

TESTING PATIENTS WITH VERY LOW VISION

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In patients with impaired vision, it is important to make a good quantitative assessment of functional vision. Such information guides the clinician's decisions related to predictions of vision capabilities and potential for improved functionality. It also provides a bench mark for identifying and quantifying changes in the disease and responses to treatment.

For visually-impaired patients clinicians often have to modify the standard vision testing techniques and make adjustments. We shall systematically consider clinical testing of Visual Acuity, Contrast Sensitivity and Visual Fields, and the effects of Illumination and its relevance to vision functioning.

In this course, we shall give quick reviews of methods most often used to test VA, CS and VF.

We will go into more detail, describing the variations from standard techniques that we prefer to use, and this will include some newly developed approaches. In the outline we have placed boxes around the new material that will be given most emphasis.

VISUAL ACUITIES

Reading acuity –	Typeset charts. Sets of Words or Text
Optotype Chart Acuity	Rows of Letters, Tumbling E's, Landolt rings, Numbers, Symbols,
Single Optotype Acuity	Letters, Tumbling E's, Landolt rings, Numbers, Symbols
Grating Acuity	Preferential looking, Orientation
Vernier Acuity	Alignment or irregularities

BASIC PRINCIPLES – for any test of visual acuity

The visual task should be the same at each size level

The size progression should have a constant ratio (i.e., geometric or logarithmic progression)

The range of size must allow the patient to pass at the largest size and fail at the smallest size.

THE SPECTRUM FOR THE CLINICAL MEASUREMENT OF VISUAL ACUITY

The letter chart is not suitable for measuring visual acuity when VA is very poor.

At lower levels of visual acuity, the task needs to be simplified systematically and, there systematic reductions in viewing distance when acuity is very poor.

LETTER CHART ACUITY

LogMAR Chart - ETDRS or similar.	(Projector-chart display-screens limit size range)
At 4.0 meters or longer	Range: LogMAR = -0.3 to 1.0 (20/10 to 20/200, 6/3 to 6/60)
At 1.0 meter	Range to LogMAR = 0.3 to 1.6 (20/40 to 20/800, 6/12 to 6/240)

SINGLE TUMBLING E ACUITY

Single Tumbling E set with size range to 100M (14.5 cm)	
At 1.0 meter	STE Range to LogMAR = 2.0 (to 20/2000, 6/600)
At 25 cm	STE Range to LogMAR = 2.6 (to 20/8000, 6/2400)

GRATING ACUITY

Grating Acuity set with size range to 60mm stripes, Cards 25 cm square	
At 25 cm	GA Range to LogMAR = 2.9 (to 20/16000, 6/4800)

BASIC VISION FUNCTION TESTS

WHITE FIELD PROJECTION

White hemi-field of quadrant fields on cards 25 cm square.

At 25 cm White field widths = 26 deg, LogMinArc = 3.2

BLACK WHITE DISCRIMINATION

Black and white cards 25 cm square

At 25 cm Field widths = 53 deg, LogMinArc = 3.5

BERKLEY RUDIMENTARY VISION TEST

Three card-pairs. Pairs of 25 cm square cards hinged

1. Single Tumbling E card-pair Sizes 100M, 63M, 40M and 25M
2. Grating Acuity card-pair Stripe widths 60mm, 38mm, 24mm and 15mm
3. WFP and BWD card pair
 - WFP 2 panels, one has white hemi-field, one has a white quadrant
 - BWD 2 panels, one black, one white

A computer version is available as a PowerPoint presentation. Viewing distances depend on screen sizes.

TEST SELECTION Use Single Tumbling E's, sizes 100M and 25M at 1.0 meters

At 1 meter SINGLE TUMBLING E size 25M

At 1.0 meter STE 25M SEEN *Letter Chart Acuity will be measured*

At 4.0 meters STE 25M **SEEN** LC acuity measured at 4 meters (to LogMAR = 1.0)

At 4.0 meters STE 25M **NOT SEEN** LC acuity measured at 1 meter (to LogMAR = 1.6)

At 1.0 meters STE 25M NOTSEEN STE acuity measurement will be attempted

At 1 meter SINGLE TUMBLING E size 100M

At 1.0 meter STE 100M SEEN *STE acuity to be completed at 1.0 meter* (to LogMAR = 2.0)

At 1.0 meter STE 100M NOT SEEN STE acuity to be attempted at 25 cm

At 25 cm SINGLE TUMBLING E size 100M

At 25 cm STE 100M SEEN *STE acuity to be completed at 25 cm* (to LogMAR = 2.6)

At 25 cm STE 100M NOT SEEN Grating Acuity to be attempted at 25 cm

At 25 cm GRATING size 200M

At 25 cm Grating 200M SEEN *Grating acuity to be completed at 25 cm* (to LogMAR = 2.9)

At 25 cm Grating 200M NOT SEEN Basic Vision Function tests to be attempted at 25 cm

At 25 cm BASIC FORM VISION Gratings to 60mm, White Field Projection, Black White Discrimination

At 25 cm Test White Field Projection--WFP (white quad field and hemifield)

At 25 cm WFP NOT SEEN Then test Black White Discrimination--BWD

CONTRAST SENSITIVITY

Weber Ratio and Michelson Ratios

$$\text{Weber Contrast} = (L_{\max} - L_{\min}) / L_{\max}$$

$$\text{Michelson Contrast} = (L_{\max} - L_{\min}) / (L_{\max} + L_{\min})$$

Unless CS is very poor, Weber contrast is approximately 2 times the value of Michelson Contrast and CS scores in log units of Weber Contrast will be about 0,3 log units lower than for Michelson.

TESTS OF CS AT VARIOUS SPATIAL FREQUENCIES

Sine Wave Gratings

Vistech & FACT 9 different contrasts at each of 5 spatial frequencies, Distance = 3m

CS range: to 2.1 log units Weber in various increments

CVS 1000E 8 different contrasts at 4 spatial frequencies Distance = 1m

CS range to 1.95 log units Weber, irregular sequence of increments

Square Wave Gratings

Cambridge Gratings Gratings with 12.5mm stripes (4.2cpd at 6 meters)

CS range to 2.55 log units Weber, irregular sequence of increments

TESTS OF CS WITH LARGE TARGETS WITH SHARP BORDERS

Pelli Robson Test Letter chart, 3 letters each at 16 contrasts 33M letters at 1 meter
CS range: 0.0 to 2.25 log units Weber in 0.15 log unit increments

MARS test Letter Chart 48 letters each with different contrast, 12M letters at 50 cm
CS range: 0.04 to 1.96 log units Weber in 0.04 log unit increments

Bailey Border Test Locate border= on 15x2.5 cm rectangles Distance =40 cm or closer
CS range to 2.2 log units Weber, 25 increments of 0.2 or 0.1 log units

Melbourne Edge Test, 25 discs, orientation of border bisecting discs Distance – at near
CS range to 2.1 log units Weber, increments of 0.1 or 0.2 log units

Berkeley Discs Test of Contrast Sensitivity

Designed as a quick test, suitable for children and
6 cards, each with six 75cm square cells, some with 50mm test discs. At 40 cm
CS range 0.0 to 1.95 log units Weber in 0.15 log unit increments

VISUAL ACUITY AT REDUCED CONTRASTS

Comparing visual acuities at different contrast levels provides a measure of
slopes within the Contrast Sensitivity Function

Many **High and Low Contrast visual acuity charts** are available.
Bailey-Lovie, Regan, Lea symbols, others

SKILL test - Smith Kettlewell Institute Low Luminance Test
Black on dark gray with black on white Bailey Lovie charts.

Small Letter Contrast Sensitivity Test

10M letters at 4 meters, 5 letters at each of 8 contrasts,
CS range to 2.0 log units Weber in 0.25 log unit increments

CONTRAST SENSITIVITY TESTS WITH RESPONSE TIMES

BLINKING SQUARES TEST

Detection of 4 cm square targets in one of 4 quadrants on a display screen.
Tests 24 contrasts, each twice. Maximum exposure time 6 seconds. Takes 2 minutes.
CS range 0.0 to 2.3 log units Weber, in 0.1 log unit increments
Records time for each response, by touch screen or computer keyboard. Displays graph.

NUMBER SEARCH TEST

Search for 8 numbers 4 cm high in Arial bold. Each screen has randomly placed numbers 1 to 8
Six screens, each for 20 seconds. Two presentations each, at 24 contrasts.
CS range 0.0 to 2.3 log units Weber in 0.1 log unit increments
Records time for each response, by touch screen or computer keyboard. Displays graph.

VISUAL FIELDS

Consider whether testing should be binocular (most useful for functional assessment) or
monocular (useful for monitoring disease & understanding fixation behavior)

Goldmann perimeter.

Excellent for detailed plotting of peripheral fields,
Plots isopters at different visual sensitivities,
Limited information from central field.

Humphrey and similar

Excellent monitoring progress.
Determines threshold at selected points using tight controls and protocols.
Limited for determining scotoma outlines. Limited information from central field.

Amsler grid.

For central 10 degrees only. Qualitative responses.
Often scotomas “filled in” and not detected.

Tangent screen

For central fields. Traditionally white targets on black backgrounds.
More helpful to use black backgrounds with white backgrounds of variable luminance,

BERKELEY CENTRAL FIELD TEST.

A computerized test for the central 10 degrees. Available in a PowerPoint Presentation, and also as a dedicated program (BCVFT)

Two versions. Black target on white background, White target on black background.

Fifty target positions – 20 superiorly, 30 inferiorly. Eccentricities 1, 3, 5, 7, and 10 degrees, 5 eccentricities along each of 10 meridians (25, 65, 115, 155 & 195, 225, 255, 285, 315, 345)

Targets follow AMA recommendations for testing central visual field for the Evaluation of Disability.

Tangent screen methods for central visual field measurement.

Black targets on a 1-meter white tangent screen allows the measurement of central field out to 30 degrees.

A 7.5 mm target at 1 meter is equivalent to a Goldmann III.

The central 10 degrees may be tested using a black target held against a white paper screen positioned 50 cm from the patient. A 7.5 mm target at 50 cm is equivalent to a Goldmann IV.

BERKELEY HAND HELD PERIMETER.

For testing peripheral visual fields.

Targets presented along an arm giving an eccentricity range of 10 to 70 degrees

May test along any meridian, Marked for (25, 65, 115, 155 & 195, 225, 255, 285, 315, 345)

Test at eccentricities 15, 25, 35, 45, 55, and 65 along 10 different meridians.

Count number of points seen. (Maximum 60, but usually about 50+)

Visual Field Score = VFS = sum of Central Field and Peripheral Field scores.

ASSESSING THE EFFECTS OF ILLUMINATION

We choose to use a standard filter to reduce task luminance from its standard level, by a constant ratio.

We chose to use a NoIR U23 filter (neutral gray filter with 3% transmission) as our standard filter.

Visual acuity and Illumination

Effects of luminance on visual acuity are measured routinely using a NoIR U23 filter.

The normally-sighted typically lose about 10 letters (0.2 logMAR units) on a LogMAR chart.

Illumination levels have more effect on visual acuity in some disease conditions than in others.

Within disease conditions there can be considerable variations in the effects of illumination.

Contrast Sensitivity and Illumination

Effects of luminance on binocular contrast sensitivity are measured routinely using a NoIR U23 filter.

The normally-sighted, on average, lose about 0.12 log units of contrast sensitivity.

Illumination levels have more effect on CS in some disease conditions than in others.

Within disease conditions there can be considerable variations in the effects of illumination

Visual Fields and Illumination

Effects of luminance on central visual fields are measured with the BCFT using a NoIR U23 filter.

When there is constriction or scotoma found at normal illumination levels.

Commonly, central field losses become more extensive with reduced illumination.

Constricted fields often become smaller, central scotomas often become enlarged,

Sometimes central islands of vision disappear.

Changes in measured visual function resulting from illumination reductions can be predictive of patients' abilities to perform common visual tasks. They can also guide the advice the clinician gives the patient about controlling illumination.