Visual Fields: A Virtual Reality

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Financial Disclosures- Ibach

Disclosure Statement:

Alcon – consultant/speaker
Allergan – consultant
Bausch Health- consultant/speaker
C-light Technologies - consultant
Dompe – consultant/speaker
Equinox/Balance Ophthalmics – consultant/shareholder
Glaukos - consultant/speaker
iCare -- consultant
NewWorld Medical – consultant
Sight Sciences – consultant/speaker
Tarsus pharmaceuticals -- consultant
Thea – consultant
Zeiss – consultant

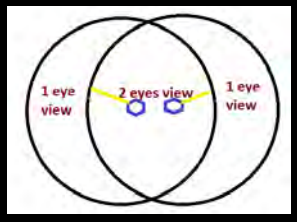
VANCE THOMPSON VISION

All relevant relationships have been mitigated

2

What is a visual field?

- Visual Field (VF) - Everything visible at a single time from one eye



Performing a VF allows examiners to identify field loss in a specific location

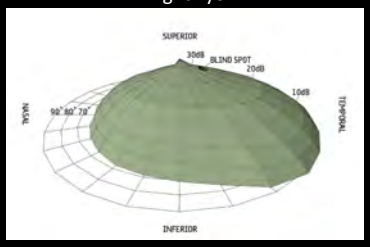
3

What is the Normal Field of Vision?

1. Temporal > 90*
2. Superior = 60*
3. Nasal = 60*
4. Inferior ~ 70*

*relative to a fixation point

Right Eye



Heijl, Anders, et al. *The Field Analyzer Primer: Fifth Edition*. 5th ed., Carl Zeiss Meditec, 2021.

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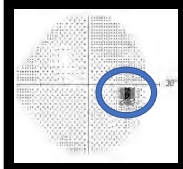
Physiologic Blind Spot – everyone has one



Physiologic Blind Spot - absolute scotoma (no sensitivity to light)

- Location of the optic nerve (ON) entering the eye (15* nasal)
- Optic nerve lacks photoreceptors
- Located 15* temporal to fixation
- Avg. blind spot is 7.5*

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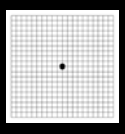
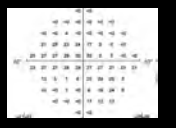
Types of Visual Field

Amsler Grid → Testing macular/GCC function Central 10*



Confrontational VF → Screening test

Perimetry → Automated and manual Commonly 20*, 48*, 60*



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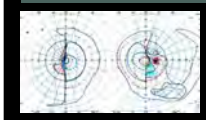
Perimetry




- Kinetic Perimetry - Test object is moved, but brightness and size are fixed.
  ie: Goldmann Perimetry and Tangent Screen
- Static Perimetry - Test object is fixed, but brightness and size are varied.
  ie: HFA, Octopus VF, Headset VF

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Standard Automated Perimetry (SAP)

Quantifies the sensitivity of a patient's peripheral vision (Not all or none)

- Standardized testing algorithms
- Quantifiable threshold test (grading)
- Measures 30* from fovea/fixation


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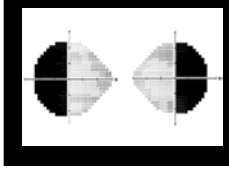
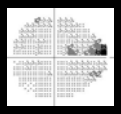
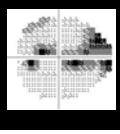
2 Goals of Perimetry

Detect and Diagnose Visual Field Abnormalities

Determine progression of Visual Field Abnormalities

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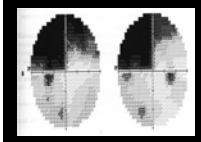
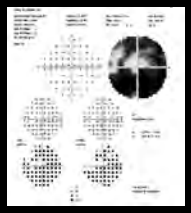
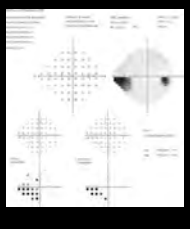
Conditions that may require VF's

Neurologic diseases **Retinal diseases** **Glaucoma**

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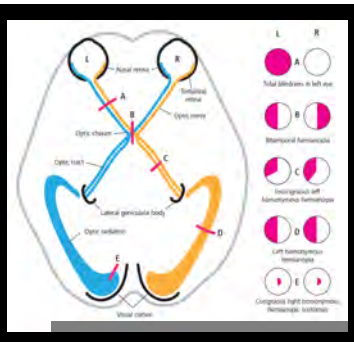
Neurologic - Understanding the Visual Pathway

1. Retina damage can be partial scotomas

2. Optic chiasm and posterior = bilateral VF loss (B)

3. More posterior damage = more congruent (matching) defects



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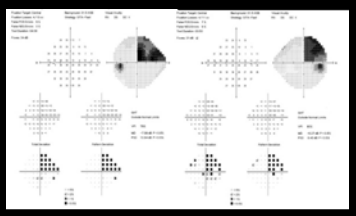
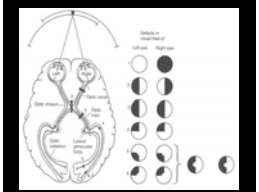
Where is the Cut/damage?

https://casebasedneuroophthalmology.pressbooks.com/chapter/superior-homonymous-hemianopia/

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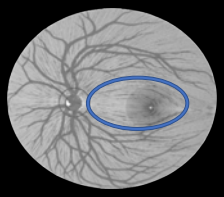
Retina VF Loss

- Monocular VF loss
- Commonly more central VF loss
  - 60-70% of optic nerve fibers compose the macular region



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Glaucoma VF Loss

- Definition of glaucoma includes the VF
- Perimetry is the #1 way to assess VF
- #1 goal of glaucoma therapy is to preserve VF and ultimately visual acuity (VA)

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Visual Fields: **Fact**

- AOA Clinical Practice Guidelines
- AAO Preferred Practice Patterns
  - Performed at diagnosis
    - 3 tests in first 1-2 years
  - Performed at least yearly
  - More frequently (q4-8m)
    - High Risk, High IOP, Progression

The Frequency of Visual Field Testing in a US Nationwide Cohort of Individuals with Open-Angle Glaucoma

Baseline 10-2 Visual Field Loss as a Predictor for Future Glaucoma Progression

Viability of Performing Multiple 24-2 Visual Field Examinations at the Same Clinical Visit: The Frontloading Fields Study (FFS)

Ability of 24-2C and 24-2 Grids to Identify Central Visual Field Defects and Structure-Function Concordance in Glaucoma and Suspects

More than **75%** of enrollees with OAG received **< 1 visual field test per year** and, thus, did not receive guideline-adherent glaucoma monitoring.

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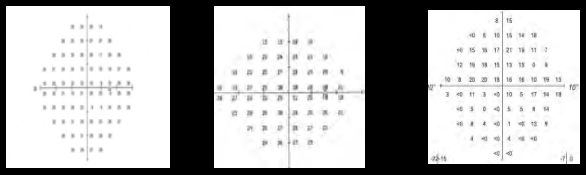
Zeroing in on Threshold VF's for Glaucoma

30-2 Test	24-2 Test	10-2 Test
76 test points, 6* spacing	54 test points, 6* spacing	68 test points, 2* spacing



Heiji, Anders, et al. *The Field Analyzer Primer: Fifth Edition*. 5th ed., Carl Zeiss Meditec, 2021.

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If Fast is Good, Faster is Better

VR Headset fields aim for similar testing times

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A New SITA Perimetric Threshold Testing Algorithm: Construction and a Multicenter Clinical Study

30.4% shorter than SITA Fast
53.5% shorter than SITA Standard

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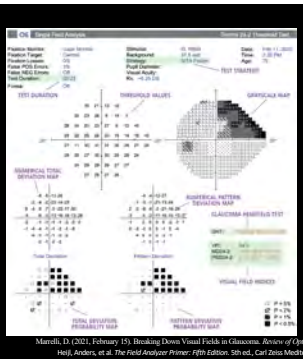
Analyzing a Threshold VF

1. Fixation losses – poor fixator <30%, or restart
2. False Positives: happy clicker < 15% or repeat
3. False Negatives: bored sleeper <20%



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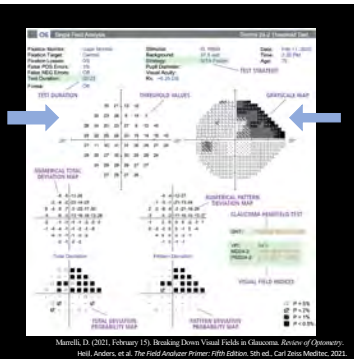
Analyzing a Threshold VF

1. Threshold values: measured decibel sensitivity at each point
2. Gray scale: Patient education map Darker areas equals less sensitivity



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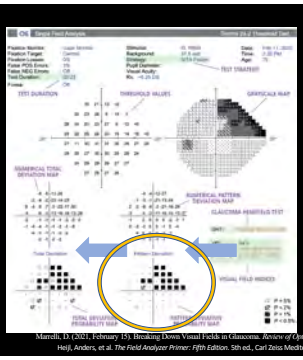
Analyzing a Threshold VF

1. Total Deviation: deviation from age-matched normal on each test point
2. Pattern Deviation: deviation measured in decibels but removes distractors
3. Probability maps: TD and PSD→ plots statistical significance of missed points



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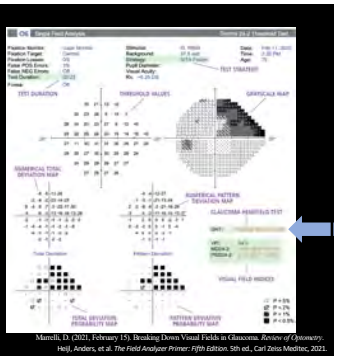
Analyzing a Threshold VF

1. GHT: compares mirror image clusters of points above and below midline
2. MD-24: weighted average of values in TD plot
3. Visual Field Index (VFI): enhancement of MD with emphasis on central field
4. PSD-24: summarizes VF loss but ignores general depression



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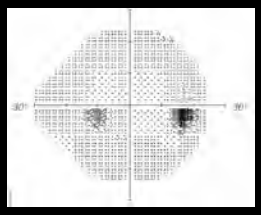
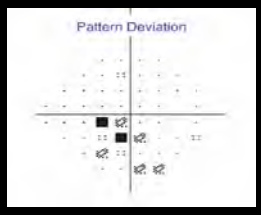
Common Glaucomatous Visual Field Defects

Paracentral Scotoma/Defect





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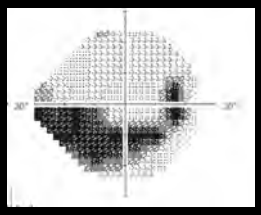
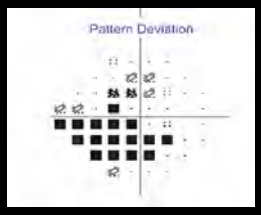
Common Glaucomatous Visual Field Defects

Arcuate Defect: Bjerrum scotoma





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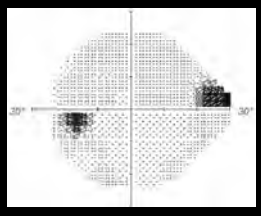
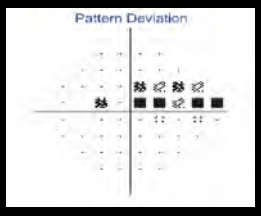
Common Glaucomatous Visual Field Defects

Nasal step defect





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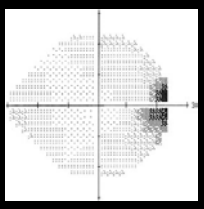
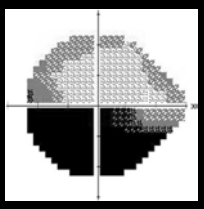
Less Common 1* Glaucomatous VF Loss

Temporal wedge



Altitudinal defect



Wall, M., Lee, E., Warunek, R., Chong, L., & Turpin, A. (2020, March). Temporal Wedge Defects in Glaucoma: Structure/Function Correlation With Threshold Automated Perimetry of the Full Visual Field. *Journal of Glaucoma*, *29*(3).

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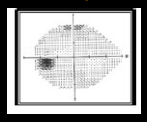
What Stage of VF Loss?

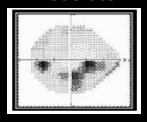
American Glaucoma Society /AAOphthalmology PP Guidelines

Mild



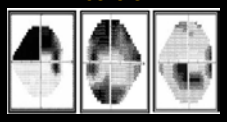
- ONH abnormalities
  &
- No VF loss
- Screening VF loss Ok

Moderate



- ONH abnormalities
  &
- GL VF loss 1 hemifield
- No VF loss within 5* fixation

Severe



- ONH abnormalities
  &
- GL VF both hemifields
  &/or
- VF loss within 5* fixation

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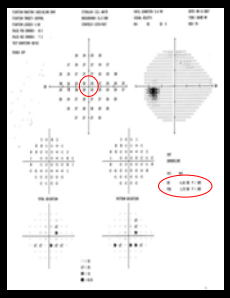
Hoddapp-Parrish-Anderson: Mild

MD < -6dB

PD Plot – less than 14 points are depressed below the 5% significance level and fewer than half of those points are depressed below the 1% level

None of central four points has sensitivity of <15dB



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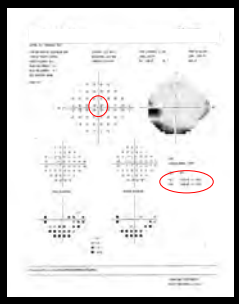
HPA: Moderate

MD -6dB to -12dB

PD Plot – 14 -28 points are depressed below the 5% significance level or 8-16 points are below the 1% level

One central point measures < 15 dB



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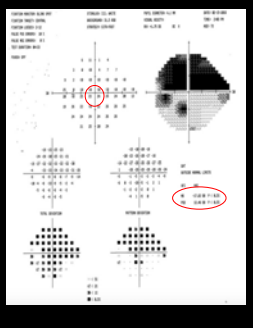
HPA: Severe

MD > -12db

PD Plot – 28 points or more are depressed below the 5% significance level or more than 16 points are below the 1% level

Any one central point at 0 dB

Both Hemifields in central 5 degrees <15dB



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What is VF Progression?

- How many fields are needed?
  - Event based– can detect worsening on 2 fields
  - Trend based– Need minimum 3 tests
- What is the gold standard for VF progression?
  - See picture
  - Negative rate change 1db/year minimum 2 tests/year
  - Rapid progression 2db/year minimum 6tests/year

Aref, A., & Budenz, D. (2017, December). Detecting Visual Field Progression. *Ophthalmology*, *124*(12)

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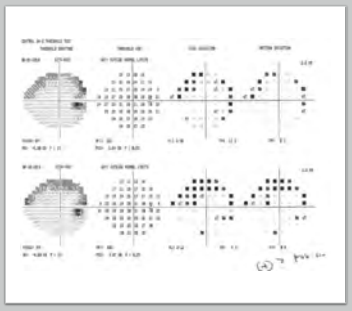
Manual Progression Analysis

1. MD and PSD quantitative values
2. PSD Plot
3. **Compare to structure**



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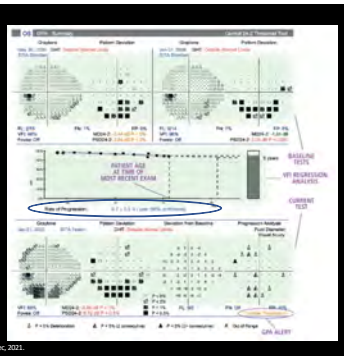
Guided Progression Analysis (Zeiss)

1. 3 tests needed to assess
2. Focus on glaucoma shifting from "Is there progression," to "What is the rate of progression?"



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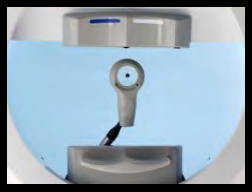
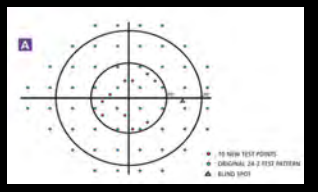
What's New in Visual Field Testing?

Humphrey Field Analyzer





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Current Potential Problems

- Bottleneck to clinic flow
- Declining reimbursements
- Requires dedicated room & lighting
- Reduced patient comfort, positioning

Virtual VF Solutions

- Improved efficiency with multiple devices
- Allows for potential home testing and telehealth
- No dedicated room/space needed
- Automated tests, easier on patient positioning

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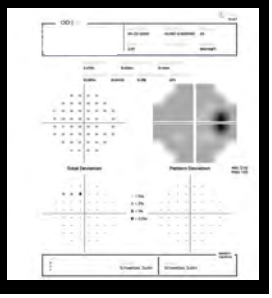
Portable Wearable VR Testing



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VR Perimetry

Preliminary Report on a Novel Virtual Reality Perimeter Compared With Standard Automated Perimetry

Visual Field:
- All common protocols e.g. 24-2, 10-2, 30-2, etc).
- Testing time is about 3 minutes for threshold and 45 seconds for screening.
- 24-2c protocol which combines 24-2 and key 10-2 locations.
- Ptosis, Esterman.

Additionally:
- Visual Acuity (near and far acuity).
- Color Vision (D-15).
- Pediatrics Visual Field.
- Contrast Sensitivity.
- LCVA (Low Contrast Visual Acuity)

J Glaucoma 2021;30:17–23

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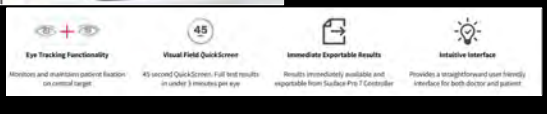
HM Perimetry (+)

- **Perimetry**
  - **Multiple tests**
- **Contrast Sensitivity**
- **Color Vision**
- **Dark Adaptation**



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And Another:

ORIGINAL STUDY

Reliability of Visual Field Testing in a Telehealth Setting Using a Head-Mounted Device: A Pilot Study

Preliminary Retrospective Validation of a Novel Virtual Reality Visual Field Standard Testing Algorithm, as Compared to Standard Automated Perimetry

Feasibility of Telehealth Perimetry Using a Head-Mounted Device in Eyes with Stable Defects

AAO Annual Meeting, September 30 - Oct 03, 2022
McLaughlin O, Munshi N, Sawatovsky E, Varner E, Grajewski AL

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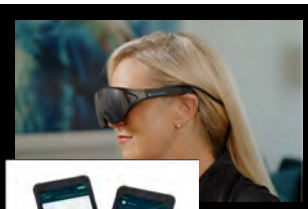
Very Light



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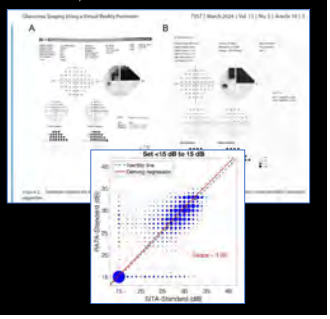
NOVA Trial (uses bowl std background illumination)

Validation of a Wearable Virtual Reality Perimeter for Glaucoma Staging, The NOVA Trial: Novel Virtual Reality Field Assessment



Translational Vision Science & Technology March 2024, Vol.13, 10. doi:https://doi.org/10.1167/tvst.13.3.10

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Watch Outs

1. Limited to mid-range stimuli (less very dim and very bright stimuli)
2. Brighter background illuminance
3. Need more data

Hoepf M, Chaglasian M, Review of Optometry Feb 2024

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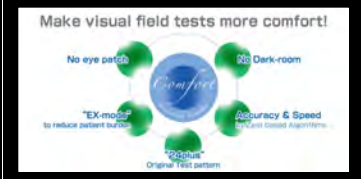
Table Mounted but No Bowl. Best of Both Worlds?



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Objective instead of Subjective test?

- mfPOP | Multi-Focal Pupillographic Objective Perimetry
- Bilateral exam (NOT Binocular)
  - Dichoptic presentation
  - Fused into a cyclopean view
- Pupil Light *Response* (NOT Pupil Light *Reflex*) No patient response
- Binocular test ~7min

Like a Multi-focal ERG/VEP but no electrodes

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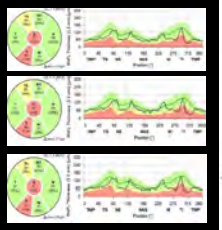
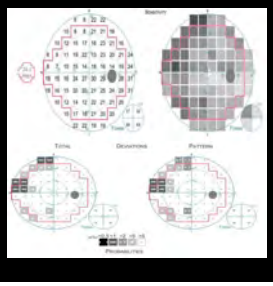
"I Never Trust That Visual Field"

IOP: 16, 17

: 13, 14

: 18, 15





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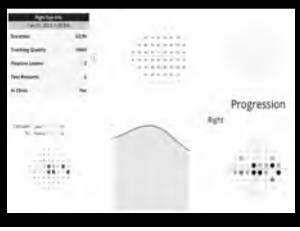
At Home Testing? Home VFT

A fully software driven, "game-ified" testing system that is more comfortable and convenient for the patient, and connects them to their practitioners.

Patient Test Portal

Doctor Analytics Portal



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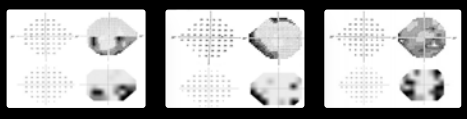
At Home Testing? Home VFT

HFA printout

VFT printout



1. 190 tests, 36 eyes, 19 patients
2. All had baseline HFA
3. PRX-VFT detection of abnormal (sensitivity) 96%
4. PRX-VFT detection of normal (specificity) 79%
5. "PRX-VFT was easier and more fun"


Clinical Ophthalmology

Dovepress

ORIGINAL RESEARCH

Peripherex Home Visual Field Demonstrates High Test-Retest Reliability, Validity

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Which is better, 1 or 2, or 3?

52

Visual Field Pearls

Perimetry allows function assessment

Neurologic d**E**fects are bilateral

Retinal defects **A**re monocular

match pe**R**imetry to nerve cupping

Wearab**L**e Devices compare well to HFA

Visual field**S** are a must in glaucoma

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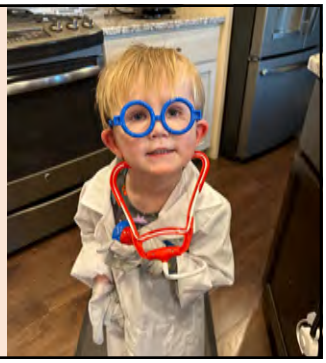
Thank You

mitch.lbach@vancethompsonvision.com



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