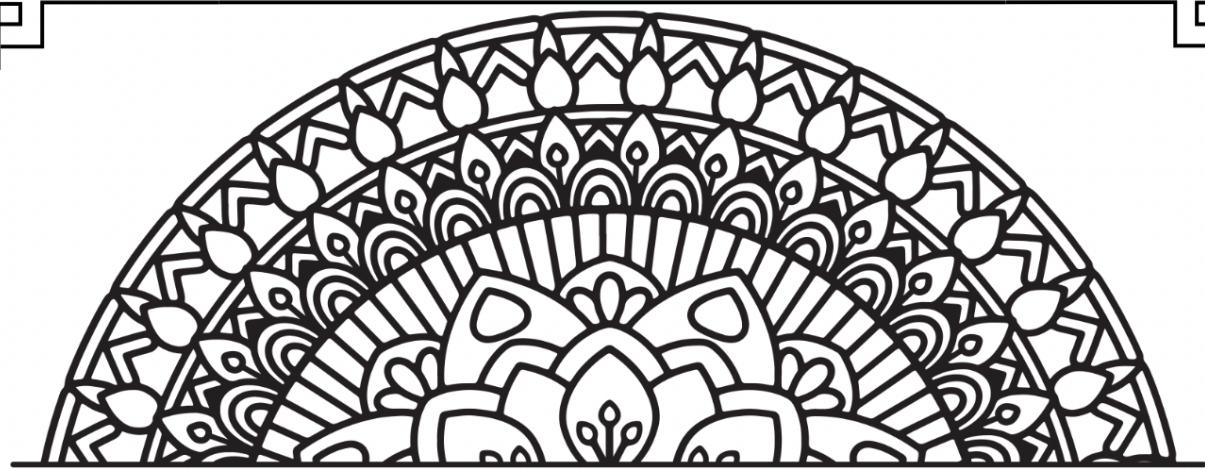




GLAUCOMA



EXAM READY

HANDWRITTEN NOTES

MADE FROM KANSKI &

SHIELDS GLAUCOMA

MADE FOR RESIDENCY EXAMS

ALL PYQ AND PYT WITH IMP TOPICS

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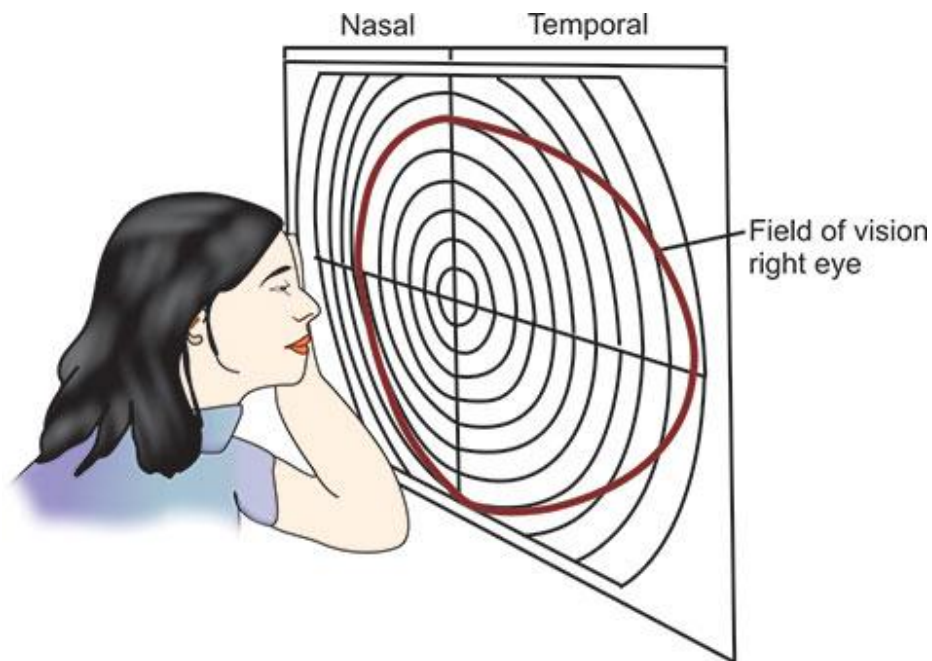
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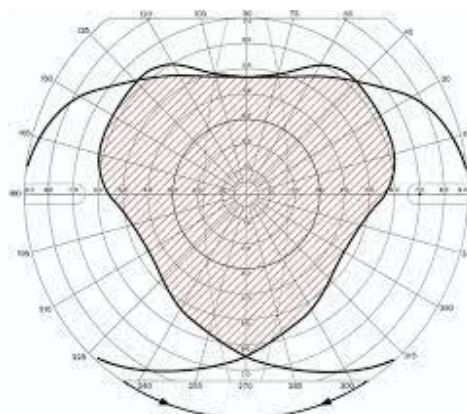
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The visual field

- The outer aspect of the visual field extends approximately:
 - 50° superiorly
 - 70° inferiorly
 - 60° nasally
 - 90° temporally.

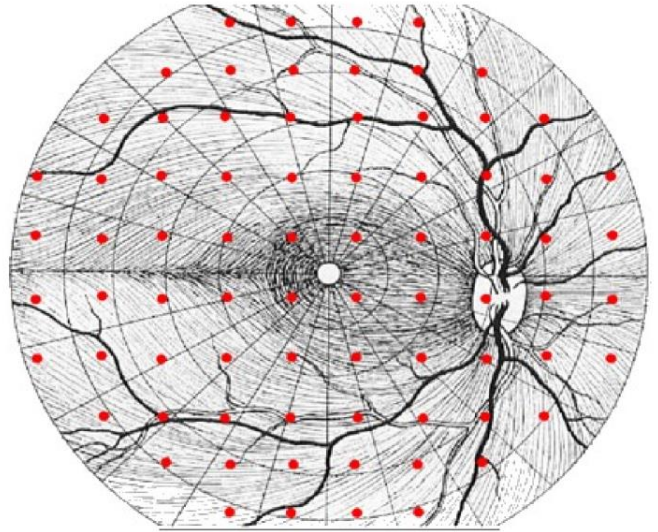


50° superiorly, 70° inferiorly, 60° nasally, and 90° temporally.

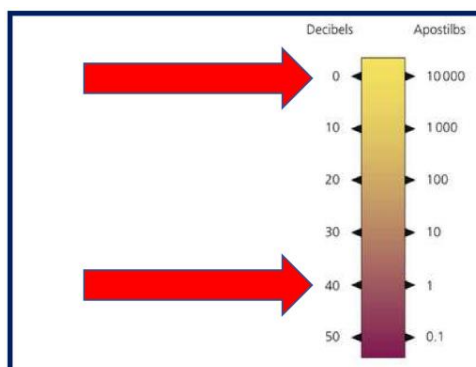


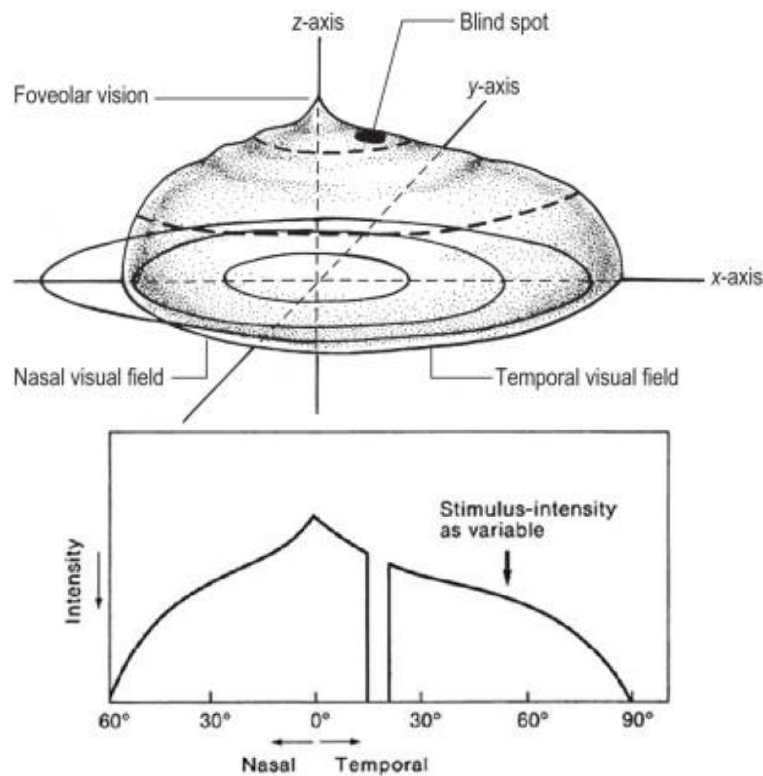
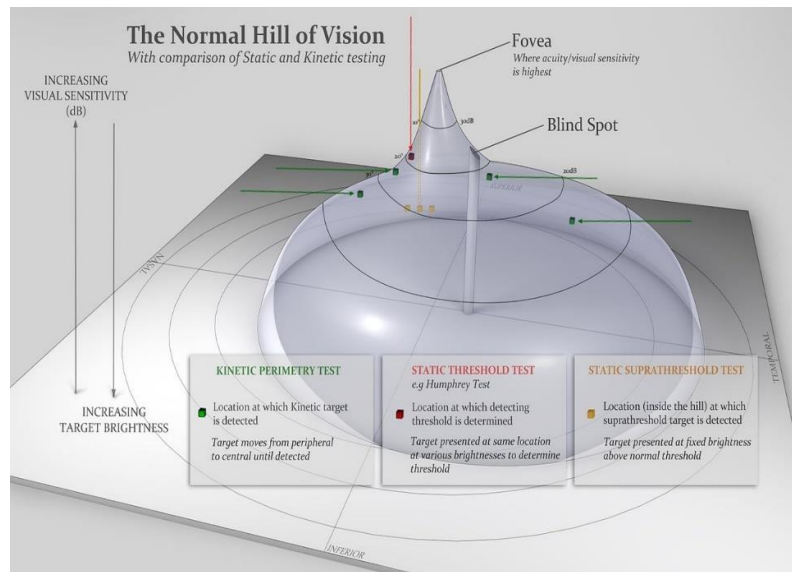
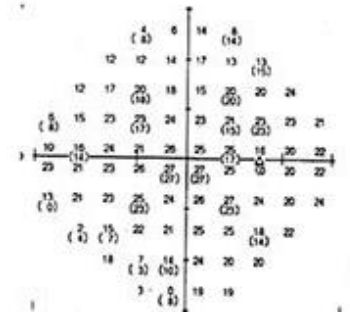
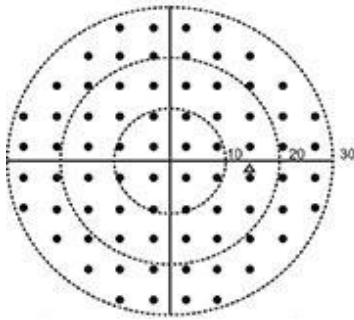
Binocular visual field

Standard Automated Perimetry (SAP)



- Such as the Humphrey
- It is static perimetry:
 - the stimulus is static in location but varies in intensity.
 - it is the most useful for quantifying and tracking visual field changes in a patient with established glaucoma
- the eye to be tested should be positioned at the centre of the hemisphere, and the near spectacle correction should be worn whilst the patient maintains steady fixation.
- spots of light are projected onto the inner surface of the hemisphere.
- Light stimuli may vary in intensity between 0.8 and 10 000 asb. This range can be expressed in logarithmic units which are termed decibels.





SAP printout

Single Field Analysis

Eye: Right

Name:

DOB:

ID:

Central 24-2 Threshold Test

Fixation Monitor: Gaze/Blind Spot

Stimulus: Ill, White

Pupil Diameter: 4.7 mm

Date: 16-08-2013

Fixation Target: Central

Background: 31.5 ASB

Visual Acuity:

Time: 2:12 PM

Fixation Losses: 0/10

Strategy: SITA-Fast

RX: +3.25 DS DC x

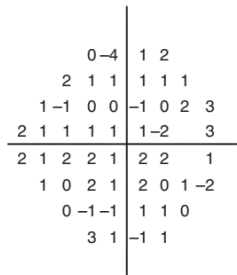
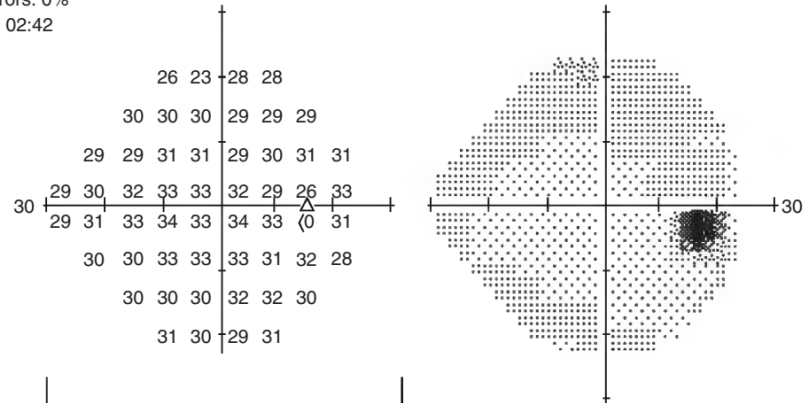
Age: 68

False POS Errors: 0%

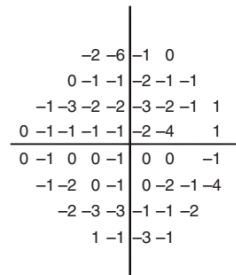
False NEG Errors: 0%

Test Duration: 02:42

Fover: OFF



Total Deviation



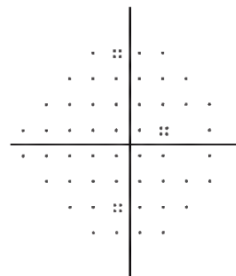
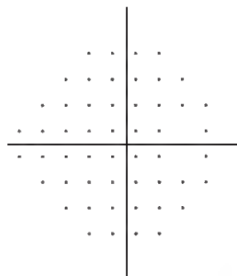
Pattern Deviation

GHT
Within Normal Limits

VFI 100%

MD +0.75 dB

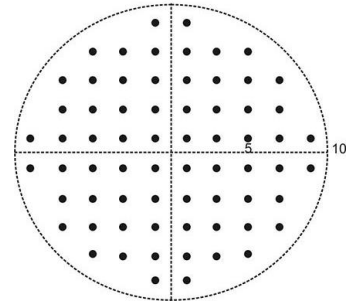
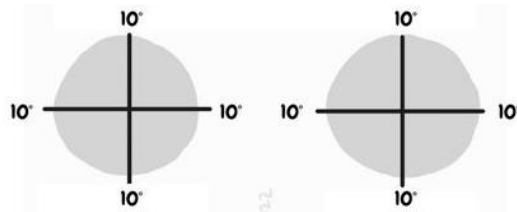
PSD 1.25 dB



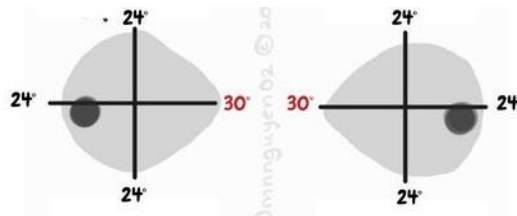
:: <5%
* <2%
* <1%
■ <0.5%

Testing patterns

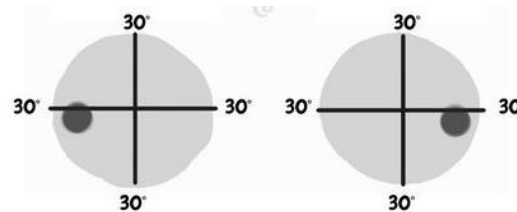
10-2



24-2



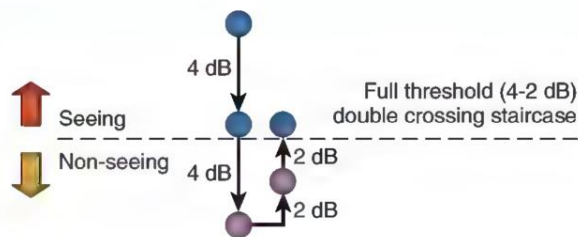
30-2



Test pattern	Point density (degrees)	No. of test points	Notes
10.2	2°	68	Test points straddle the horizontal and vertical meridians. The region tested is the same as the Amsler grid.
24.2	6°	54	Test points straddle the horizontal and vertical meridians and used for routine glaucoma monitoring.
30.2	6°	76	Test points straddle horizontal and vertical meridians. Used for first glaucoma field.

Testing Strategy

- i.e., how the visual field is assessed
- The choice of strategy affects the speed, accuracy, and reproducibility of the visual field results.
- In Standard Automated Perimetry (SAP), either threshold or supra-threshold algorithms are used to assess the visual field:
 - Threshold algorithms:
 - ✓ used to estimate the threshold sensitivity at individual locations
 - ✓ they are "staircase" methods



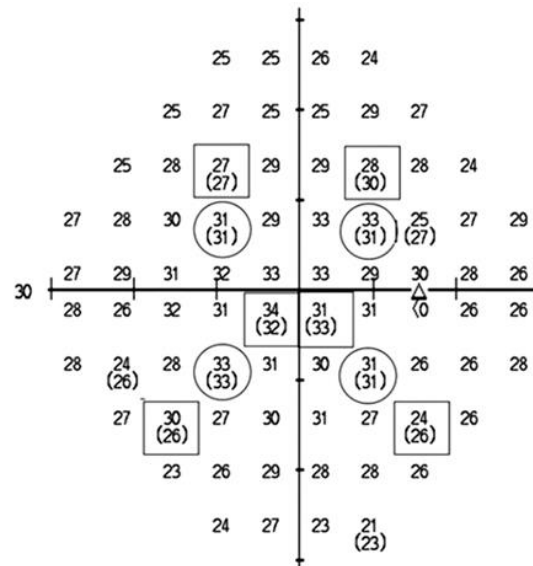
- ✓ e.g., Full Threshold, SITA Standard, SITA FAST, FAST PAC... etc
- Supra-threshold algorithms:
 - presents a stimulus at an intensity expected to be brighter than the patient's threshold and is designed for screening purposes to detect moderate to severe visual field defects.

Reliability indices

- False-positive error:
 - occurs when a patient responds at a time when no test stimulus is presented
 - A nervous or trigger-happy patient may have a high false-positive rate
- False-negative error:
 - occurs when a patient fails to respond to a supra-threshold stimulus presented in a location where a dimmer stimulus was previously seen
 - may indicate a patient who is failing asleep or losing interest.
- Fixation losses:
 - The best parameter for determining the unreliability of a Humphrey visual field
 - occur when a patient fails to maintain their gaze on the central fixation target during visual field testing.
 - identified by:
 - ✓ Blind Spot Monitoring: The perimetry device periodically presents stimuli in the patient's known blind spot. If the patient responds to these stimuli, it indicates they are not looking at the fixation light.
 - ✓ Gaze Tracking: Some advanced perimetry machines use gaze tracking technology to continuously monitor the patient's eye position and detect fixation losses.

Short-term fluctuation (SF)

- a measure of normal physiologic variation and intratest reliability.
- It is assessed by testing ten preselected points twice and analysing the difference



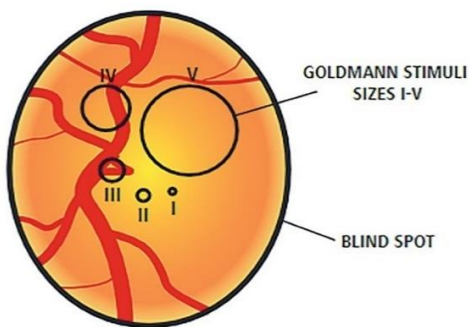
- It is typically expressed in decibels (dB)

Stimulus size and brightness

Goldmann Isopters Table

Isopter	Target Size	Brightness	Description
I-4e	I	4e	Smallest size, high brightness
I-3e	I	3e	Smallest size, moderate brightness
I-2e	I	2e	Smallest size, low brightness
II-4e	II	4e	Small size, high brightness
II-3e	II	3e	Small size, moderate brightness
II-2e	II	2e	Small size, low brightness
III-4e	III	4e	Medium size, high brightness
III-4e	III	4e	Medium size, high brightness
III-3e	III	3e	Medium size, moderate brightness
III-2e	III	2e	Medium size, low brightness
IV-4e	IV	4e	Large size, high brightness
IV-3e	IV	3e	Large size, moderate brightness
IV-2e	IV	2e	Large size, low brightness
V-4e	V	4e	Largest size, high brightness
V-3e	V	3e	Largest size, moderate brightness
V-2e	V	2e	Largest size, low brightness

- The Roman numeral (I – V) indicates the size of the test object in mm², and is a logarithmic scale → each increment of the roman numeral doubles the diameter (and quadruples the area) of the test object. e.g., changing from size I to II is 1 log unit, and size II has four times the area of size I.

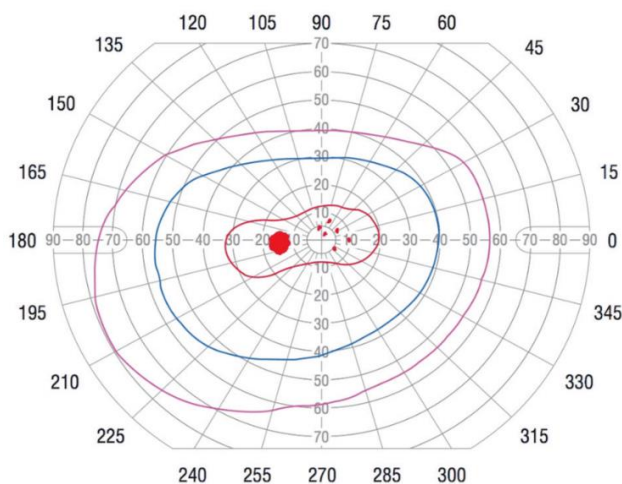


GOLDMANN STIMULUS SIZE	DIAMETER (in mm)	AREA (in mm ²)
0	0.28	1/16
I	0.56	1/4
II	1.13	1
III	2.26	4
IV	4.51	16
V	9.03	64

- The standard test object (i.e., stimulus size) for most automated perimeters is a Goldmann size III white target
- The Arabic number and letter indicate the intensity of the light:
 - Filters **1** to **4** are in increments of 5 dB each.
 - Filters **a** to **e** are in increments of 1 dB each.
 - The combination "4e" is used when there is no attenuation (high brightness).

Isopter

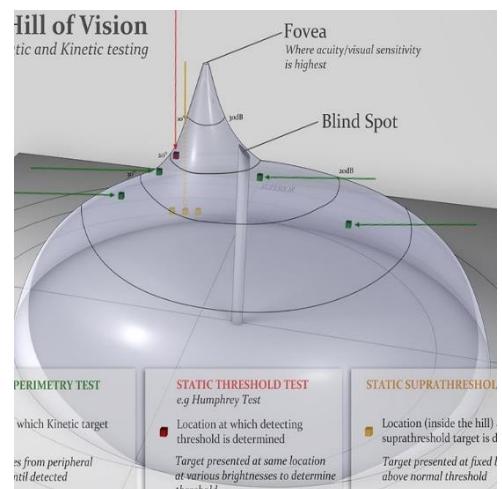
It is a line connecting points of the same sensitivity (i.e., a line on a visual field map that connects points where a person perceives a stimulus of the same size and brightness)



V-4e isopter (purple)

I-4e isopter (blue)

I-2e isopter (red)



Background luminance



- The retinal sensitivity at any location varies depending on background luminance.
- The HFA uses a background luminance at 31.5 asb.

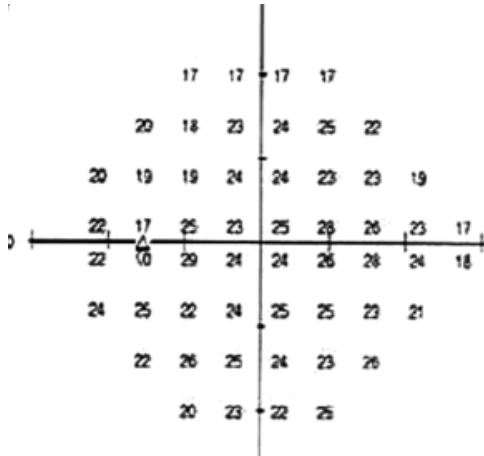
Pupil size

- It is best to test the field with a pupil larger than 3 mm to obtain reliable results
- A pupillary diameter of less than 3 mm can cause general depression of the field.
- Patients taking pilocarpine may need to refrain from taking the medication for 24 hours before the test or be dilated at the time of their examination.

Plots (maps) found in perimetry printouts

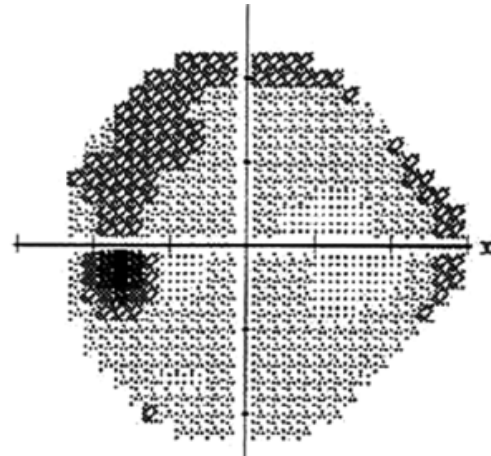
include:

1- Threshold plot:



Numeric Plot:

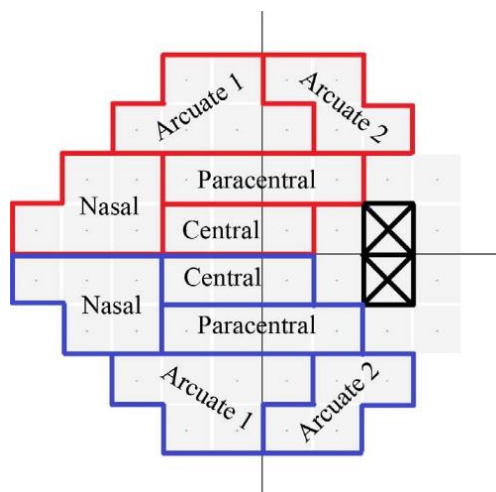
Displays the exact threshold values measured at each test location in decibels (dB).



Gray Scale Plot:

represents the sensitivity of each point in the visual field using varying shades of gray. Darker areas indicate regions of lower sensitivity or more significant visual field loss.

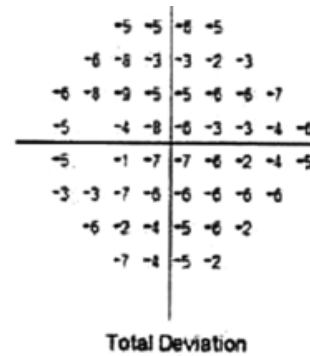
- The visual threshold is the minimal visual stimulus seen at a point.
- Higher decibel values indicate higher visual sensitivity.
- Corresponding points above and below the horizontal midline should not vary markedly. Normally the superior field is depressed 1 to 2 dB compared with the inferior field.
- Glaucoma hemifield test:
This program provides information concerning differences between superior and inferior halves of the visual field by evaluating threshold at mirror-image points above and below the horizontal meridian.



2- Total Deviation Plot:

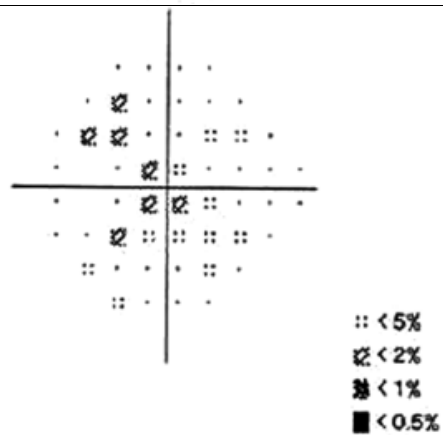
Numeric Plot:

- ✓ Shows the differences between the patient's threshold values and the age-corrected normal values for each test location.
- ✓ Positive values indicate better-than-average sensitivity, while negative values indicate worse-than-average sensitivity.

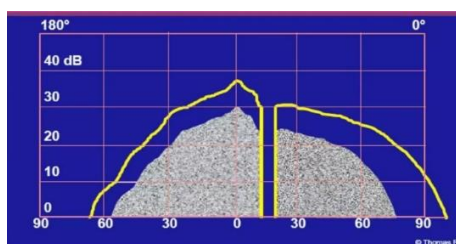


Probability Plot:

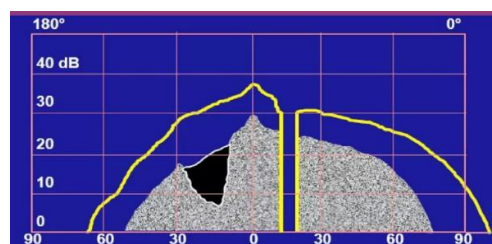
- ✓ Uses symbols to indicate the statistical significance of the deviations from normal values.
- ✓ It highlights areas where the sensitivity is significantly different from the normal range.



- A cluster of two or more points depressed ≥ 5 dB compared with surrounding points is suspicious.
- A single point depressed >10 dB is very unusual but is of less value on a single visual field than a cluster, because cluster points confirm one another.
- The mean deviation (MD):
 - ✓ It is a centerweighted mean of all deviation from normal values in the visual field
 - ✓ It provides an indication of the degree of generalized loss (overall field sensitivity, not localized abnormalities) in the visual field compared to age-adjusted normal population values



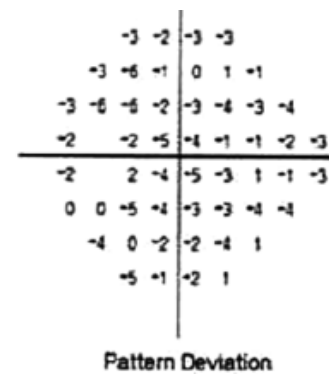
Generalized depression



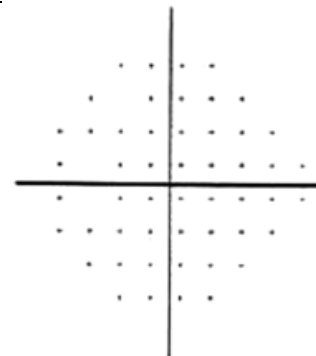
Generalized depression
with hidden scotoma

3- Pattern Deviation Plot:

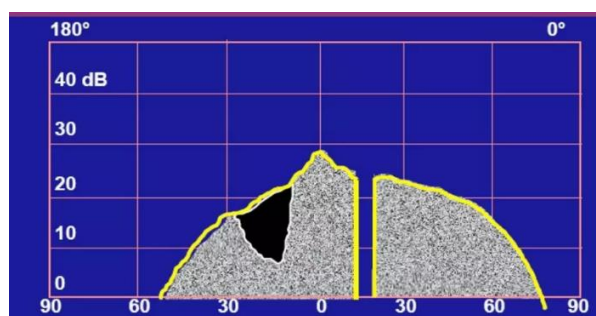
Numeric Plot: Adjusts the total deviation values to account for generalized depressions in the visual field, focusing on localized defects.



Probability Plot: Similar to the total deviation probability plot, it uses symbols or colors to indicate the significance of localized deviations from the normal pattern.



- Pattern standard deviation (PSD):
 - ✓ represents a summary measurement of the average deviation of individual test points from the normal hill of vision after correcting for any overall sensitivity differences.
 - ✓ If there is global reduction in sensitivity (from cataract for example) the pattern standard deviation adjusts for this, to give a better indication of areas in the visual field that are relatively less sensitive than other areas (useful for monitoring conditions such as glaucoma).
 - ✓ In other words; in a patient with dense bilateral cataracts, their PSD would be the most useful index in monitoring for glaucoma progression



Scotoma revealed after adjusting for generalised depression due to cataract

- Corrected pattern standard deviation (CPSD):
 - It is the pattern standard deviation (PSD) after taking into account the short-term fluctuation (SF)

Summary values ('global indices')

Include:

- ☞ MD
- ☞ PSD
- ☞ GHT
- ☞ Visual field index (VFI):
a measure of the patient's overall visual field function expressed as a percentage, the normal age-adjusted value being 100%.

GHT	
Within Normal Limits	
VFI	100%
MD	+0.75 dB
PSD	1.25 dB

High-sensitivity field modalities

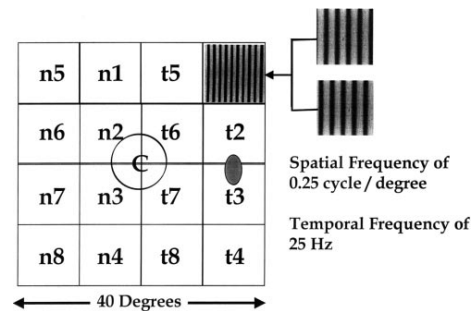
Standard automated perimetry (SAP) is (white-on-white) perimetry that tends to detect field damage only after substantial ganglion cell loss is established → attempts at detecting change at an earlier stage → development of high-sensitivity field modalities like SWAP and FDT

Short wave length automated perimetry (SWAP)



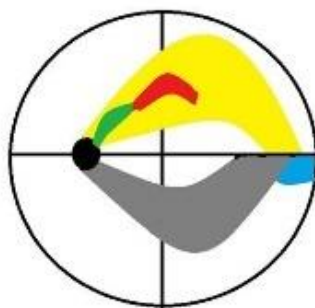
- A blue stimulus is projected onto a yellow background.
- This method is sensitive in early identification of glaucomatous damage.
- The rate of perimetric change due to early glaucoma may be higher than with conventional white-on-white visual fields.

Frequency-doubling technology (FDT) perimetry



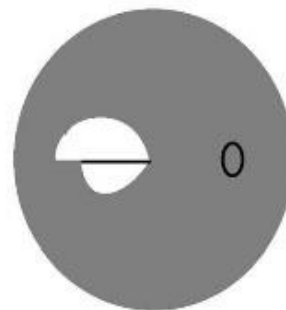
FDT presents a low spatial frequency sinusoidal grating stimulus that undergoes rapid flickering → this flickering appears to double the frequency of the grating → preferentially activates the M cells (magnocellular cells are a type of retinal ganglion cell which are thought to be affected early in glaucoma) → FDT particularly useful for **early** detection of glaucoma.

Glaucomatous visual field patterns



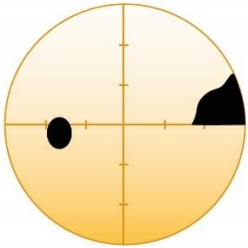
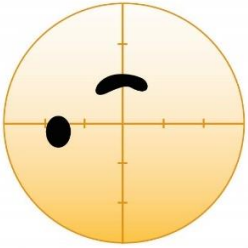
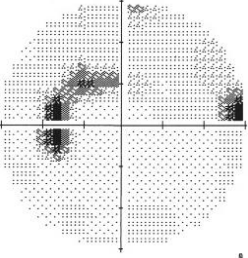
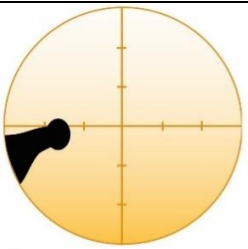
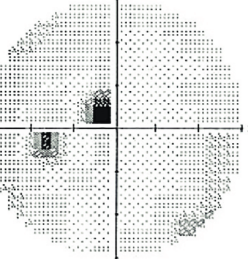
Visual field of Left Eye

- **Nasal step**
- **Paracentral scotoma**
- **Seidel scotoma**
- **Arcuate scotoma**
- **Biarcuate scotoma**



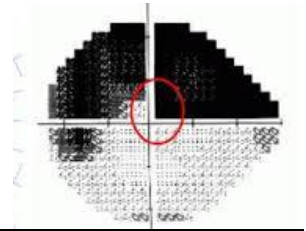
Visual field of Right Eye

Advanced glaucomatous field defect

Nasal Step	Sharp discrepancy in sensitivity across the nasal horizontal meridian in the nasal field	
Paracentral Scotoma	- The most common early glaucomatous field defect, constituting 70% of all early defects. - They are usually supero-nasal and respect the horizontal midline.	
Seidel's Scotoma	Sickle-shaped extension of the blind spot into the adjacent central visual field	
Arcuate (Bjerrum) Scotoma	- Arc-shaped areas of vision loss extending from the blind spot - typically develop from coalescence of paracentral scotomas - the most decreased sensitivity in an arcuate scotoma occurs in superotemporal quadrant	
Temporal Wedge	Wedge-shaped area of vision loss extending temporally from the blind spot	
"threatened" fixation Or "split" fixation	Visual field loss that comes close to fixation	

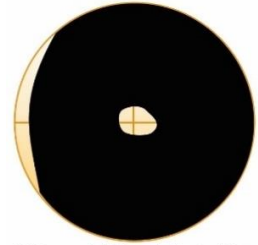
altitudinal defect

corresponds to the greatest
glaucomatous optic nerve damage



End stage

characterised by a central island and a
temporal island of vision



Blindness

central vision is not affected
until late in the disease



TIP

A typical pattern of progression:
paracentral scotoma → to split fixation scotoma → to loss of fixation.

Grading of glaucomatous damage

- 1) Grade 1 (mild):
 - minimal cupping
 - a nasal step or paracentral scotoma
 - a MD < -6 dB
- 2) Grade 2 (moderate):
 - thinning of neuro-retinal rim
 - an arcuate scotoma
 - a MD < -12 dB
- 3) Grade 3 (severe):
 - marked cupping
 - extensive VF loss including the central 5 degrees
 - a MD > -12 dB
- 4) Grade 4 (end-stage):
 - gross disc cupping
 - a small residual field

Anderson's minimal criteria for glaucomatous damage

1. Glaucoma hemifield test (GHT) outside normal limits on at least two consecutive occasions
2. A cluster of three or more non-edge points, all depressed on pattern deviation plot at the level of P less than 5%, one of which is at P less than 1%, on two consecutive occasions
3. CPSD that occurs in less than 5% of normal individuals on two consecutive occasions

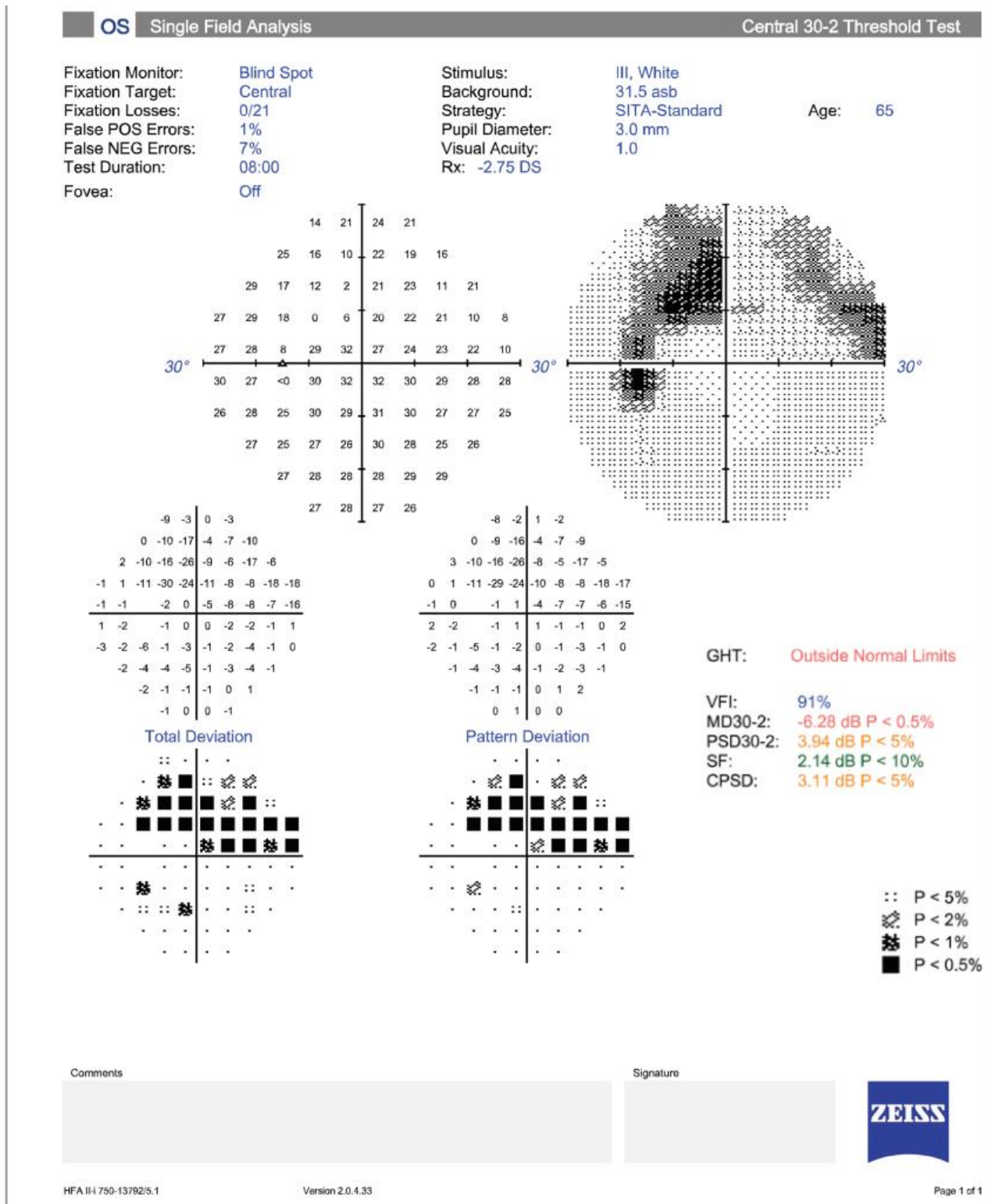
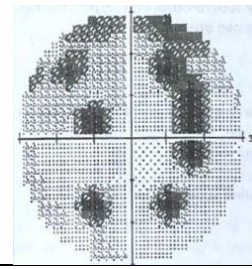


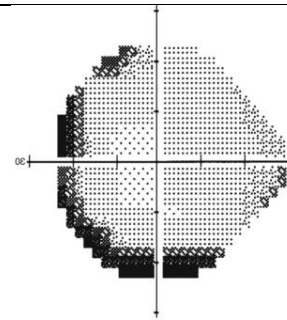
Fig. 4.11 Reliable field. Superior arcuate scotoma. An additional 10-2 field may provide information about any central loss.

Causes and Results

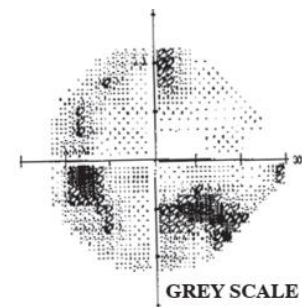
- if the patient misses the early portion of the test when the machine attempts to determine the threshold for each quadrant → isolated depressed quadrantic defects result



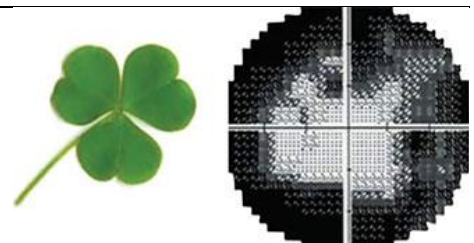
- Narrow-aperture trial frame lenses → spectacle rim artefact



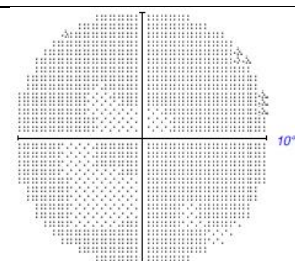
- High false-positive errors → white scotomas



- High false-negative errors → a clover leaf appearance

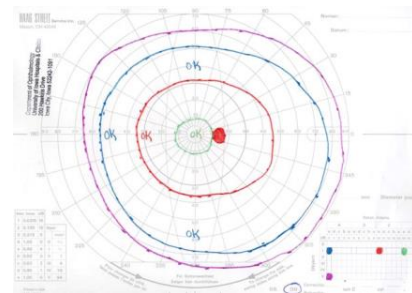
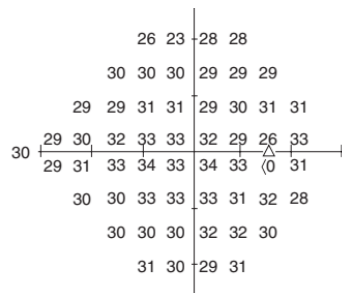


- If both eyes are open for a field, no blind spot will be plotted.



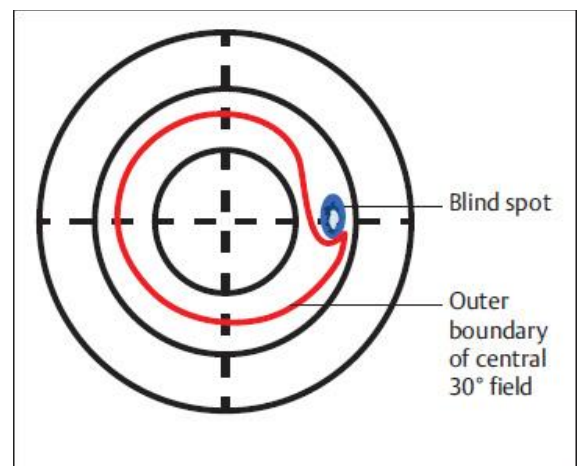
Static vs Kinetic perimetry

Aspect	Static Perimetry	Kinetic Perimetry
e.g.,	Humphrey	Goldmann
Stimulus	Stationary with variable intensity	Moving with constant intensity
Assessment Focus	Sensitivity at fixed points	Boundaries of the visual field
Results	Quantitative measure of sensitivity	Qualitative map of field boundaries



- Goldmann perimetry offers an advantage for children and the elderly, who need more Interaction with the examiner, but it requires a skilled technician or examiner.
- Baring of the blind spot:

- means the exclusion of the blind spot from the central field due to inward curve of the outer boundary of the 30° central field
- it is showed by kinetic perimetry
- it is the earliest visual field change in glaucoma
- generalized constriction of isopters and baring of the blind spot are not very specific and can be produced by miosis, uncorrected refractive error, aging, and cataract.

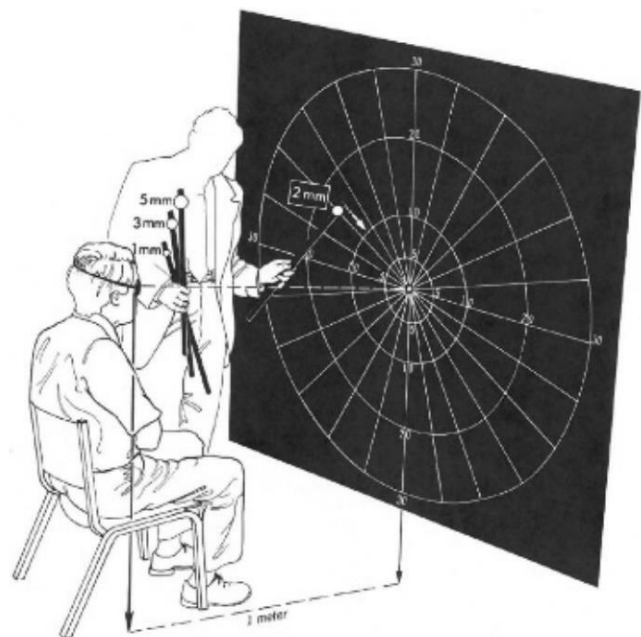


Remember that

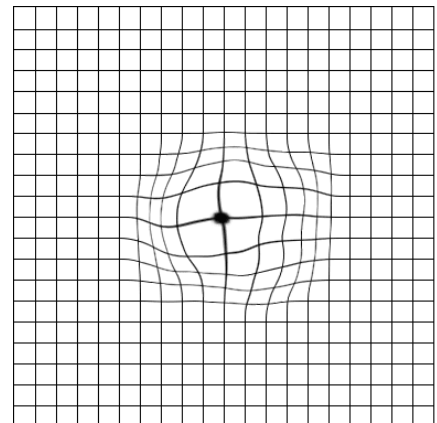
- Retinal and optic nerve lesions produce field defects that do not generally respect the vertical midline.
- The presence of a field defect that respects the vertical midline should always arouse suspicion of a neurologic lesion (e.g., cerebrovascular accident, tumor), especially when the disc and field changes do not correspond.

- For a visual field defect to be classified as glaucomatous, it should have corresponding optic nerve head abnormalities.
- Some studies have shown that patients with low-tension glaucoma have scotomas with steeper slopes, greater depth, and closer proximity to fixation than POAG patients with higher IOP.
- any initial abnormal glaucoma field test or interval change in field should be confirmed by repeating the test.
- Generalized depression can occur from many non-glaucoma causes such as cataract.
- Automated perimetry does not prevent lens rim artifacts
- A trigger-happy patient would have a field with high false-positive errors and a high mean deviation.
- Focal ischemic glaucomatous optic disc (subtype 1) is typically associated with a localized field defect near to fixation.
- Areas of retina and/or optic nerve damaged by glaucoma are believed to be more vulnerable to ongoing damage at lower intraocular pressures
- The tangent screen (Bjerrum screen):

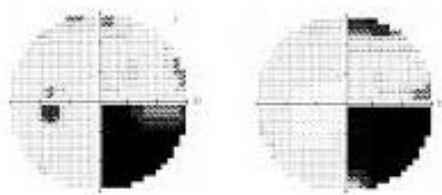
- a form of kinetic perimetry
- is most useful in testing for psychogenic or functional visual disturbances (nonorganic visual loss)



- The Amsler grid:
 - held at 33 cm to measure approximately 10 degrees of central vision
 - it is the best visual field test for assessing metamorphopsia



- a lesion in the parietal lobe → inferior quadrantanopia

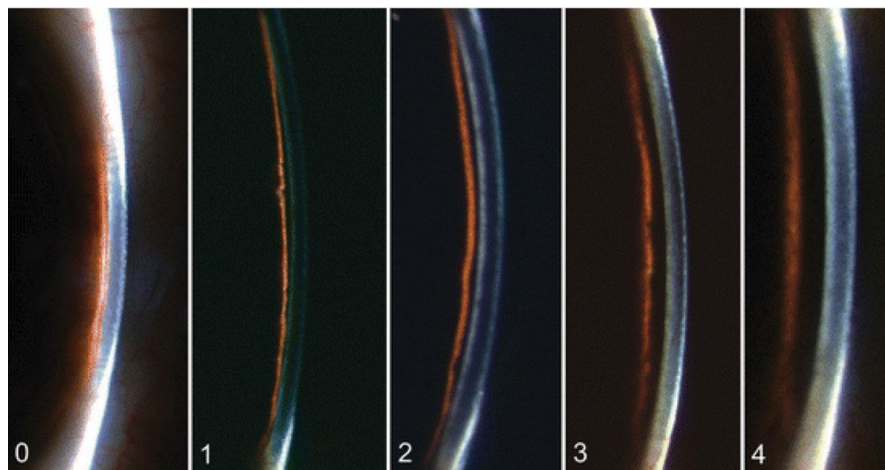
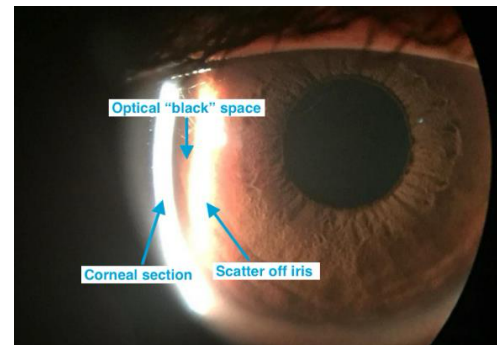
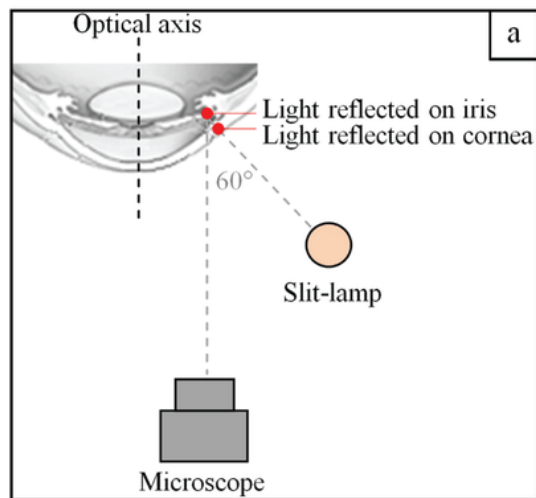


- Occipital infarction → homonymous hemianopia



Van Herick method

(<https://www.youtube.com/watch?v=3fiGUOa0Pek>)



van Herick's Grading Scale			
van Herick grade	Corneal thickness	Optical/aqueous space thickness	Implications
IV	1	1 or more	Wide open, can't close
III	1	0.5 to 1.0	Open, unlikely to close
II	1	0.25 to 0.5	Suspicious
I	1	0.25 or less	Angle closure likely
0	1	0	No aqueous visible. Angle is closed