Assessment of functional vision

in healthy infants and children

Lea Hyvärinen, MD, PhD

Professor h.c., Rehabilitation Sciences, University of Dortmund

Senior Lecturer, Developmental Neuropsychology, University of Helsinki

Hong Kong 10.1.2012

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”Functional” and ”healthy”

Functional:

Visual acuity measured in ways that describ visual functioning in every day tasks of infants and children in a defined cultural situation and age.

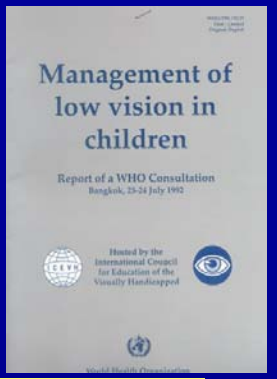
Healthy:

An infant and child whose functioning is not restricted

by a disease or trauma:

Diabetes, retinitis pigmentosa, amblyopia, retinoschisis

Visual functioning



We use vision for:
Communication and interaction

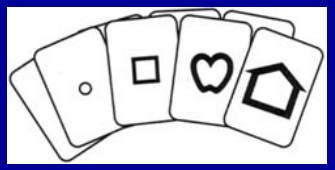
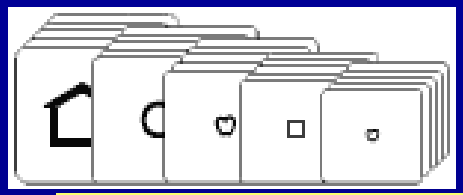
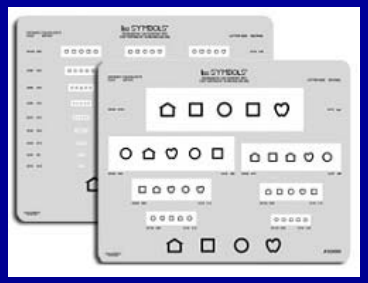
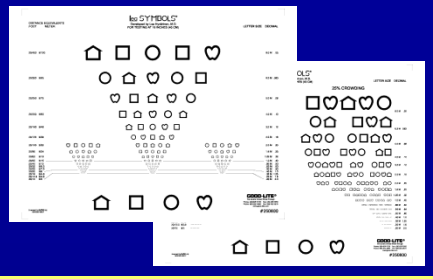
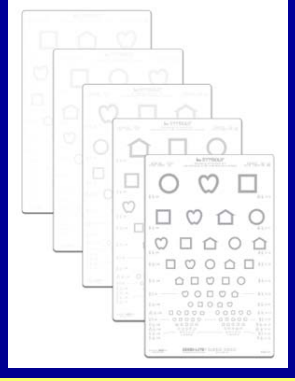
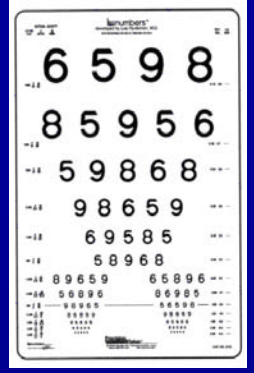
Orientation and planning moving

Numerous daily tasks

Demanding near tasks like reading and writing

Visual functions

- Visual acuity as optotype and grating acuity
- Visual field, peripheral and central
- Contrast sensitivity
- Colour vision
- Visual Adaptation to luminance levels
- Motion perception
- Visual processing functions
- Ocular motor functions, scanning

Variation of visual acuity values

Test

Child's age

Communication

Tester

Standardised measurement

Before measuring VA

- Refraction
- Binocularity
- Strabismus, altern.
- Stereovision
- Accommodation

Binocularity tests - fusion

Worth 4-dot test

Stereovision

Lang test

9 months

Effron rectangles

Visual acuity

Detection acuity – small objects, **”where”function**

– grating acuity ” ”

[Resolving orientation of long lines (gratings)]

Recognition acuity – optotype acuity

Hand movements, light perception/ projection

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

WORLD HEALTH ORGANIZATION

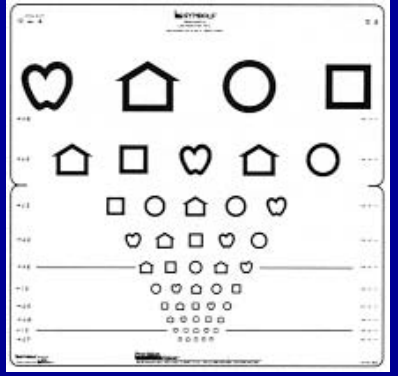
WHO/PBL/03.91

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



Logaritmic design

Distance & near VA, same optotypes

Distances 6m (**4m**) and 40cm; children 3m

the distance to fit the needs of the child

NOT to point at the optotypes.

Luminance between 80 and 160 cd/m^2

Visual acuity

- Measurement of visual acuity using optimal refractive correction that the child can use
- in standard luminance + optimal luminance
- using standised tests
- using varying postures when needed

Optotype tests

Single optotype tests

Line tests

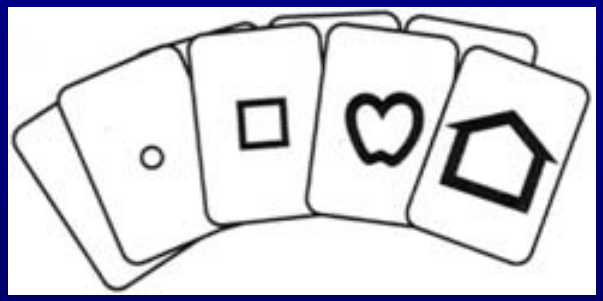
Crowded tests

Letters, numbers, paediatric symbols

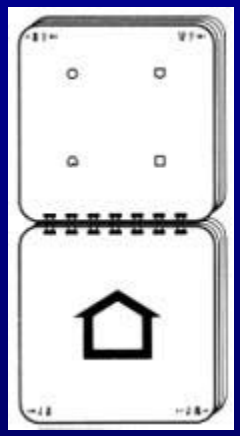
Young children
and
Children with different abilities

Single LEA Symbols tests

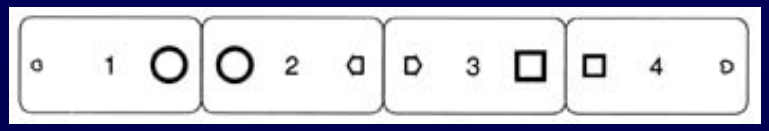
the earliest tests for measurement of VA



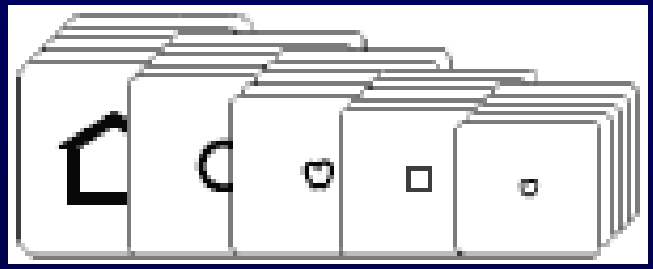
LEA Playing Cards



LEA Single Symbols Book



LEA DOMINO Cards
for training of amblyopic eyes



LEA Symbols Flash Cards

Consept ”same” in measurement of VA

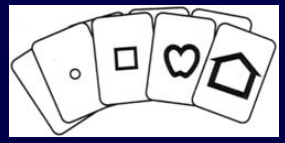
with colours

with B & W forms

comparing concrete object with picture

VA= m/M

Playing Cards



Learning to match forms

Naming symbols

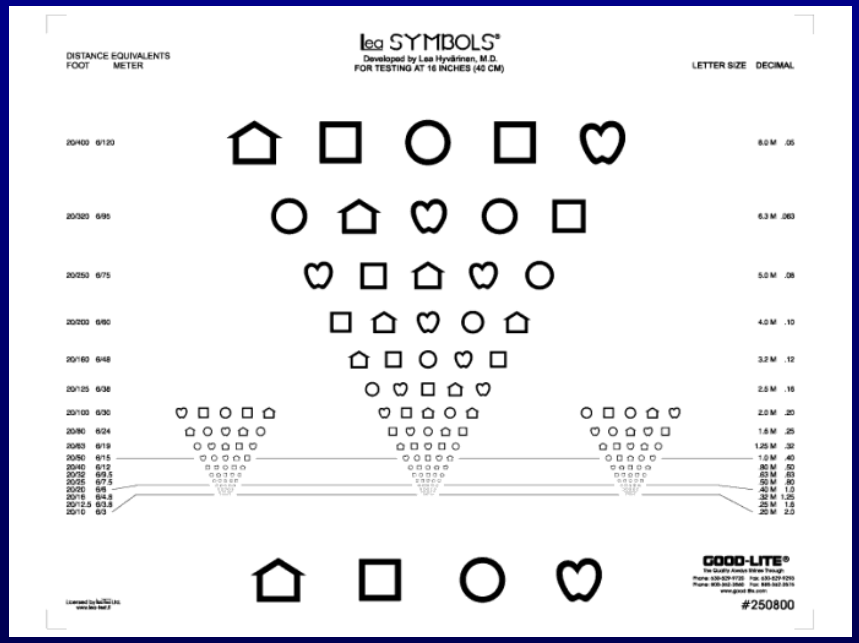
monocular testing

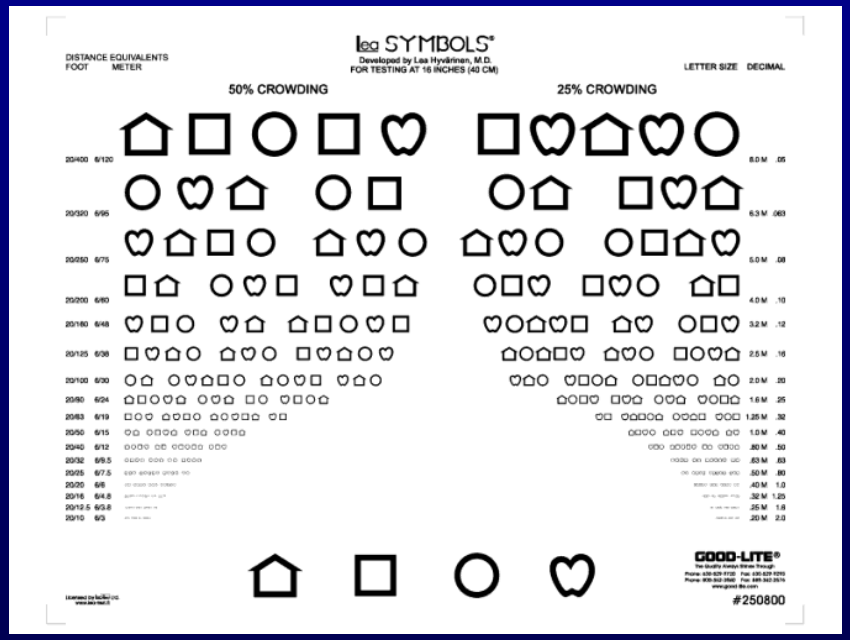
Playing cards in training

Visual acuity

- measure distance of the card (with your arm)
- record the M-size of the symbols
- visual acuity = distance (m) / M-size

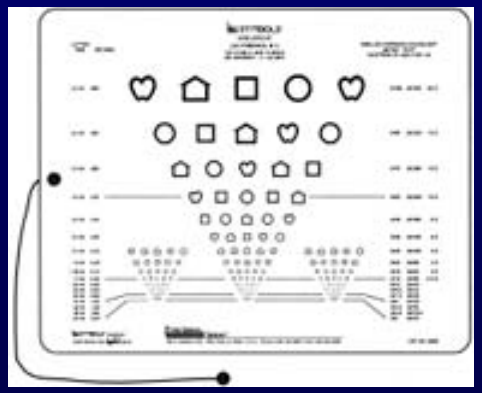
VA - line test

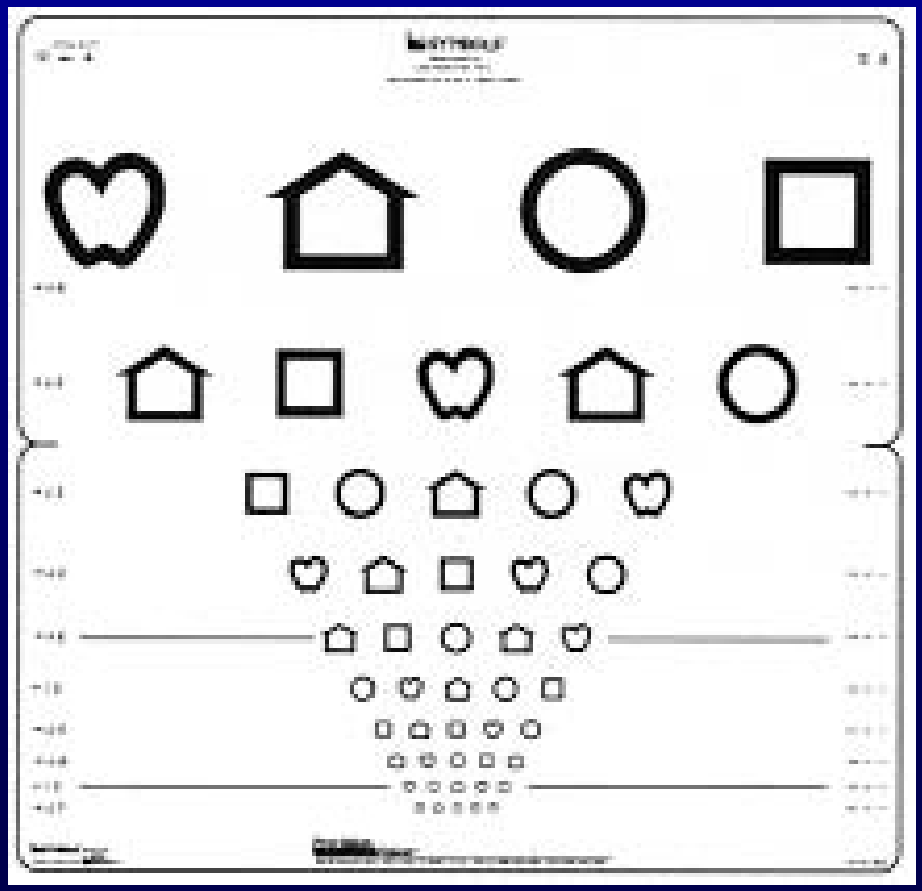




Spasing needs to be recorded

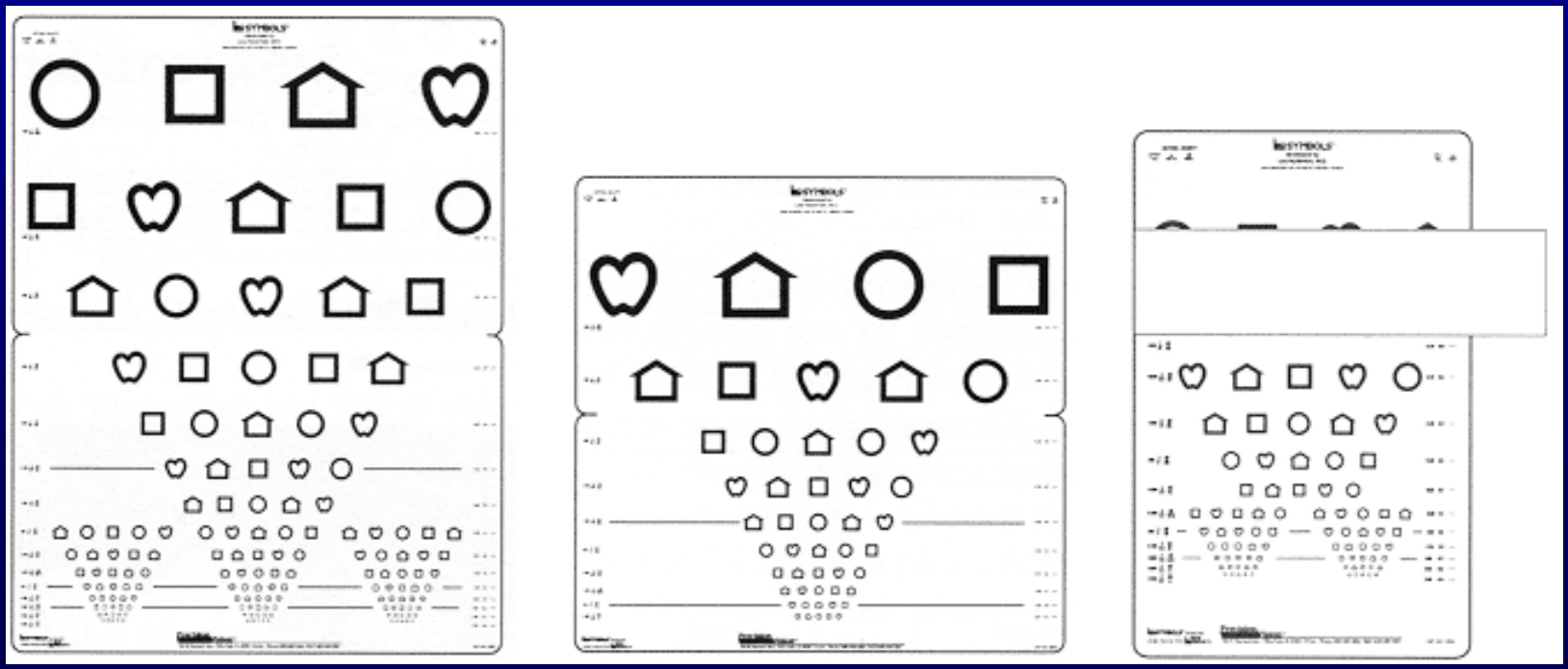
Line tests for the 3-4 year old



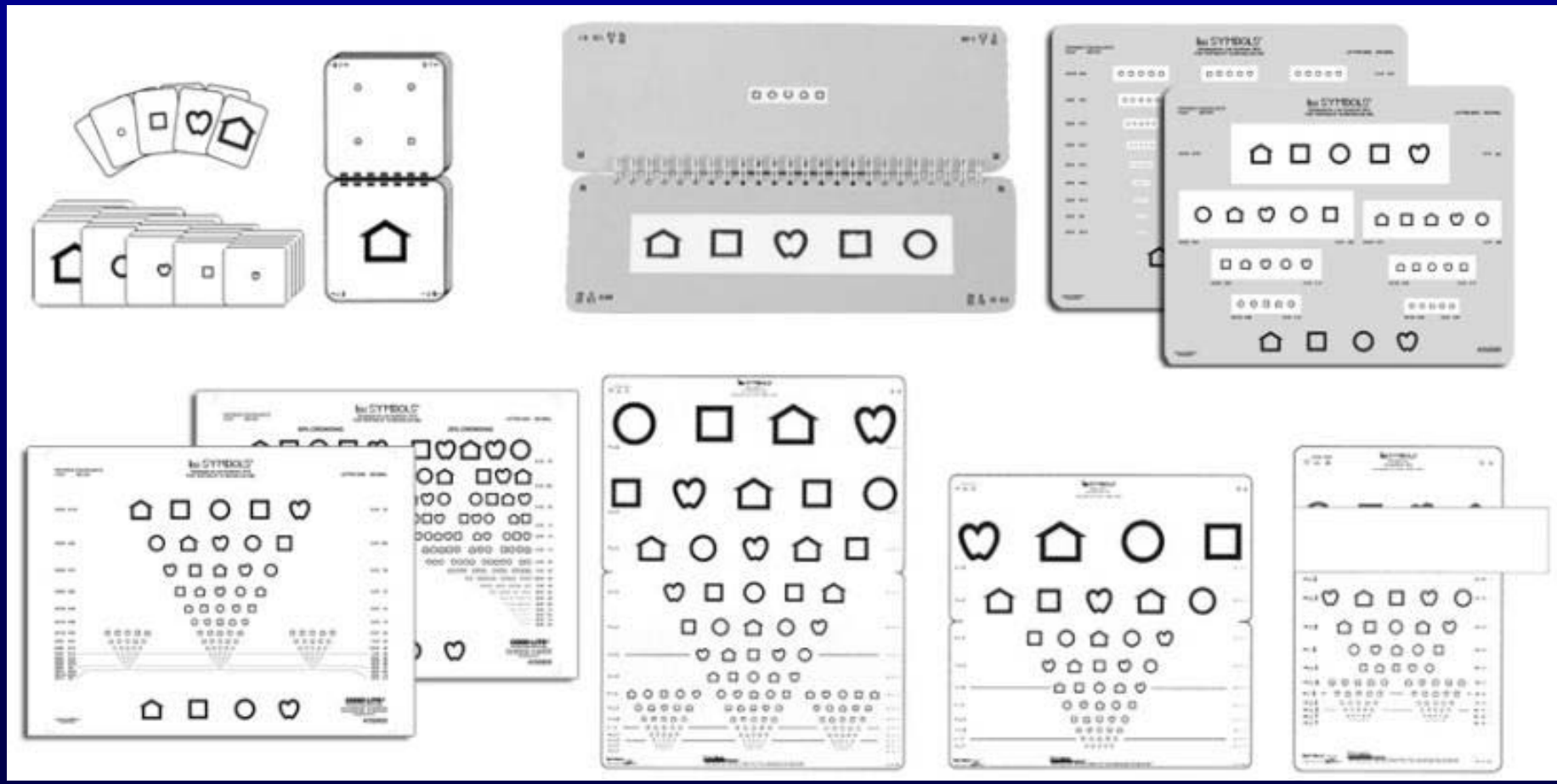


Visual acuity, line tests

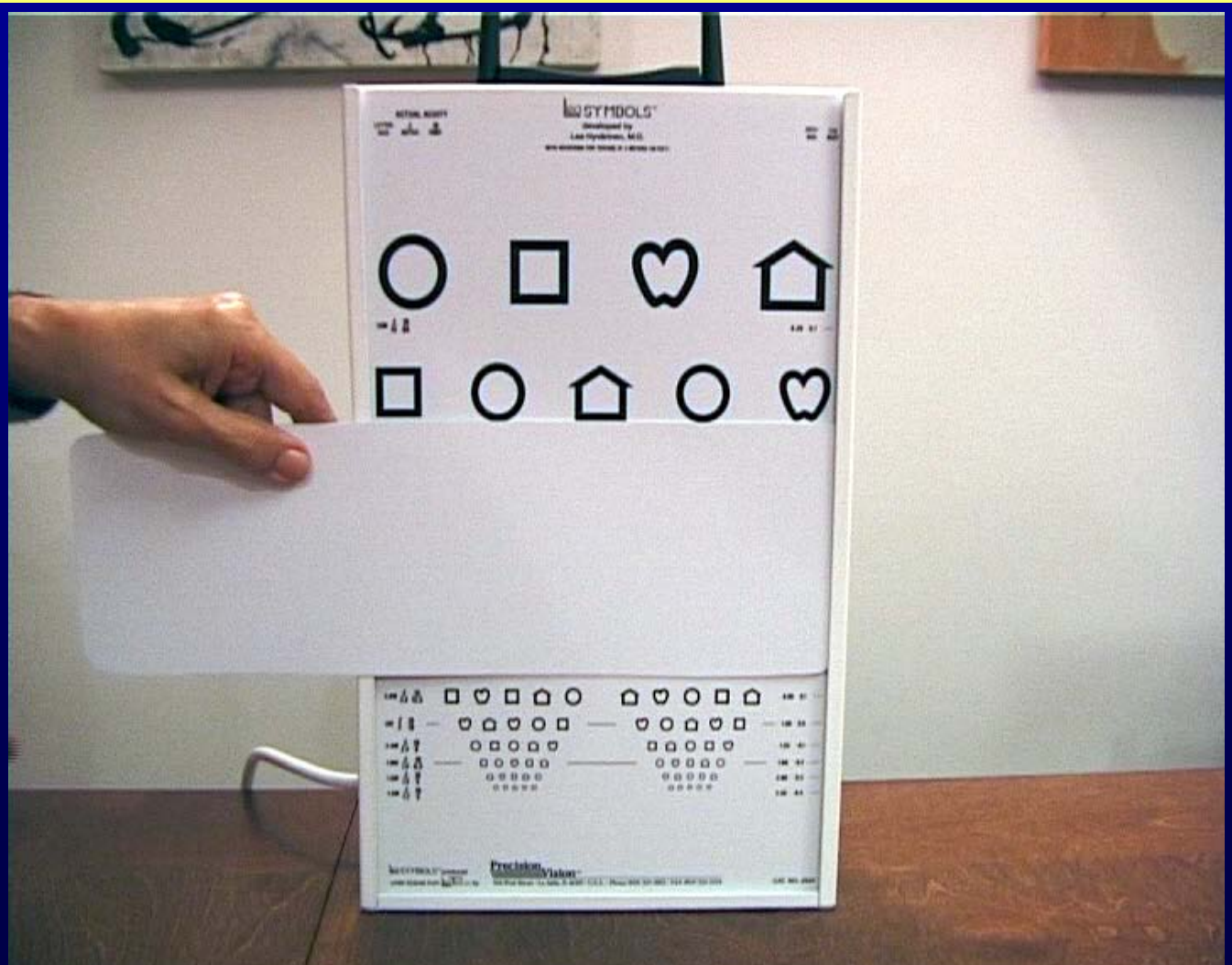
standard tests for assessment



Single, line, crowded

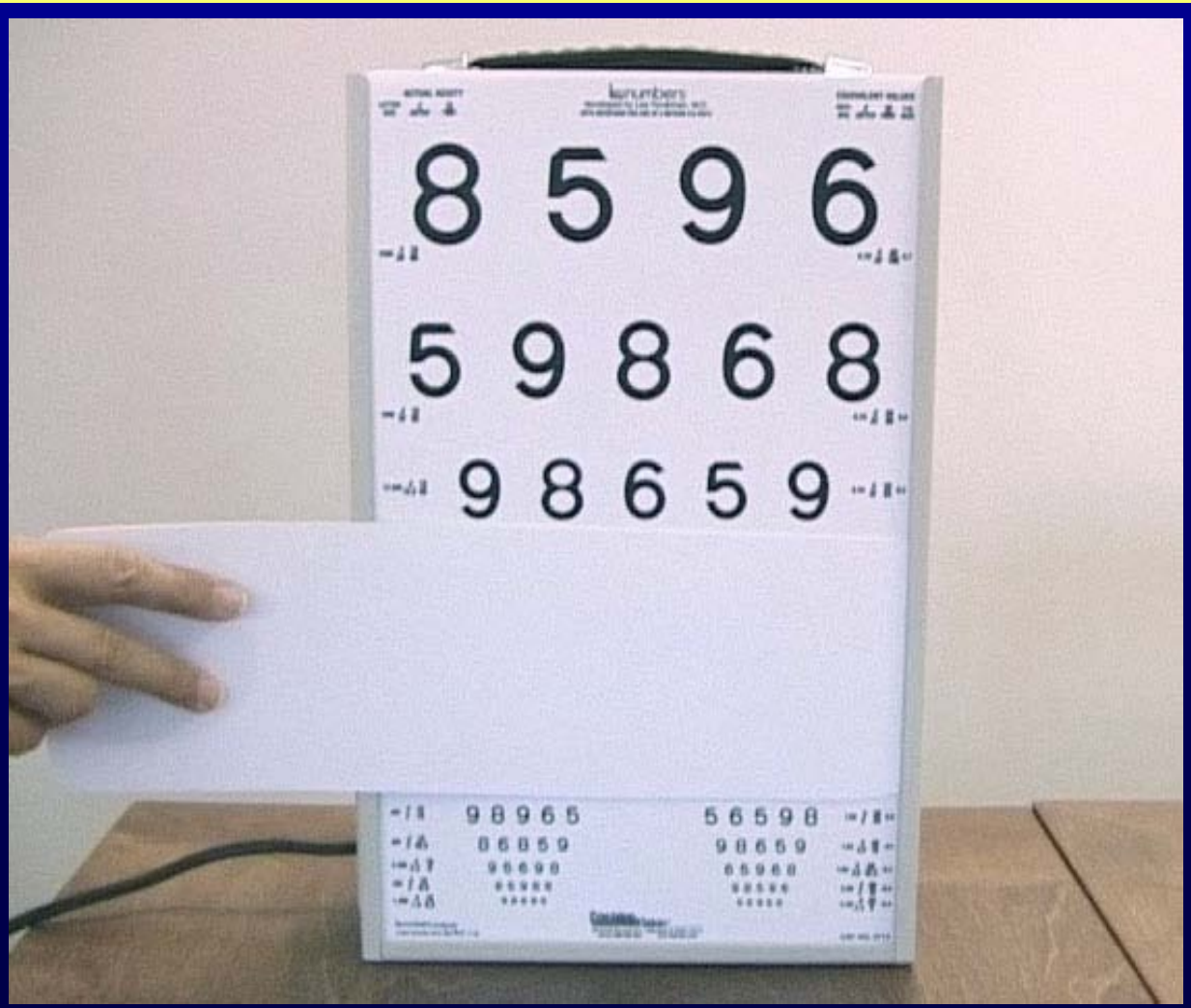


LEA Symbols charts on lightbox



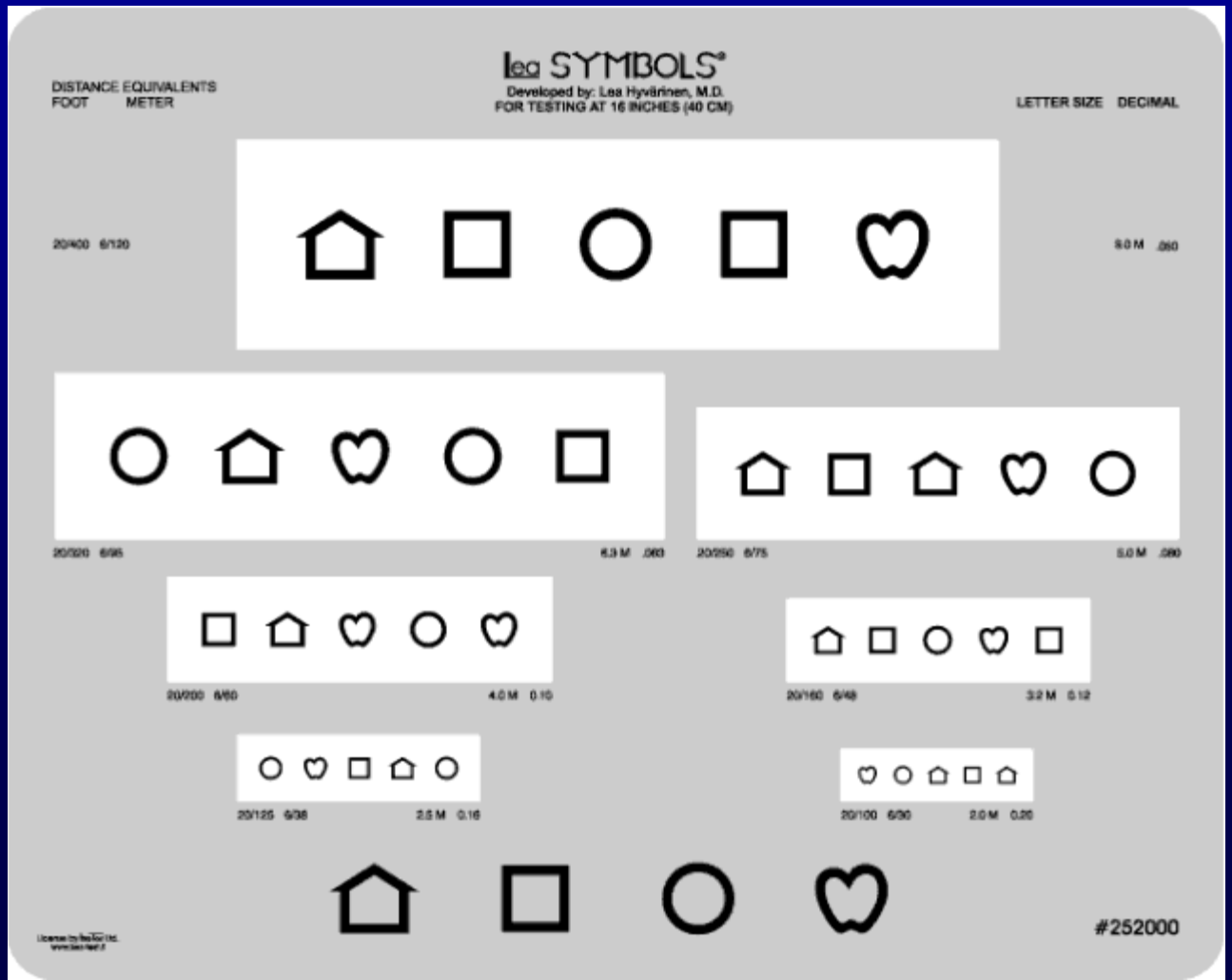
LEA Numbers chart

on the small lightbox



Test at the eye level

Screening Near Test




SYMBOLS
SYMBOLS
GOOD-LITE

Visual Acuity

Detection acuity, objects

Grating acuities

Recognition, optotype acuities

near & distance

Optimal reading acuity

Text size and spacing

for the best reading speed and duration

car Daddy school mine yesterday, 12 point

car Daddy school mine yesterday

car Daddy school mine yesterday, 2 point extra spacing

car Daddy school mine yesterday

car Daddy school mine yesterday, 18 point

car Daddy school yesterday, 28p, 0.3p ex

Daddy school yesterday,

36point, 2p extra spacing

Detection Acuity

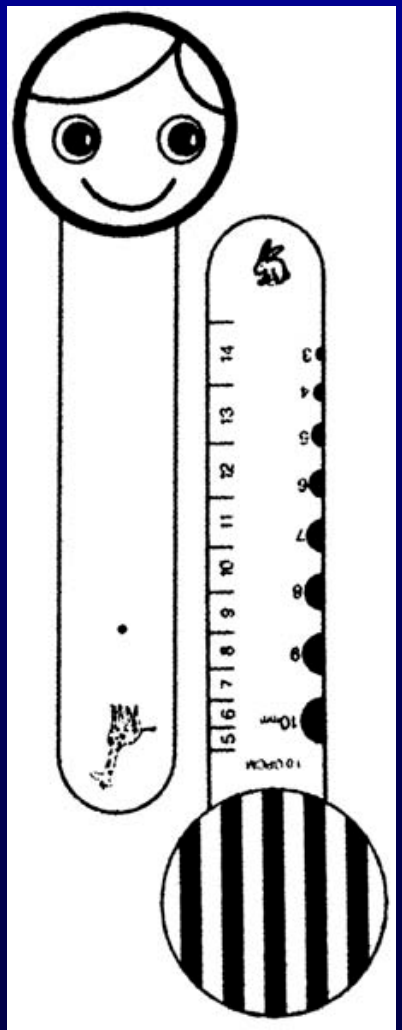
Detection acuity

- Question: ”Where”, not ”What”

- The size of the object
- The background/ contrast
- The distance
- Doctor can calculate the size of the object as angular size.

Fixation

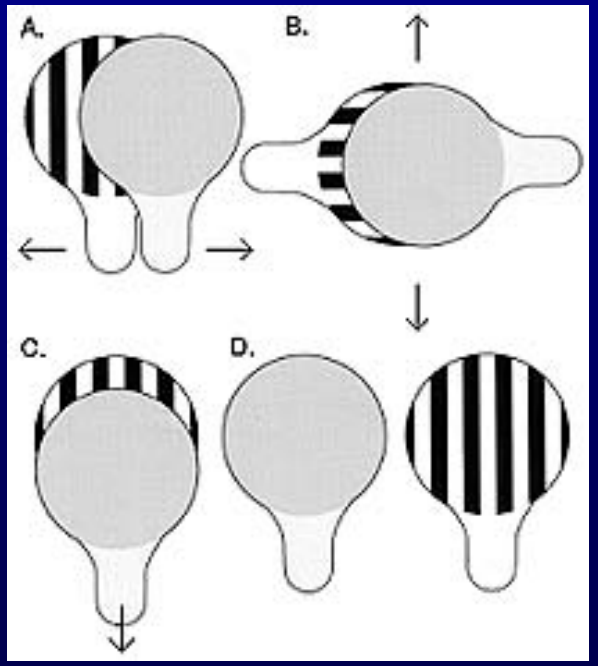
small object/30s, penlight



Detection Acuity

small objects & GrA as detection acuity

Teller Acuity Cards



Lea Gratings

Grating Acuity

as detection acuity

Grating acuity values

MUST NOT

be converted

to

optotype acuity values

Variation of VA values

- Use of several fixation areas
- Changes in the retinal function, oedema
- Variation in brain functions:
  - wakefulness
  - medications
  - environment
  - communication

Measurement of VA

- both eyes open
  - binocular or VA of the dominant eye
- monocular VA << **covering an eye**
- freely alternating >> preferred eye

Summary on VA

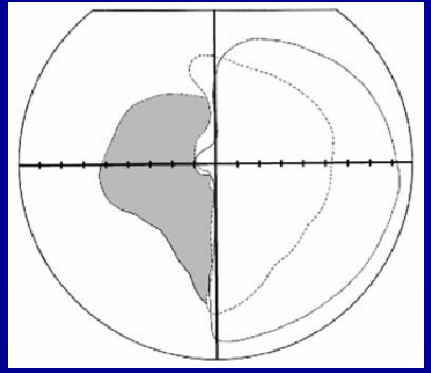
- Several visual acuities:
  - single, line, crowded
  - high and low contrast, 2.5% convenient

- Technique: line test, ask which is the first optotype on each line until error or hesitation, next test the previous line

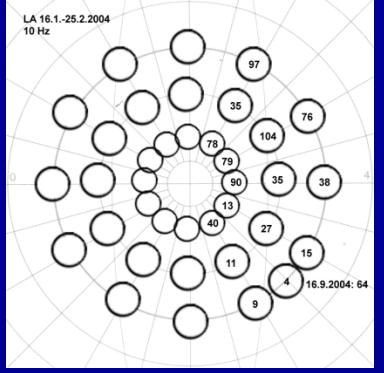
Summary on VA

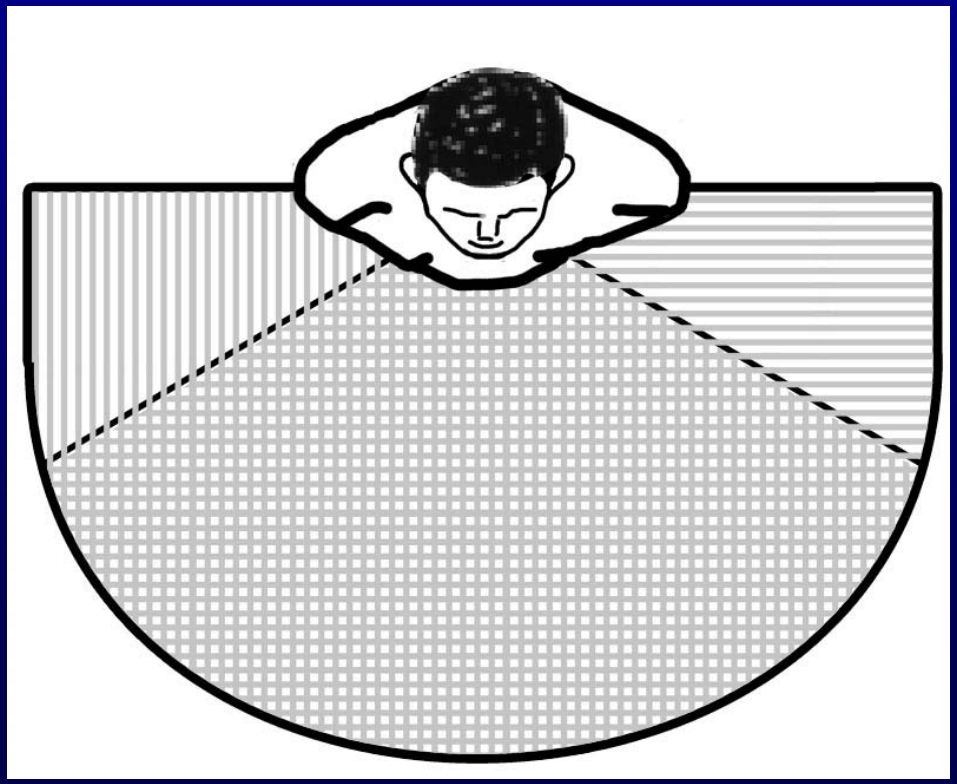
- Several visual acuities:
  - single, line, crowded
- Technique: line tests,ask which is the first optotype on each line until error or hesitation
- Test the previous line
- Pointing helps fixation, line test without pointing; as a second test try with pointing
- Do not repeat, do not reveal errors
- Accept **any name** for symbols
- Always report the name of the test, distance, luminance

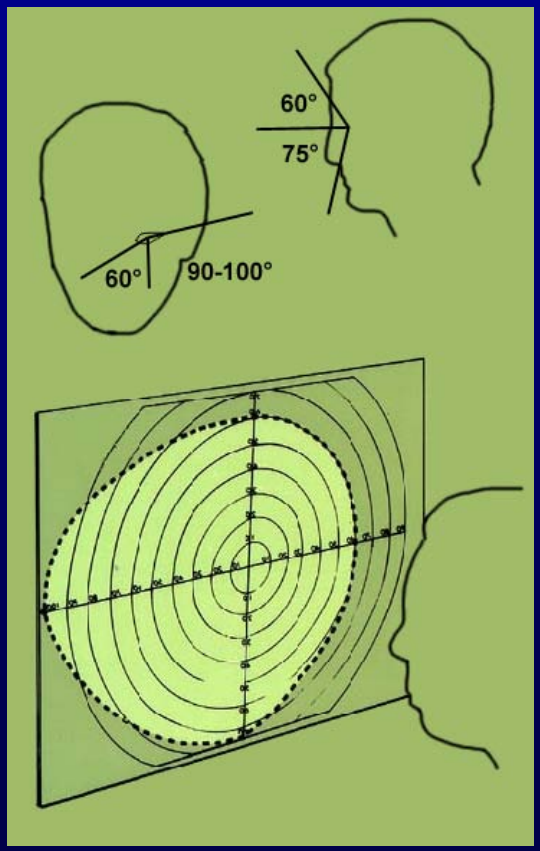
- Rowan Candy



Visual field





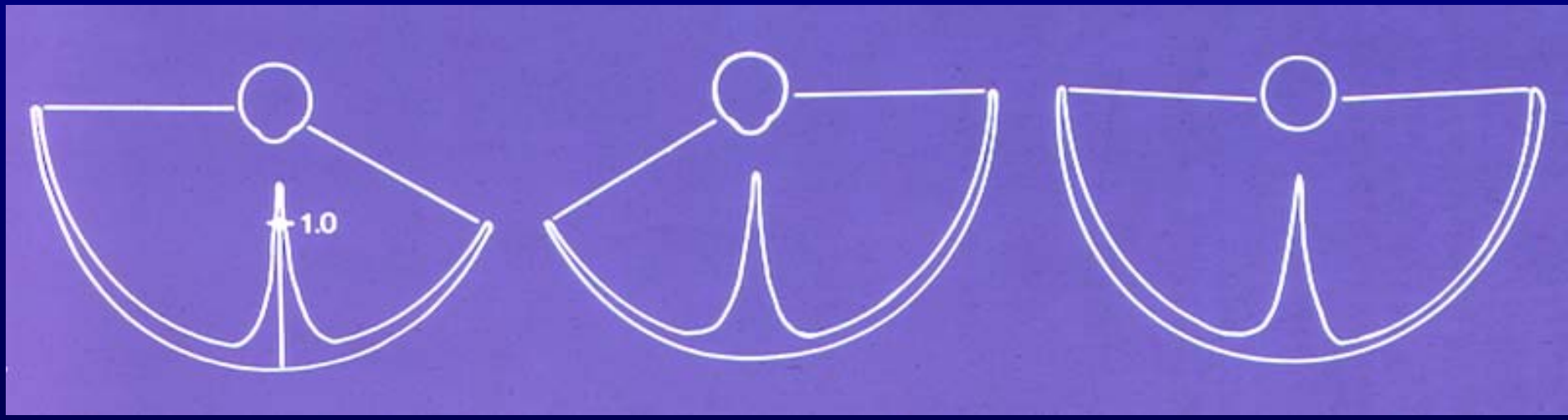


Binocular visual field

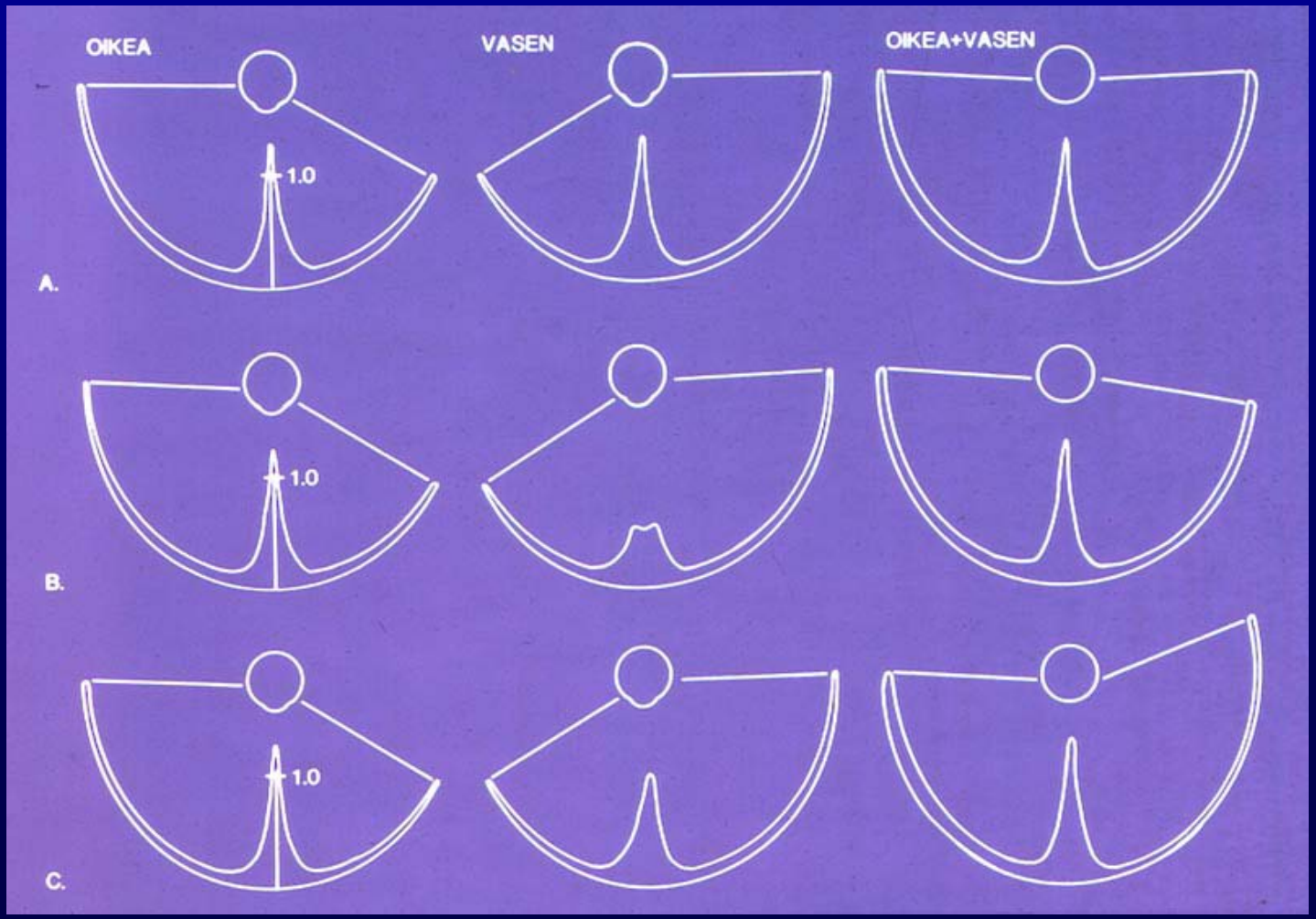
Right VF

Left VF

Binocular VF



Effect of strabismus

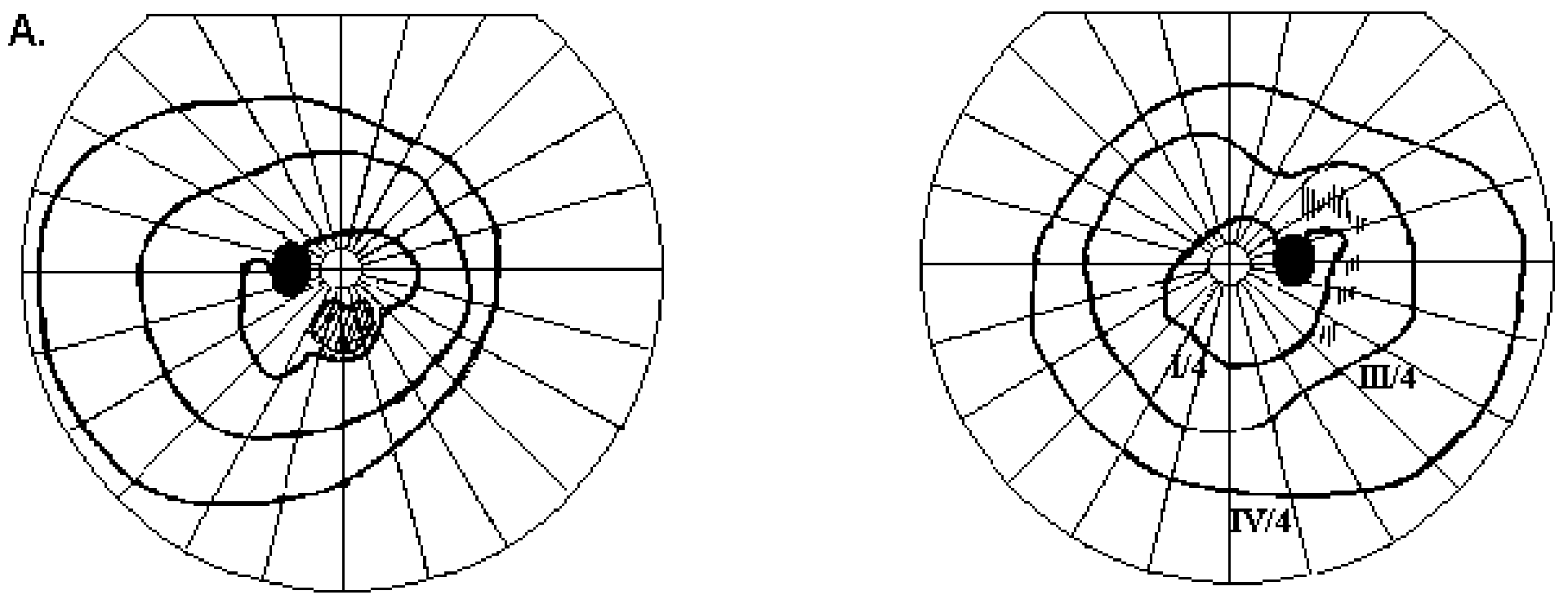


Goldmann perimeter

interpreter explaining the test to a deaf child

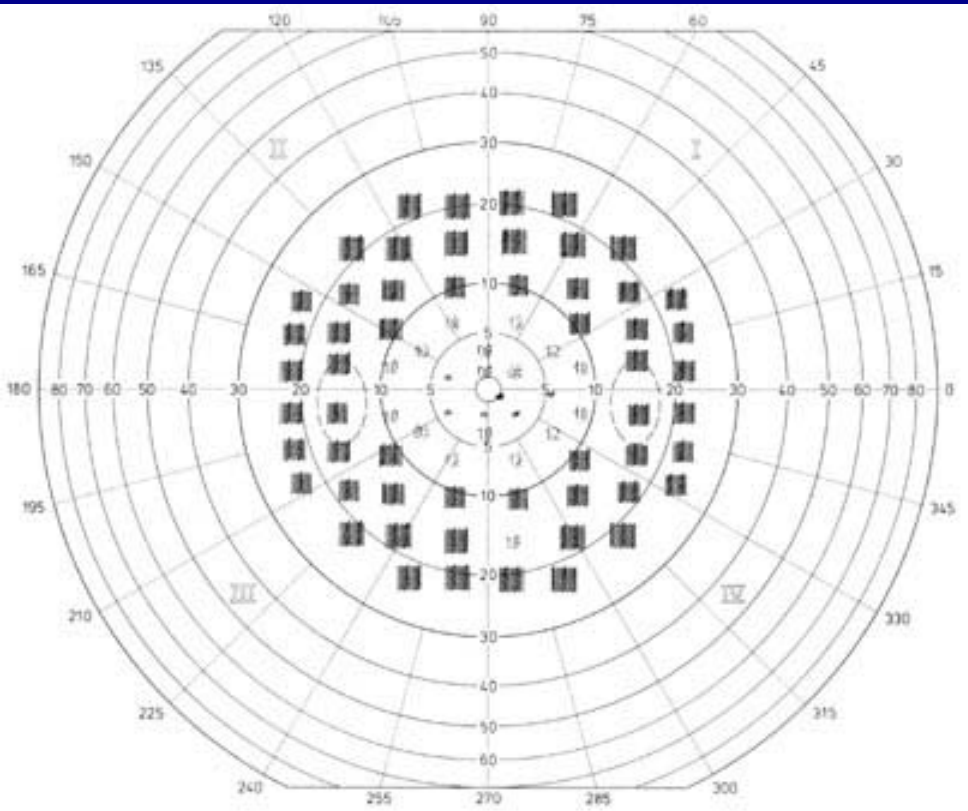
Retinitis pigmentosa

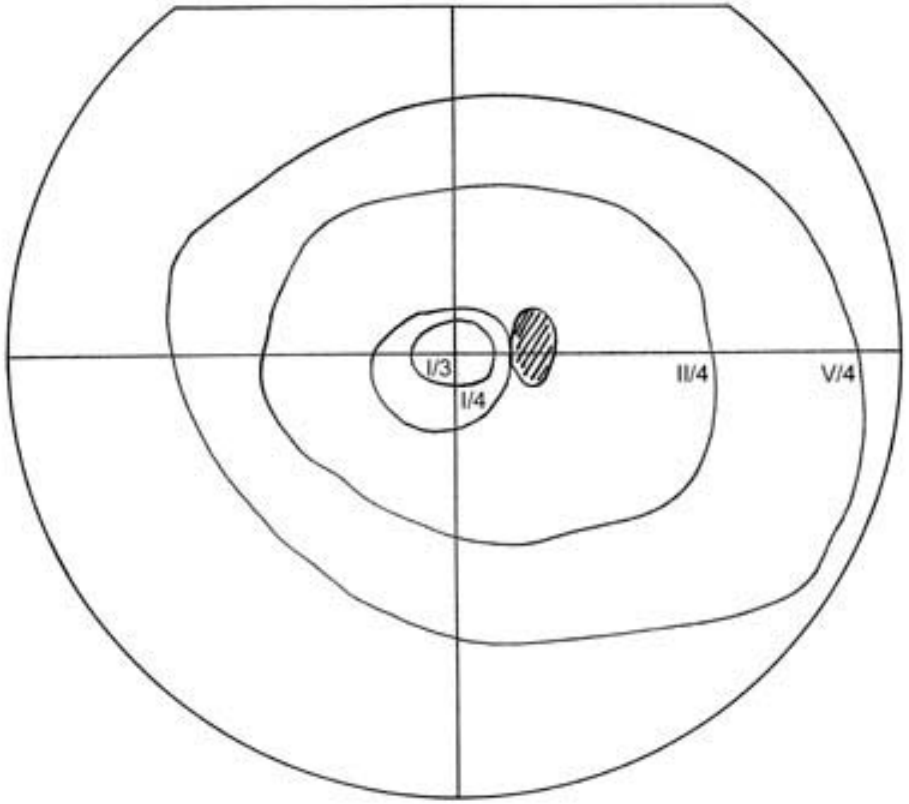
early visual field changes



Automatic v. Goldmann

Retinitis pigmentosa, boy at 11 years of age





Goldmann perimetry

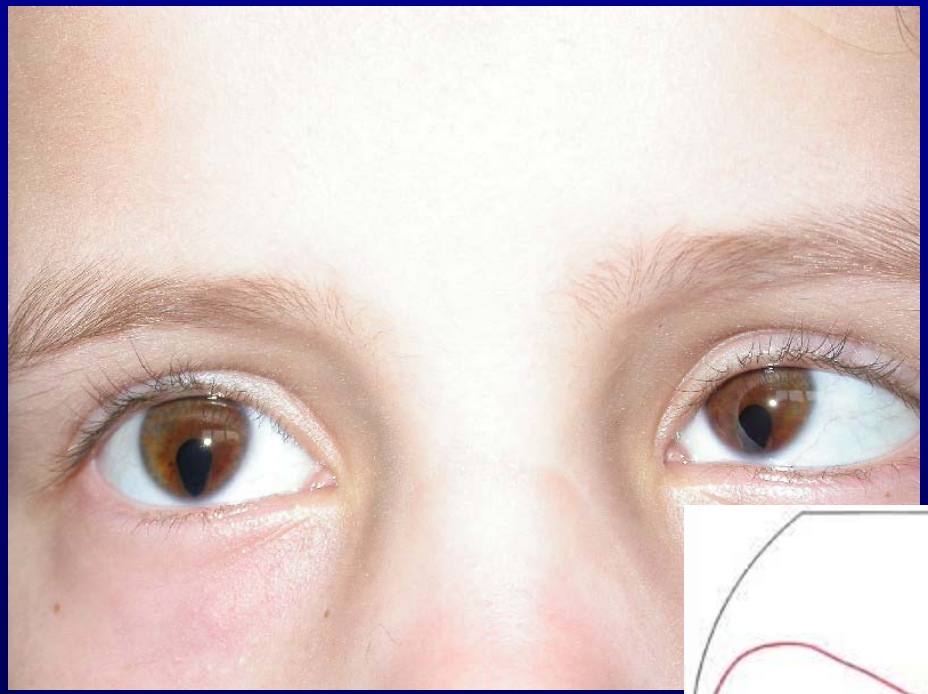
Low luminance level, 10 cd/m2

Low speed of the stimulus

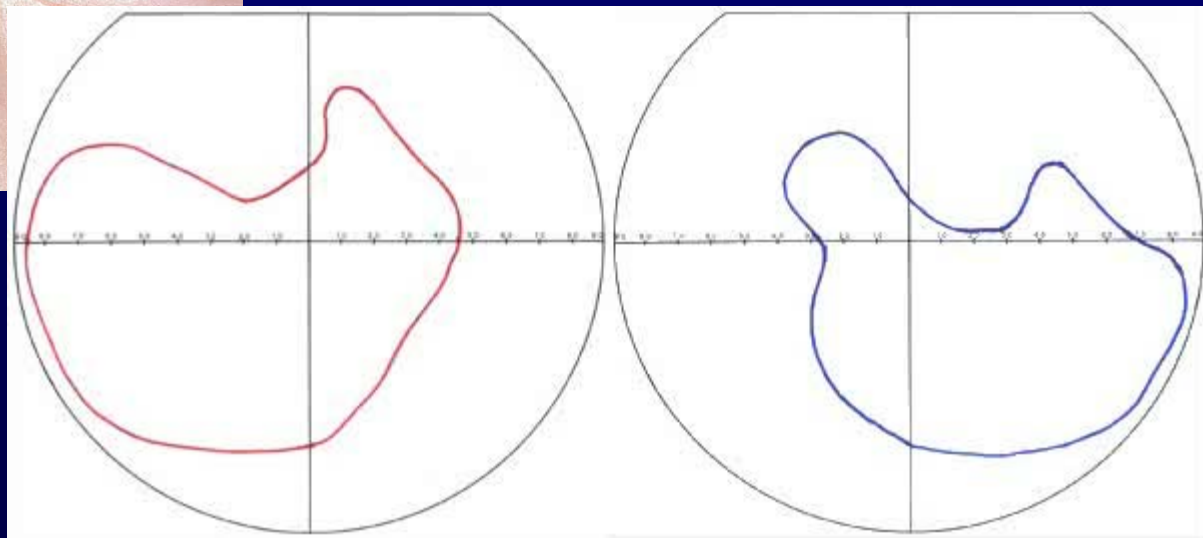
”Absolute” scotomas are not absolute

Coloboma

monocular versus binocular visual field



Defect in the lower part of the retina causes loss of visual field in its upper part. If a child is binocular, the visual fields are fused to a single field.



Sheridan ball test

Flicker Wand

Perimetry with Flicker Wand

Size of visual field

Flicke 10Hz

Right hemianopia?

Borders of visual field

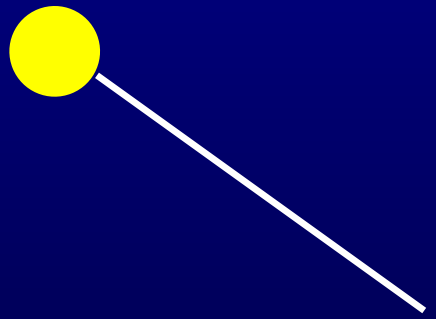
Normal

Right sided hemianopia

Normal response

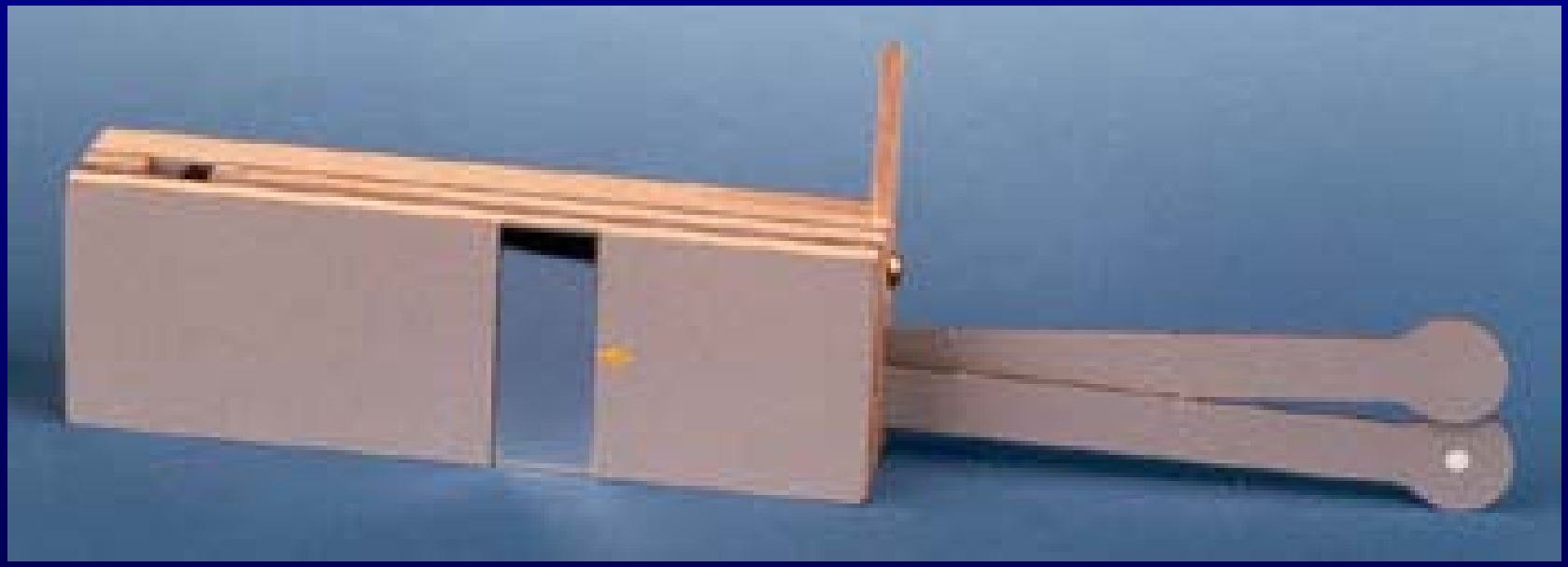
Perimetry with Vice Versa

Vice Versa



Ball on stick

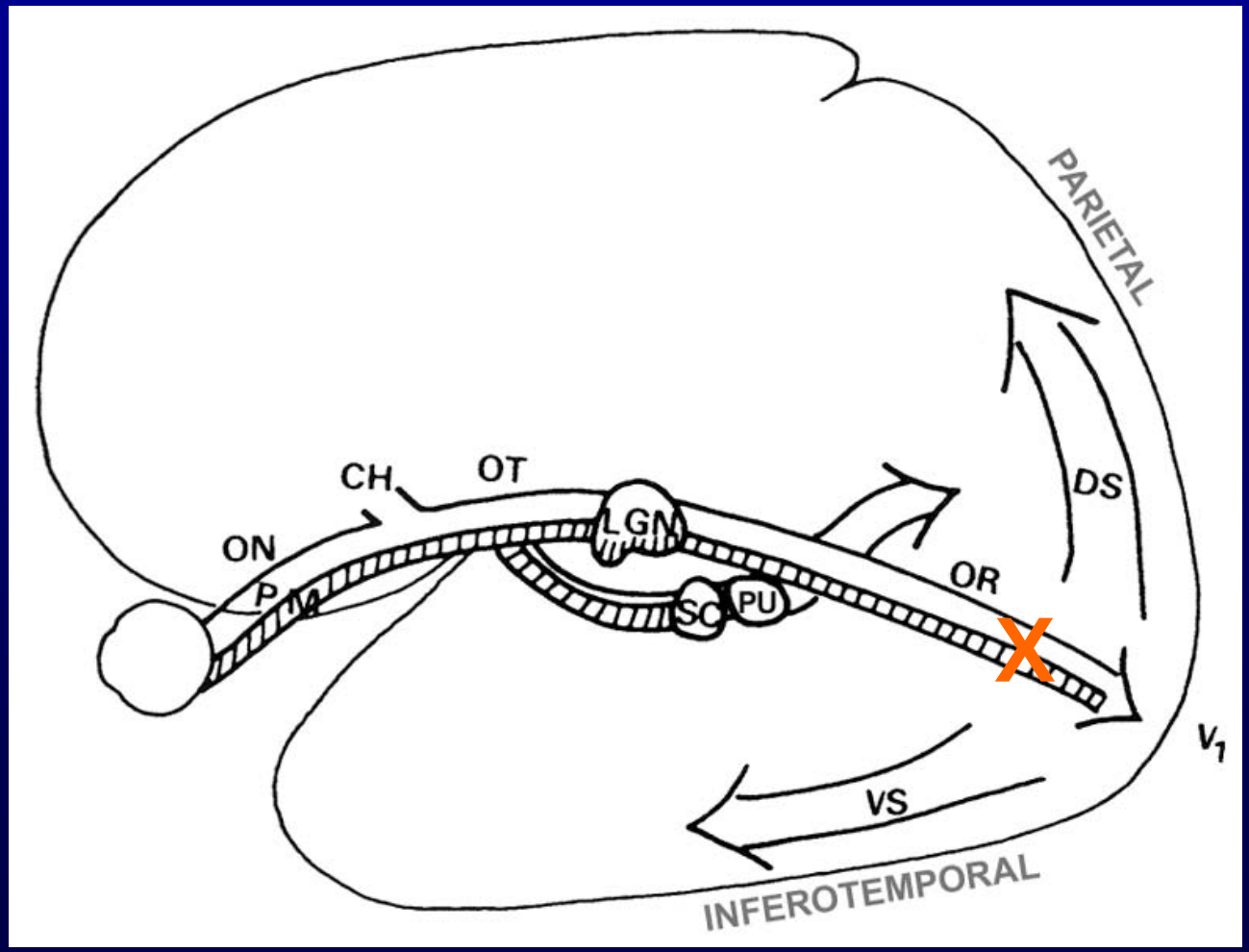
ViceVersa



Motion perception+Visual field

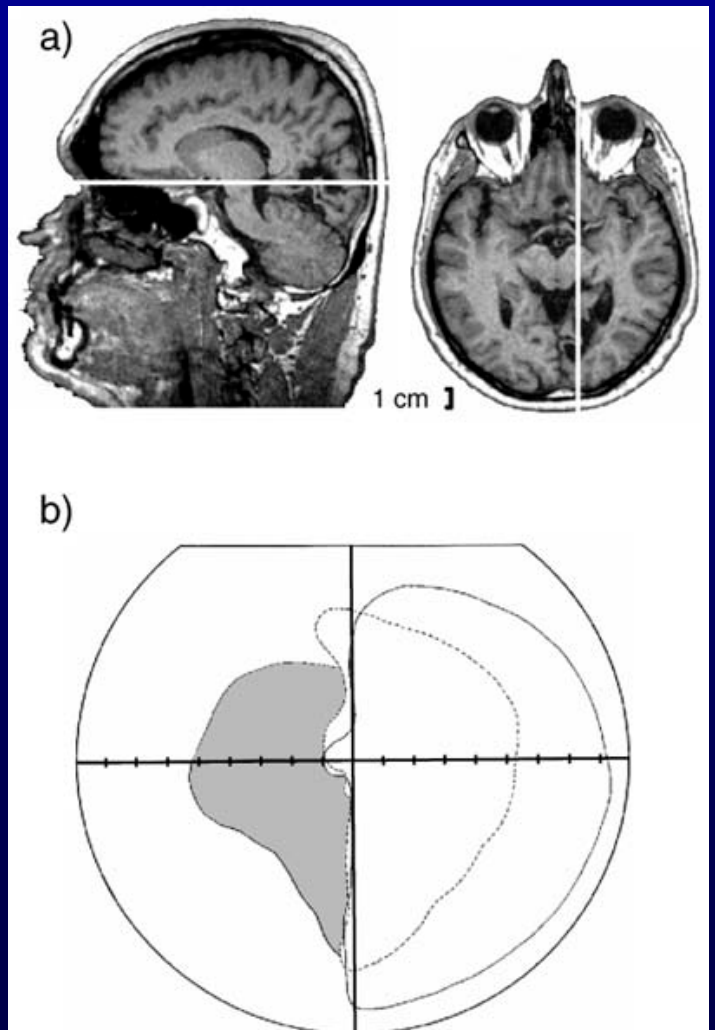
diagnostic play situatons

Retinocalcarine & tectal pathway



Lesion in the posterior pathway

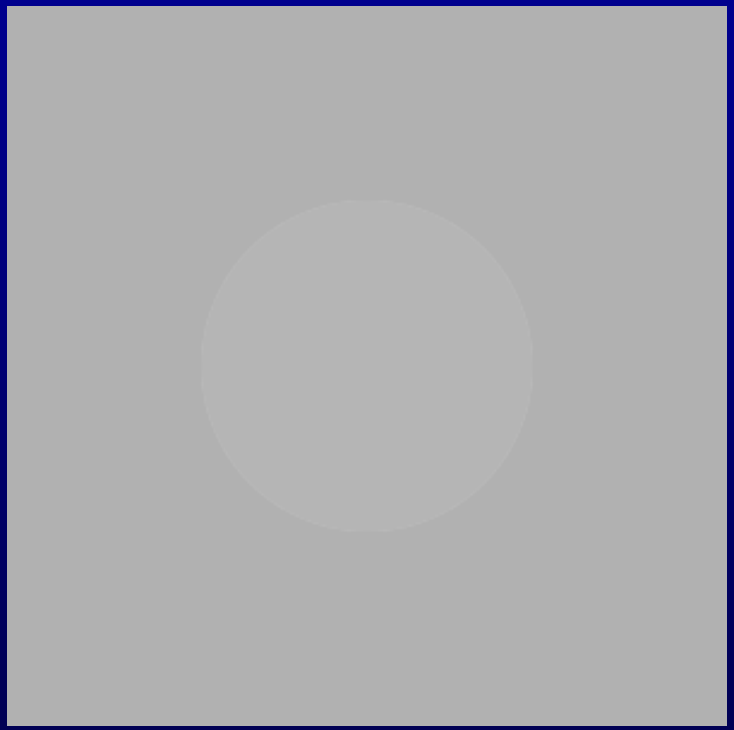
Näköradan takaosan vaurio



Plasticity in relative scotomas

- Hemianopia:

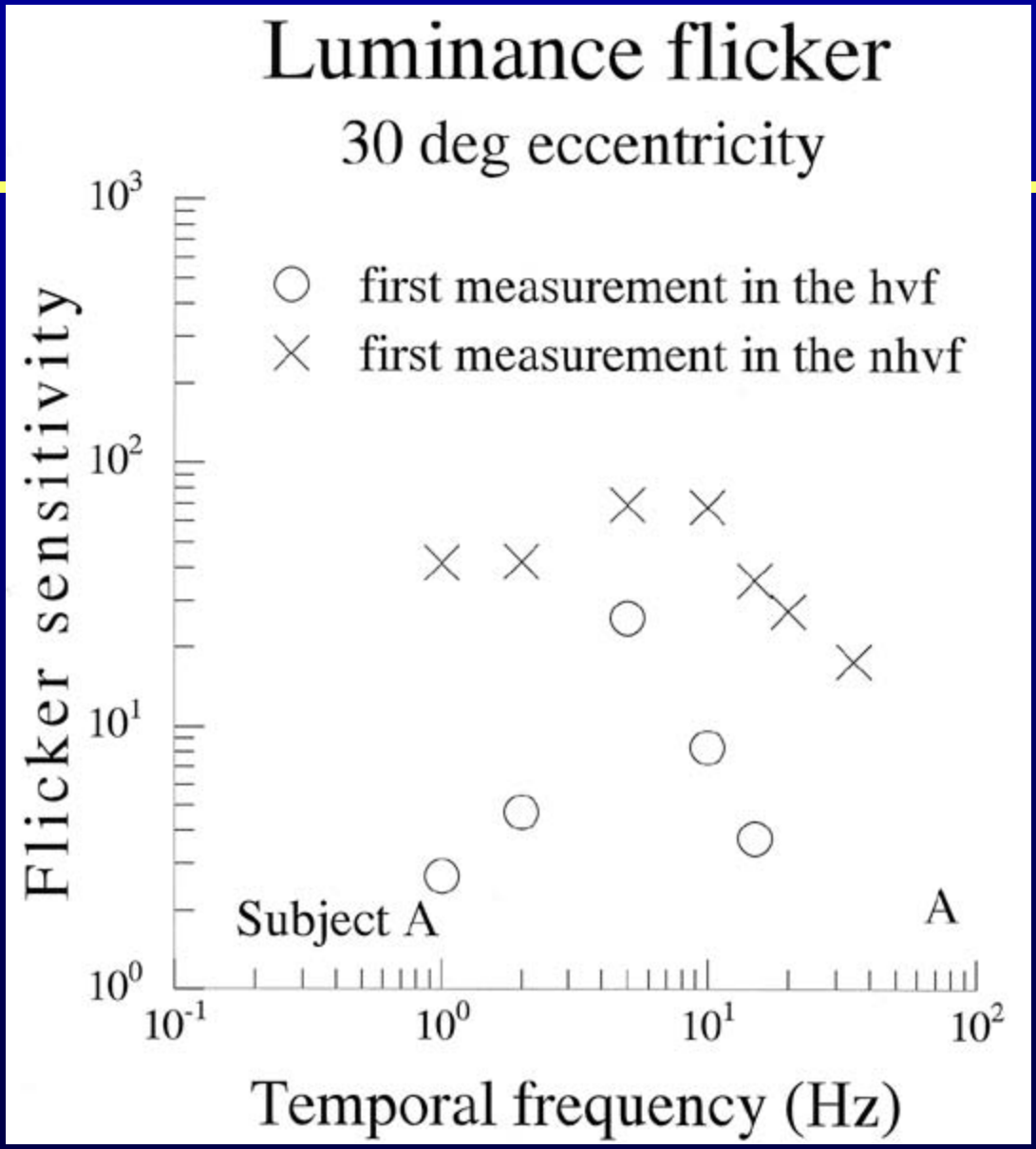
  1. In scotomatous area there can be motion perception that cannot be recorded in Goldmann perimetry.
  2. Training may improve function in hemianopia, a new challenge in rehabilitation.



Measurement of flicker sensitivity

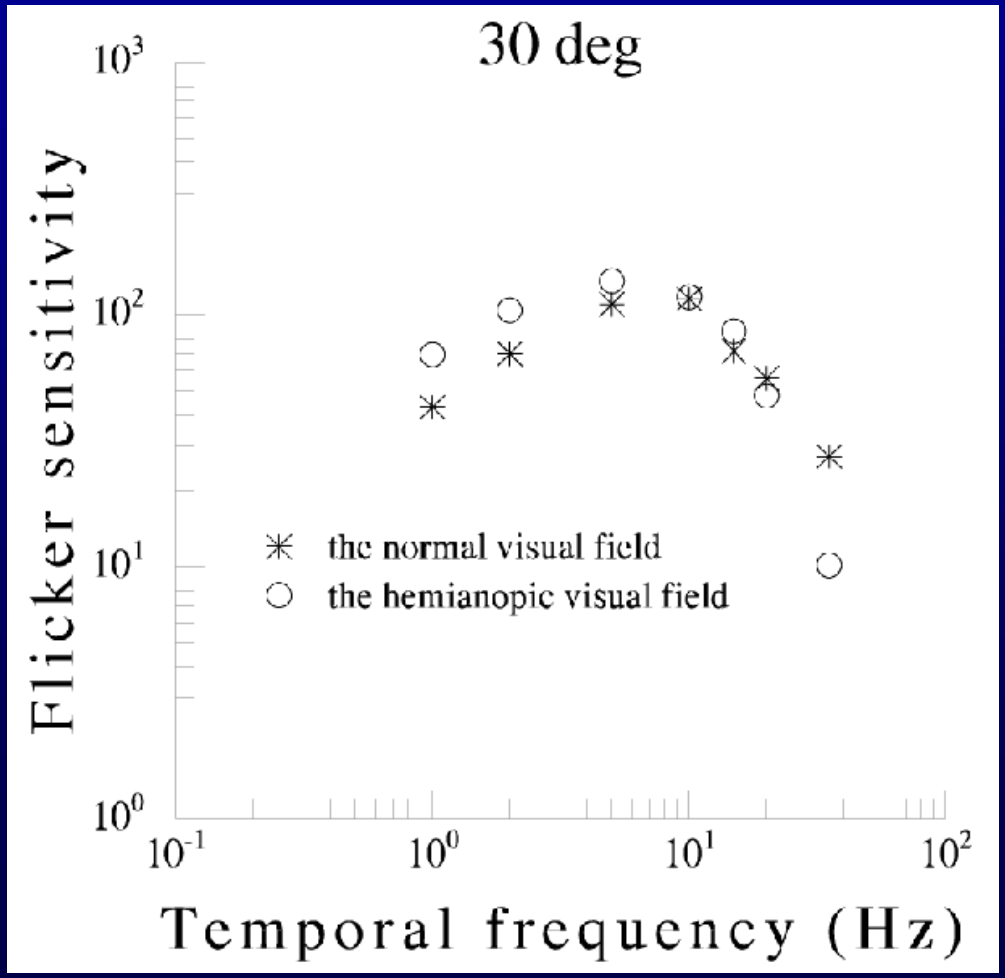
Välkeherkkyyden mittaus

Antti Raninen, Vision Laboratory, Univ. of Helsinki


Luminance flicker
30 deg eccentricity
first measurement in the hvf
first measurement in the nhvf
Flicker sensitivity
10^3
10^2
10^1
10^0
10^{-1}
10^0
10^1
10^2
Subject A
A
Temporal frequency (Hz)

- Luminance flicker measurement
  - a session once a month
  - 13 sessions within a year

Flicker sensitivity in the blind hemifield may become normal.



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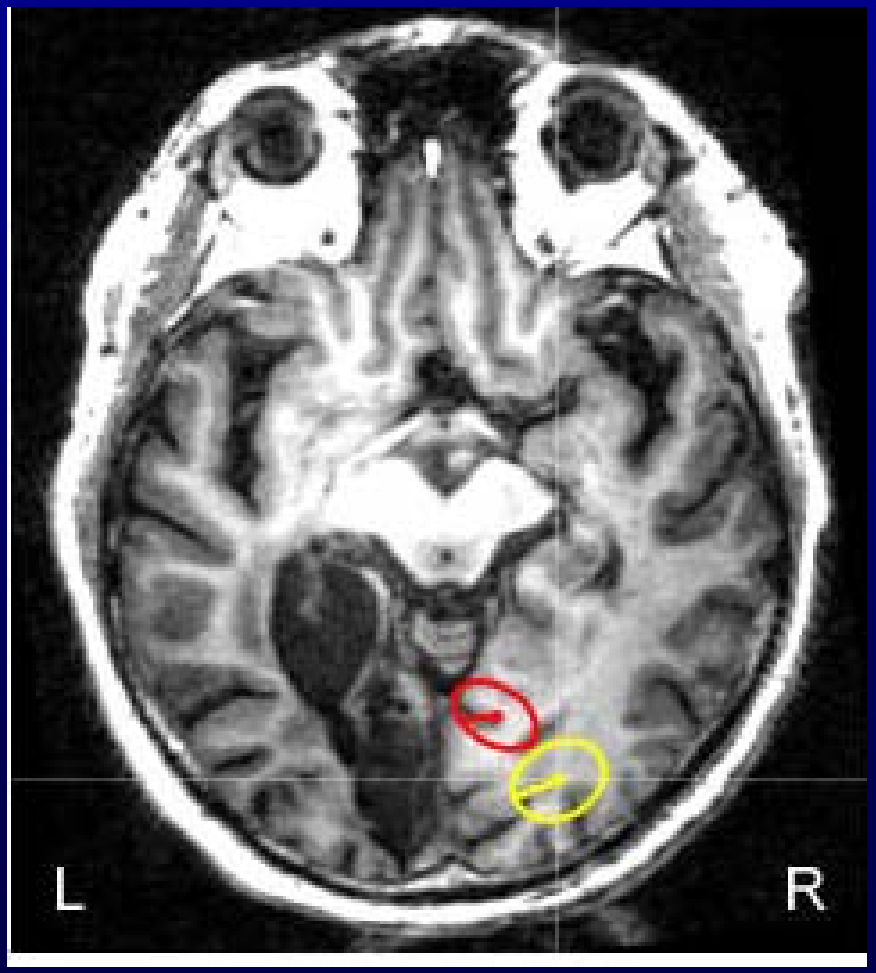
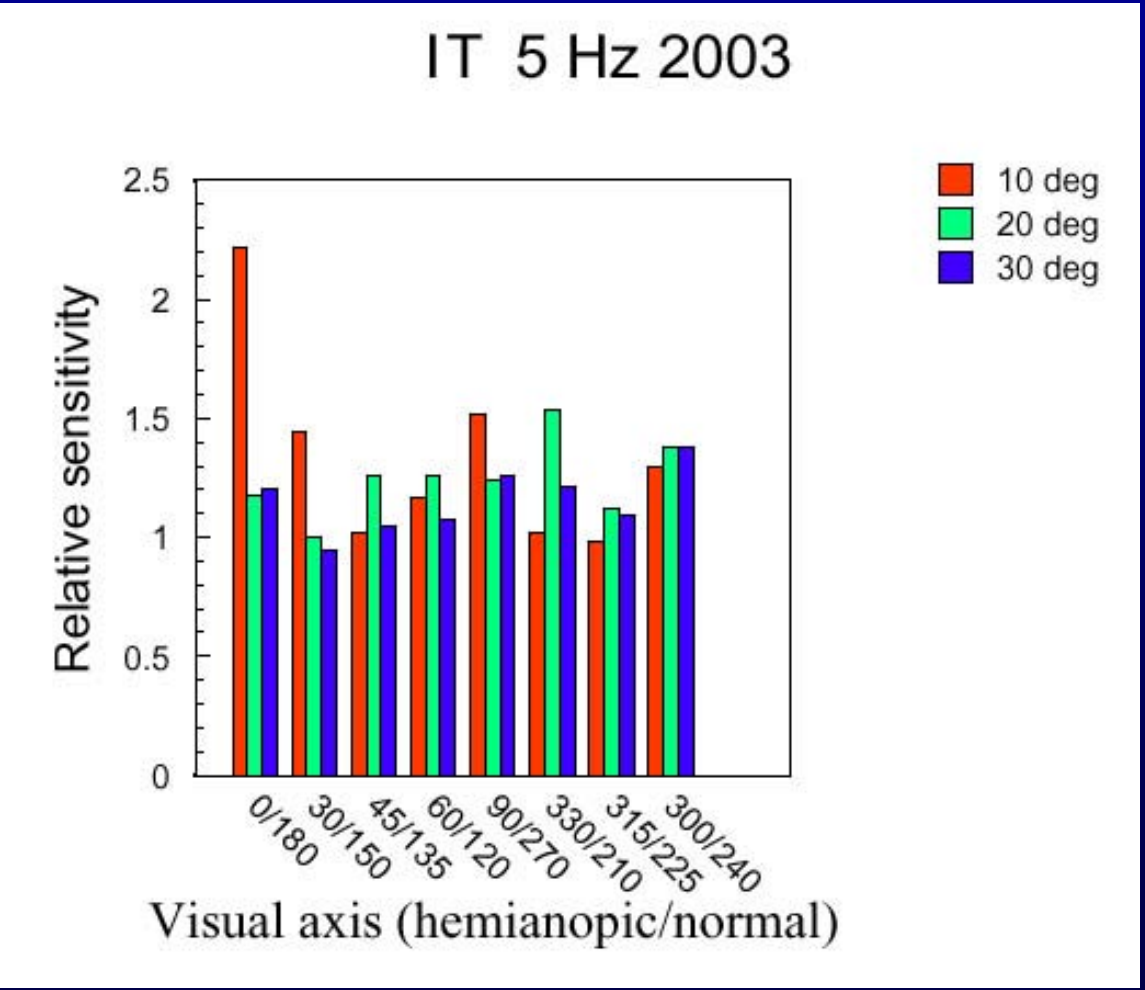


Improvement of sensitivity

measurements on 3 distances from fovea at corresponding meridians



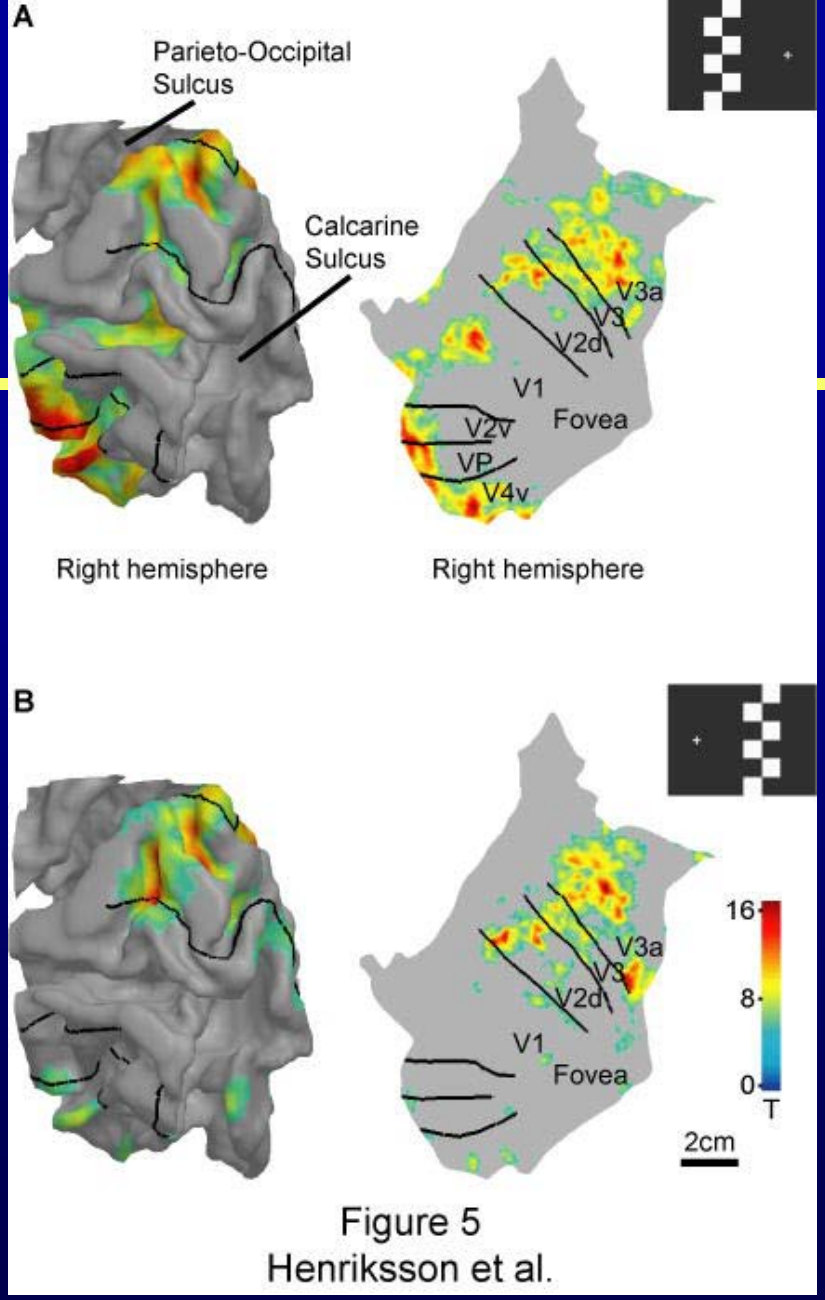


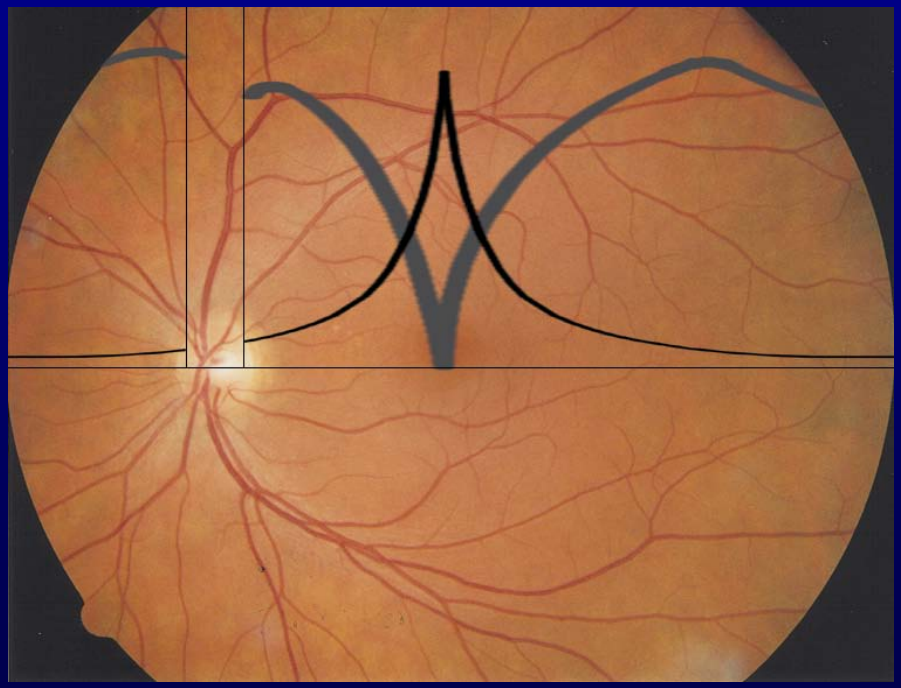
Figure 5
Henriksson et al.

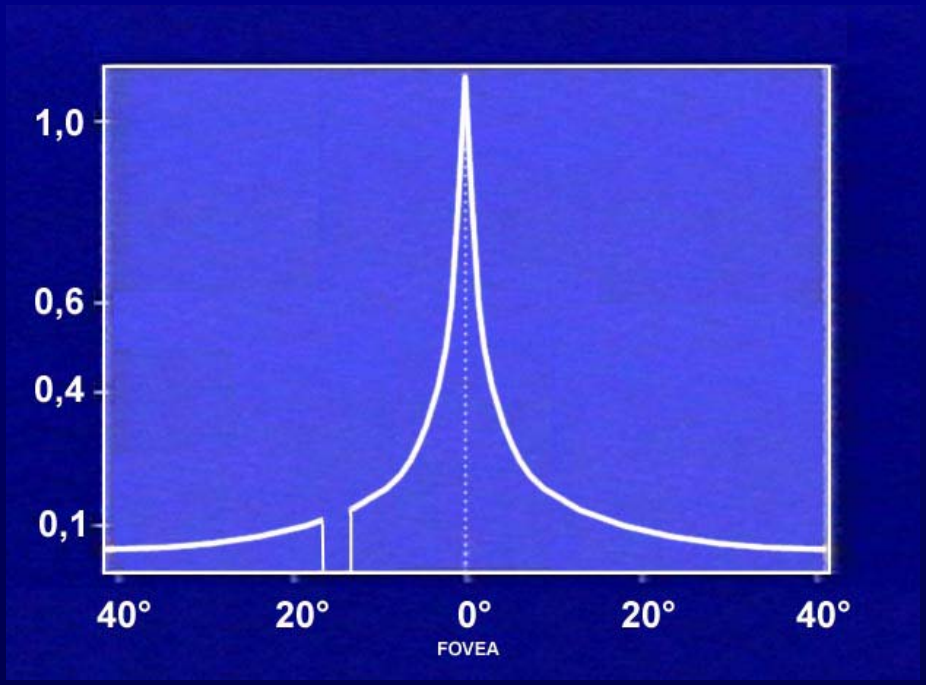
Stimulus on the left side of the fixation, i.e. in the left visual field.. Activity in the right occipital cortex.

Stimulus on the right side of the fixation, i.e. in the RIGHT visual field.. Activity in the RIGHT occipital cortex.

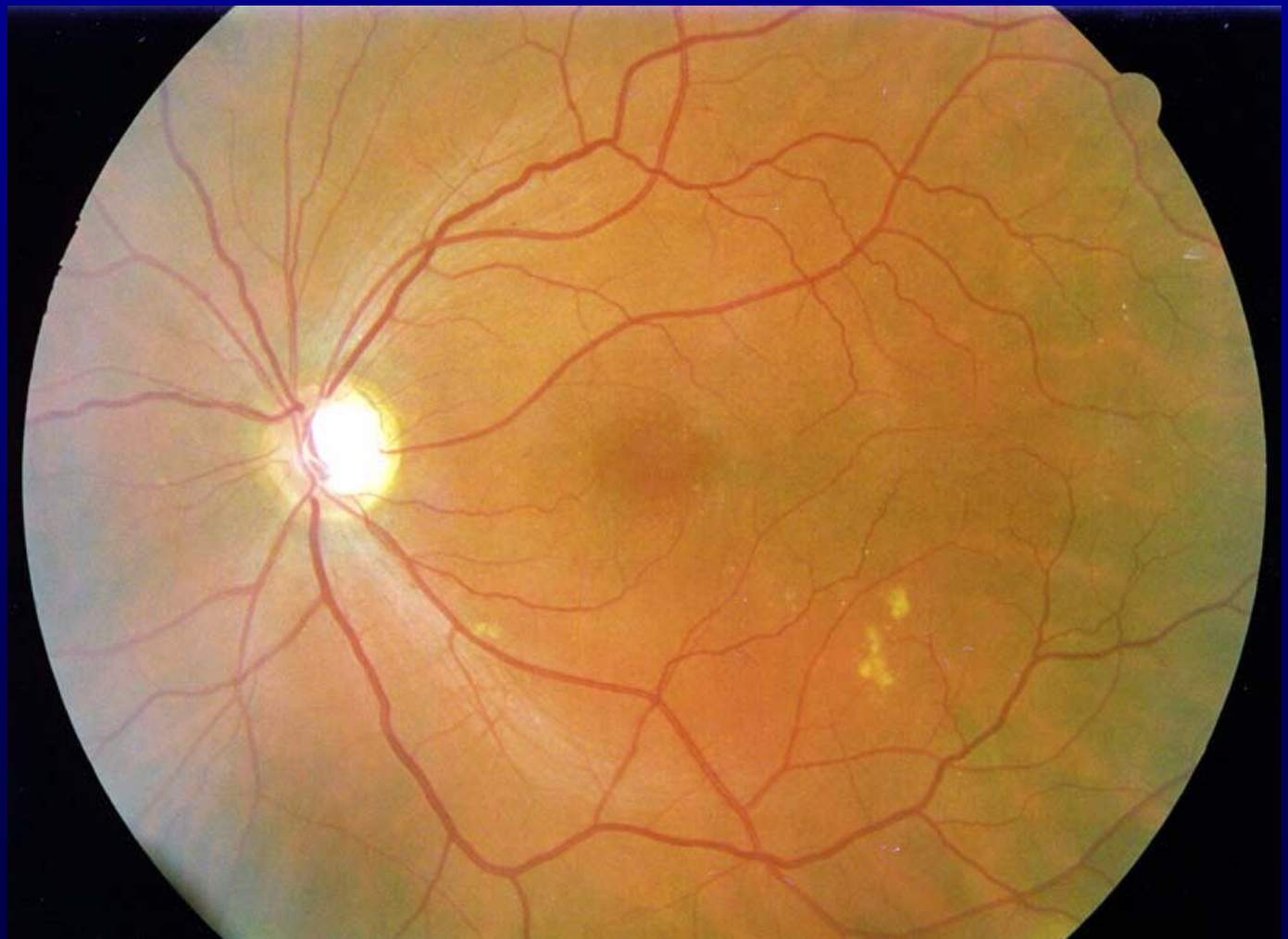
Functions from the damaged left side of the brain have moved to the normal right side.

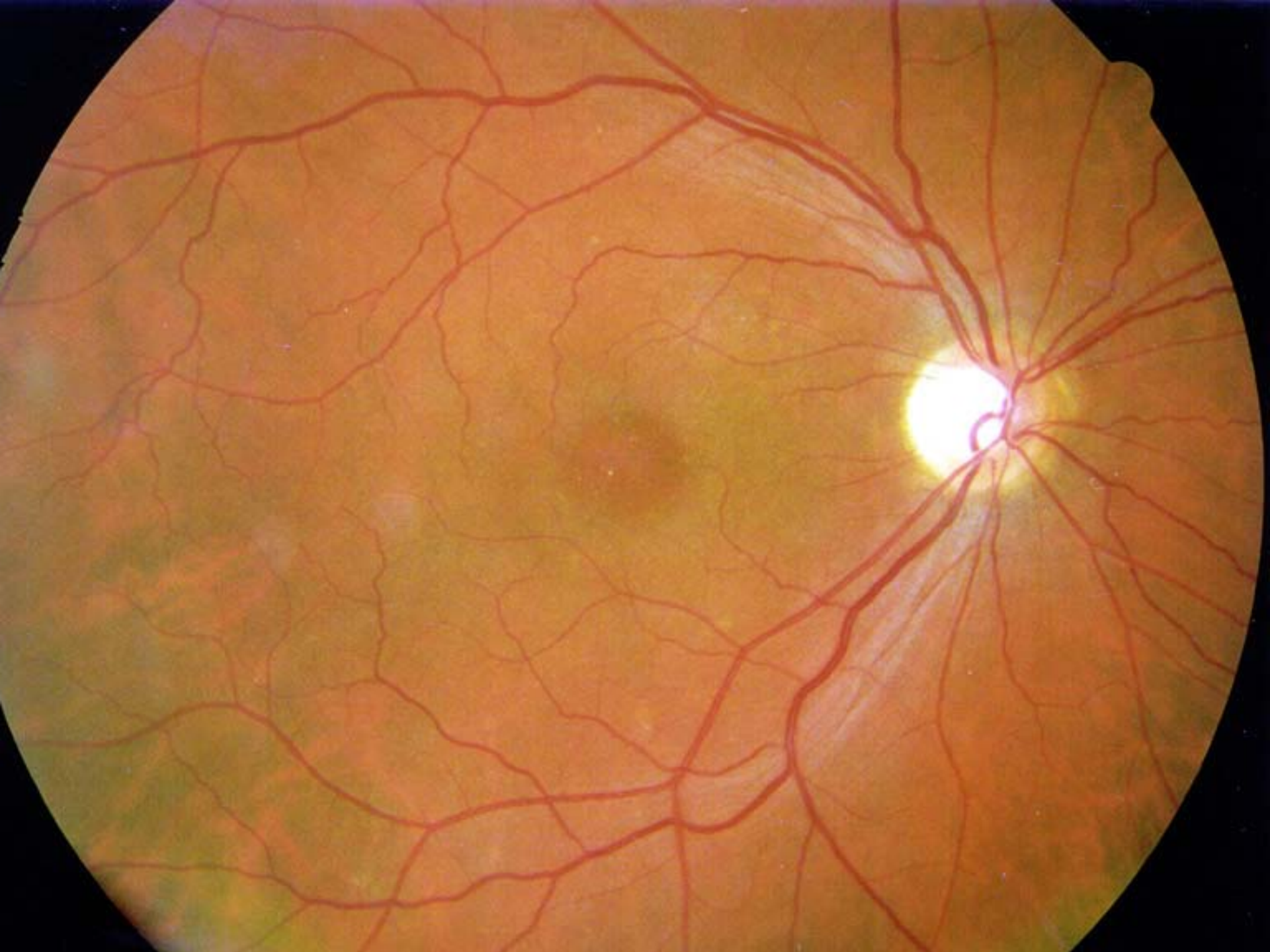
Cell distribution in retina
Visual acuity in the visual field





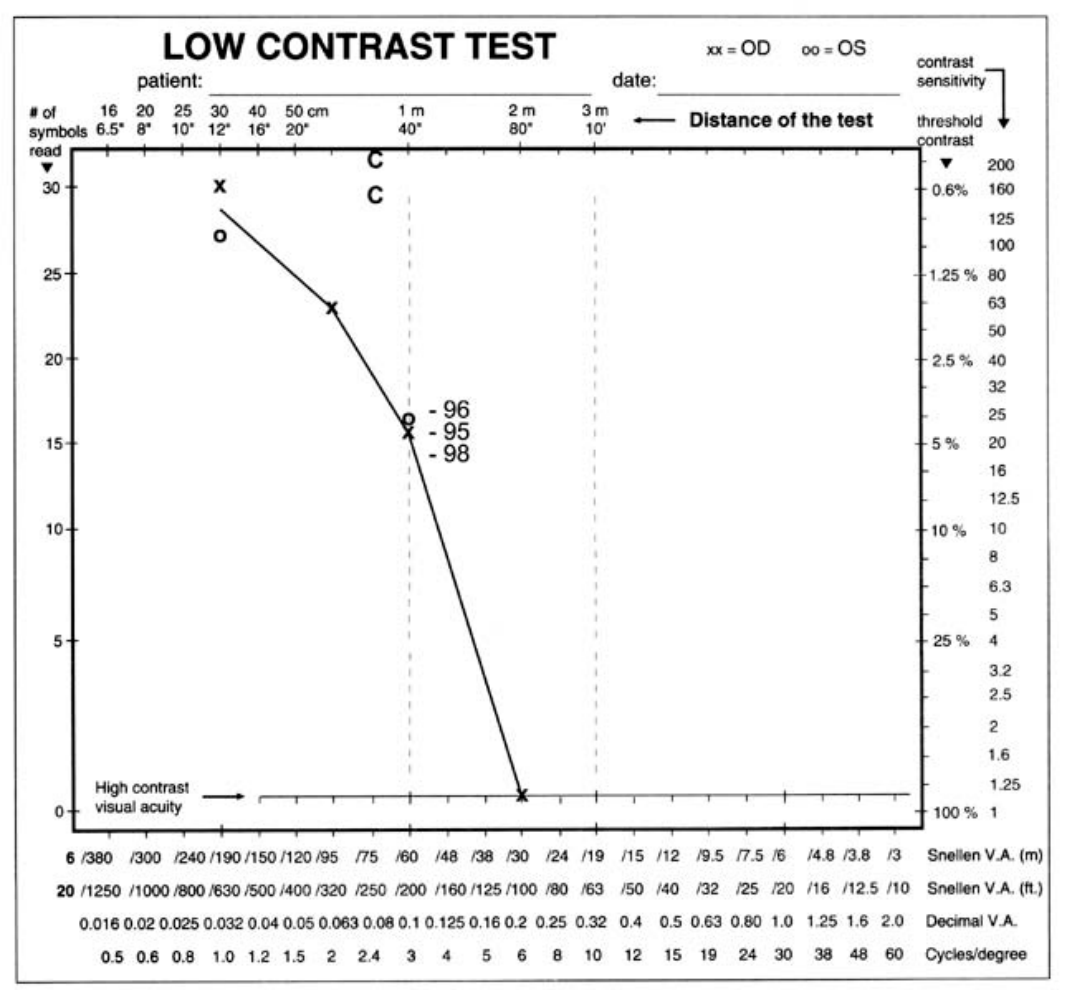
Retinoschisis





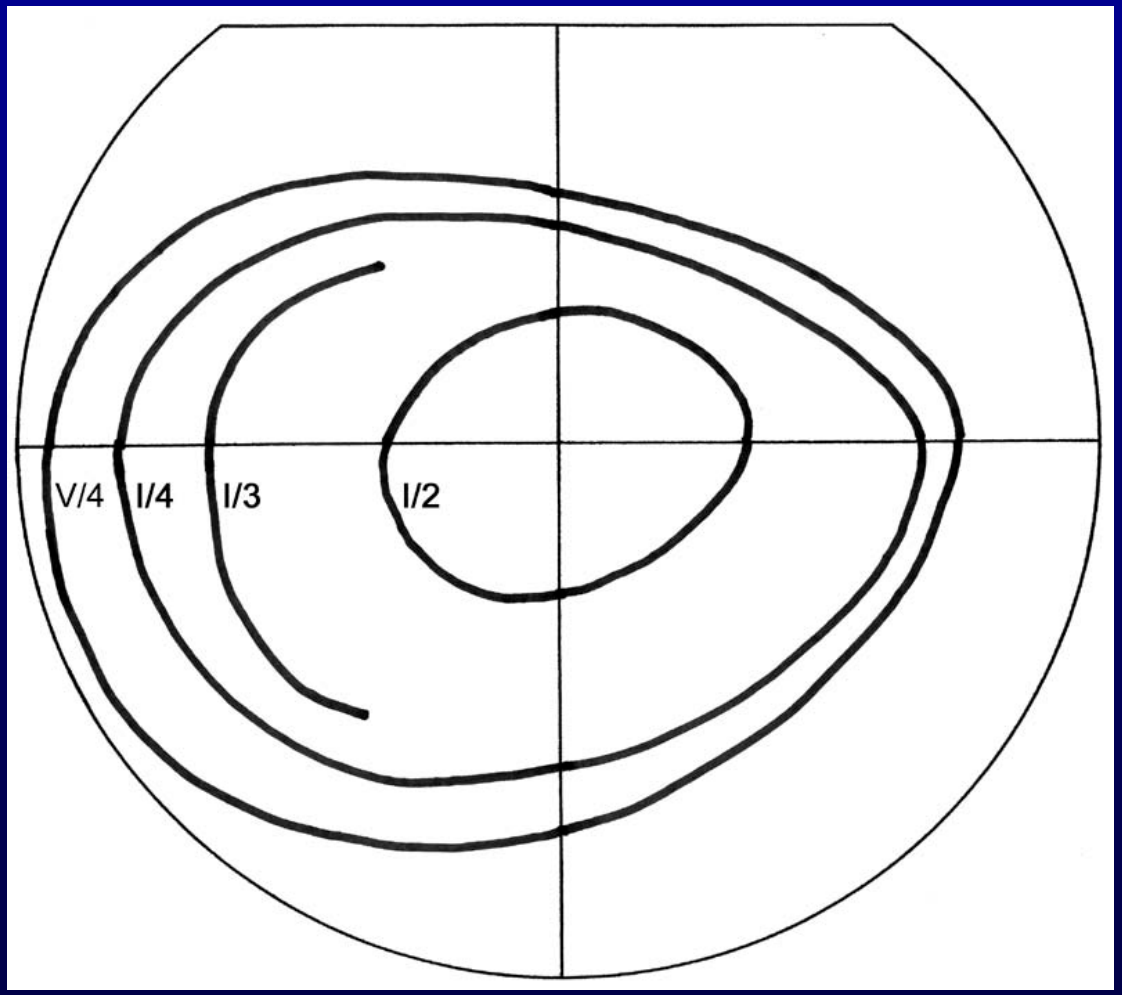
Contrast sensitivity in retinoschisis

note the good normal function at low contrast levels



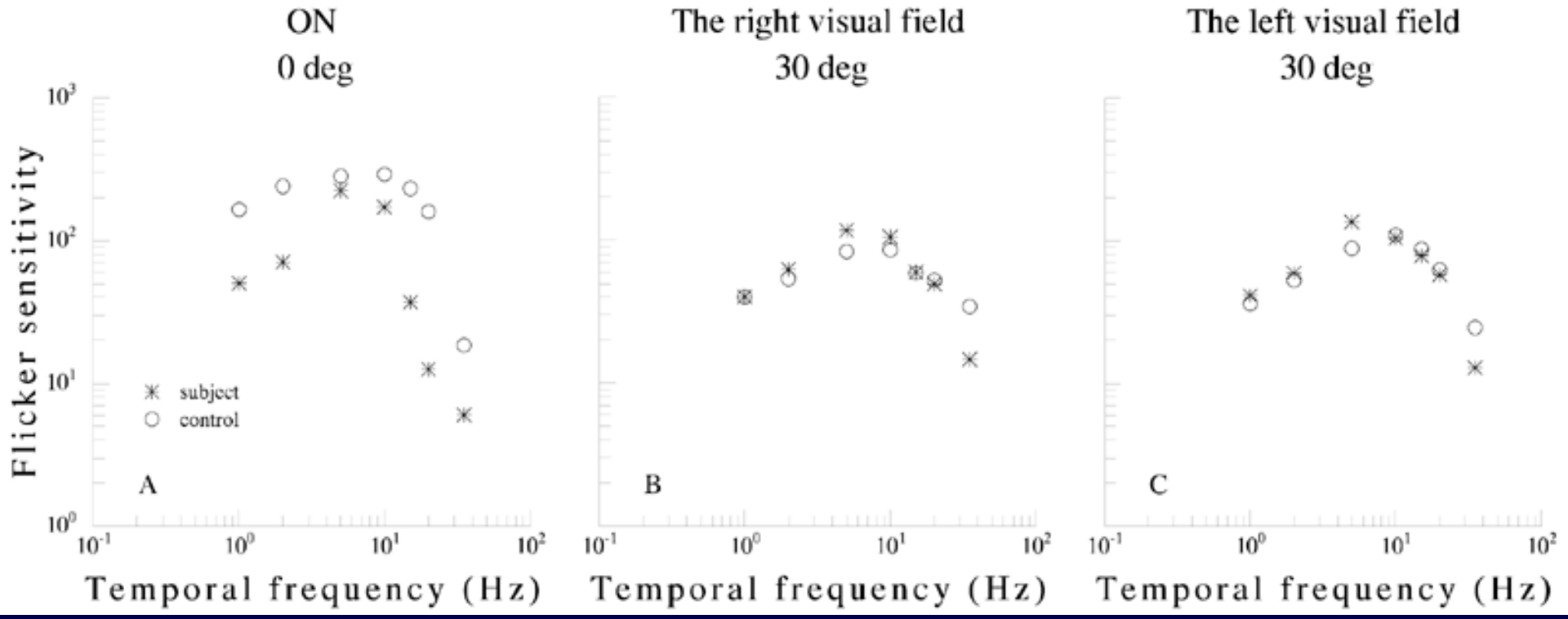
Goldmann field

in mild retinoschisis



Flicker sensitivity

nearly normal findings in the fovea, normal at 30 deg eccentricity



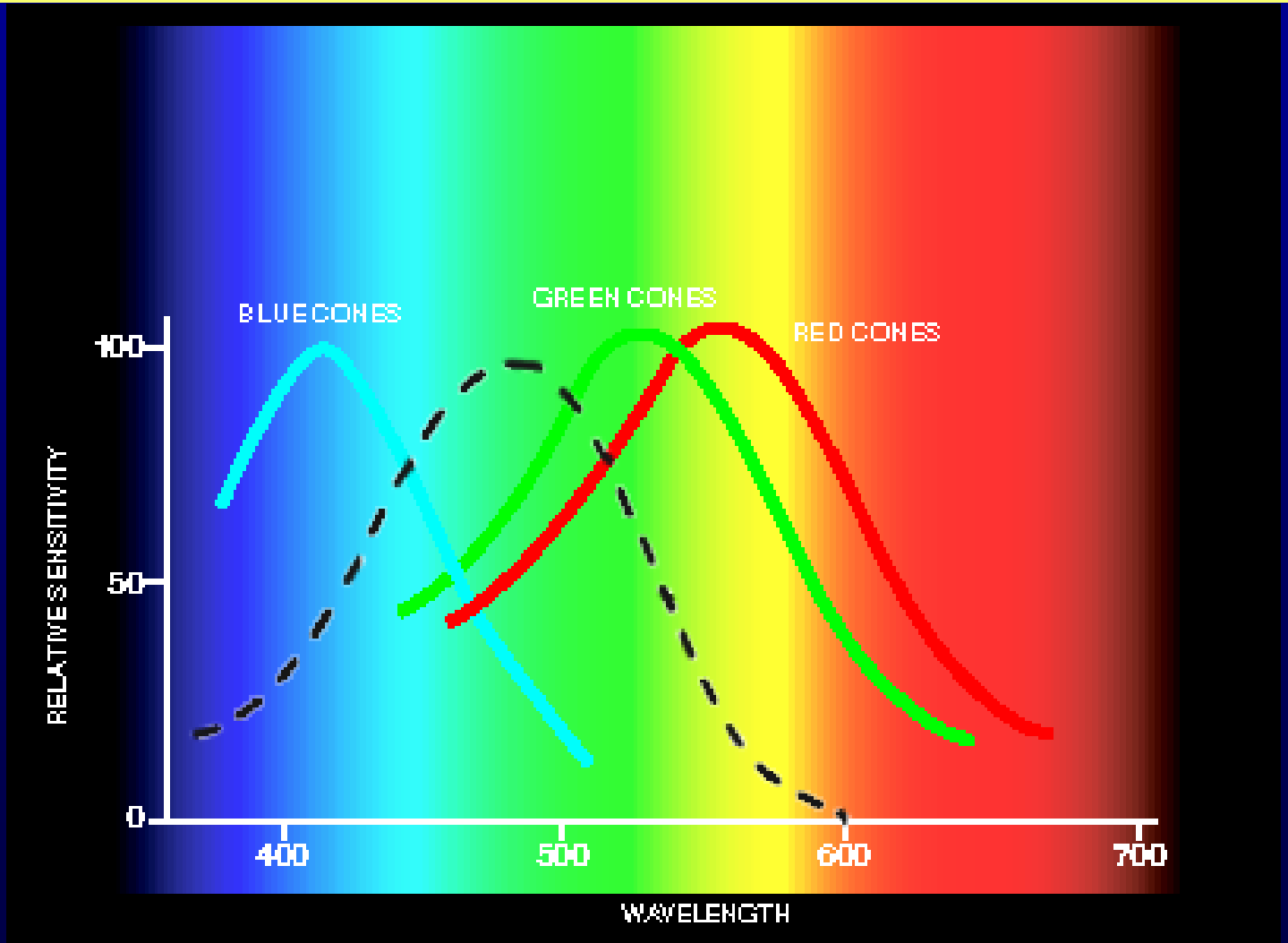
Retinoschisis

The boy whom the camera follows was one of the best players of the team , has normal driving licence and has served a normal military service, VA 0.4, 6/15.

Retinoschisis – very limited visual field

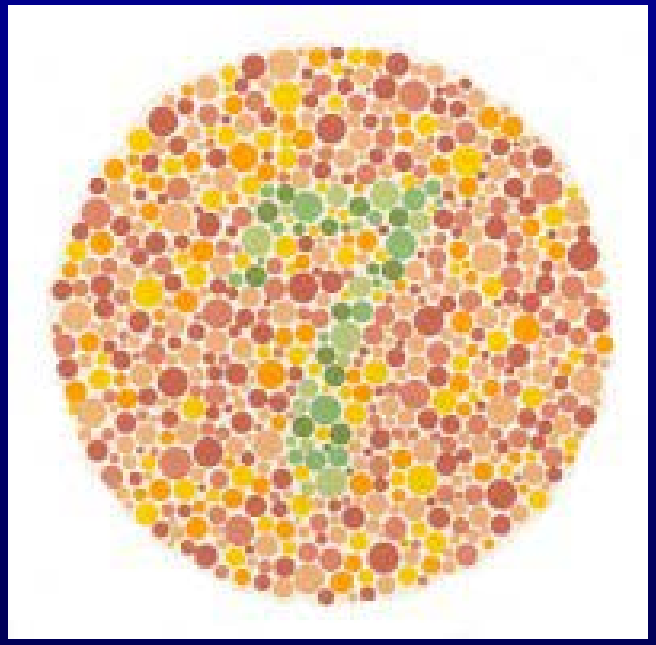
Tea break

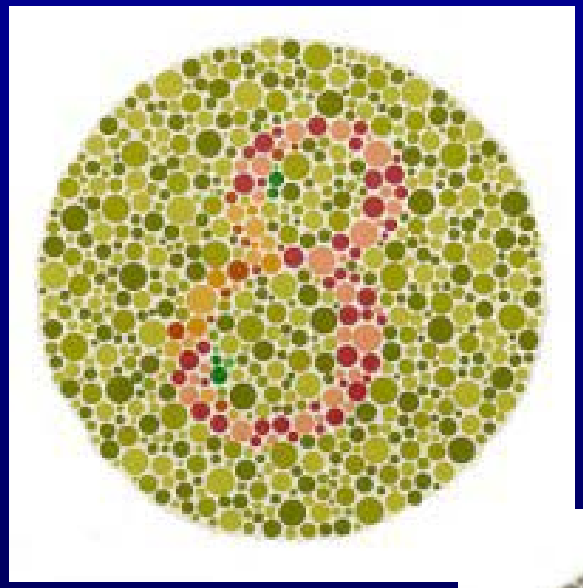
Colour vision

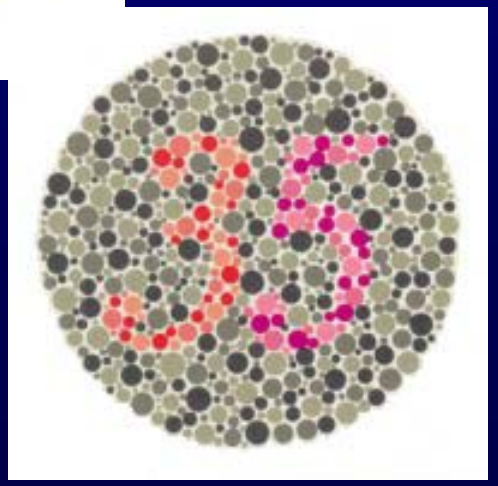


Colour vision

Ishihara test:

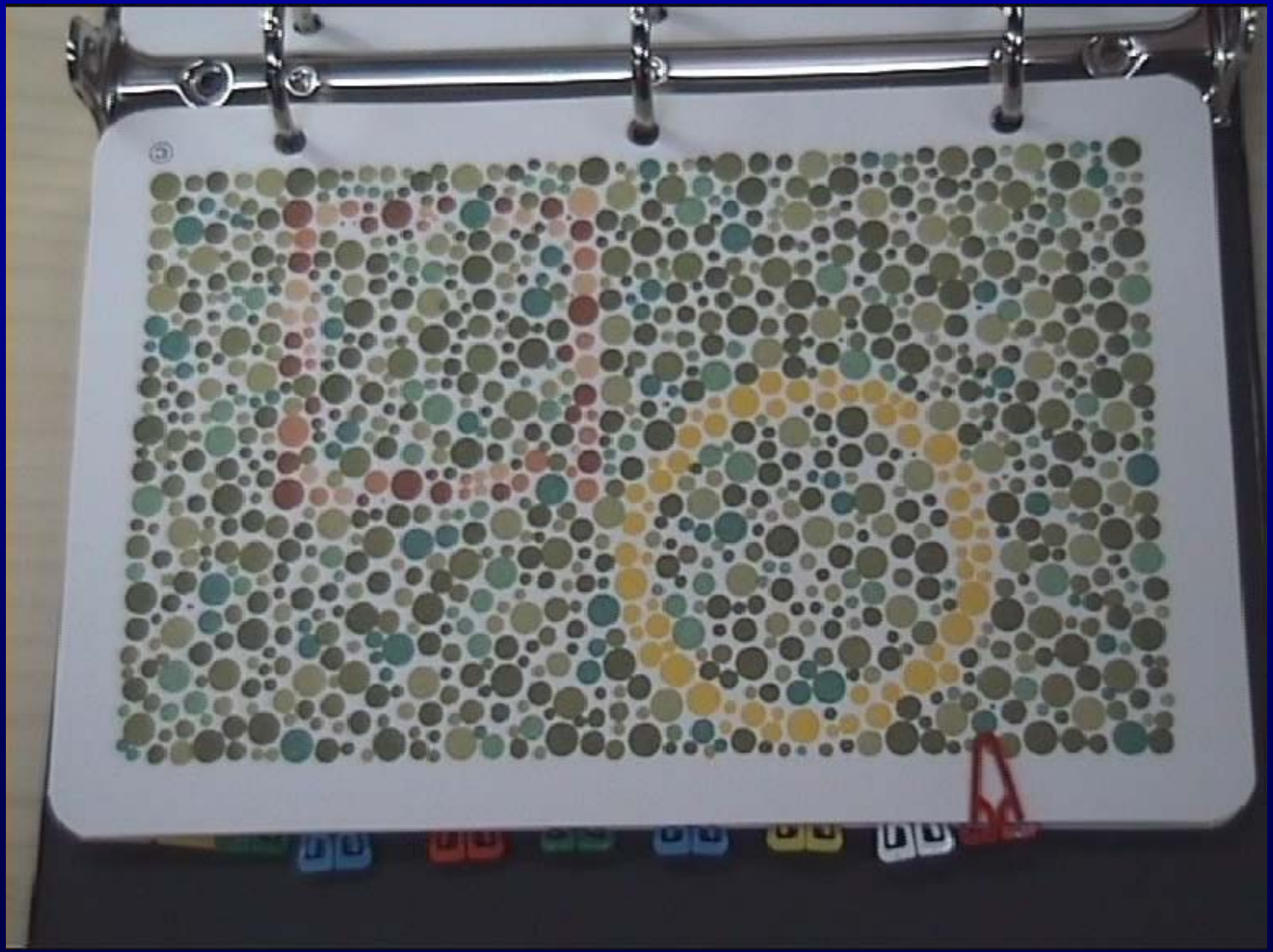






Confusions by
decreased contrast sensitity

Waggoner test



Light

colour temperature > 6500 K

Colour vision

SCREENING

- Ishihara
- Waggoner
- HRR

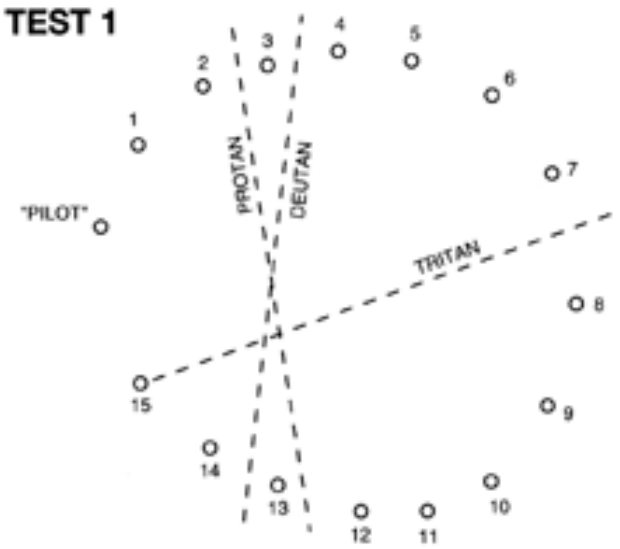
ASSESSMENT

Farnsworth D-15

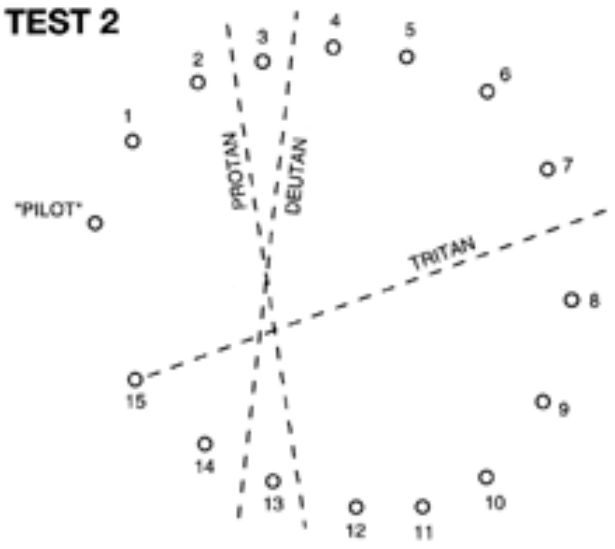
LEA Panel 16

CASE HISTORY NO. _____ DATE _____

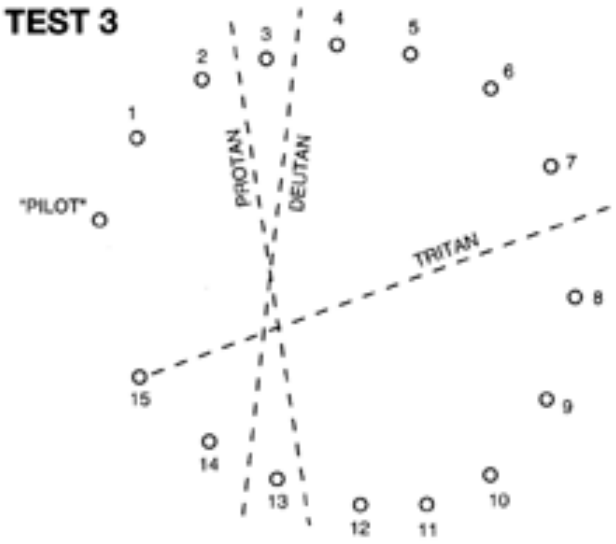
TEST 1



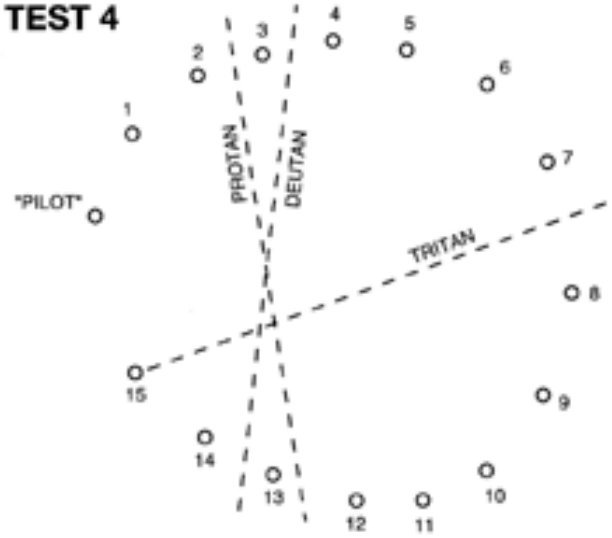
TEST 2



TEST 3

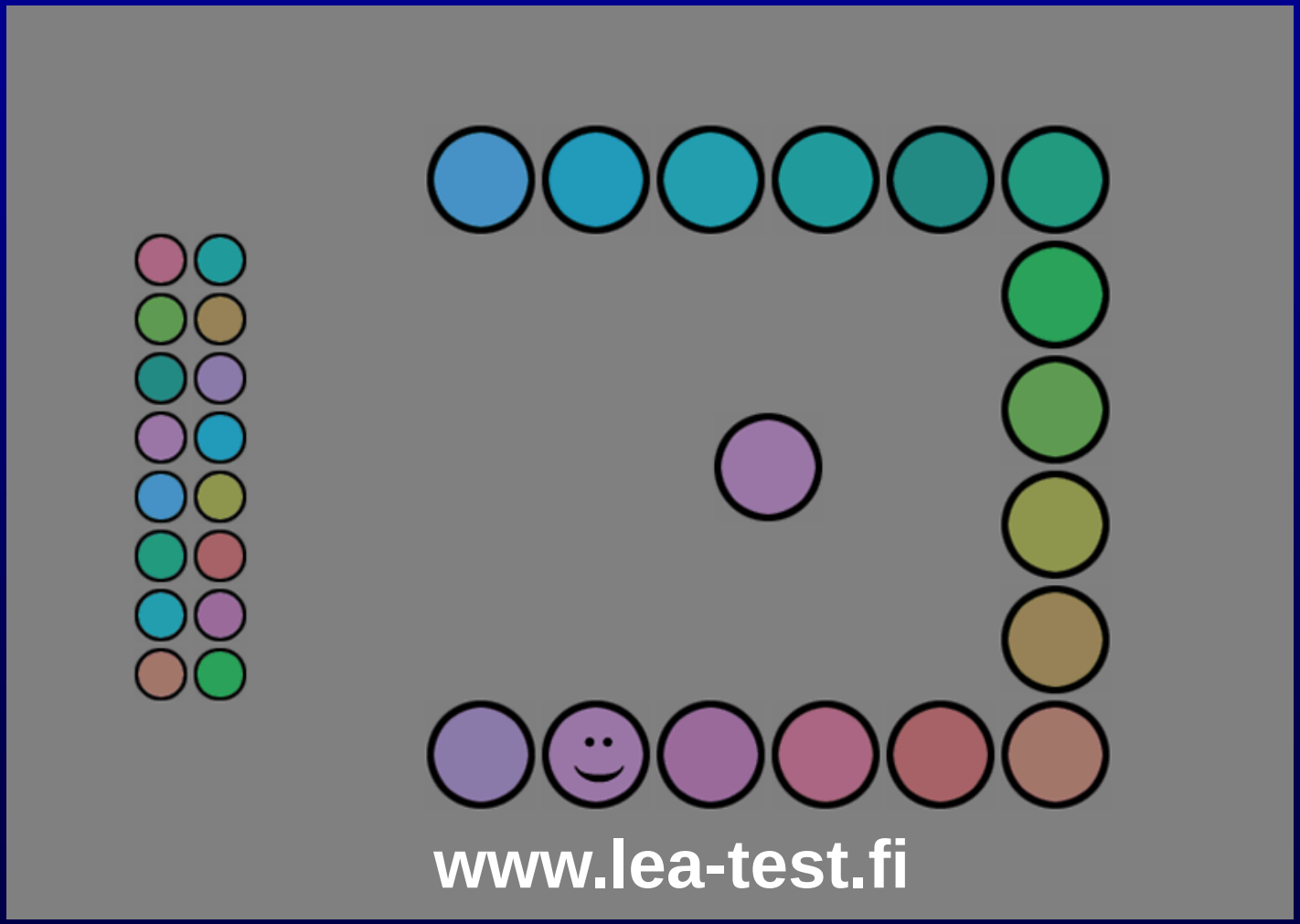


TEST 4



CONCLUSIONS AND RECOMMENDATIONS:

Colour Vision Game



Visual Adaptation

CONE Adaptation test

Filter lenses

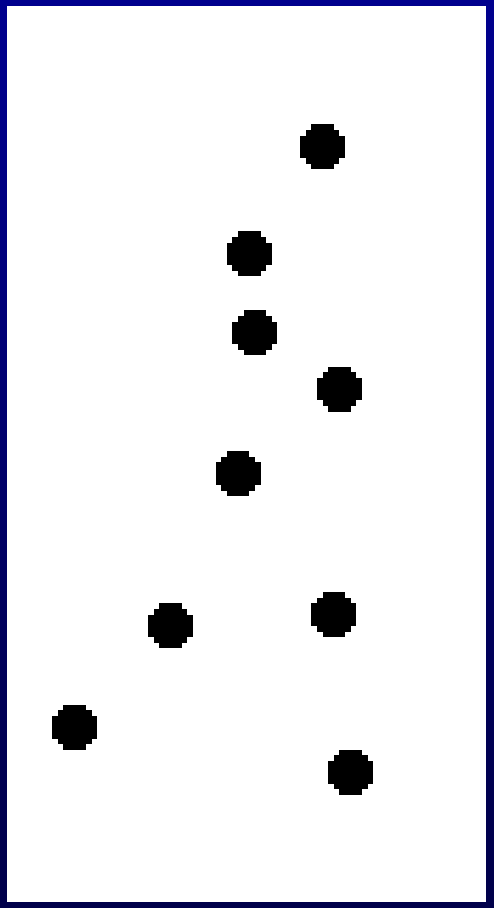
Locally tinted filter lenses require good workmanship.

Coherent Motion – ’Pepi’

www.lea-test.fi

MOTION PERCEPTION

Perception of biological movement



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?

Visual perception of movement

- Communication:

  lip reading, sign language, fingerspelling
- Spatial orientation and moving

  swings, ball games, traffic, - relative movement
- Activities of daily life

  boiling not seen, people, animals, cars moving fast
- Near vision tasks

  movement helps perception of pictures

Contrast sensitivity

optotype and grating tests

Information at low contrast

Communication
low contrast information in motion

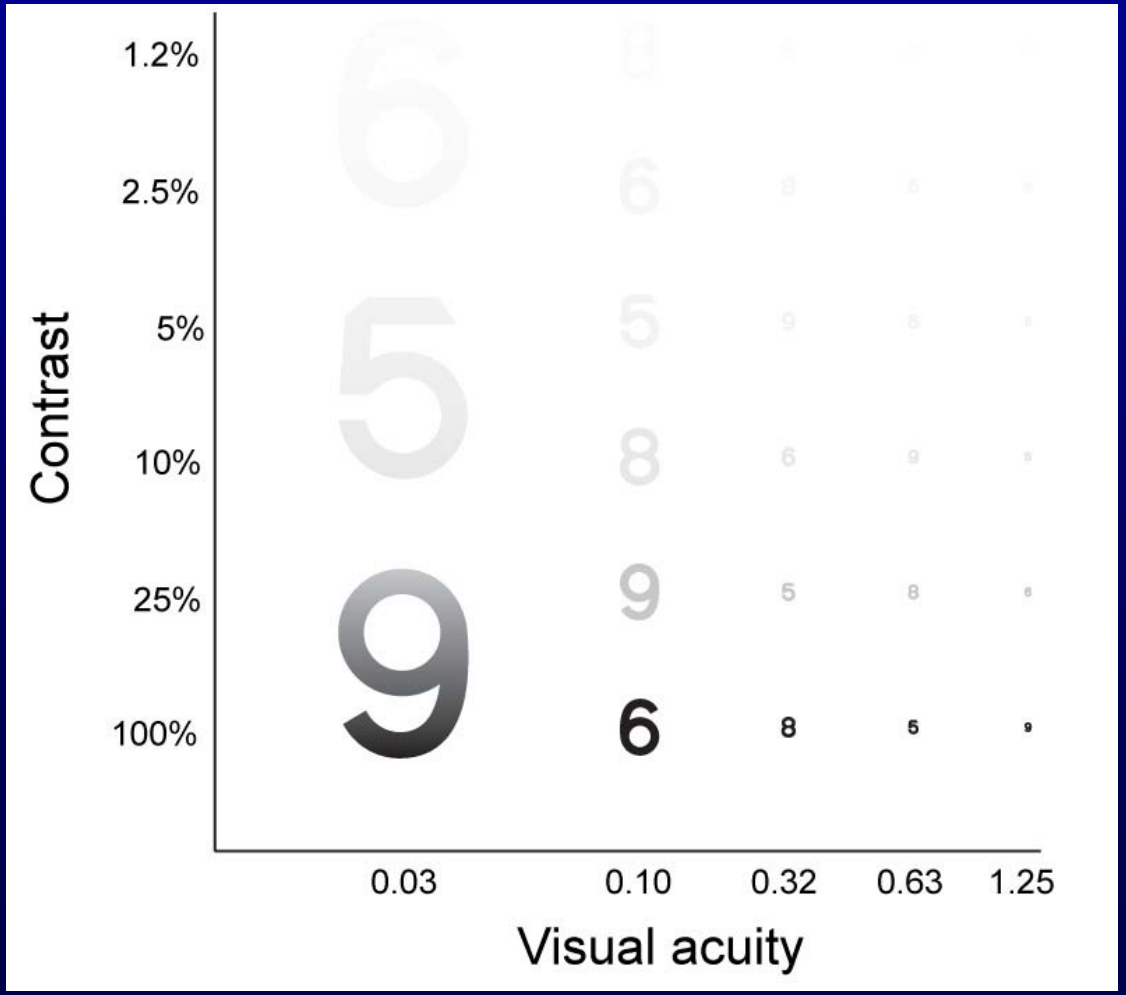
Orientation in space

Daily activities (ADL)

Low contrast in texts and pictures

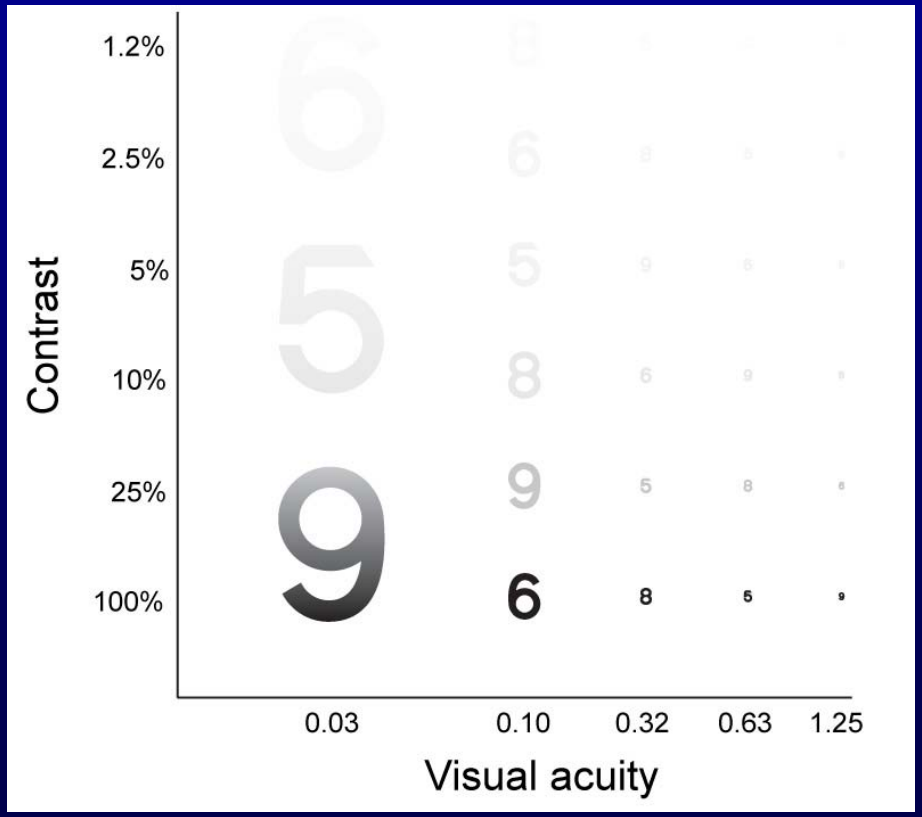
Contrast sensitivity

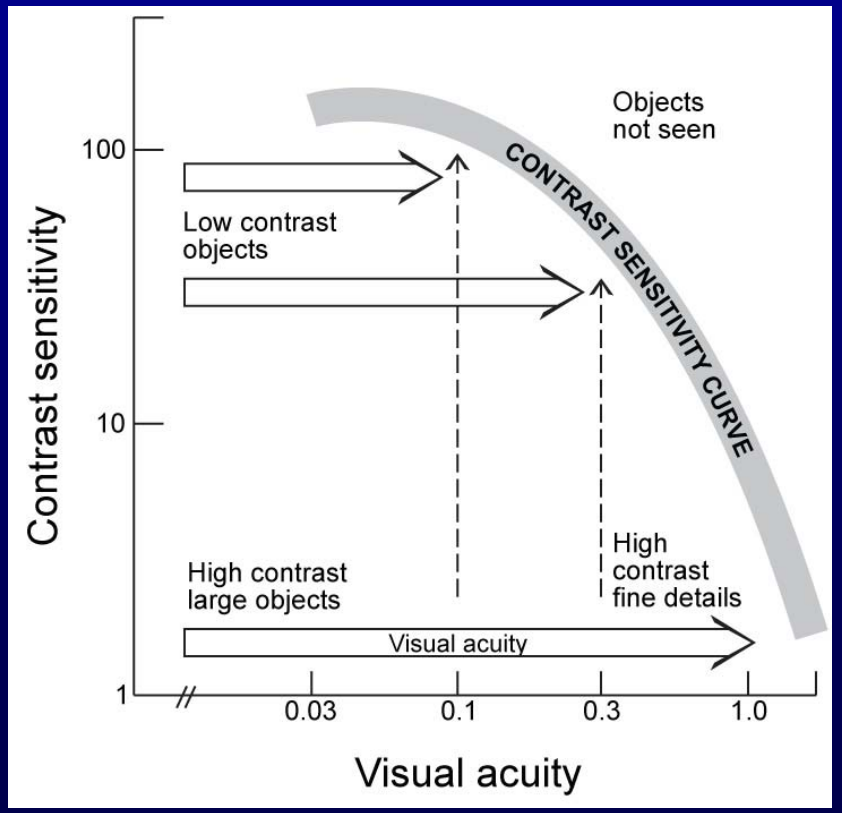
the better the lower contrast is perceived



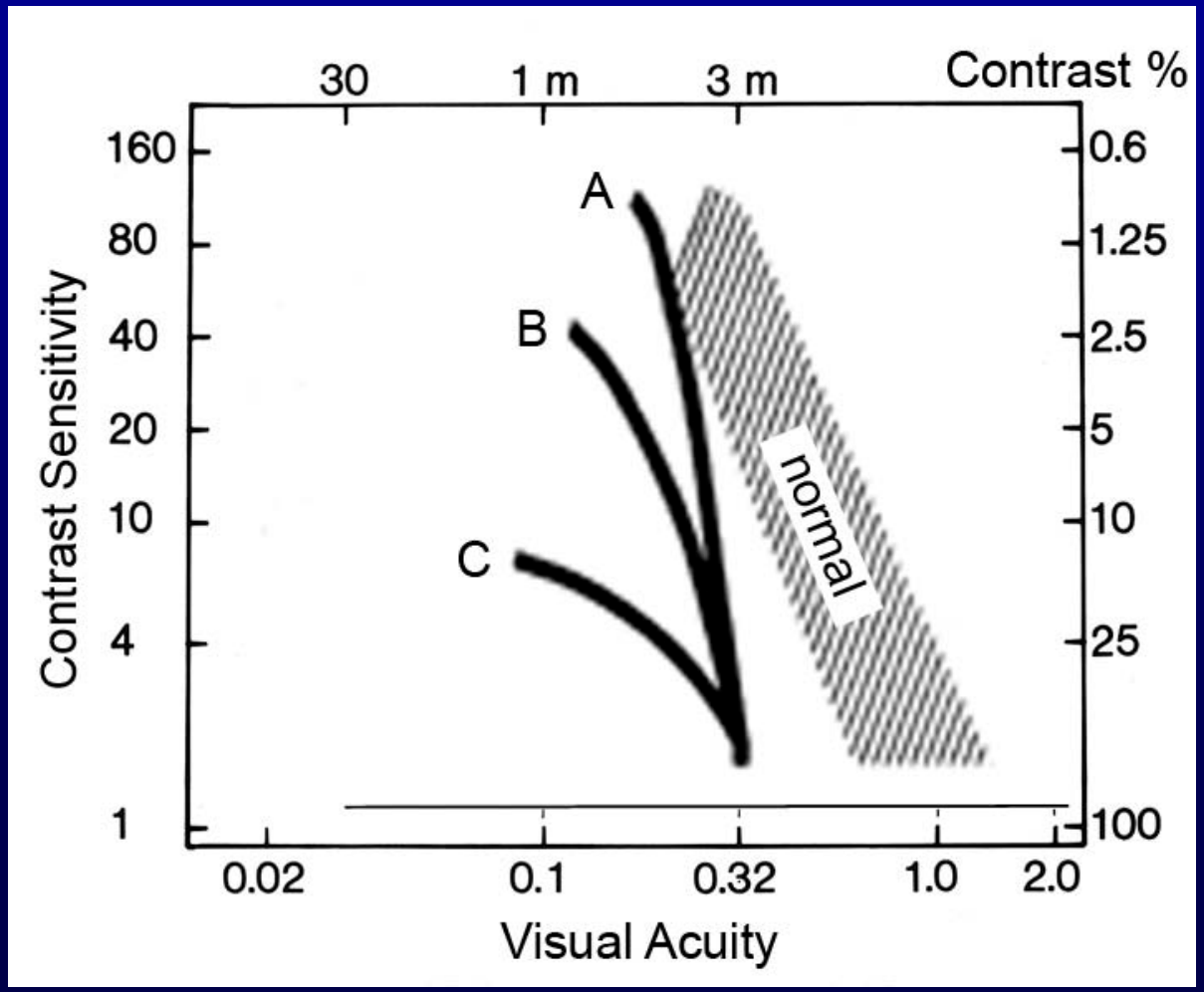
Contrast sensitivity

the better the lower contrast is perceived

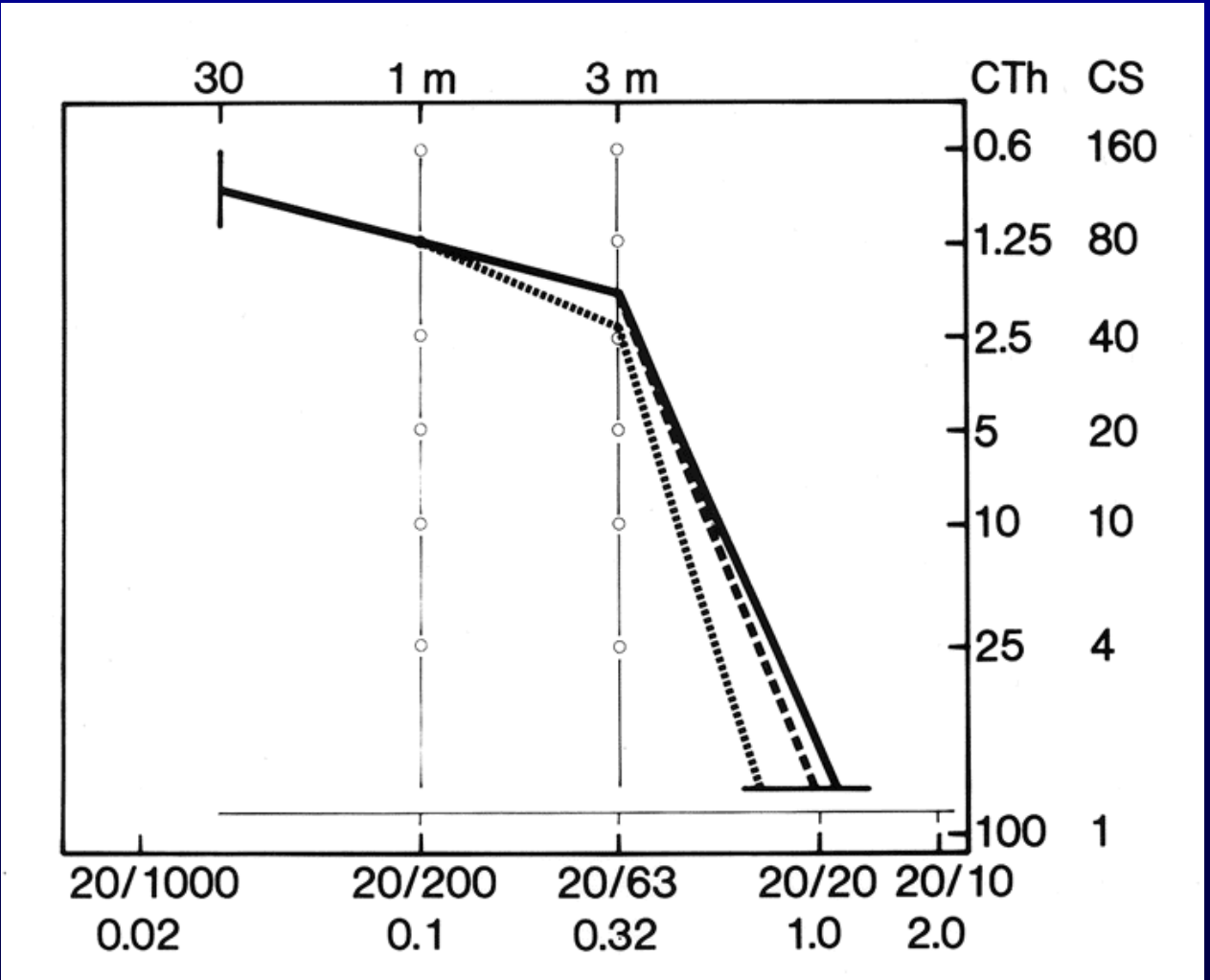




Three children with VA 0.3, 6/18



CS-curves, 3-4 and 5 yrs

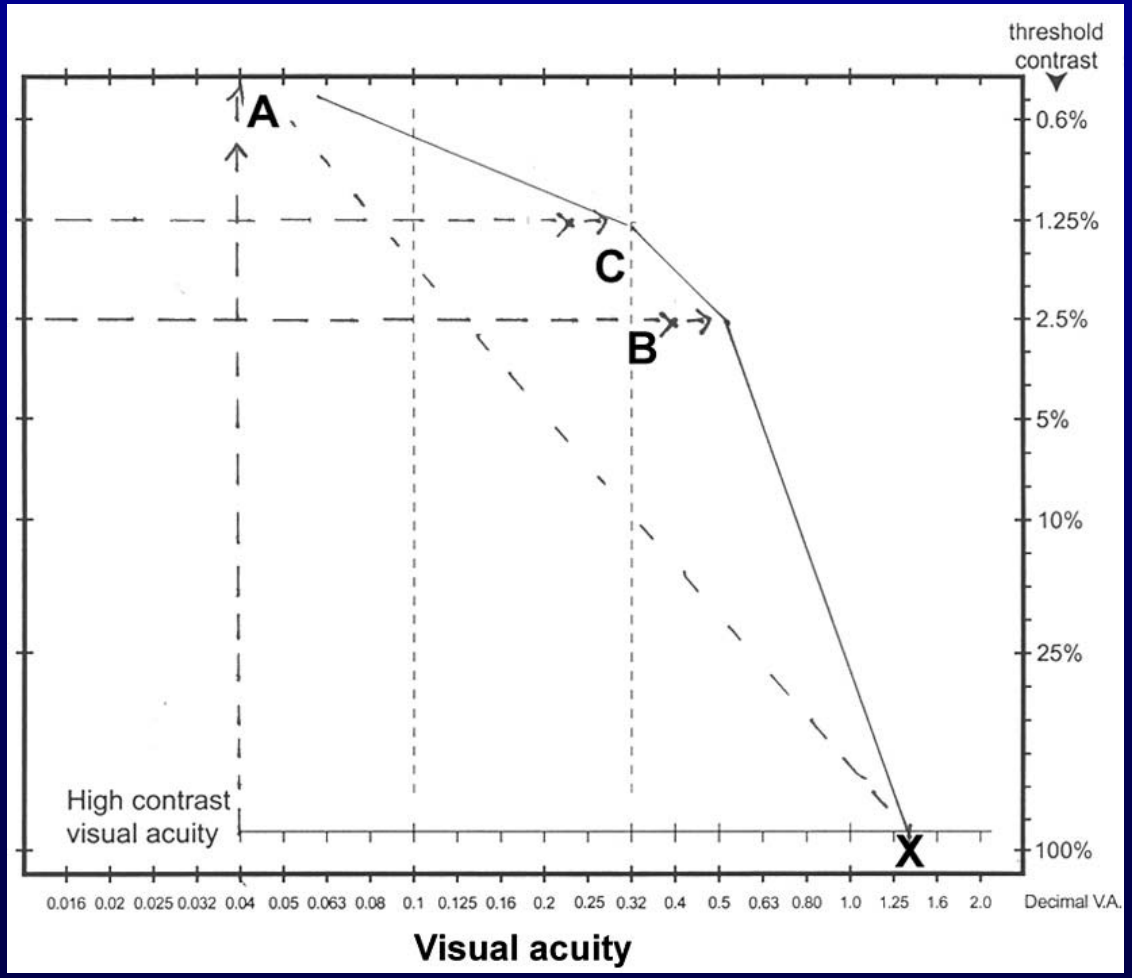


Contrast sensitivity

- 40 healthy children, 34-59 months of age
- binocular testing possible with every child
- monocular testing possible in 24/26 children older than 44 months
- children reach adult like contrast sensitivity at the age of three years: at 2.5% contrast all children had a visual acuity of 0.3 and half of the group older than 44 months had that visual acuity at 1.2% contrast during the first measurement with the LEA Symbols 10M test.

Contrast sensitivity curve

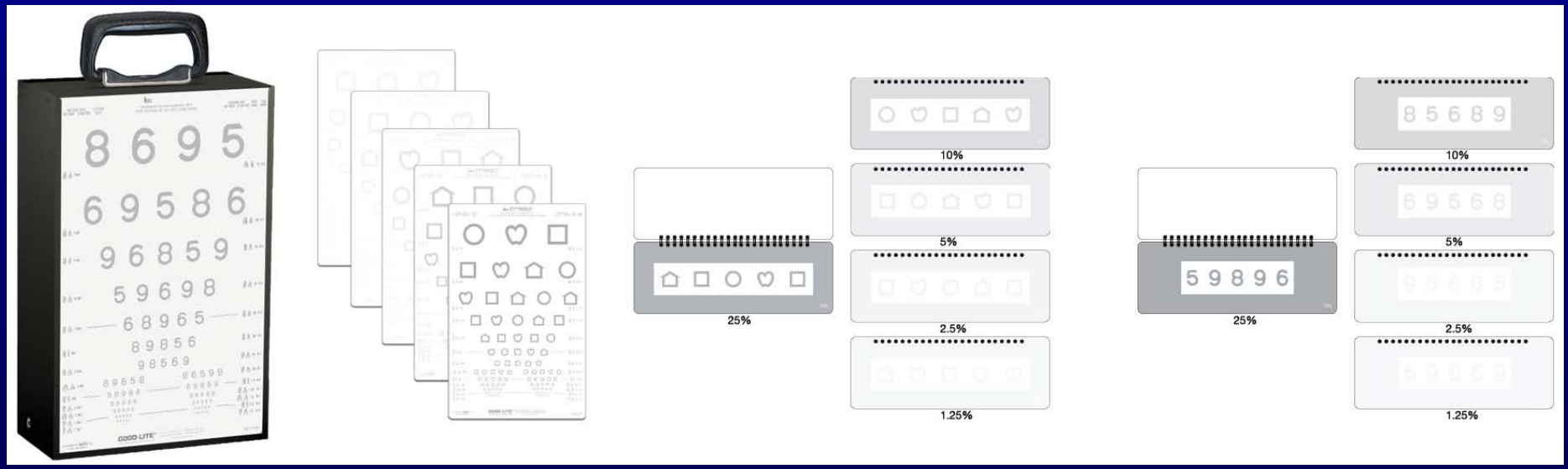
versus the point of contrast sensitivity maximum



Pelli-Robson

Mars

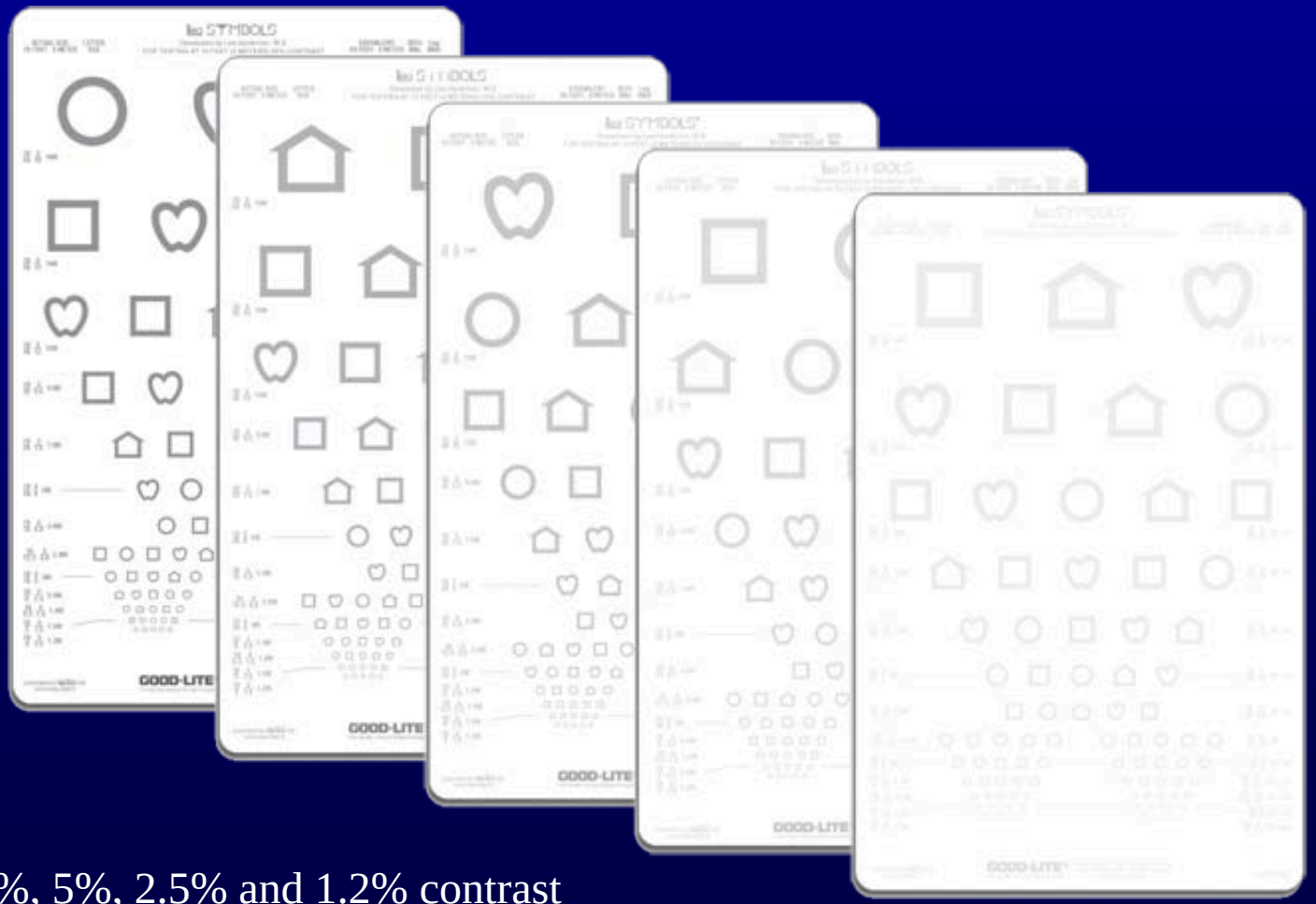
Low contrast optotype tests



translucent tests for lightbox
LEA Symbols & Numbers

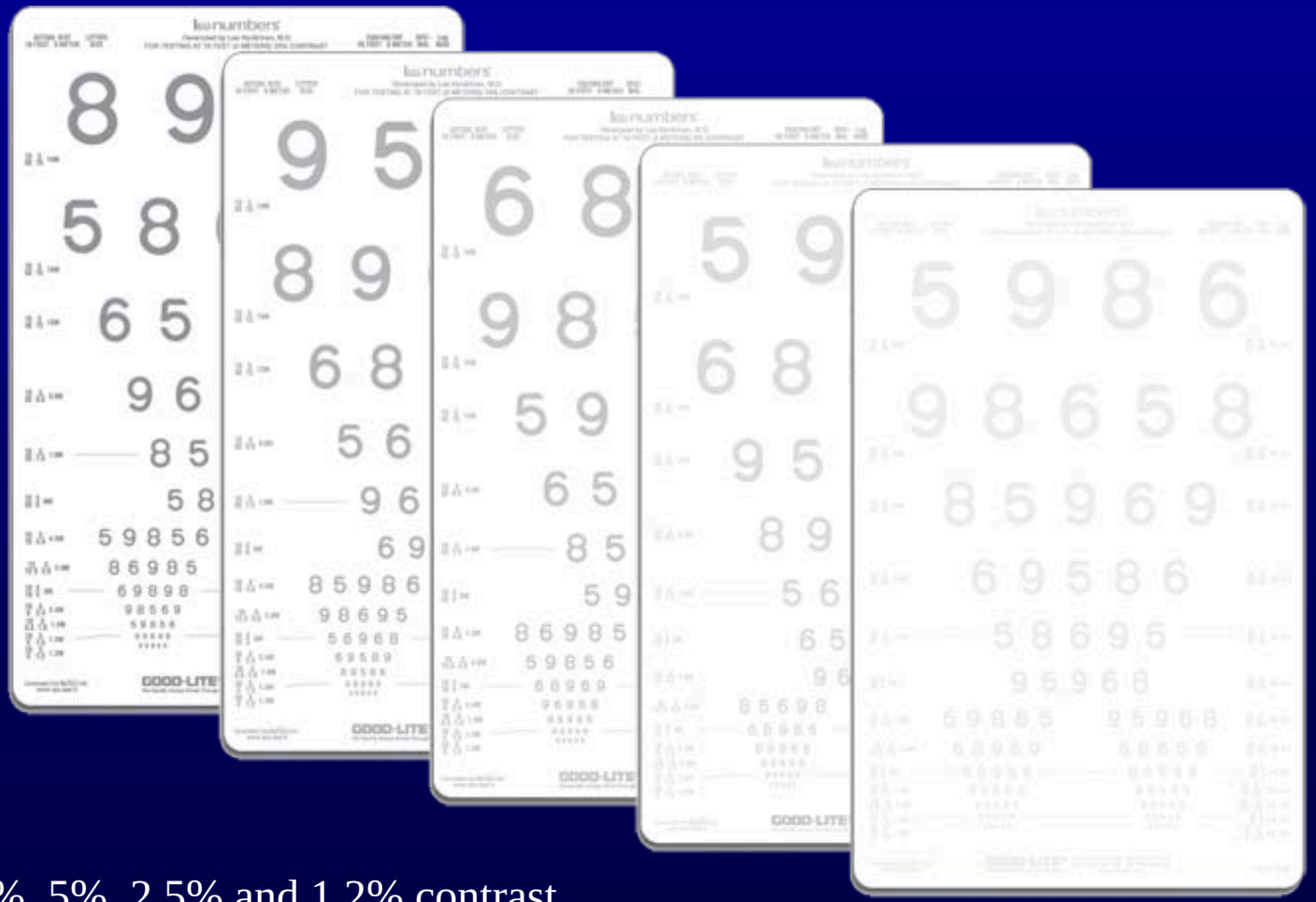
screening tests
LEA Symbols & Numbers

LEA Symbols low contrast tets



25%, 10%, 5%, 2.5% and 1.2% contrast

LEA Numbers low contrast tests



25%, 10%, 5%, 2.5% and 1.2% contrast

Translucent low contrast test

at 2.5% contrast on the small lightbox

Contrast sensitivity

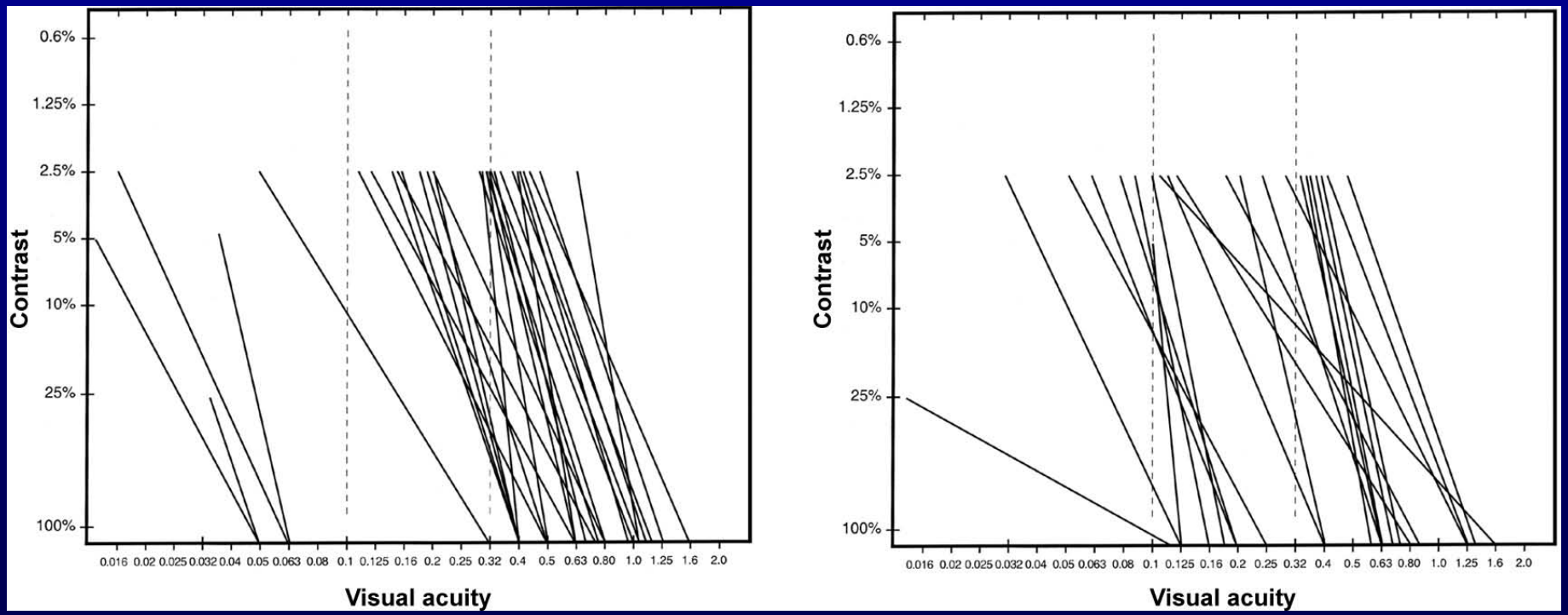
In normal visual system

low contrast visual acuity value

at 2.5% contrast

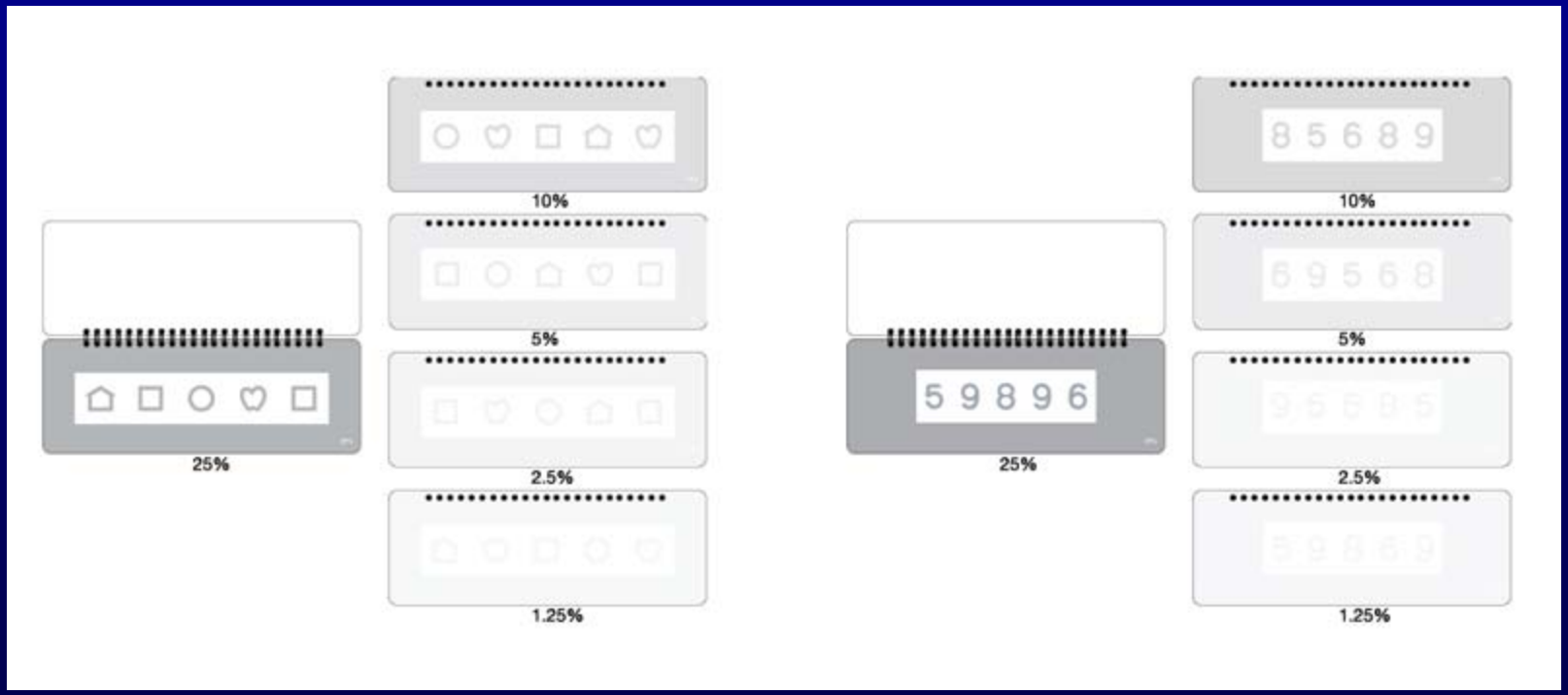
is close to one half of visual acuity at full contrast.

CS slopes of a group of children with CP

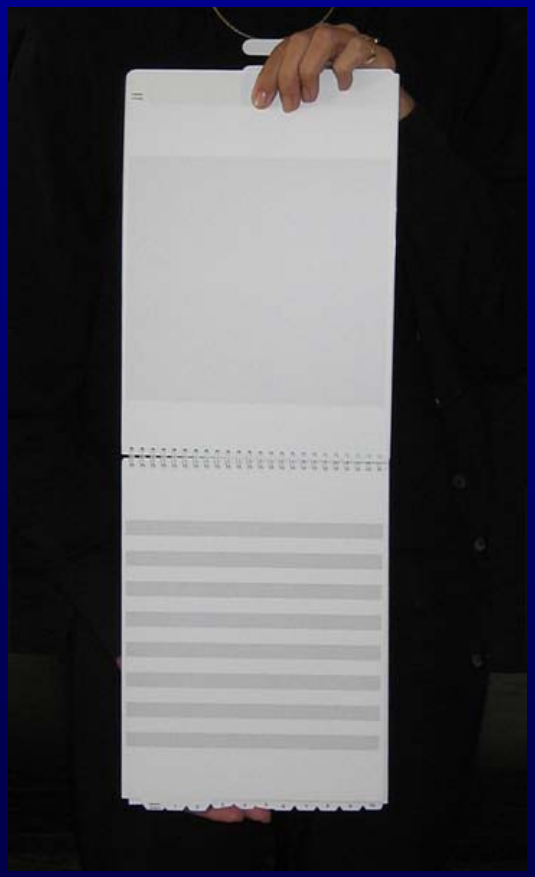


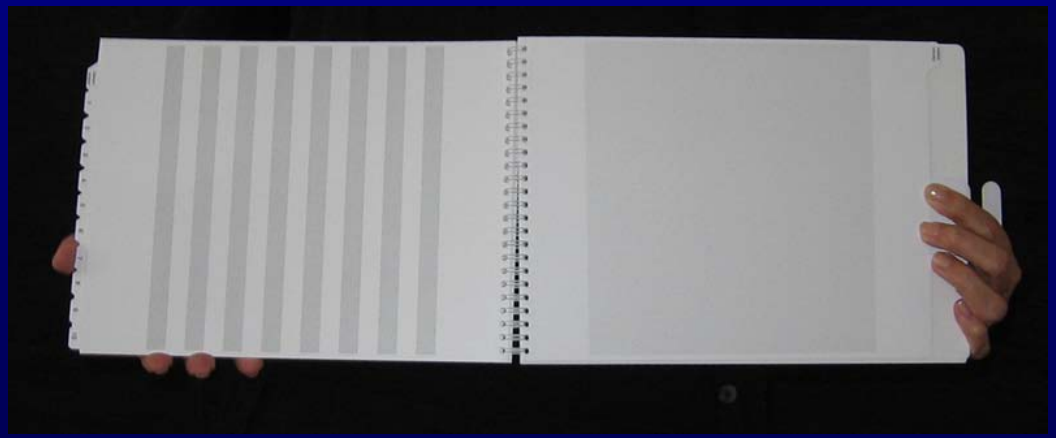
Most children function at 2.5% contrast and most slopes have the usual declination, some are steep and a few flat.

Low contrast 10M optotypes

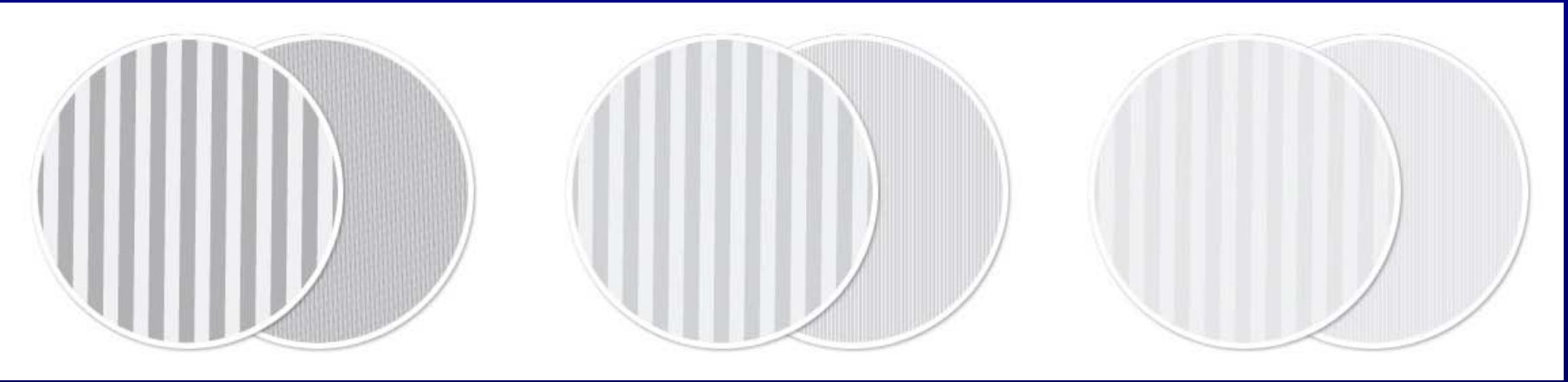


Cambridge Low Contrast Gratings

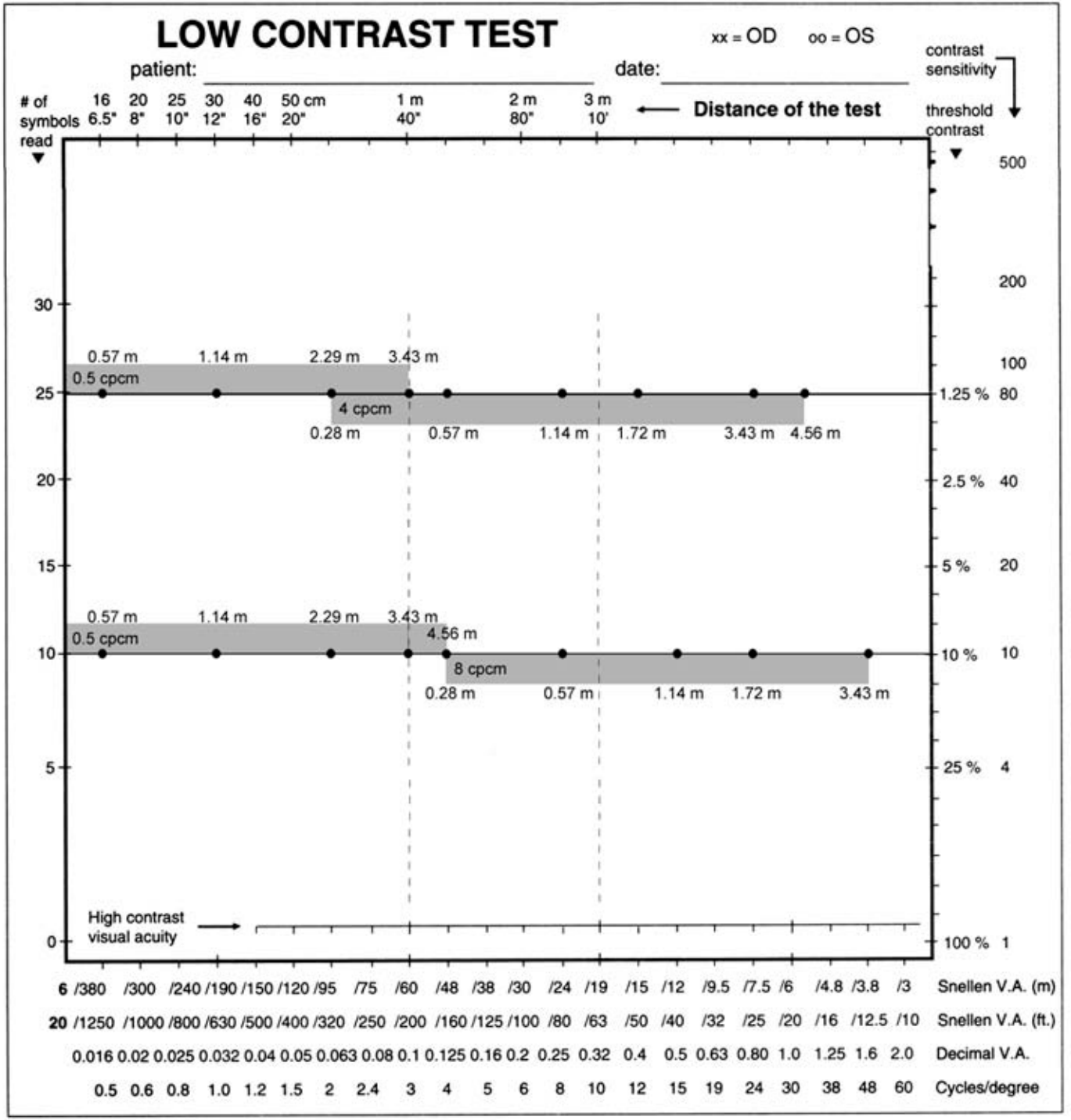


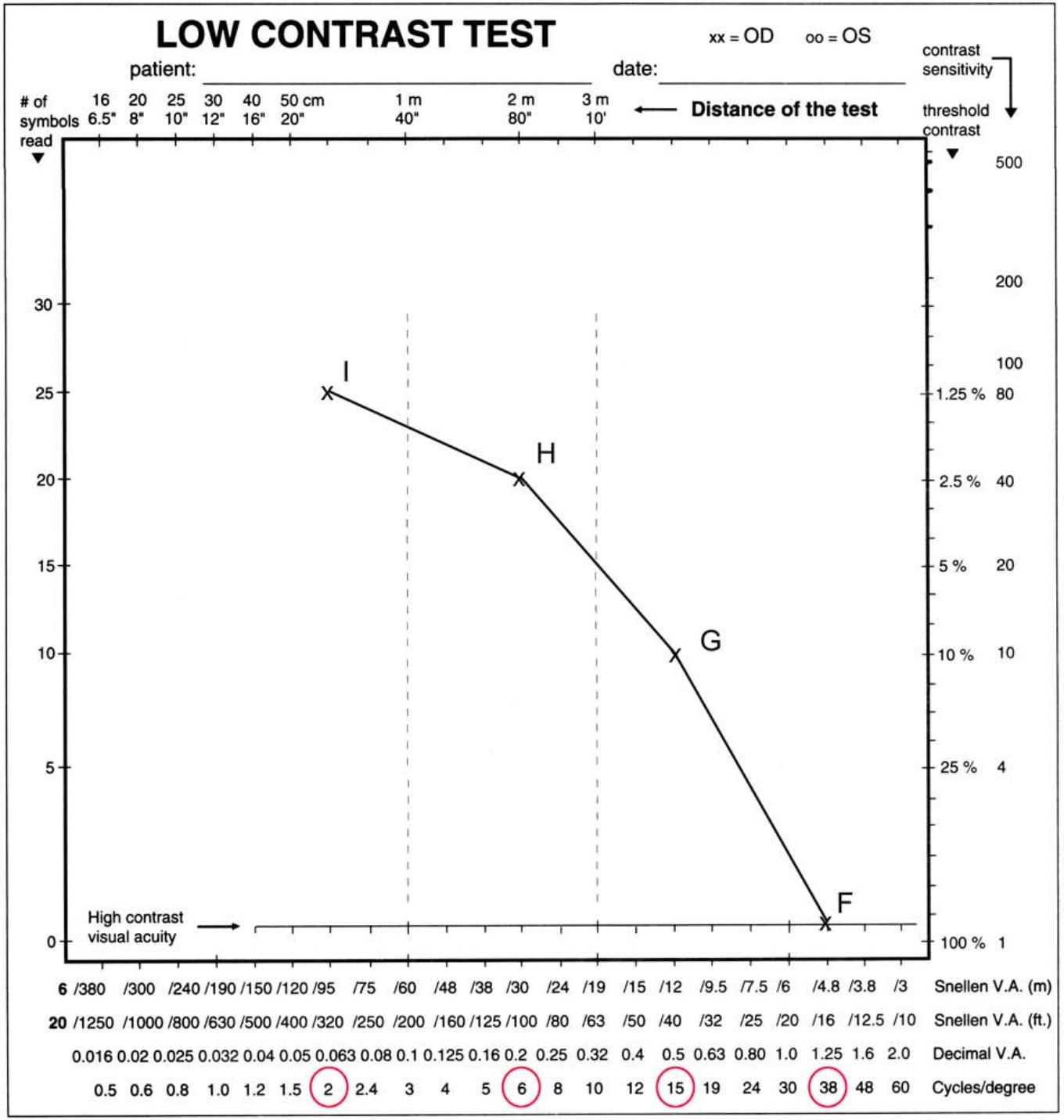


Low Contrast Grating Acuity



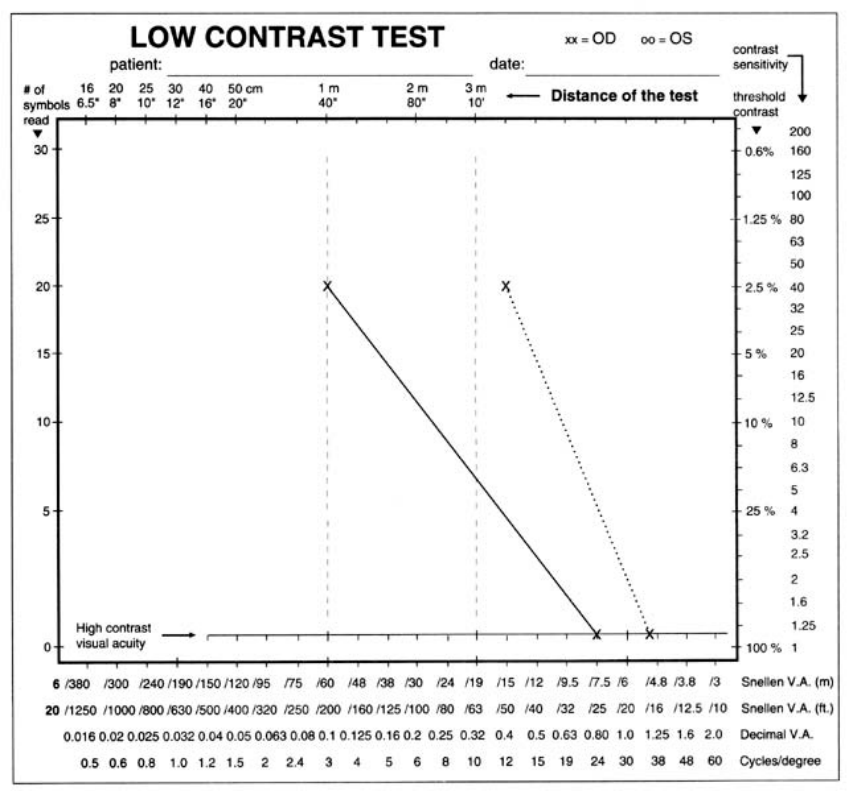
To be able to measure at contrast levels 10%, 2.5% and 1.2%, three pairs of gratings are needed: 0.5cpcm and 8cpcm at 10%; 0.scpcm and 4cpcm at 2.5% and 1.2% contrast. To get the cpd-values we need nomograms.


LOW CONTRAST TEST
xx = OD
oo = OS
patient:
date:
contrast sensitivity
threshold contrast
# of symbols read
16 6.5"
20 8"
25 10"
30 12"
40 16"
50 cm 20"
1 m 40"
2 m 80"
3 m 10'
Distance of the test
500
200
100
80
40
20
10
4
1
30
25
20
15
10
5
0
0.57 m
1.14 m
2.29 m
3.43 m
0.5 cpcm
4 cpcm
0.28 m
0.57 m
1.14 m
1.72 m
3.43 m
4.56 m
1.25 %
2.5 %
5 %
10 %
25 %
100 %
4.56 m
8 cpcm
High contrast visual acuity
6 /380 /300 /240 /190 /150 /120 /95 /75 /60 /48 /38 /30 /24 /19 /15 /12 /9.5 /7.5 /6 /4.8 /3.8 /3
Snellen V.A. (m)
20 /1250 /1000 /800 /630 /500 /400 /320 /250 /200 /160 /125 /100 /80 /63 /50 /40 /32 /25 /20 /16 /12.5 /10
Snellen V.A. (ft.)
0.016 0.02 0.025 0.032 0.04 0.05 0.063 0.08 0.1 0.125 0.16 0.2 0.25 0.32 0.4 0.5 0.63 0.80 1.0 1.25 1.6 2.0
Decimal V.A.
0.5 0.6 0.8 1.0 1.2 1.5 2 2.4 3 4 5 6 8 10 12 15 19 24 30 38 48 60
Cycles/degree

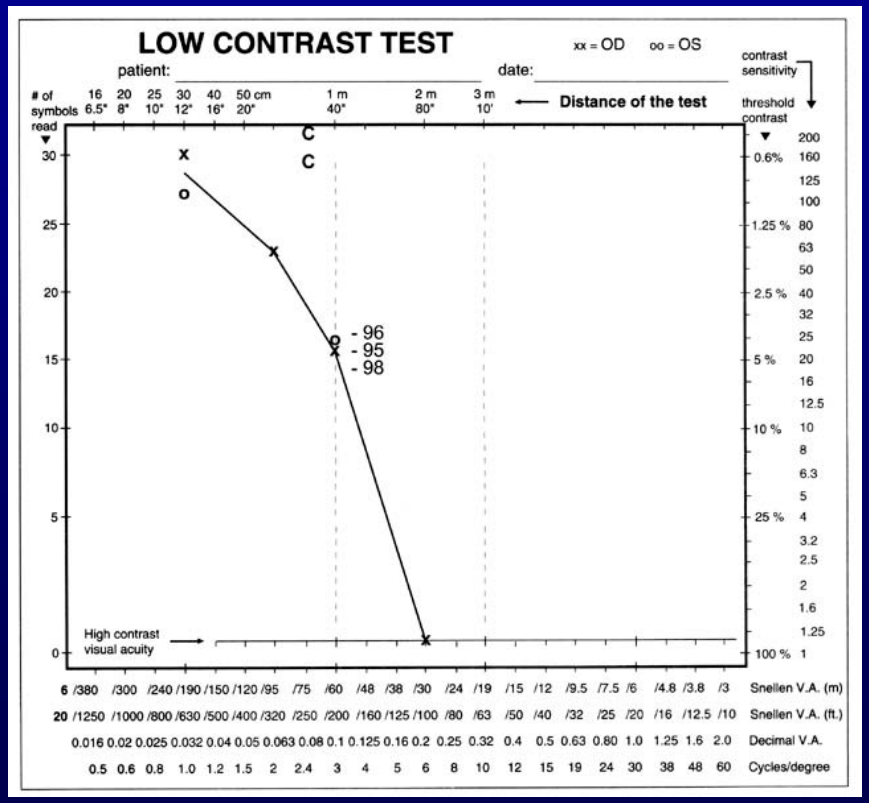

LOW CONTRAST TEST
xx = OD
oo = OS
patient:
date:
contrast sensitivity
threshold contrast
# of symbols read
16 6.5"
20 8"
25 10"
30 12"
40 16"
50 cm 20"
1 m 40"
2 m 80"
3 m 10'
Distance of the test
500
200
100
80
40
20
10
4
1
30
25
20
15
10
5
0
1.25 %
2.5 %
5 %
10 %
25 %
100 %
I
H
G
F
High contrast visual acuity
6 /380 /300 /240 /190 /150 /120 /95 /75 /60 /48 /38 /30 /24 /19 /15 /12 /9.5 /7.5 /6 /4.8 /3.8 /3 Snellen V.A. (m)
20 /1250 /1000 /800 /630 /500 /400 /320 /250 /200 /160 /125 /100 /80 /63 /50 /40 /32 /25 /20 /16 /12.5 /10 Snellen V.A. (ft.)
0.016 0.02 0.025 0.032 0.04 0.05 0.063 0.08 0.1 0.125 0.16 0.2 0.25 0.32 0.4 0.5 0.63 0.80 1.0 1.25 1.6 2.0 Decimal V.A.
0.5 0.6 0.8 1.0 1.2 1.5 2 2.4 3 4 5 6 8 10 12 15 19 24 30 38 48 60 Cycles/degree

Contrast sensitivity

depicting visual functioning



Incipient cataract



Retinoschisis

Contrast sensitivity & Infants

Vision for communication

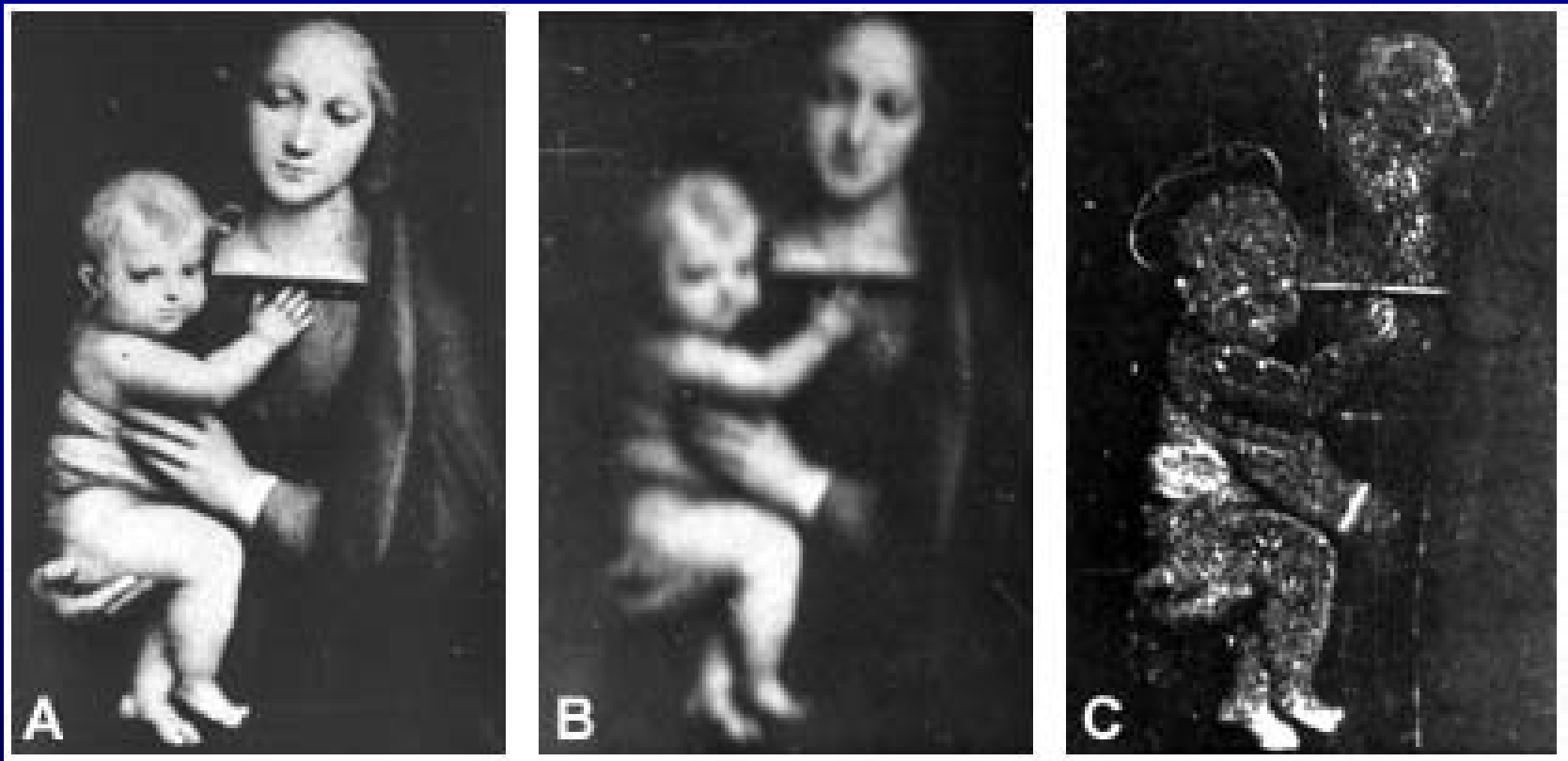
Hiding Heidi test

Vision for communication

Hiding Heidi test

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.

Nobody whispers
to
a hearing impaired child.

Nobody whispers
to
a hearing impaired child.

Why do we whisper visually
to
visually impaired children.

Discussion

Lunch break