ABSTRACT

Previous prism corrections to help tunnel-vision patients (e.g., InWave™ lens) are based on image shifting principles. Prisms are mounted around a central clear portion of the carrier lenses with the prisms' bases directed away from the lens center (Apex-Center). The prisms are fitted binocularly for patients with two functional eyes.

The effect of such a design is to shift images more centrally when the eyes move into the field of the prisms but they do not increase the visual field. In addition, these prisms cause an optical ring scotoma around the primary position of gaze.

I propose a Tri-Field lens correction for binocular tunnel-vision patients. Two (Fresnel) prisms are mounted horizontally with their bases (Base-Center) or apexes (Apex-Center) in the middle of one lens, in front of the eye with lower acuity. The prisms' power is larger than the horizontal dimension of the wider visual field.

While the eye with better acuity scans the environment as freely and effectively as before the treatment, the eye with lower acuity is brought into the field of one prism or the other. The residual visual field of that eye is presented with a segment of the scene shifted by the prism that does not overlap with the segment seen by the better eye.

Since the scene segments seen by the two eyes do not overlap, the patient does not have double vision (diplopia). Instead, the patient sees the two separate scenes superimposed (confusion).

The separate eye views are distinguishable due to differences in chromatic dispersions and prismatic spatial distortions, enabling the patient to correctly identify the image source and potentially adapt to the prismatic shift.

An increase in the patient's instantaneous visual field at all positions of gaze can be demonstrated with standard perimetry.

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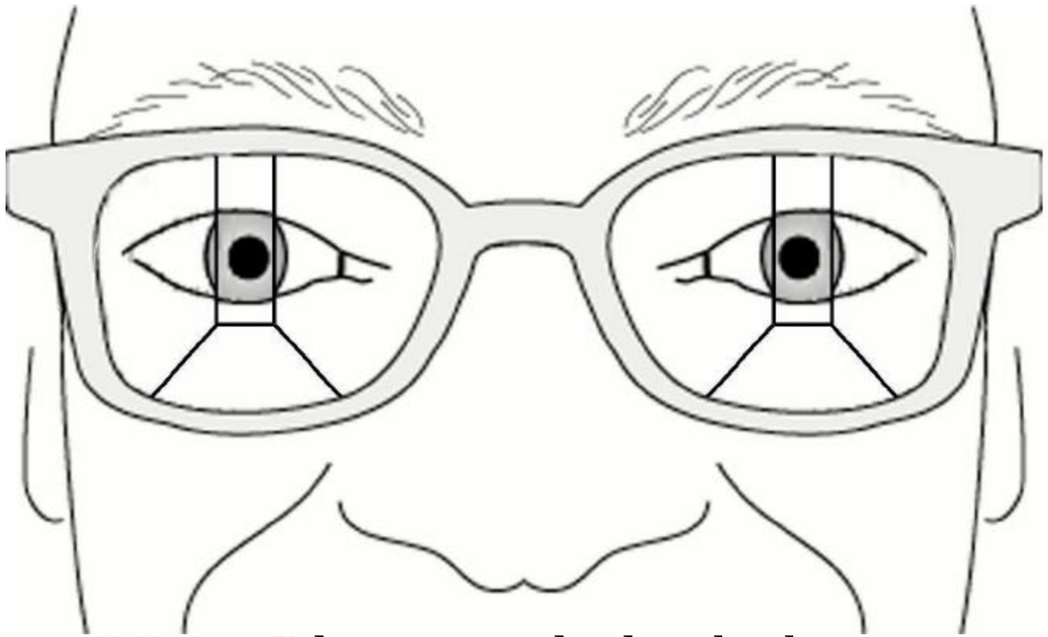
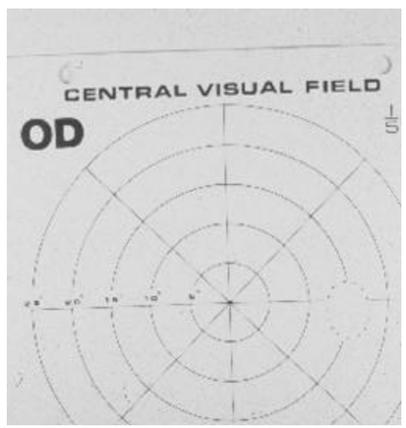
URL: http://www.eri.harvard.edu/faculty/peli/index.html

PREVIOUS PRISM APPROACHES

- InWave™ design and others
- Based on image shifting
- Does not increase visual field
- Fitted binocularly for binocular patients
- No effect in primary position of gaze
- Shifts the scene view more centrally on eccentric gaze
- Weak prism (12, about 6° of shift)
- "Jack in the Box" scotoma at the apex of the prisms



InWave™ lens is applied to both eyes. All prisms are apex-centered. No prism in the central channel.



Without Prism

With InWave™ Prism

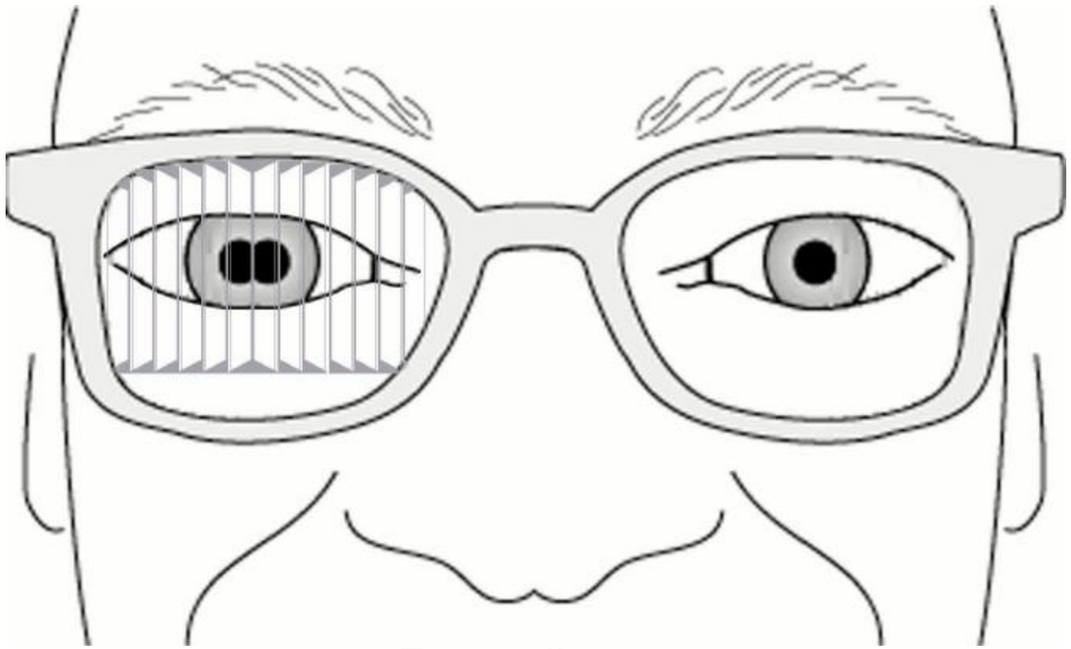
Without Prism

With InWave™ Prism

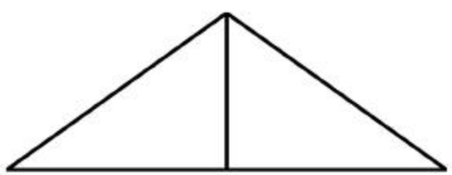
Photographs taken with and without InWave™ lens in front of camera lens

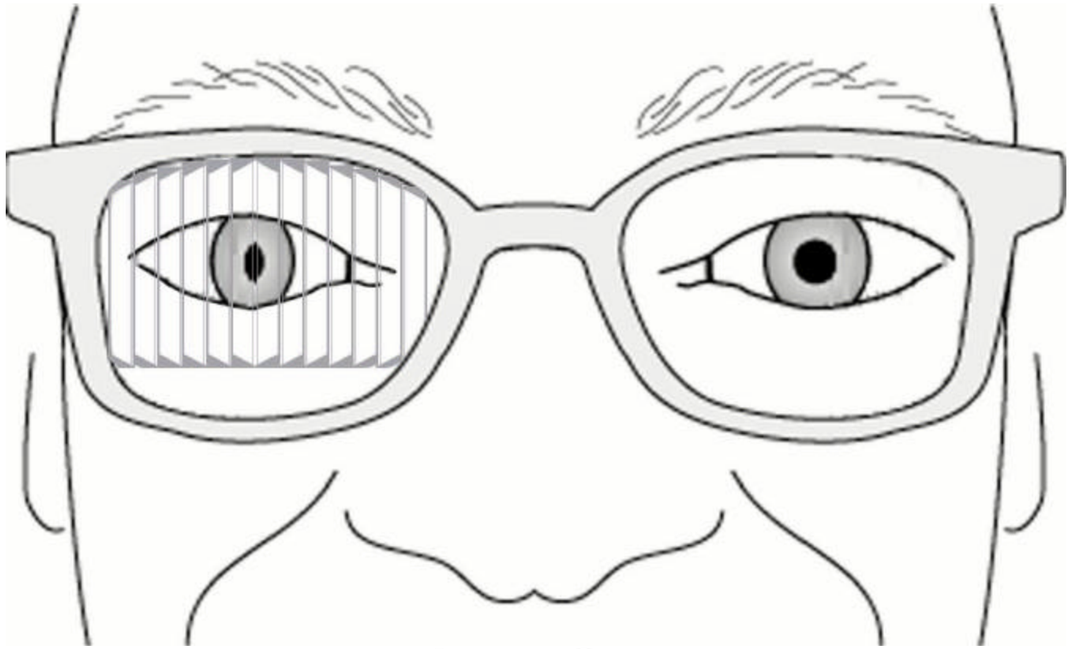
THE TRI-FIELD LENS

- For patients with 2 functioning eyes of about equal acuity
- Fitted monocularly over the worse eye
- Bi-ocular multiplexing
- Two possible designs – Base-Center or Apex-Center
- Lower segment clear for reading and stairs



Base-Center





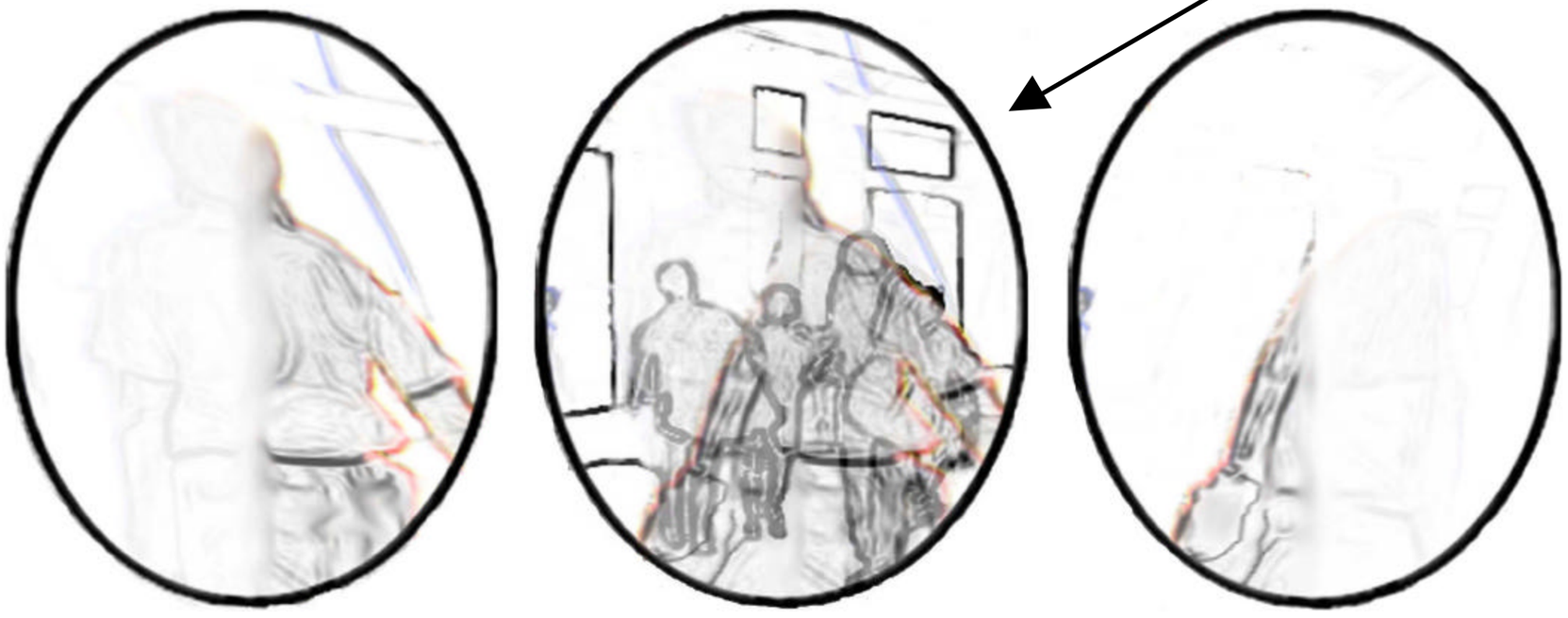
Apex-Center

- The better eye scans the environment as always
- An additional segment of the scene is brought into view by one of the prisms
- Prism power [in degrees] is larger than the sum of the two eyes' horizontal visual fields
- The two visible scene segments are not overlapping – no diplopia
- Normal observer will have diplopia (even triplopia)
- The images in both eyes are foveal, projecting to the same direction (confusion)
- The prism image is distinguishable due to prism distortions and color fringes
- No "Jack in the Box" phenomenon (one eye is unaffected by prism)
- Expect situational adaptation (Kohler, 1964)

Simulation of the appearance in Kohler's (1964) experiment

Simulated Appearance with the Tri-Field Glasses

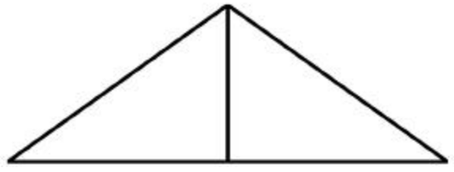
- In primary position of gaze each prism contributes to half the visual field
- Half an image from each prism is superimposed onto the non prism image
- The specific half-images depend on the format (Apex vs. Base)



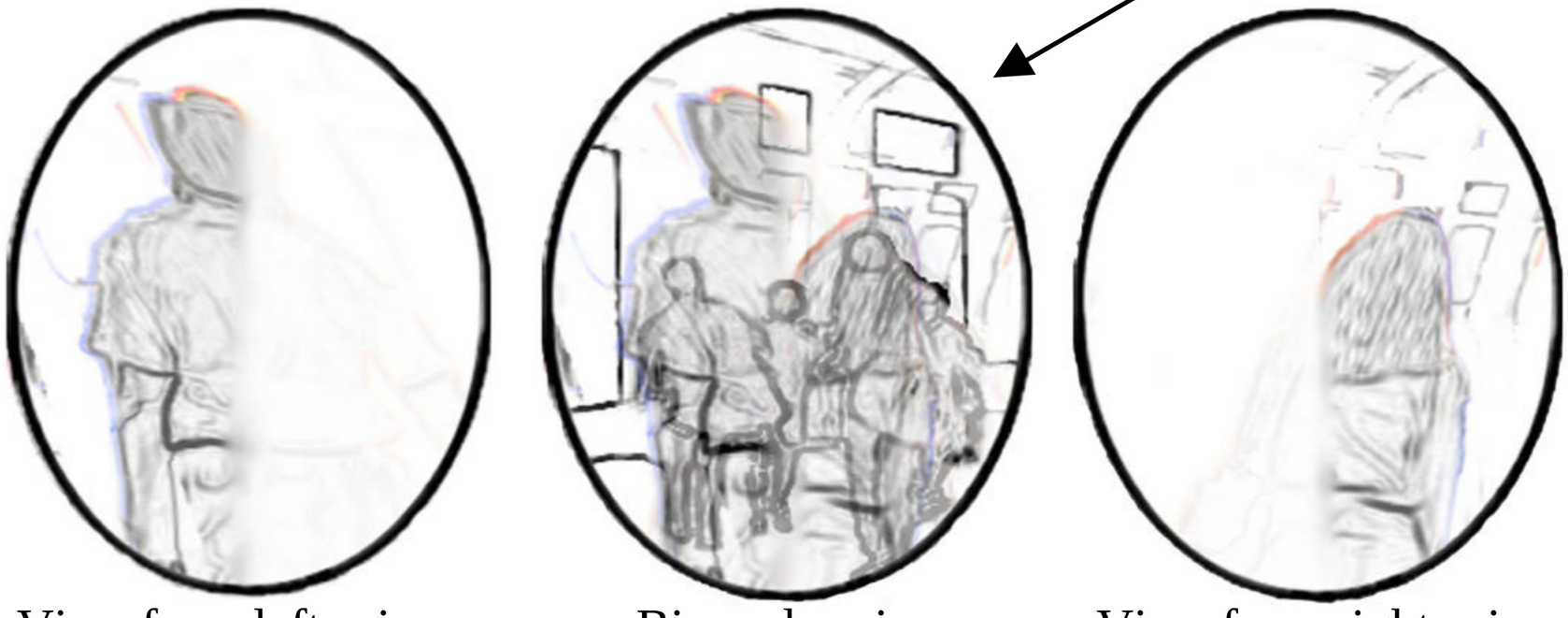
View from left prism | Binocular view | View from right prism

View without visual aid

Views with the Tri-Field lens (Base-Center) in primary position of gaze

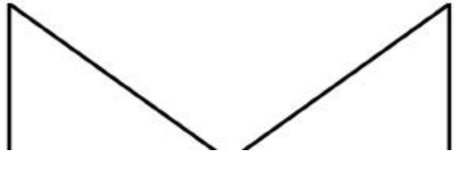


View without visual aid

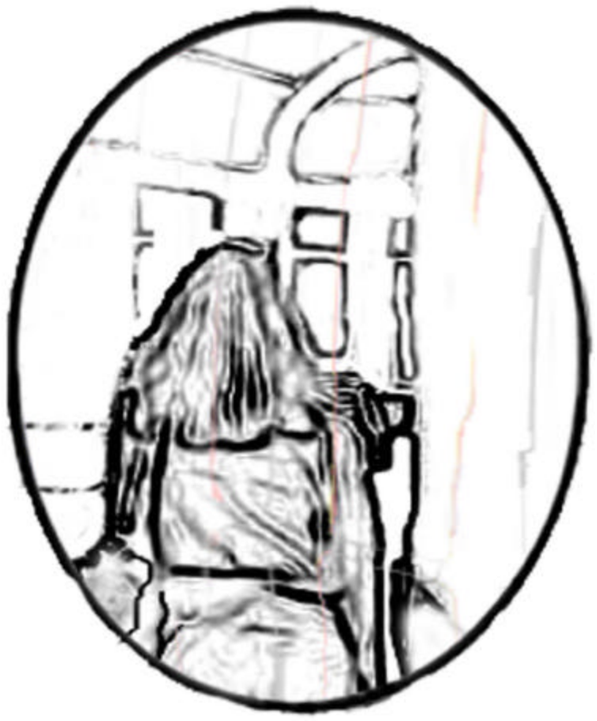


View from left prism | Binocular view | View from right prism

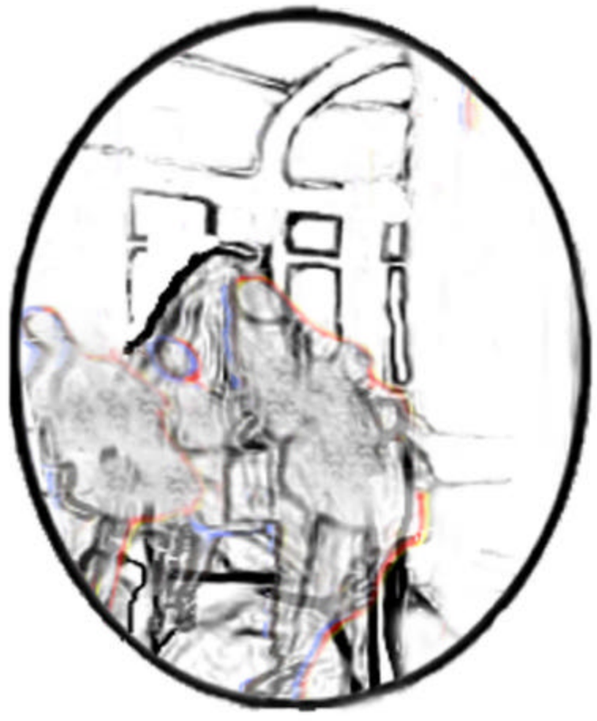
Views with the Tri-Field lens (Apex-Center) in primary position of gaze



When looking to the right with the Apex-Center design a scene segment further to the right will be seen through the prism



Apex-Center,
Right gaze



Base-Center,
Right gaze

When looking to the right with the Base-Center design a scene segment further to the left (more centrally) will be seen through the prism

- The Apex-Center design may be more intuitive and therefore adaptation may be easier
- The Base-Center design is presumed to be advantageous in obstacle avoidance

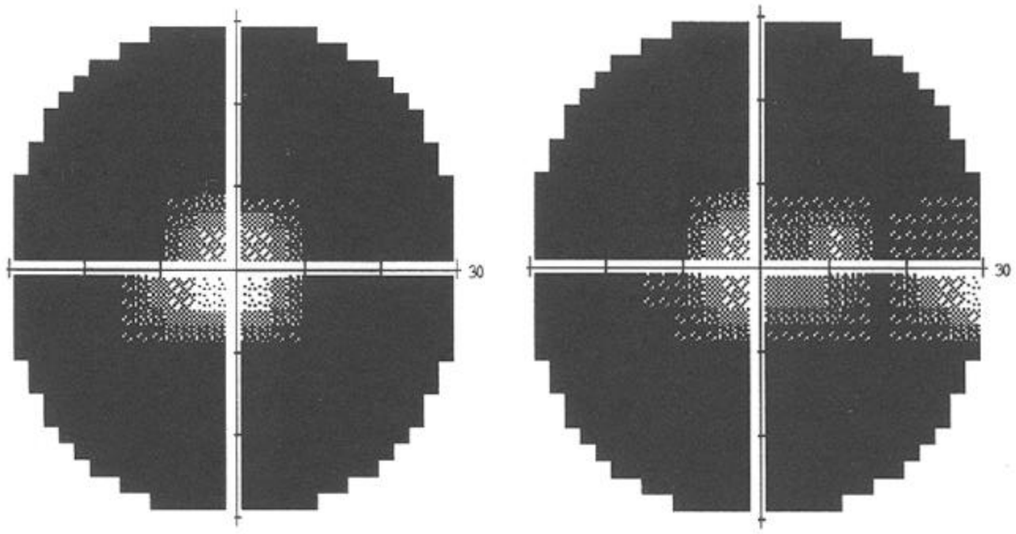
SEE the video simulations here or on the web at

http://www.eri.harvard.edu/faculty/peli/index.html

PRELIMINARY CASE REPORTS

- Binocular visual field (Humphrey 30-2) with and without Tri-Field lens

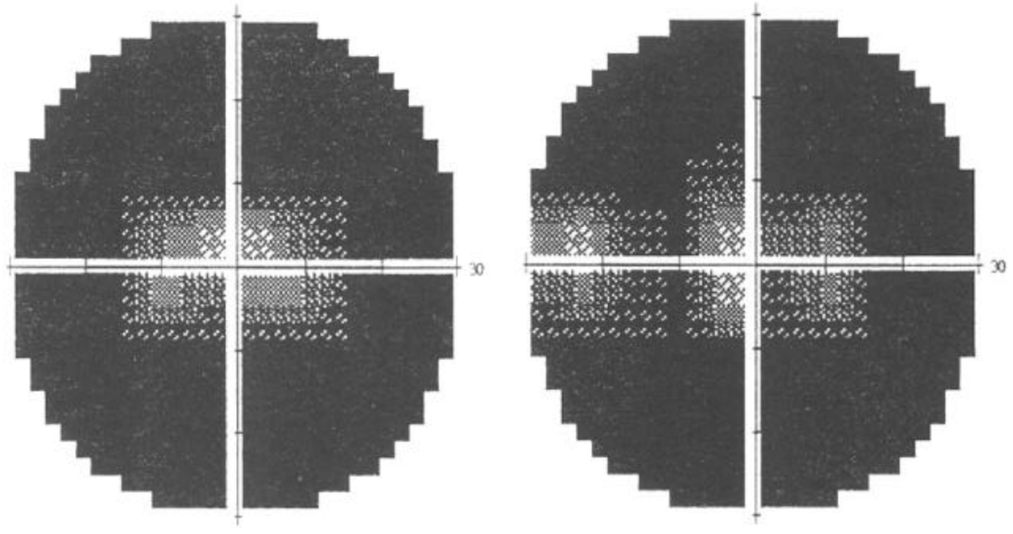
SUBJECT: HA



Binocular Without Prism

With Prism Tri-Field 25 Apex-Center

SUBJECT: RS



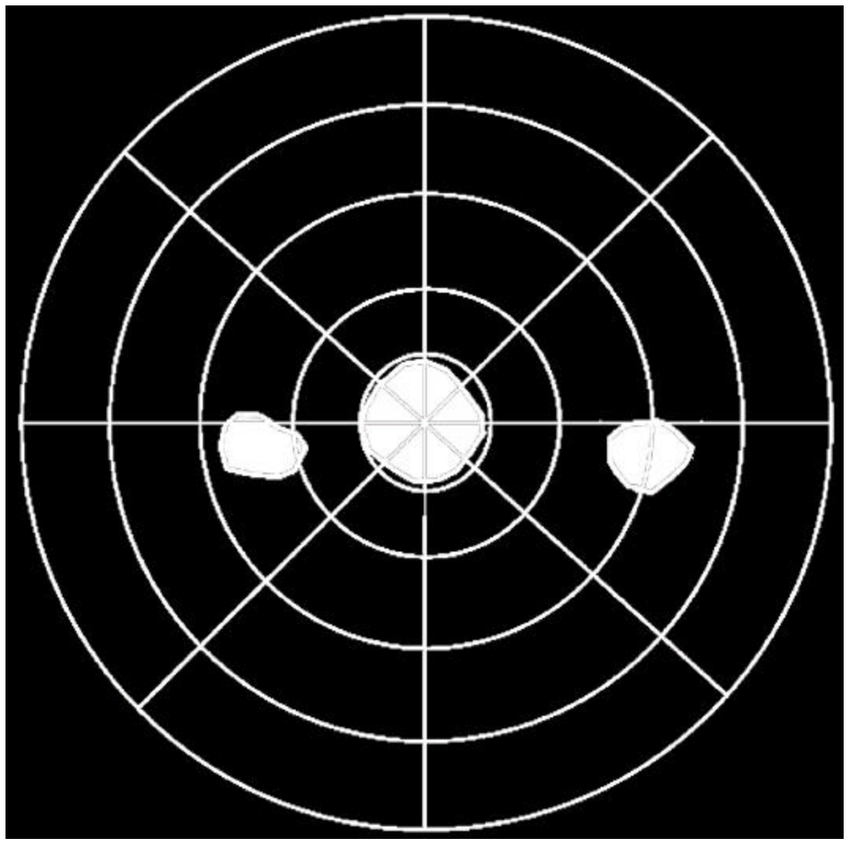
Binocular Without Prism

With Prism Tri-Field 25 Apex-Center

- Only one additional view is usually recorded

- Adaptation is slow
- Reduced acuity through the Fresnel lens – more severe for RP patients than for normal observers
- The two views may be recorded by changing head position during perimetry

SUBJECT: HA



Binocular field with Tri-Field lens; 25 Apex-Center

Future Work

- Measure adaptation of perception of visual direction with a pointing task
- Verify adaptation by measuring an after effect
- Evaluate mobility and obstacle avoidance in natural and virtual environments
- Evaluate impact of the Tri-Field lens correction on quality-of-life
- Try better quality lenses (e.g. InWave™) for better vision and better cosmesis

References

Kohler, I. (1964). The formation and transformation of the perceptual world. *Psychol Issues* 3(4), 14-173.

Acknowledgements

Alex K. Nugent created the video simulations.