"MOVE IT OR LOSE IT: THE ROLE OF KINETIC VISUAL FIELDS"

Tiffany M. Young, OD
COPE COURSE ID: 56306-PD
Harper's Point Eye Associates
April 15, 2018

Course Objectives

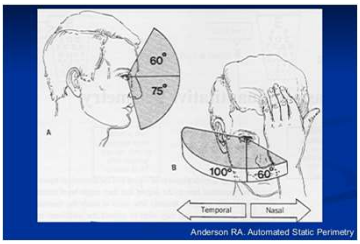
- Review the visual field
- Review types of perimetry
- Discuss advantages and disadvantages of different types of visual field testing
- Explore kinetic visual fields
- Clinical examples

Financial Disclosure

None

Extent of Visual Field

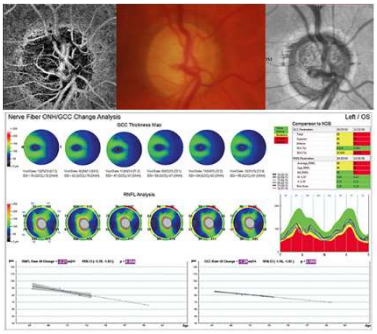
- Binocular



Evaluation of Visual Field[1]

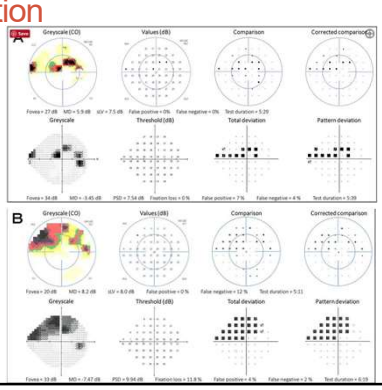
- Pathology
- Disease status
- Progression vs stability
- Treatment efficacy
- Visual Ability

Structure

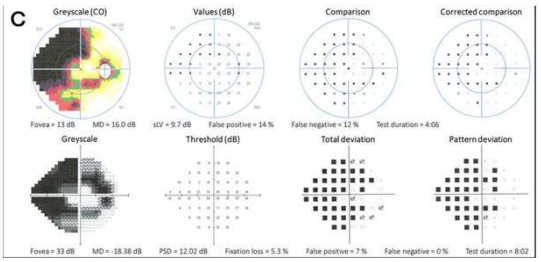


https://www.oct-optovue.com/angioOCT-opticNerve/oct-angiography-opticNerve-4.html
https://www.ophthalmologymanagement.com/supplements/2017/december-2017/glaucoma-physician/widefield-oct-improves-glaucoma-management

Function



Function



https://www.nature.com/articles/srep25563/figures/4

Function vs. Structure

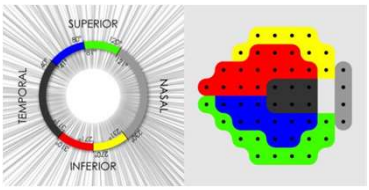
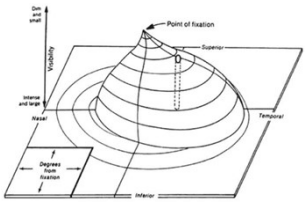


Image courtesy of: https://www.researchgate.net/figure/Map-representing-the-relationship-between-Standard-Automated-Perimetry-visual-field_fig1_51546681

Hill of Vision

- Sensitivity to light depends on location[1]
  - Highest in center and decreases toward periphery



- Connect sensitivity thresholds at tested locations[1]

Image courtesy of: https://entokey.com/visual-fields-in-glaucoma/

Hill of Vision

- Normal sensitivity to light ↓ at age 20

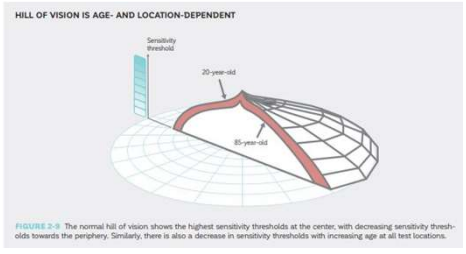
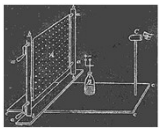
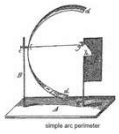


FIGURE 3-9 The normal hill of vision shows the highest sensitivity thresholds at the center, with decreasing sensitivity thresholds towards the periphery. Similarly, there is also a decrease in sensitivity thresholds with increasing age at all test locations.

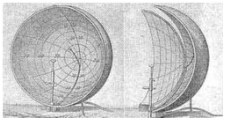
Origins of Perimetry



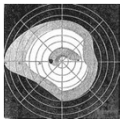
1857: Tangent screen



1869: Arc perimeter



1857: Bowl perimeter



1889: Bjerrum

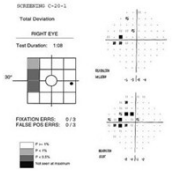
Origins of Perimetry

- 1945: Goldmann bowl

- 1980: Automating Goldmann

Non-Conventional Perimetry[8]

- Short Wavelength Automated Perimetry (SWAP)
- Flicker Perimetry
- Frequency Doubling Technology (FDT)



SWAP[1]

- Blue-on-yellow
- Blue = short wavelength stimulus
- Yellow background suppresses green (medium) and red cones (long)

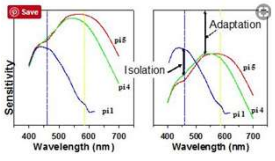
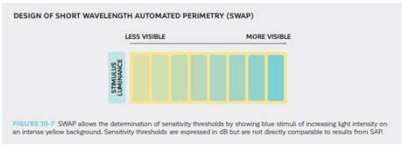


Image courtesy of: http://webeye.ophth.uiowa.edu/ips/PerimetryHistory/Short-wavelength-automated-perimetry.htm

SWAP[1]

- Easy to understand
- Early glaucoma detection



- Long test
- Increased test=retest variability

Flicker Perimetry[8]

- **F**li**c**k**e**r = light/dark stimulus alterations

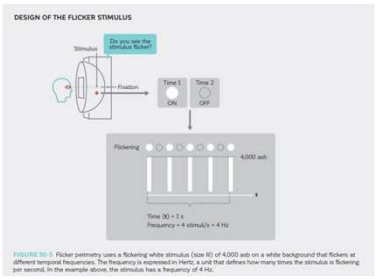


FIGURE 30-5 Flicker perimetry uses a flickering white stimulus (size III) of 4,000 asb on a white background that flickers at different temporal frequencies. The frequency is expressed in Hertz; a unit that defines how many times the stimulus is flickering per second. In the example above, the stimulus has a frequency of 4 Hz.

Flicker Perimetry

- Sensitive and specific to early glaucoma detection[1]
- Minimally influenced by media opacities

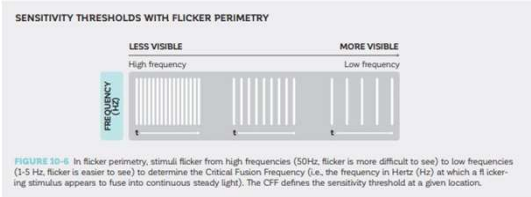
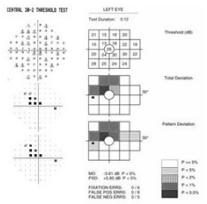


FIGURE 30-6 In flicker perimetry, stimuli flicker from high frequencies (50Hz, flicker is more difficult to see) to low frequencies (1-5 Hz, flicker is easier to see) to determine the Critical Fusion Frequency (i.e., the frequency in Hertz (Hz) at which a flickering stimulus appears to fuse into continuous steady light). The CFF defines the sensitivity threshold at a given location.

- More demanding of patients
- Instruction and observation even more important

Frequency Doubling Technology (FDT)[8]

- Frequency of light and dark stimuli appears 2x as actual when temporal frequency of counterphased frequency increased
- Stimulates **m**agnocellular ganglion cell pathway



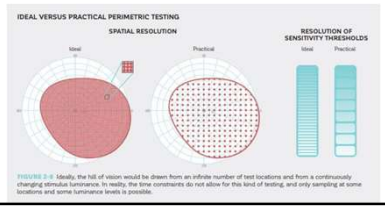
FDT

- Portable
- Detect early glaucoma
- Neurological disorders with high sensitivity and specificity
- Not largely influenced by media opacities
- Test-retest ability

- Large targets*
- Lack of fixation monitor throughout testing*
- Unclear ability to monitor progression into advanced stage[9]

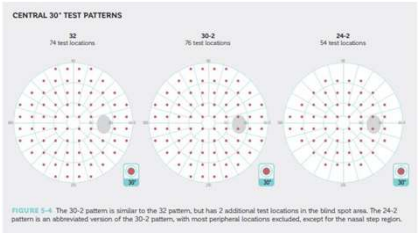
Static Perimetry[1]

- Stimuli of varying luminance levels
- Deviations from normal hill of vision[1]
  - Constriction of boundaries
  - Depressions of sensitivity
- Quantifies patient's sensitivity to light



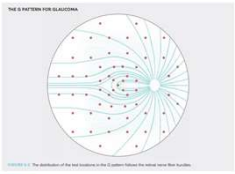
Central 30°

- 32
- 30-2
- 24-2



G

- 59 locations within central 30°



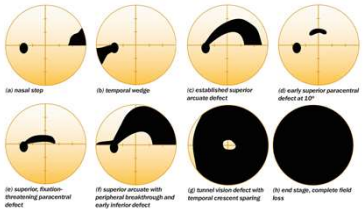
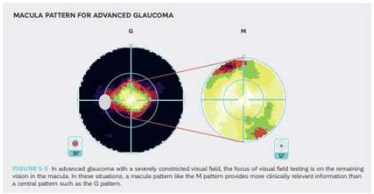
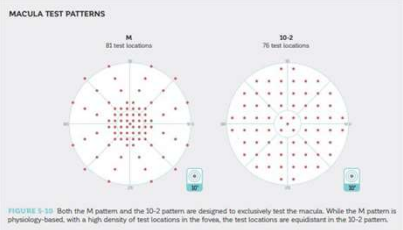


Image courtesy of: https://www.cehjournal.org/article/visual-field-testing-for-glaucoma-a-practical-guide/



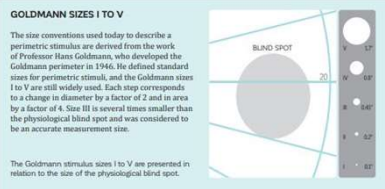
Macular Testing

- 10-2
- M (12°)



Goldmann Sizes

- Standard = Round, size III

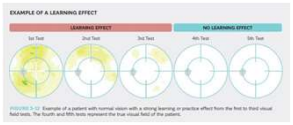


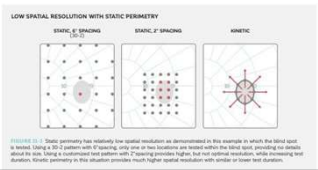
Static Perimetry Advantages

- Clinical gold standard
- Automated
- Glaucoma[2]
- Macular diseases

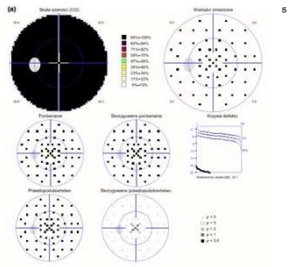
Static Perimetry Disadvantages

- Learning curve
- Fatigue
- Subjective
- Poor test takers
- Limited to central 30 degrees
- Low spatial resolution[1]



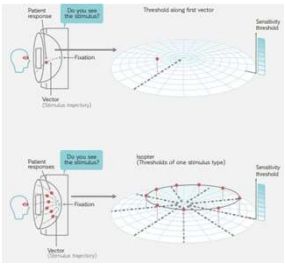


SAP in Advanced Glaucoma



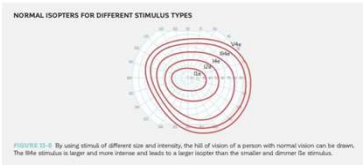
Kinetic Perimetry

- Moving stimuli moved from non-seeing to seeing areas[1]
- Patient response = location of specific light sensitivity threshold



Kinetic Perimetry

- Isopters



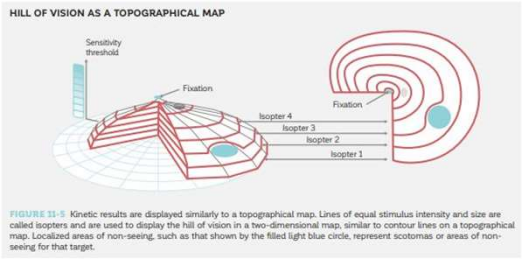
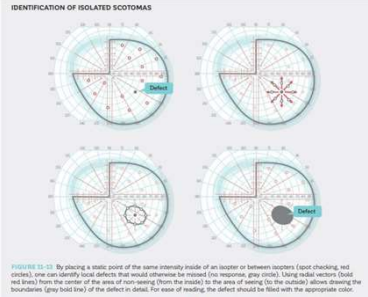


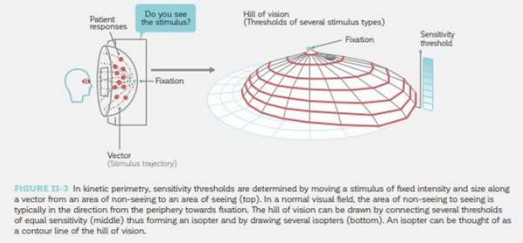
FIGURE 11-5 Kinetic results are displayed similarly to a topographical map. Lines of equal stimulus intensity and size are called isopters and are used to display the hill of vision in a two-dimensional map, similar to contour lines on a topographical map. Localized areas of non-seeing, such as that shown by the filled light blue circle, represent scotomas or areas of non-seeing for that target.

Isolated Scotomas



Stimuli

- Stimulus types/size/intensity/speed

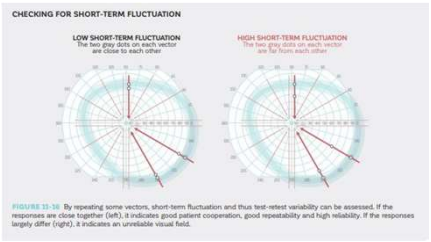


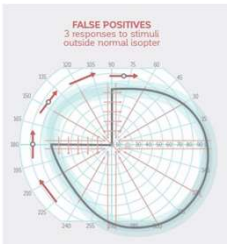
Stimuli

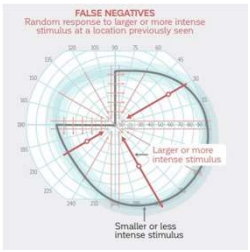
GOLDMANN STIMULUS SIZES I TO V — TABLE 11-3

SIZE	DIAMETER	AREA [MM²]	RECOMMENDED FOR
V	1.7°	64	Low vision (end stage disease) Far periphery (determination of anatomical visual field borders)
IV	0.8°	16	
III	0.43°	4	Periphery Standard for static testing
II	0.2°	1	
I	0.1°	0.25	Peripheral and central testing Small area and high resolution (e.g., blind spot, small or shallow scotomas)

Reliability[1]







Kinetic Perimetry Automation

- Manual[1]
- Goldmann

- Automated[1]
  - Expected responses known
  - Ptosis template
- Semi-Automated[1]
  - Predefined template
  - Responses can be repeated or deleted

Image courtesy of: https://www.haag-streit.com/haag-streit-diagnostics/products/perimetry/

Kinetic Perimetry Advantages

- Easy to understand
  - Moving stimulus
  - Children, cognitive impairment
- Faster
- Higher spatial resolution
- Advanced scotoma detection[4]
- Periphery

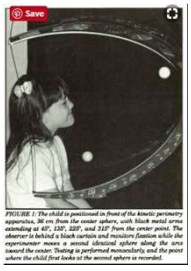


FIGURE 1: The child is positioned in front of the kinetic perimetry apparatus, 30 cm from the center sphere, with black metal arms extending at 45°, 135°, 225°, and 315° from the center point. The observer is behind a black curtain and monitors fixation while the experimenter moves a second (dissimal sphere along the arm toward the center. Testing is performed monocularly, and the point where the child first looks at the second sphere is recorded.

Image courtesy of: https://doi.org/10.3928/0191-3913-19910501-08

Kinetic Perimetry Disadvantages

- Examiner skill
  - Manual[4] → Semi-Automated
  - Standardization[3] [6]
- Learning effect
- Reaction time and fatigue[3]
- Small sensitivity changes
- Diffuse loss

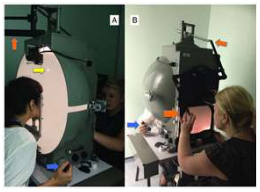


Image courtesy of: http://pn.bmj.com/content/15/5/374

Reaction Time

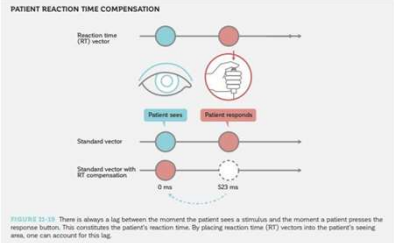


FIGURE 11-19 There is always a lag between the moment the patient sees a stimulus and the moment a patient presses the response button. This constitutes the patient's reaction time. By placing reaction time (RT) vectors into the patient's seeing area, one can account for this lag.

Reaction Time

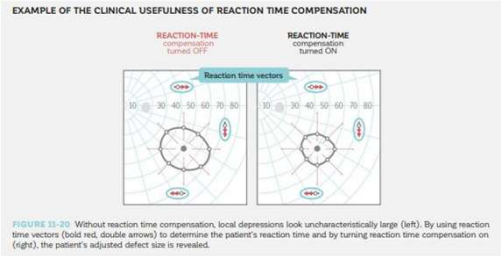


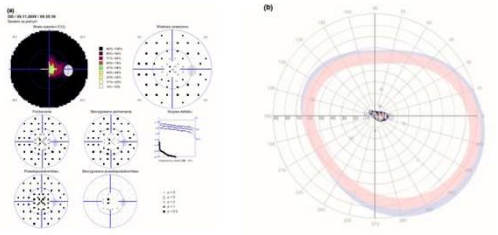
FIGURE 11-20 Without reaction time compensation, local depressions look uncharacteristically large (left). By using reaction time vectors (bold red, double arrows) to determine the patient's reaction time and by turning reaction time compensation on (right), the patient's adjusted defect size is revealed.

Clinical Use

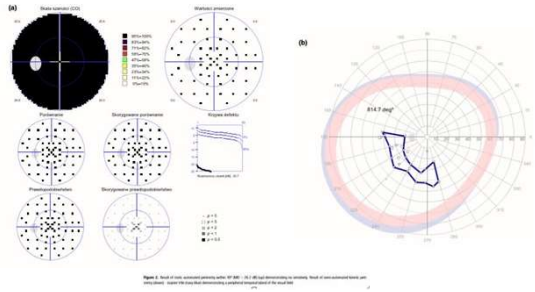
- Advanced glaucoma
  - Preferred by patients[4]
  - Improved retest ability[4]

Advanced Glaucoma

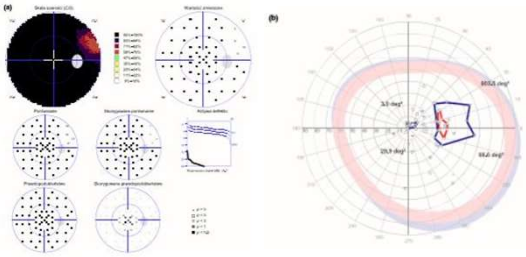
- Small central island and larger temporal island[5]
- SKP provides additional information



Advanced Glaucoma[5]



Advanced Glaucoma[5]



Optic Neuropathy[7]

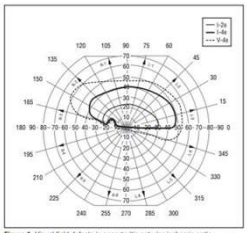


Figure 1. Visual field defects in nonarteritic anterior ischemic optic neuropathy, plotted with a Goldmann perimeter (using I-2e, I-4e, and V-4e targets), show absolute inferior altitudinal defect with I-2e, I-4e, and V-4e isopters. The visual acuity in the eye was 20/20.

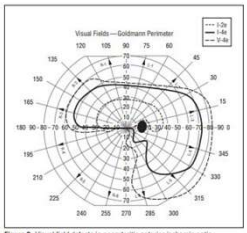
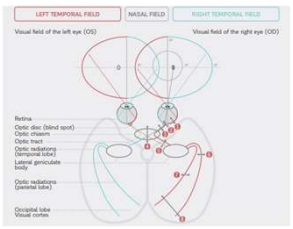
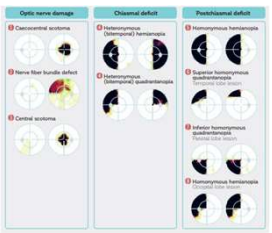


Figure 2. Visual field defects in nonarteritic anterior ischemic optic neuropathy, plotted with a Goldmann perimeter (using I-2e, I-4e, and V-4e targets), show inferior altitudinal defect with I-2e and inferior nasal defect with I-4e and V-4e isopters. The visual acuity in the eye was 20/20.

Neurological cases





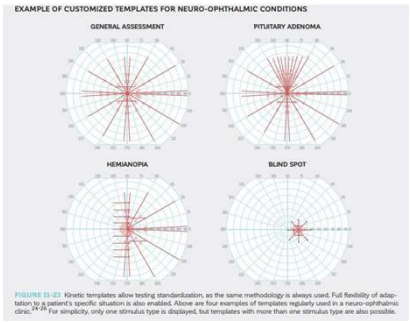
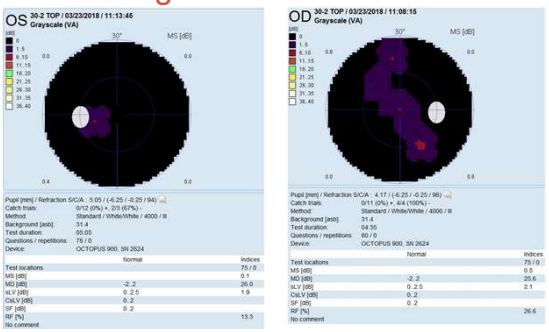
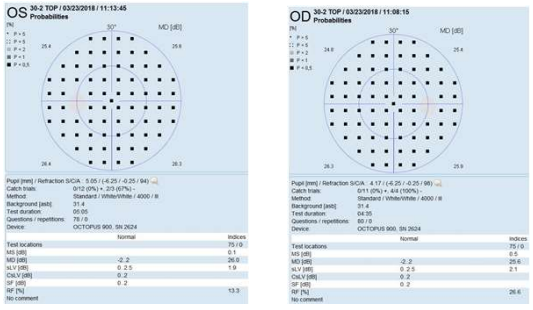


FIGURE 11-23 Kinetic templates allow testing standardization, as the same methodology is always used. Full flexibility of adaptation to a patient's specific situation is also enabled. Above are four examples of templates regularly used in a neuro-ophthalmic clinic.[14-24] For simplicity, only one stimulus type is displayed, but templates with more than one stimulus type are also possible.

Retinitis Pigmentosa



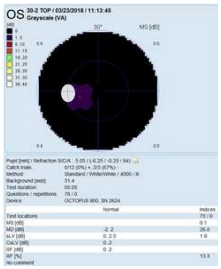
Retinitis Pigmentosa



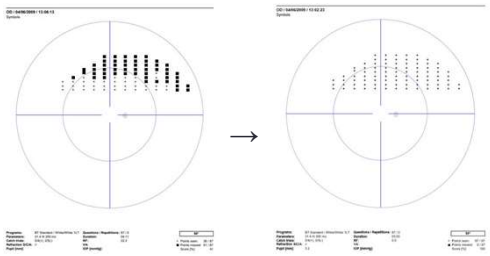
Retinitis Pigmentosa

Disability Exams

- Social Security Administration (SSA) requirements



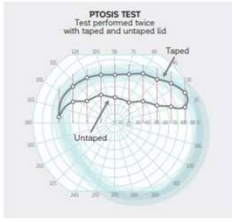
Ptosis Testing

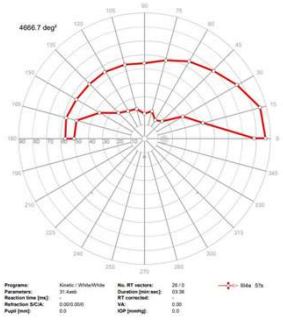


Untaped Taped

Ptosis Testing

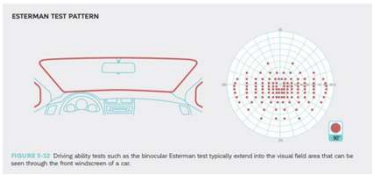
Faster with kinetic





Driving

- Esterman- 120 test points (non-kinetic)
  - Binocular



- Kinetic

	STATIC	KINETIC
LOCATION	Fixed # of predetermined locations	Individual adjustable moving targets
AUTOMATION	Fully automated	Semiautomated
SPATIAL RESOLUTION	Low	High
ACCURACY OF SENSITIVITY THRESHOLD	Higher	Lower
BEST FOR DETECTING	Small changes in sensitivity Changes in central 30°	Small changes in spatial extent Changes in periphery Remaining vision in advanced disease Children defects
COMMON USES	Glaucoma Macular diseases Visual ability	Neuro-ophthalmological conditions Peripheral retinal diseases Low vision Children

References

1. Racette, L., et al. *Visual Field Digest.* 6th ed. Haag-Streit: 2016. Print.
2. Hirasawa, K., & Shoji, N. (2014). Learning Effect and Repeatability of Automated Kinetic Perimetry in Healthy Participants. *Current Eye Research, 39*(9), 928-937. doi:10.3109/02713683.2014.888450
3. Nowomiejska, K., Brzozowska, A., Zarnowski, T., Rejdak, R., Weleber, R. G., & Schiefer, U. (2012). Variability in Isopter Position and Fatigue during Semi-Automated Kinetic Perimetry. *Ophthalmologica, 227*(3), 166-172. doi:10.1159/000333821
4. Nevalainen, J., Paetzold, J., Krapp, E., Vonthein, R., Johnson, C. A., & Schiefer, U. (2008). The use of semi-automated kinetic perimetry (SKP) to monitor advanced glaucomatous visual field loss. *Graefes Archive for Clinical and Experimental Ophthalmology, 246*(9), 1331-1339. doi:10.1007/s00417-008-0828-1
5. Nowomiejska, K., Wrobel-Dudzinska, D., Ksiazek, K., Ksiazek, P., Rejdak, K., Maciejewski, R., . . . Rejdak, R. (2014). Semi-automated kinetic perimetry provides additional information to static automated perimetry in the assessment of the remaining visual field in end-stage glaucoma. *Ophthalmic and Physiological Optics, 35*(2), 147-154. doi:10.1111/opo.12183
6. Nowomiejska, K., Vonthein, R., Paetzold, J., Zagorski, Z., Kardon, R., & Schiefer, U. (2010). Reaction time during semi-automated kinetic perimetry (SKP) in patients with advanced visual field loss. *Acta Ophthalmologica, 88*(1), 65-69. doi:10.1111/j.1755-3768.2008.01407.x
7. Hayreh, S. S. (2005). Visual Field Abnormalities in Nonarteritic Anterior Ischemic Optic Neuropathy. *Archives of Ophthalmology, 123*(11), 1554. doi:10.1001/archopht.123.11.1554
8. Perimetry History. (2008). Retrieved March 30, 2018, from http://webeye.ophth.uiowa.edu/ips/PerimetryHistory/7-comput-perim.htm
9. Hu R, Wang C, Racette L (2017) Comparison of matrix frequency-doubling technology perimetry and standard automated perimetry in monitoring the development of visual field defects for glaucoma suspect eyes. PLoS ONE 12(5): e0178079. https://doi.org/10.1371/journal.pone.0178079
10. Rowe, F. J., Noonan, C., & Manuel, M. (2013). Comparison of Octopus Semi-Automated Kinetic Perimetry and Humphrey Peripheral Static Perimetry in Neuro-Ophthalmic Cases. *ISRN Ophthalmology, 2013*, 1-8. doi:10.1155/2013/753202