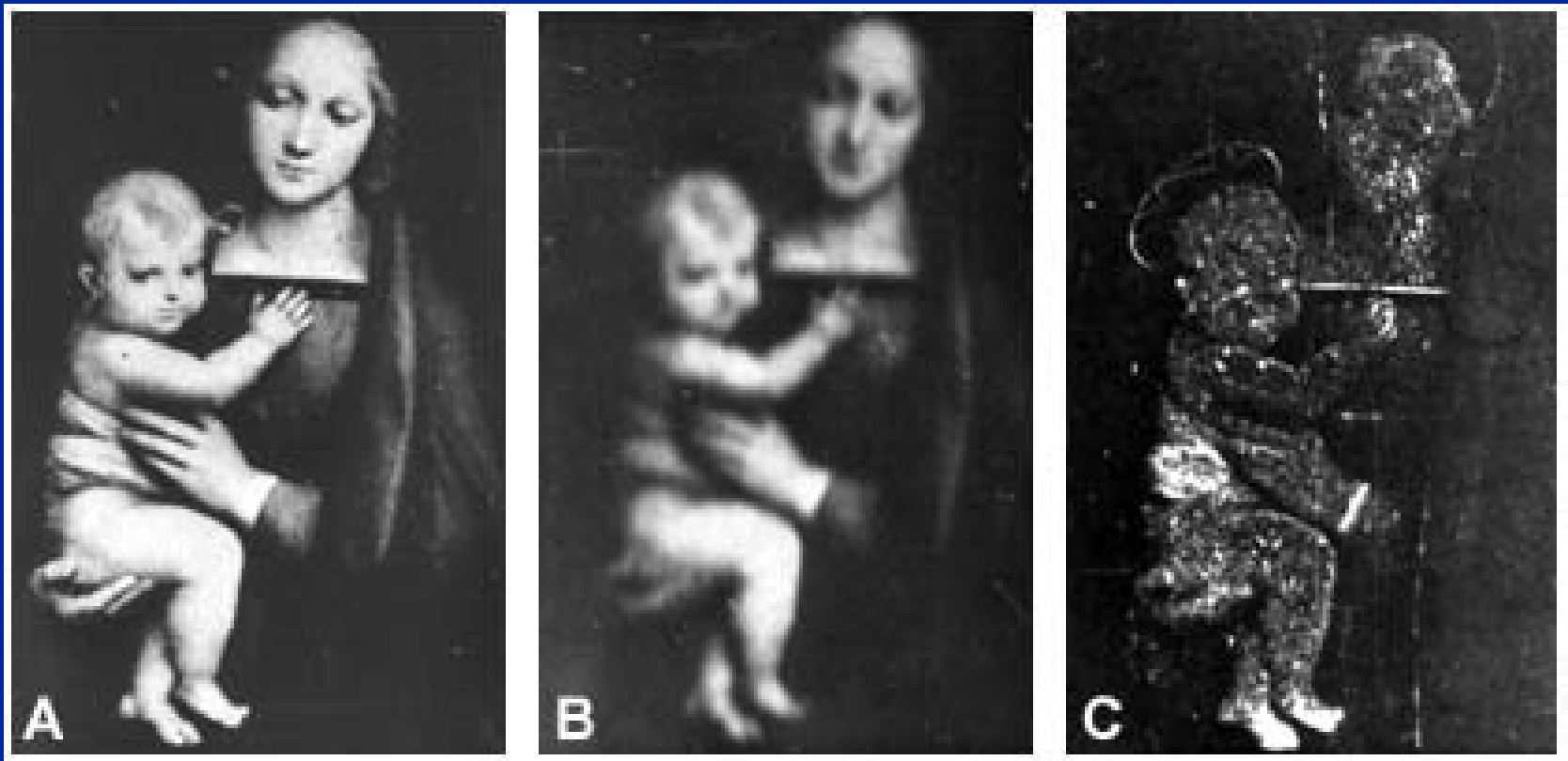
is not depicted by a number but a curve





Low contrast information & image quality

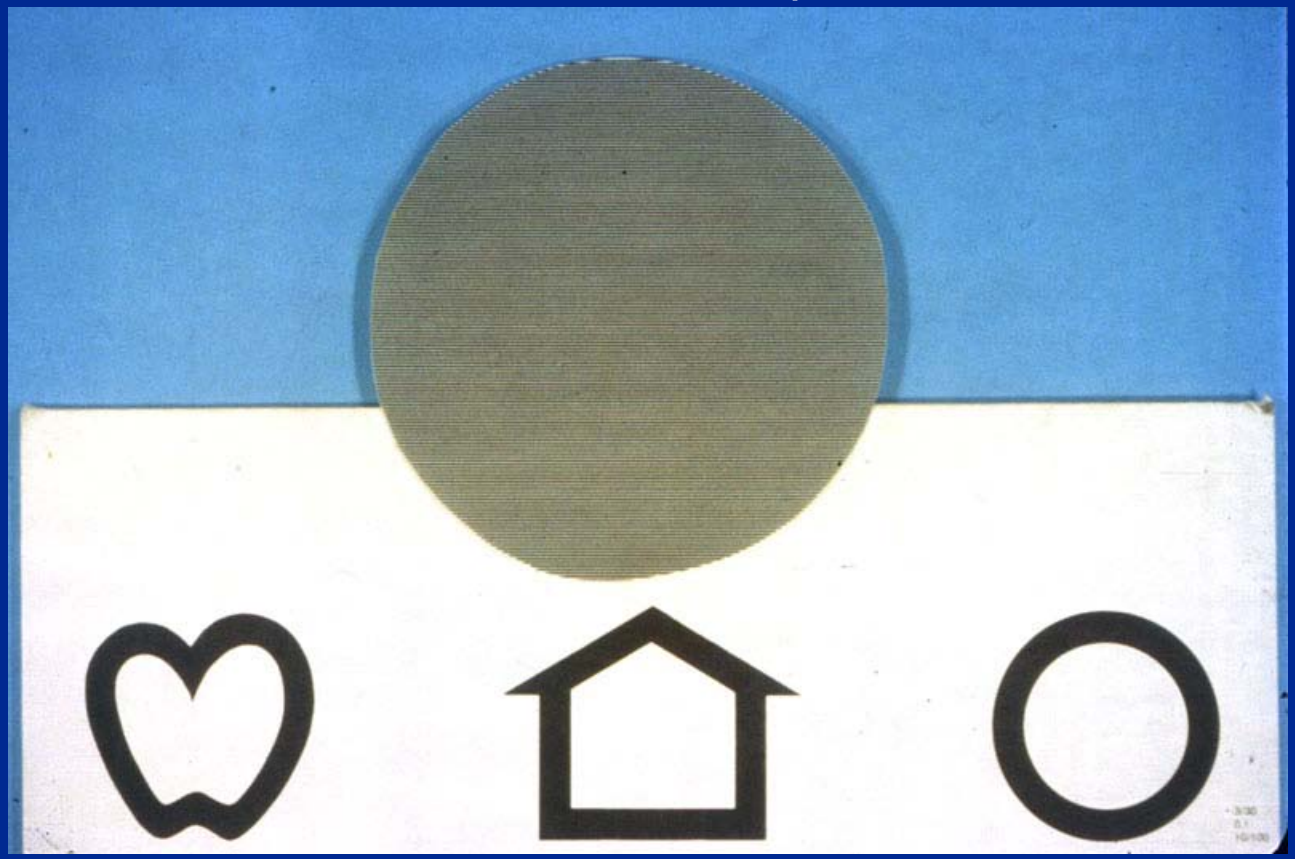
Lamberto Maffei 1981



Visual information for percetion of round forms and in communication is NOT transferred by fine lines (high VA) but broad lines (low VA) at low contrast.

VA < 0.01, GrA 6cpd

12 pairs of lines/ cm

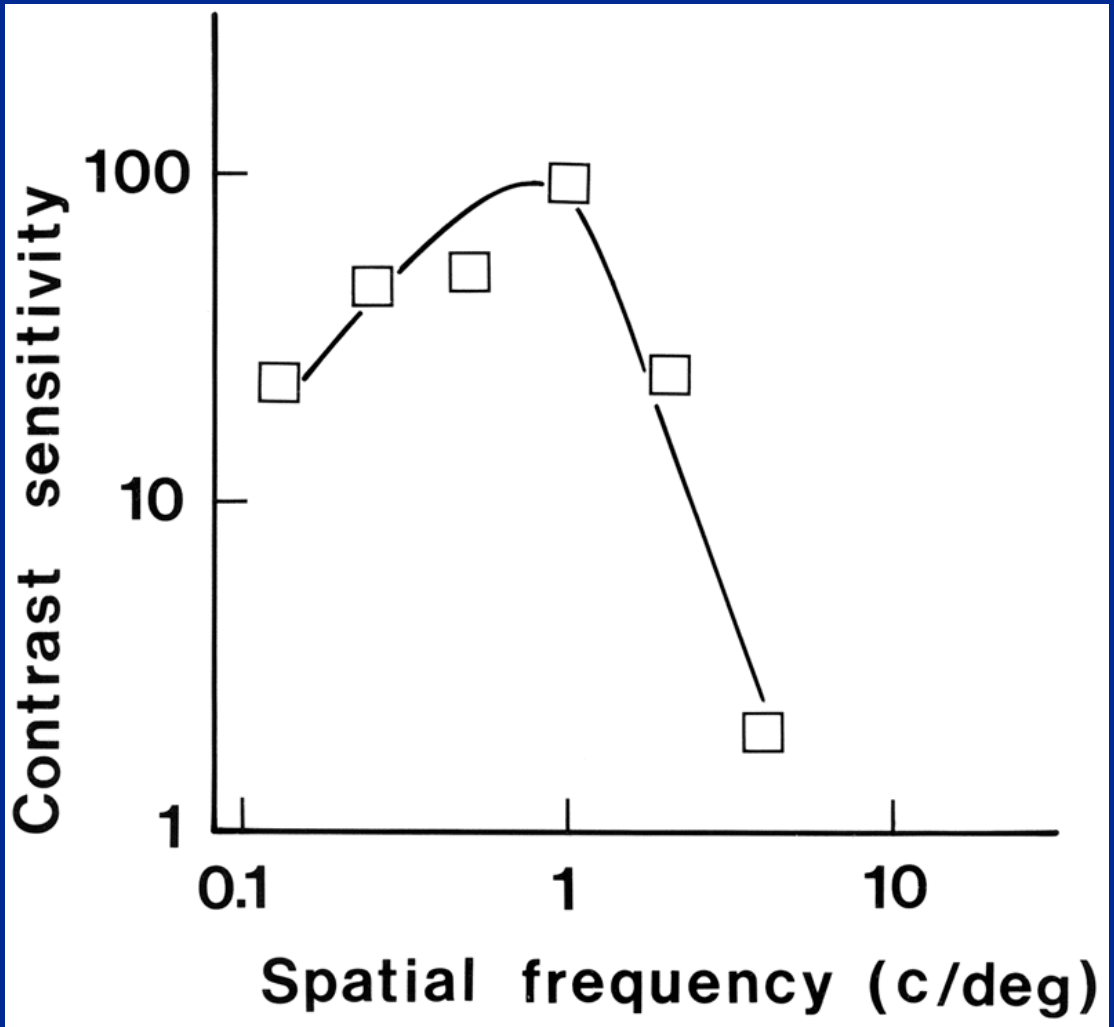


This boy with grating acuity 6cpd was also tested with low contrast gratings, which he saw nearly normally when they were broad.

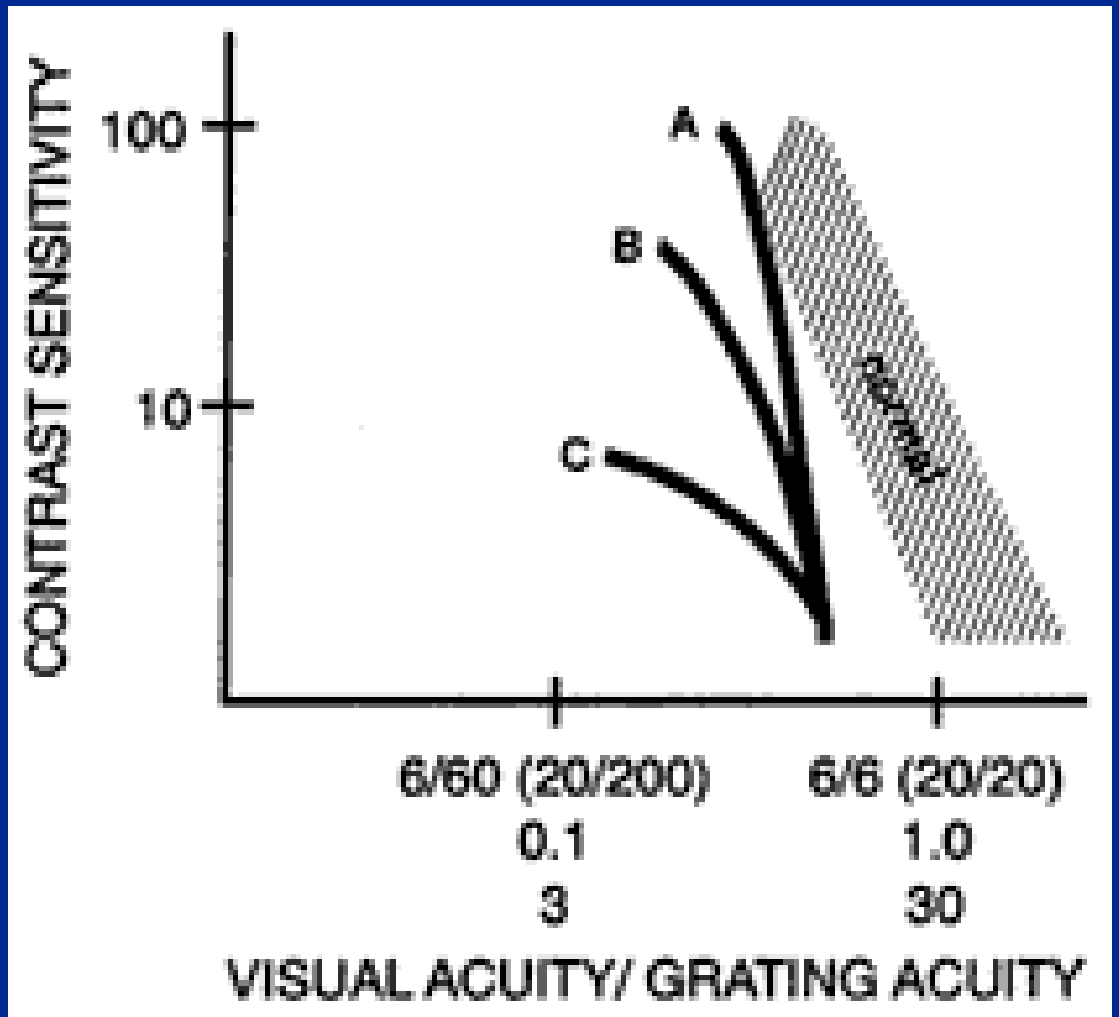
CVI

Visual acuity
< 0.01, <20/2000
2005: 0.004, 6/1500
Grating acuity
4 cpd

Contrast
sensitivity
close to normal
at low frequencies



Three children with VA 0.3, 6/18



Nobody whispers
to
a hearing impaired child.

Nobody whispers

to

a hearing impaired child.

We whisper visually

to

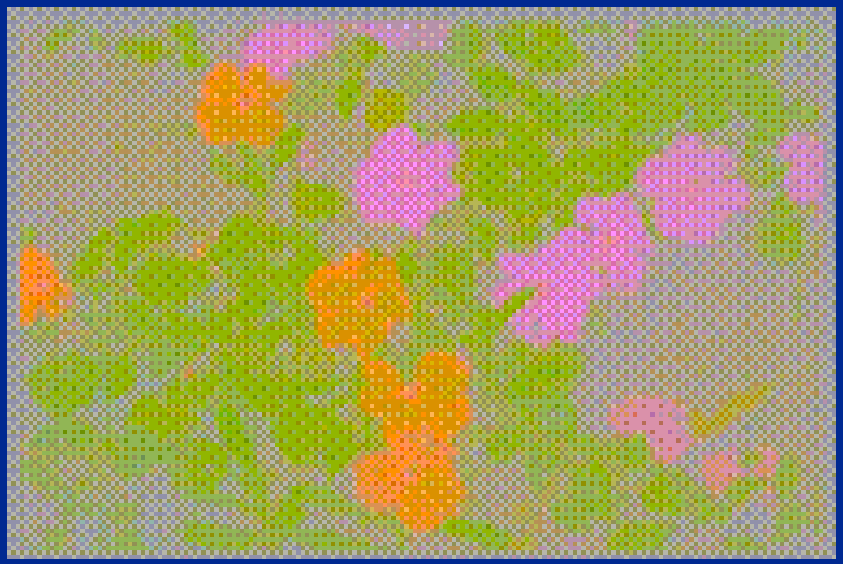
visually impaired children.

Contrast - Form

- Karl R. Gegenfurtner, Max-Planck-Institut für biologische Kybernetik, Tübingen
- http://www.allpsych.uni-giessen.de/karl/teach/farbe.html

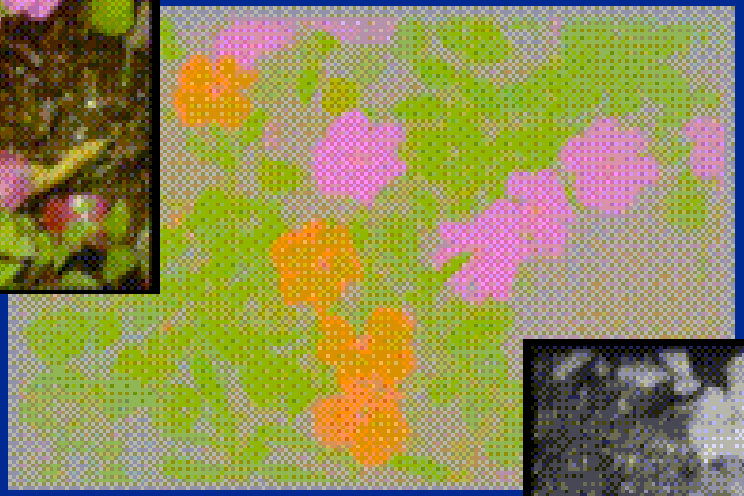
Contrast – Form - Colours

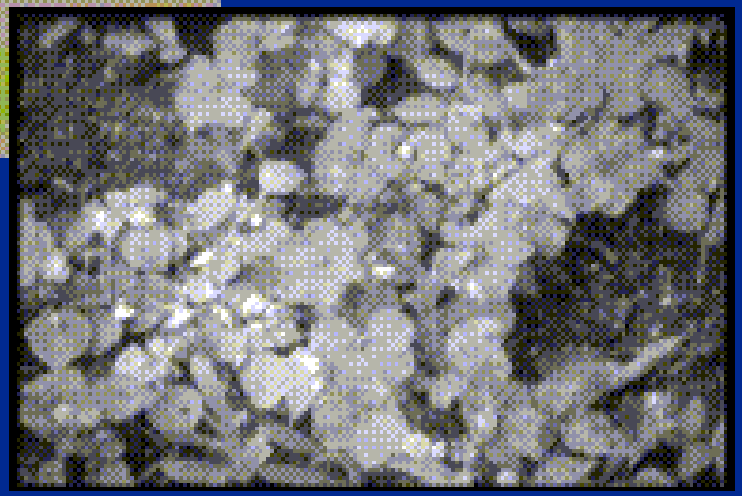
Isoluminant colours



- Karl R. Gegenfurtner, Max-Planck-Institut für biologische Kybernetik, Tübingen
- http://www.allpsych.uni-giessen.de/karl/teach/farbe.html

Contrast – Form - Colours





- Karl R. Gegenfurtner, Max-Planck-Institut, Tübingen
- http://www.allpsych.uni-giessen.de/karl/teach/farbe.html

Colour vision

SCREENING

- Ishihara
- Waggoner
- HRR

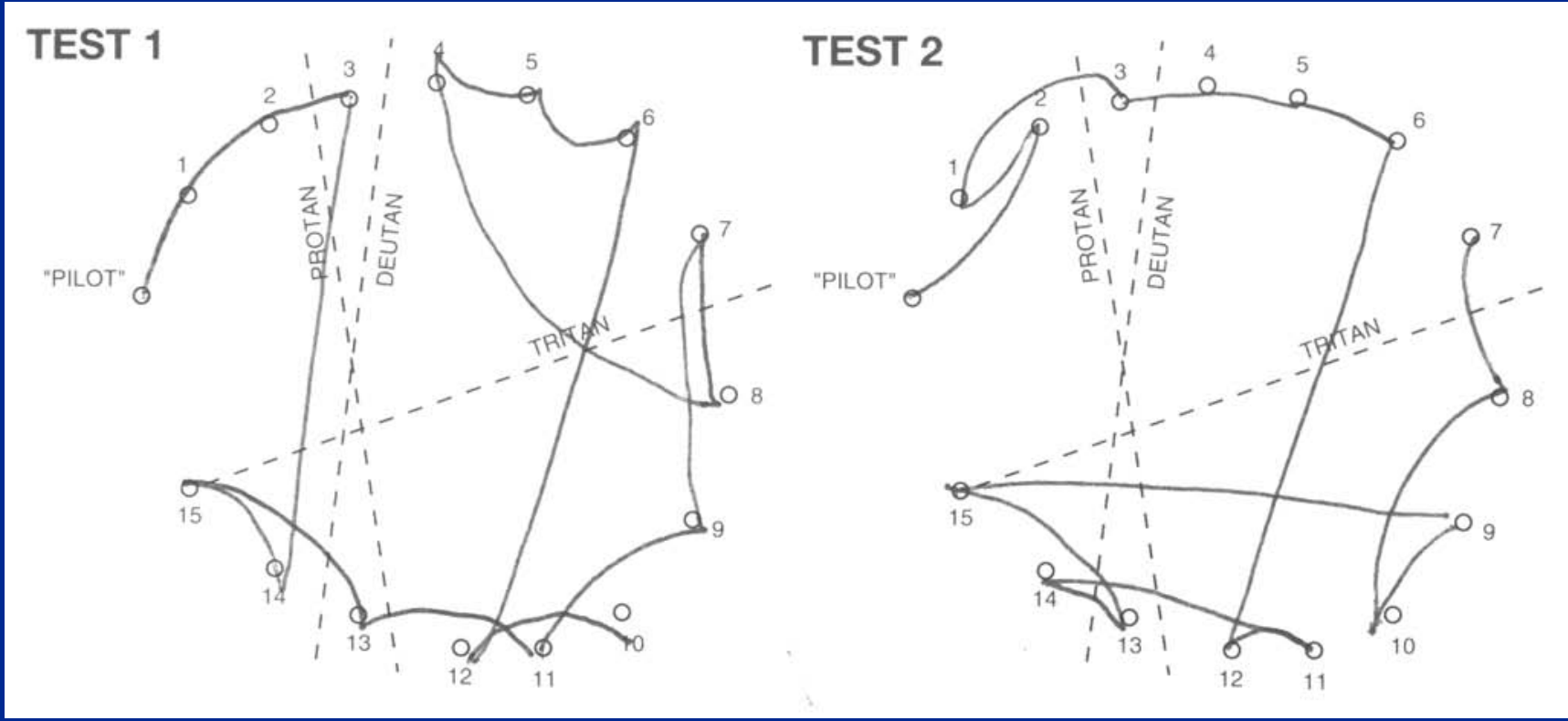
ASSESSMENT

Farnsworth D-15

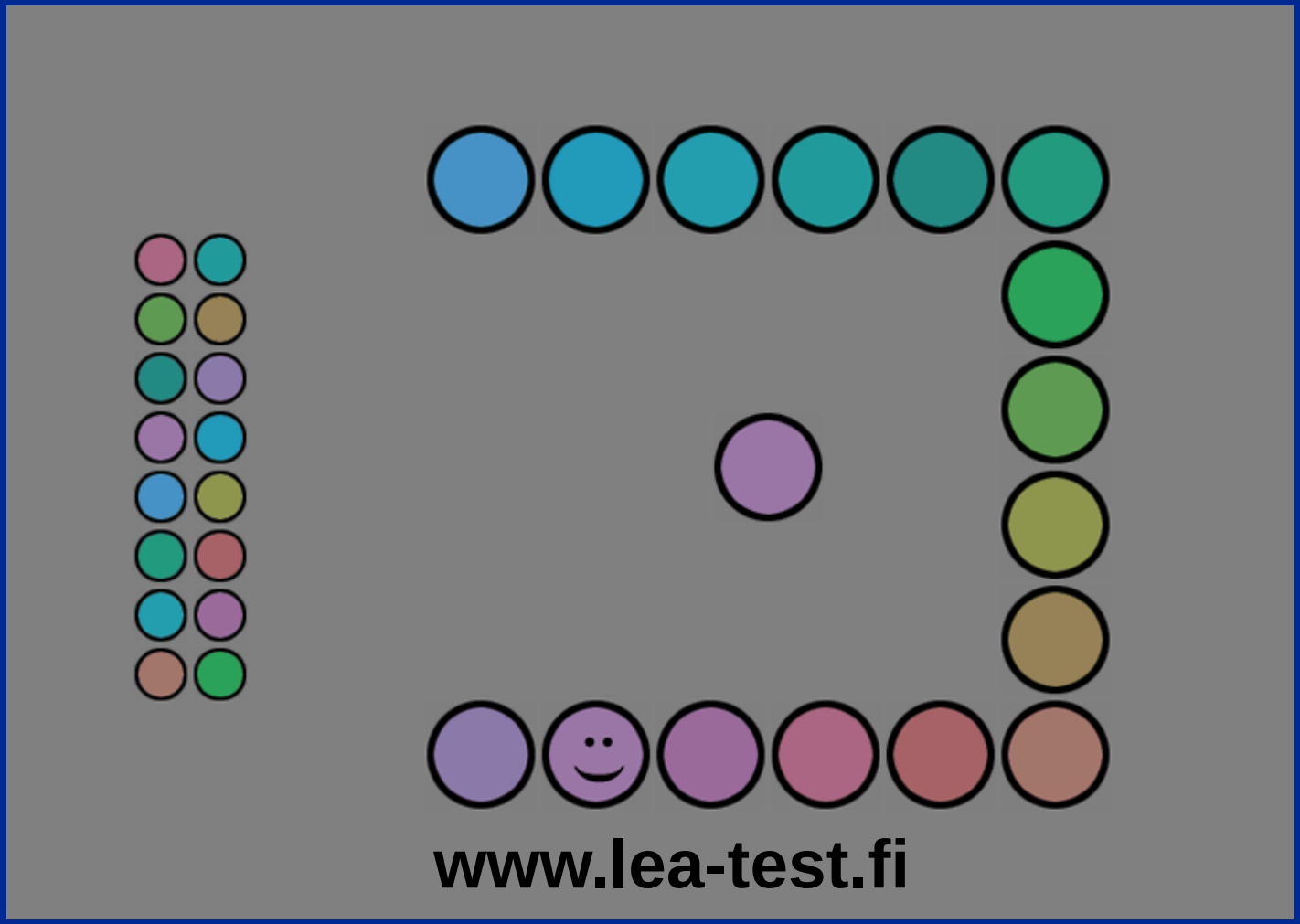
LEA Panel 16

Test caps in a row

Optic atrophy

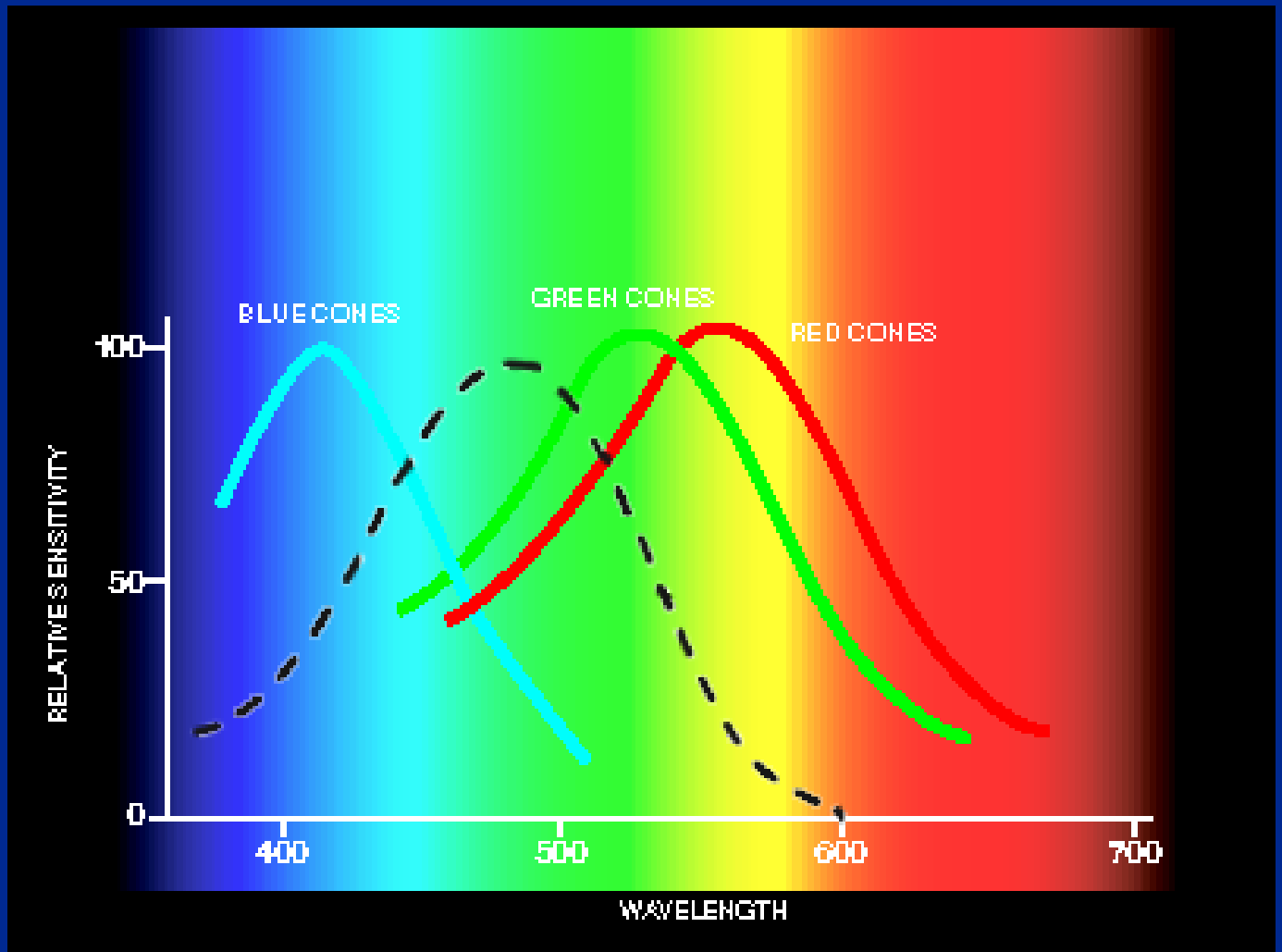


Colour Vision Game



CONE Adaptation Test

Absorption curves



Rod cell absorption

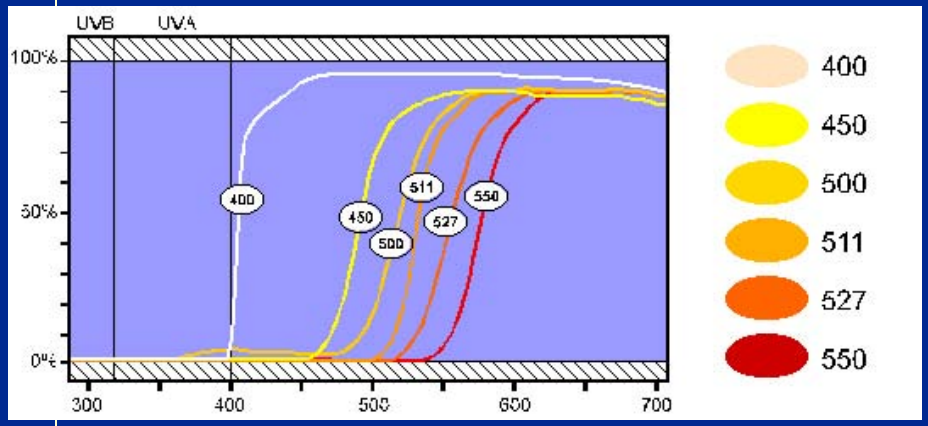
- Rod cells have their maximum absorption in bluegreen part of the spectrum.
- The peak absorption is between the absorption maximum of the green sensitive and of the blue sensitive cells.

Rod-cone interaction

- Rod cells function in scotopic conditions
- Cone cells function in day light
- Both cells function in mesopic conditions

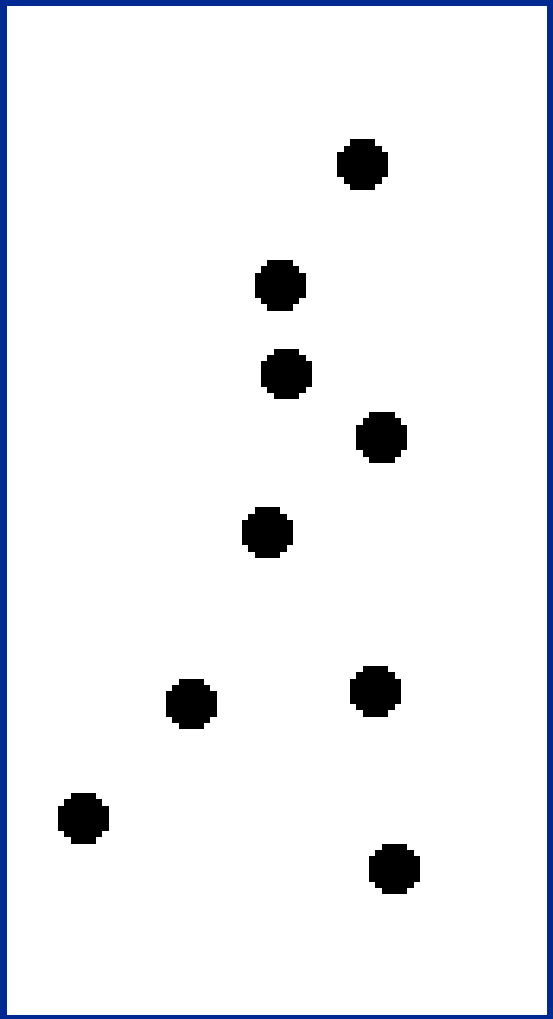
- Increase in cone cell function inhibits rod cells from functioning
- Loss of cone cells > loss of inhibition > dazzle in day light > need for filter lenses

Filter transmission & filters



Test outside for outside use, inside for inside use

Perception of movement



Motion perception

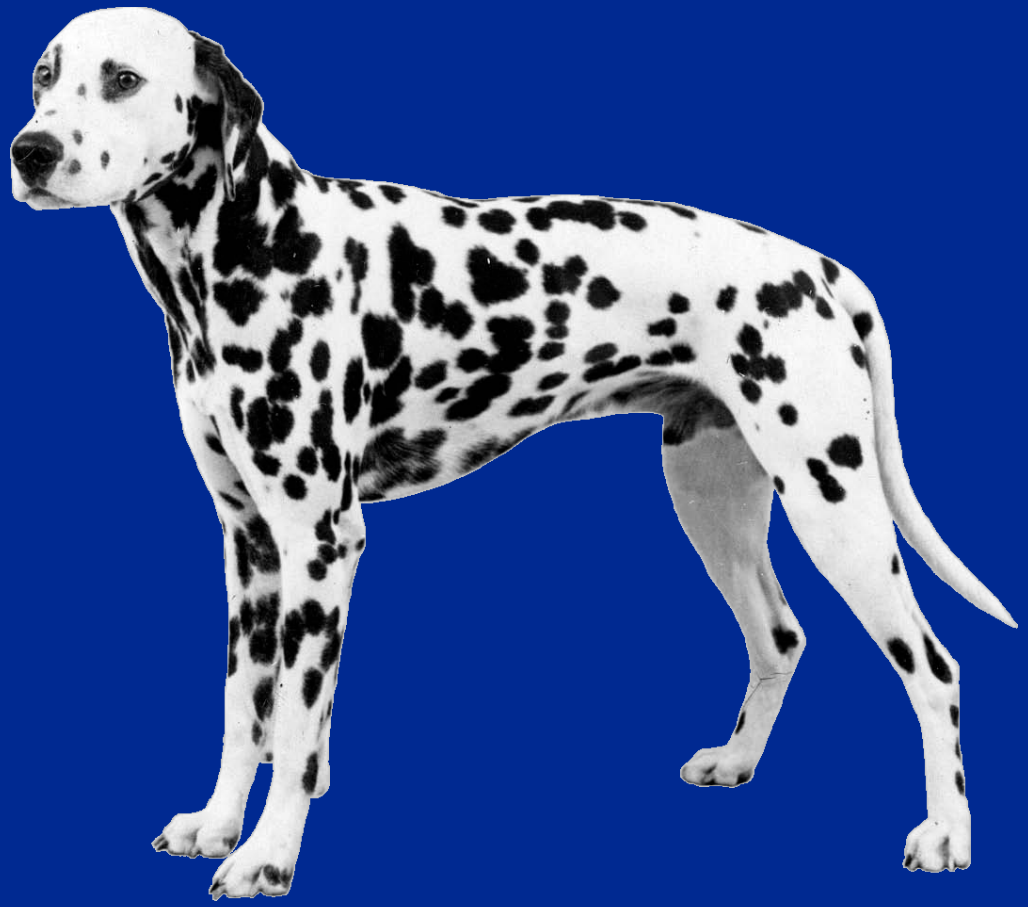
In most activities visual information is in motion:

either the object moves. the observer moves or

at least the eyes move.

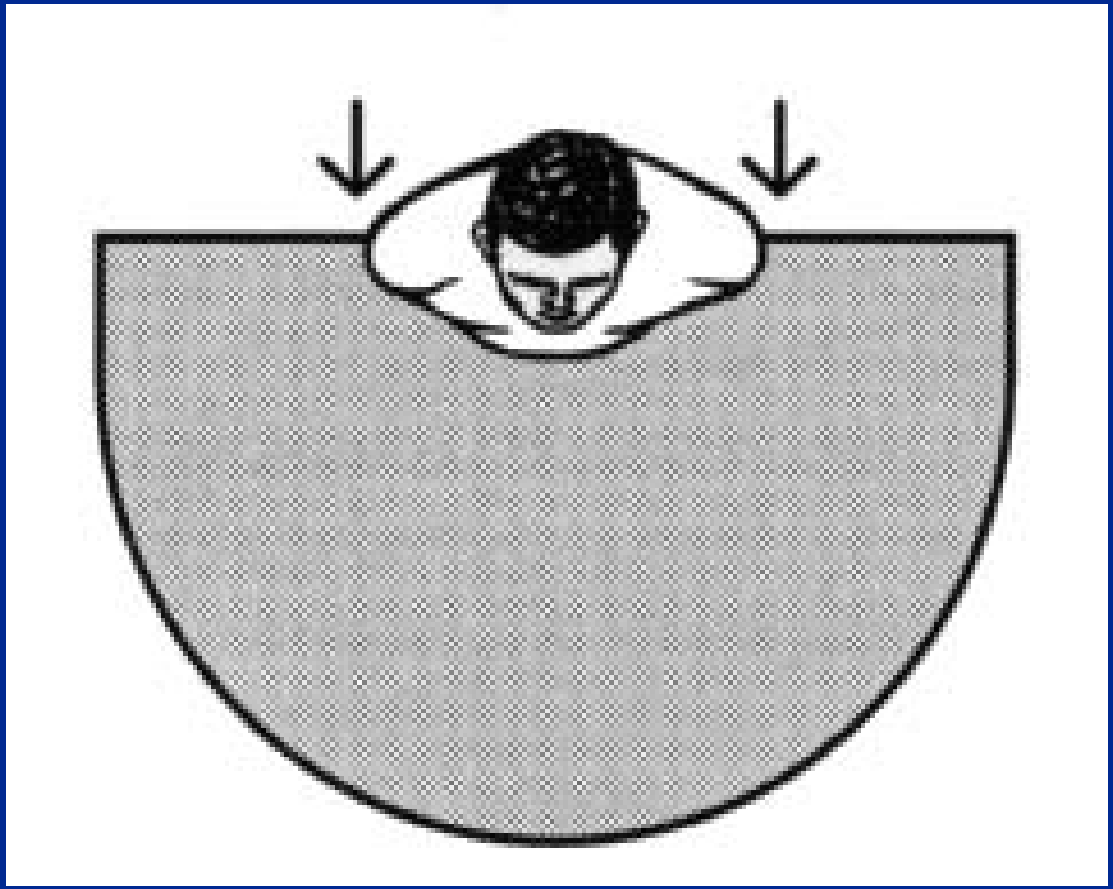
How does the world look like without movement?

Coherent Motion – ’Pepi’



MOTION PERCEPTION, www.lea-test.fi

Visual field – Confrontation

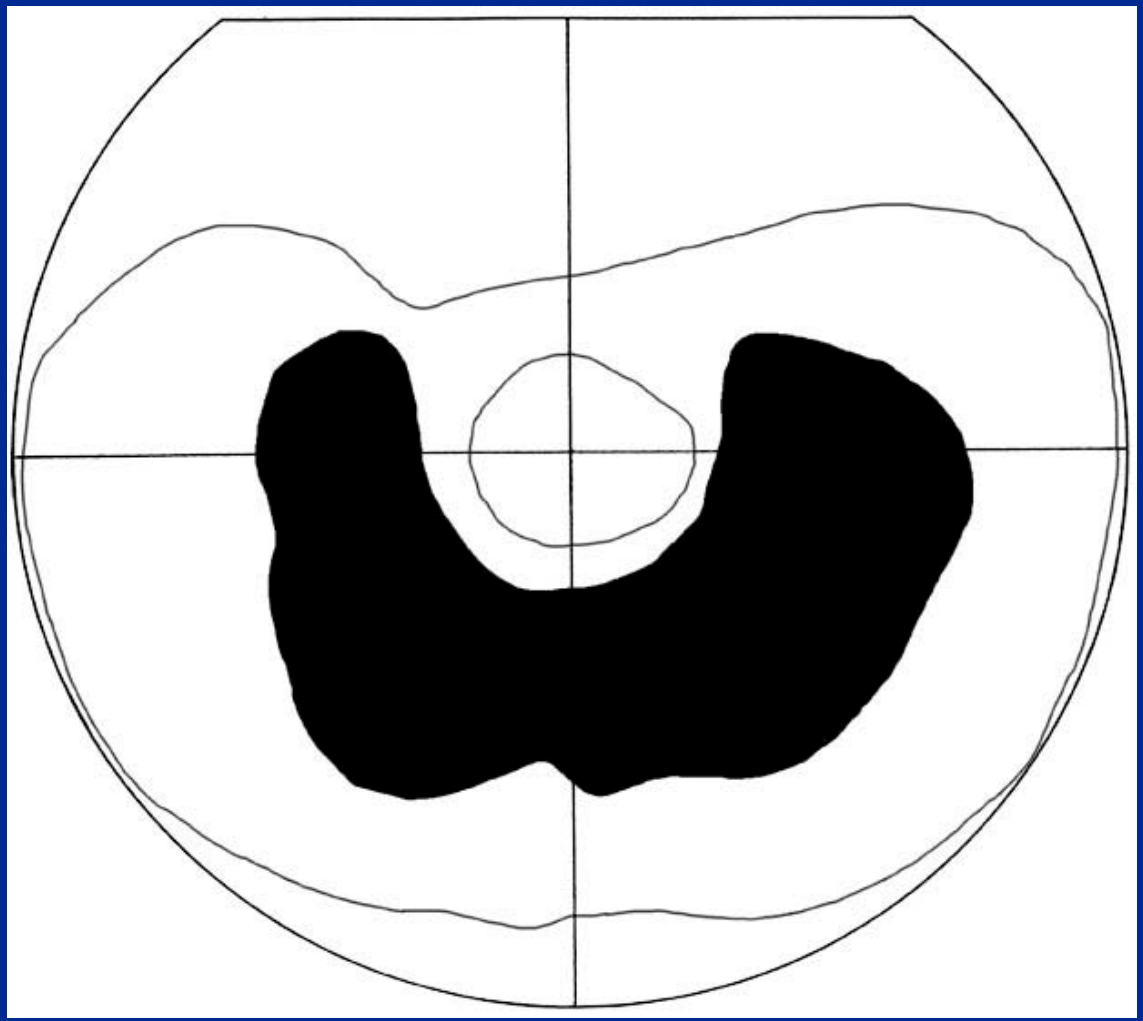


Sheridan ball test

using an arc perimeter

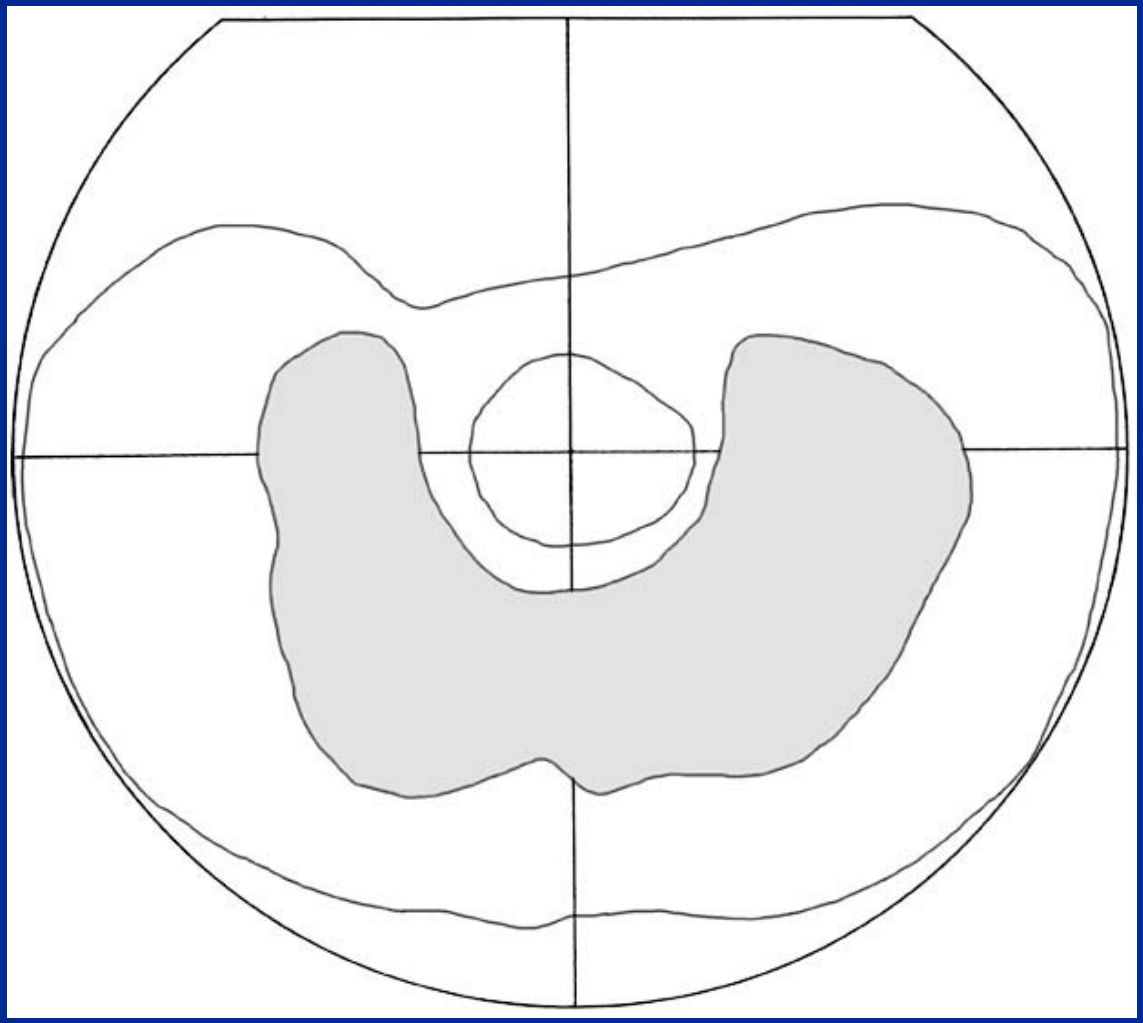
Goldmann perimetry

RP – goal keeper

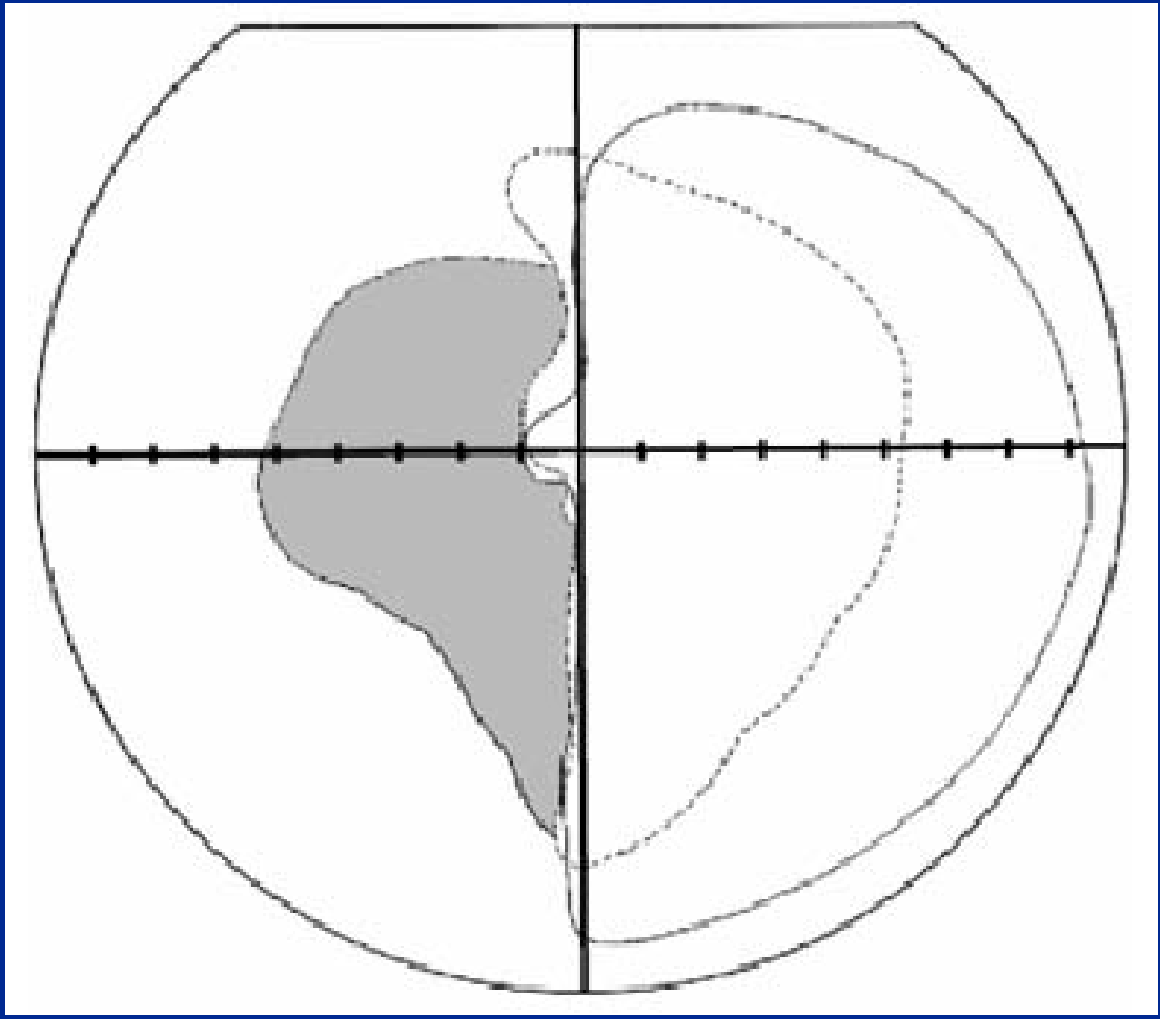


Luminance flicker

RP – goal keeper



Homonymous hemianopia



Motion perception+Visual field

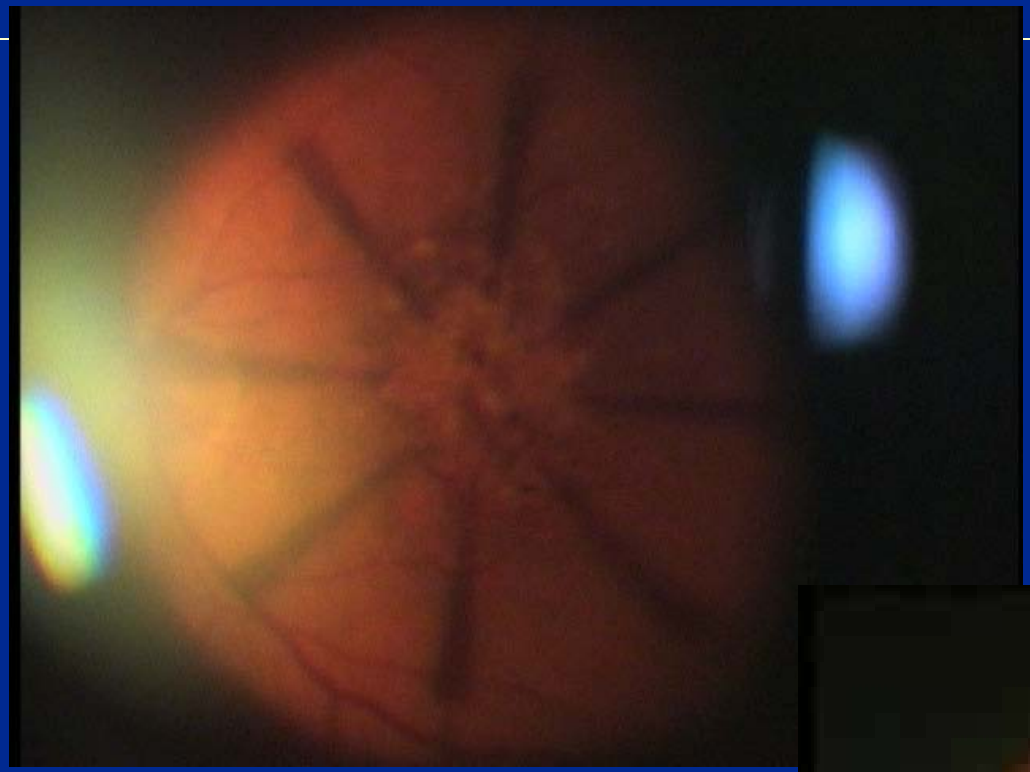
Central Scotoma

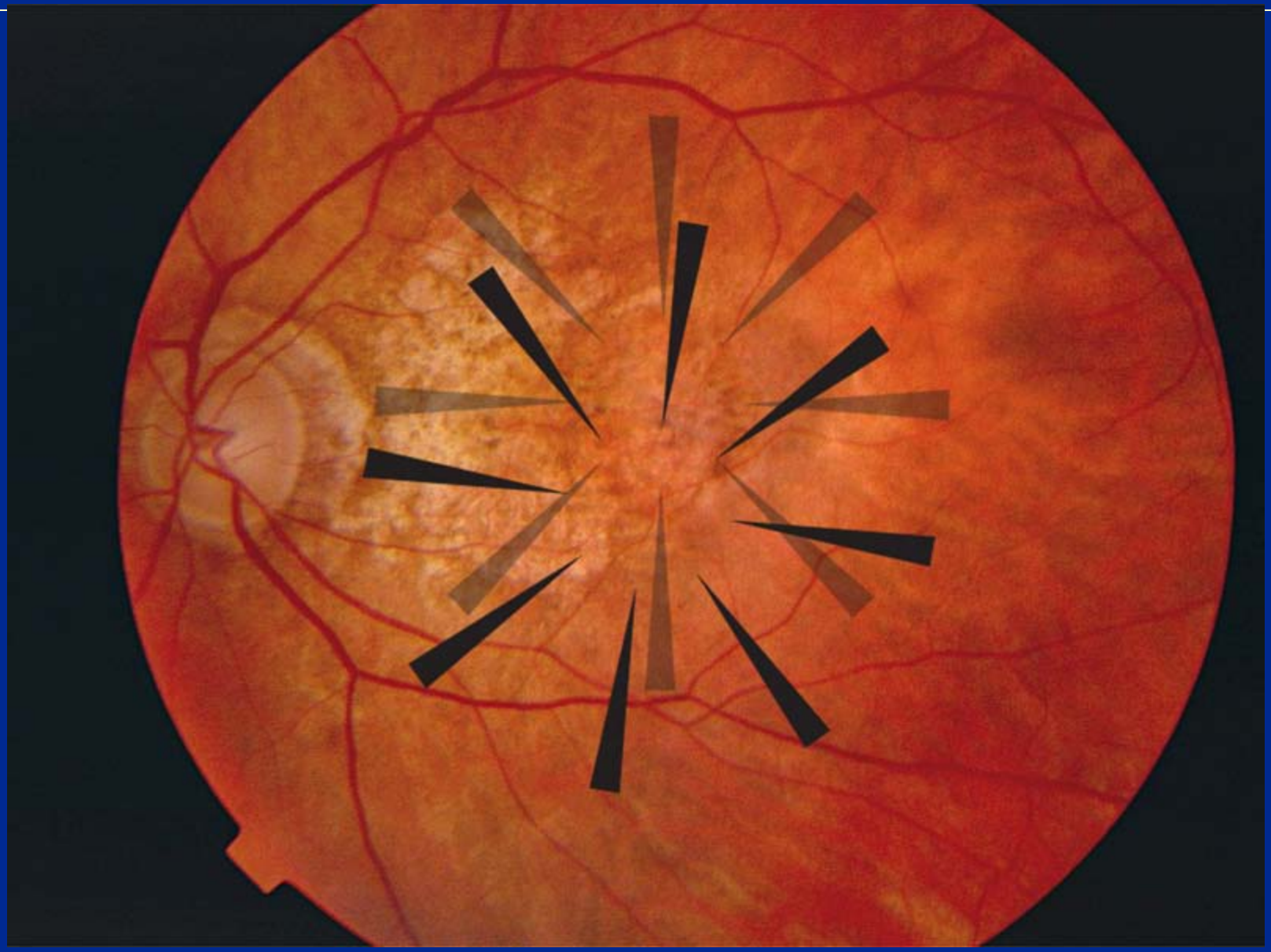
- **fixation is shifted** to an area with best resolution in a large enough a field

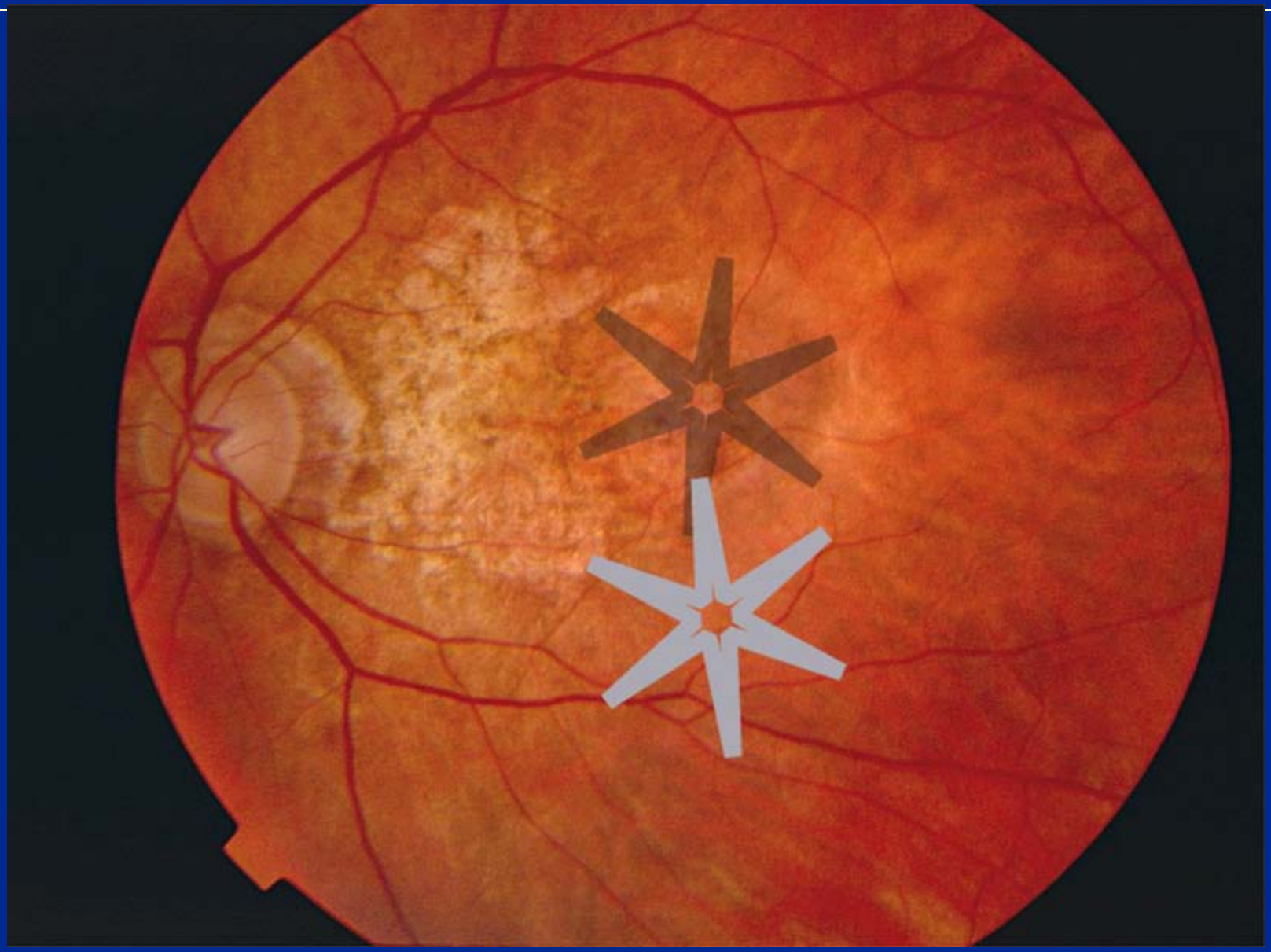
- a child may use **varying fixation** areas depending on the visual tasks –

Turku – modified slitlamp for direct observation of fixation


Haag-Streit slitlamp
markku.leinonen@iki.fi

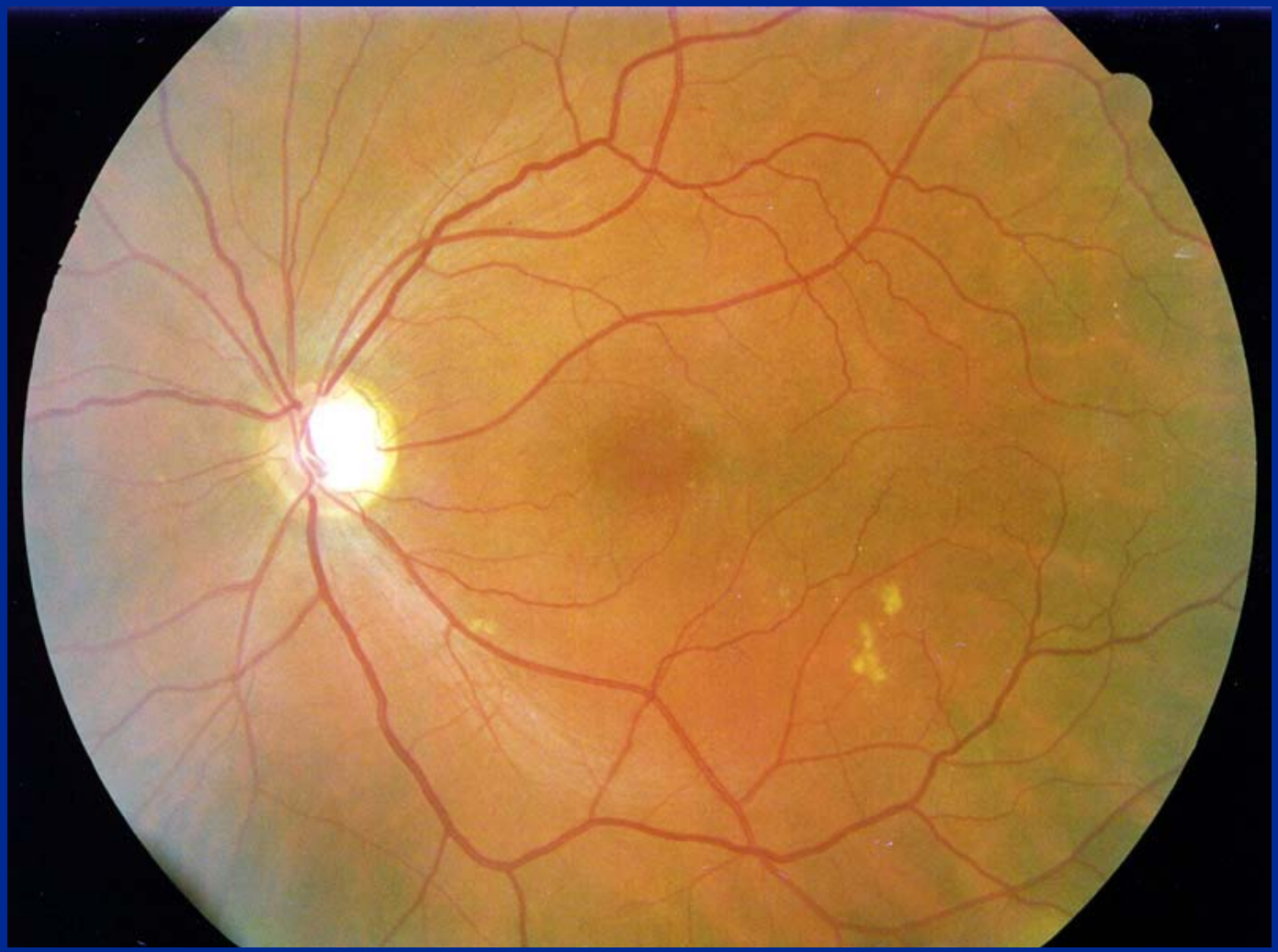


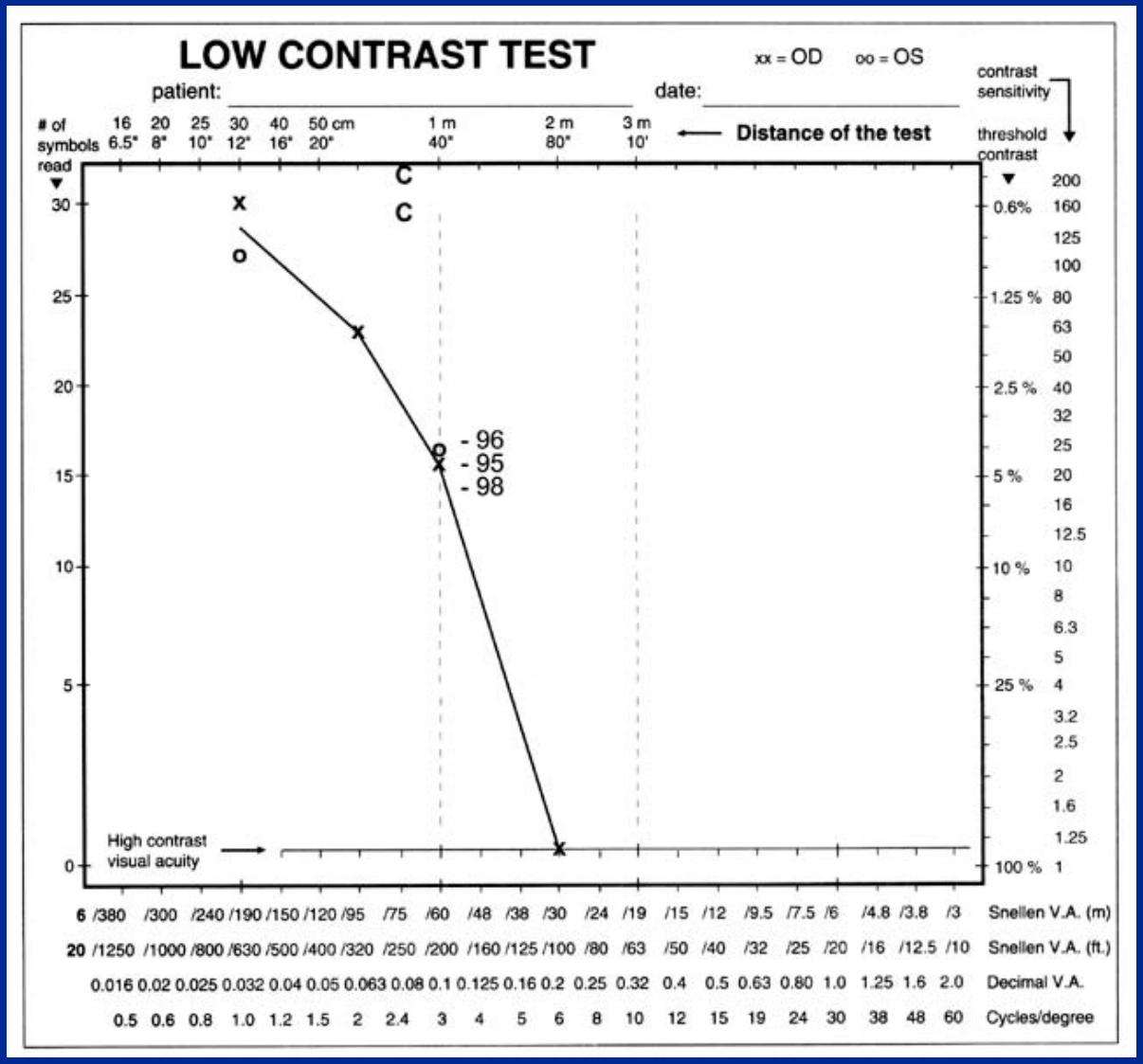




Retinoschisis

VA 0.2, 6/30, 20/100





If a boy has a contrast sensitivityt curve like this, he will be able to drive.

Retinoschisis – very limited visual field

Visual functioning

- Quality of the image
- Processing of visual information in brain functions
- Oculomotor functions

Visual processing disorders

- Children with problems in visual processing functions
- 1) with good, clear image
- 2) with distorted or blurred image due to anterior visual impairment

- The effect of other disorders and diseases on visual functioning
    1) intellectual disability
    2) motor problems, often cerebral palsy
    3) executive functions
    4) other disorders and diseases affecting the child’s functioning

Assessment requirements

- Variation in age of children
- Variation in cognitive functions
- Variation in communication
- Variation in motor functions
- Variation in visual functions

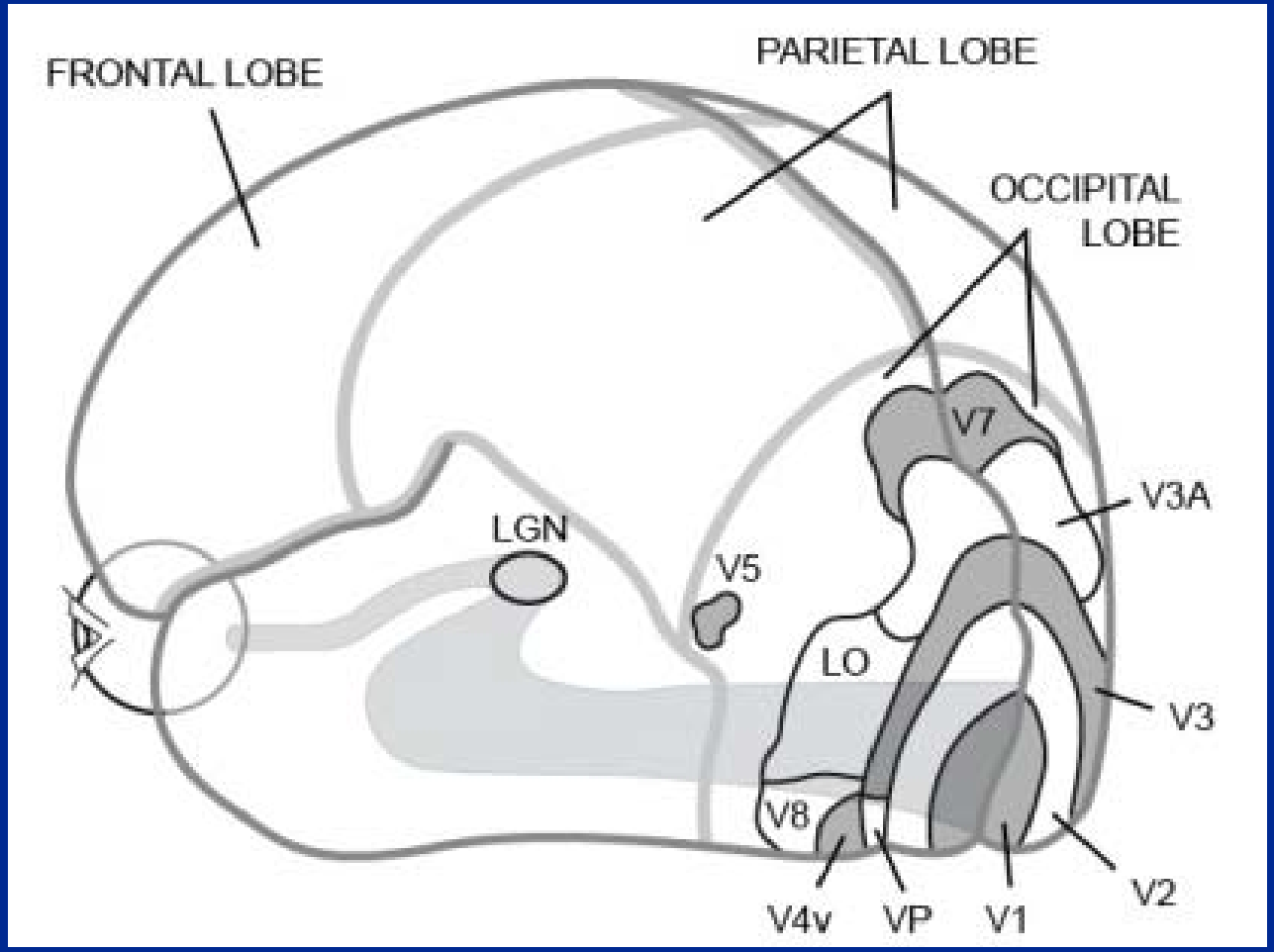
INDIVIDUAL TESTING - many tests needed

OBSERVATIONS - by all team members

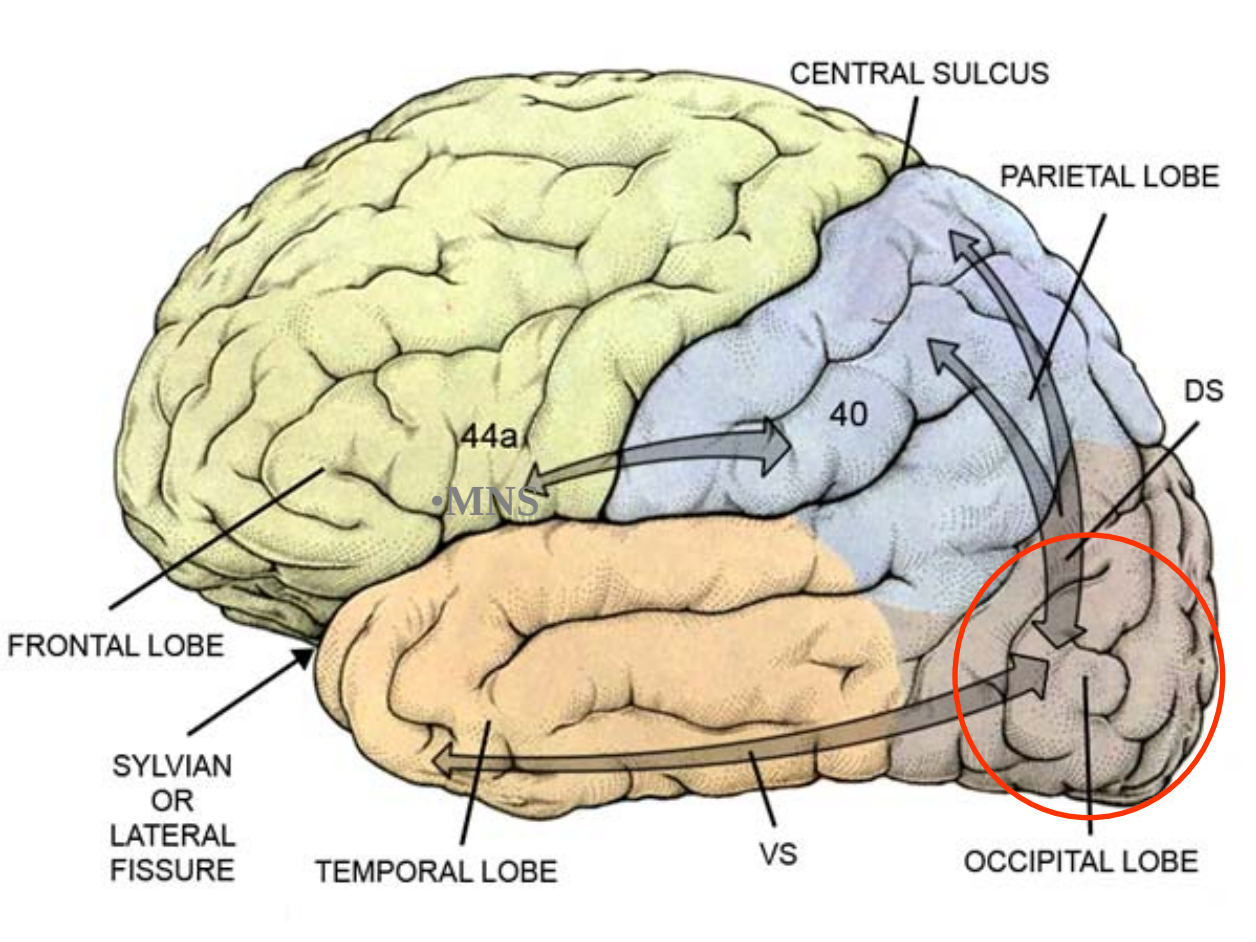
TRAINING - of all persons involved

EVERY CHILD IS A NEW CHALLENGE.

Retinocalcarine pathway



Early processing in occipital lobe
Ventral and dorsal stream/network



- Colours
- Contrast edges
- Movement/ motion

- Early processing:
- Line directions & length
- Stereovision
- Object/ background
- Figure/ ground
- Visual closure, filling-in
- Visual illusions
- Figure-in-motion

Rectangles – Mailbox
Heidi Expressions- Colorama

Testing early and higher visual processing

Table 2.

RECOGNITION and READING
Concrete objects
Landmarks
Faces, familiar and unfamiliar
Facial expressions, Body language
Pictures of concrete objects
Geometric forms
Letters
Numbers
Words
Crowding effect
Reading speed
Scanning lines of text
Efficiency of reading

PERCEPTION OF PICTURES
Length of lines
Orientation of lines
Details of pictures
Figure-ground
Visual closure
Noticing errors
Noticing missing details
Comparison with pictures in memory
'Reading' series of pictures
Visual problems in copying pictures
Geometric pictures depicting 3D forms

MATHEMATICS
Calculations, logical reasoning

AWARENESS OF AND ORIENTATION IN SPACE
Perception of one's body in space
Depth perception
Perception of near space and far space
Simultanagnosia
Perception of textures and surface qualities
Orientation in space
Memorising routes
Vision in traffic situations and in playgrounds

EYE-HAND COORDINATION
Grasping and throwing objects
Drawing, free hand
Copying, from near/ from blackboard
Copying, motor pl anning and execution

INTEGRATION PROBLEMS
Vision not used when listening or exploring
Vision not used when moving
Balance

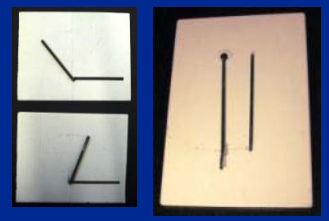
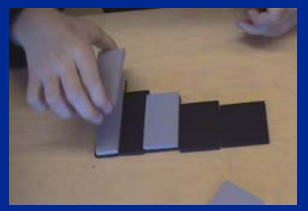
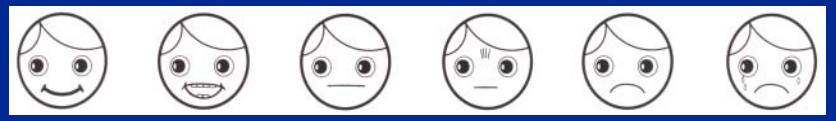
COMPENSATORY STRATEGIES
Auditory information
Tactile, kinaesthetic and haptic information
Memory, reasoning

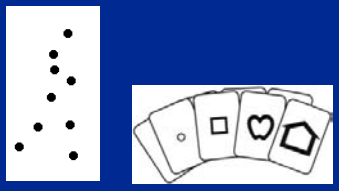
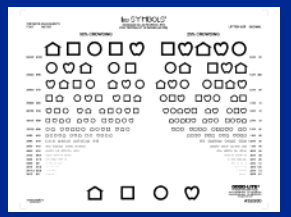
DISTURBING FACTORS
Environmental noise, visual and auditory
Balance problems and motor problems
Medications, epilepsy

Cognitive vision tests

- Hiding Heidi for communication
- LEA-Mailbox
- LEA-Rectangles
- Face pictures
- Heidi Expressions
- LEA Puzzle
- Crowding effekt
- Pepi-test, Johansson’s Walking Man
- **Reading tests**
- OBSERVATIONS



CASE		N	I	P
OCULAR MOTOR FUNCTIONS				
A Fixation				
B Following movements				
C Saccades				
D Nystagmus				
E Strabismus				
F Accommodation				
G Convergence				
CLINICAL FINDINGS, sensory				
H Binocularity				
I Visual Acuity				
J Grating Acuity				
K Contrast sensitivity, optotype, grating				
L Colour Vision				
M Adaptation speed, observation				
N Photophobia				
O Visual field, central scotoma?				
P Visual field, peripheral				
Q Motion perception, Pepi-test				
R Biological motion, Walking Man				
S Refraction				
T Correction of refractive errors				

EARLY PROCESSING				
V Length of lines				
W Orientation of lines				
X Objects/figures on a patterned background				
Y Textures and surface qualities				

DORSAL STREAM				
A Perception of near and far space				
B Observation of surrounding				
C Orientation in space, map based				
D Route based orientation				
E Simultaneous perception				
F Eye-hand coordination				
G Length of lines				
H Direction of lines				
I LEA-Puzzle				
J Grasping and throwing objects				
K Drawing, free hand				
L Copying from blackboard				
M Spatial problems in mathematics				
N Spatial problems in reading				

OTHER PROFILES AVAILABLE				
A Developmental level				
B Motor Functions				

VENTRAL STREAM		N	I	P
A Lenght of lines, purely visual test				
B Direction of lines, purely visual test				
C Recognition of details				
D Noticing missing details in pictures				
E Recognition of faces				
F Interpretation of facial expressions				
G Reading body language				
H Landmarks				
I Concrete objects				
J Pictures of concrete objects				
K Abstract pictures of objects of different categ				
L Abstract forms (Roman letters, numbers)				
M Reading words, characters				
N Cartoons				
O Visual problems in copying pictures				
P Increased crowding effect				
Q Recognition problems n math tasks				

MIRROR NEURON SYSTEM				
A Early communication and interaction				
B Interpretation of emotions and intentions				
C Observation and copying of movements				
D Effect of image quality, motion perception				
E Effect of image quality, contrast sensitivity				
F				
G				

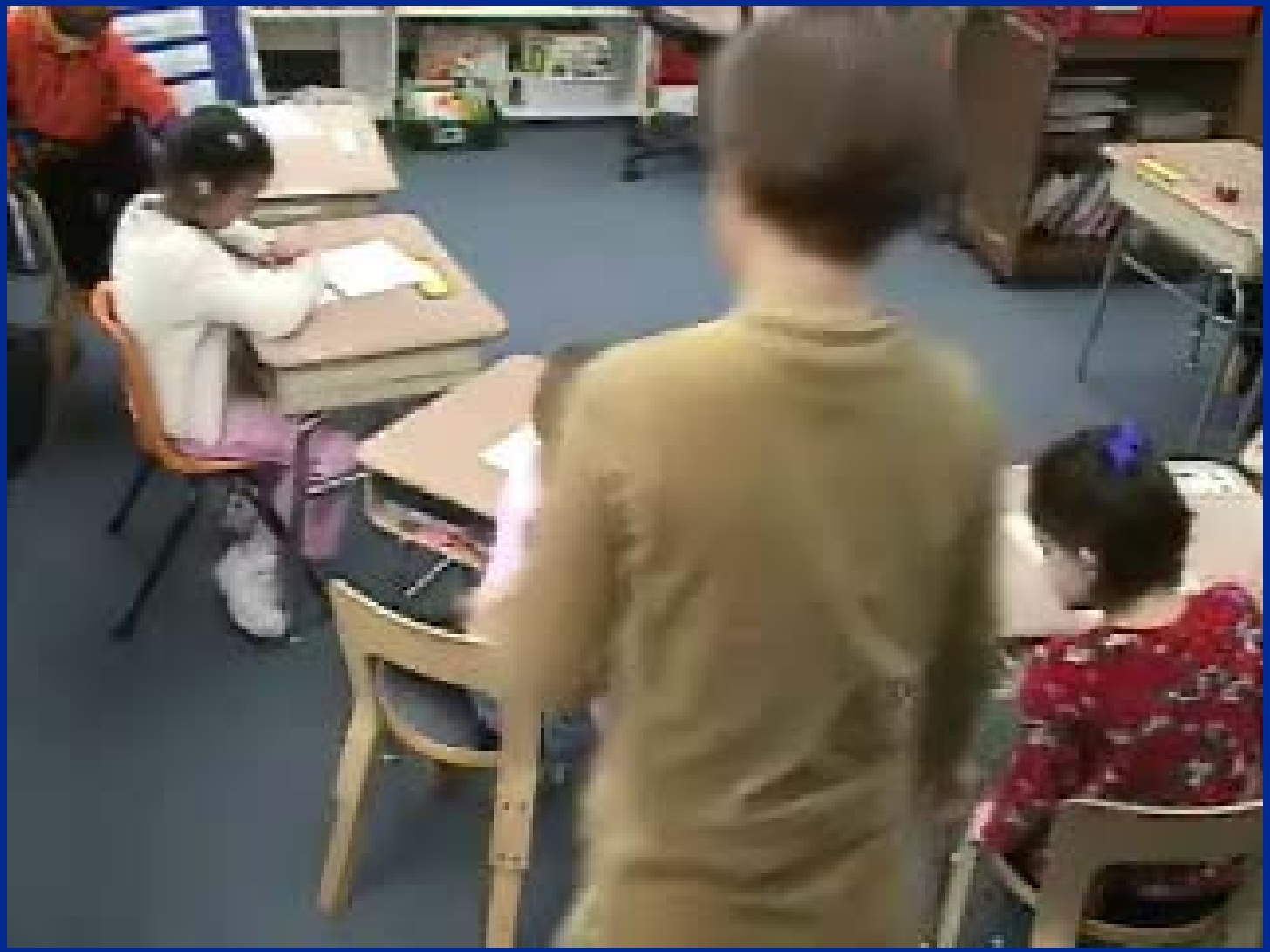
OTHER COMMON PROBLEMS				
M Integration of sensory information				
N Visual and auditory overload				
O Specific memory problems				
P Head control				
Q Body control				
R Hand functions				
S Moving				
T Hearing				
U Executive functions				
V Other				
W Use of devices at school, KG, work				
X Use of devices at home				
Y Services of educational resource centre				
Z Vision services as medical care				

MAIN FUNCTIONAL AREAS				
A Communication				
B Orientation and moving				
C Activities of daily living				
D Demanding vision tasks				

PROFOUND loss of function in __visual funcitions
IMPAIRED but useful visual functions in __
NORMAL visual function in __ functions

DISCUSSION

Environmental disturbance



Visual acuity alone

DOES NOT

depict visual functioning