Monocular Bioptic Telescopes May Not Be A Hazard When Driving

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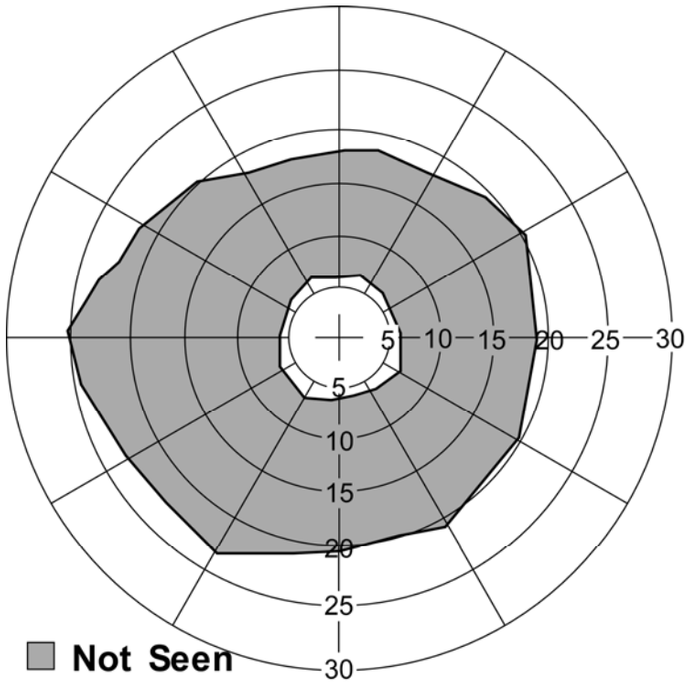
Background

- Bioptic telescopes enable people with poor visual acuity to see details at distance
- Bioptics are permitted for driving in 39 states in the US
- There is little scientific basis for allowing or restricting them[1]

Bioptic users view below the telescope most of the time.

To see detail, users make brief glances through the bioptic by a downward tilt of the head.

Driving with Bioptics is Controversial

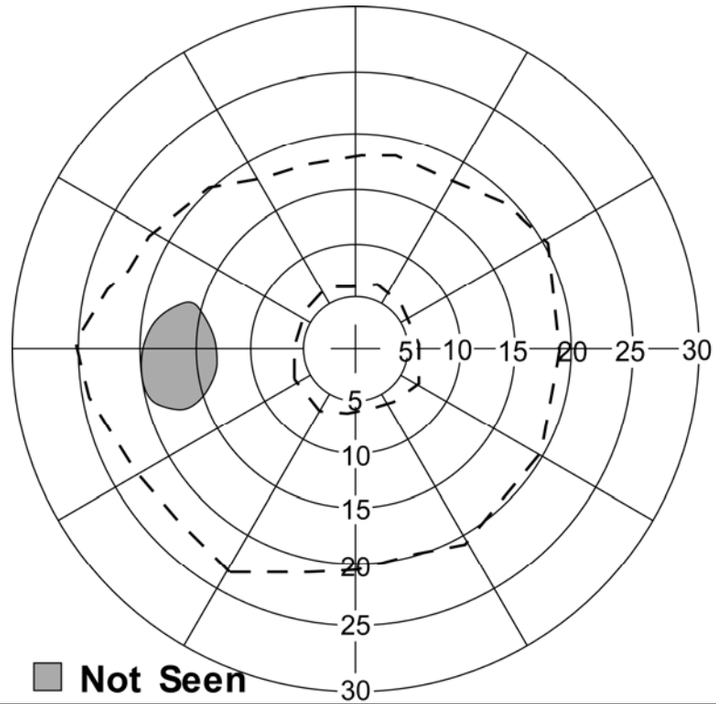


Magnification of the bioptic causes a ring scotoma (blind area) around the magnified field of view

(MONOCULAR visual field of 3x Ocutech mini bioptic on the right eye)

Some believe that the ring scotoma causes the driver to be blind to traffic when viewing through the bioptic.

(Simulated view of a street scene through a bioptic; the intersection is blocked by the ring scotoma)



Others argue that the ring scotoma is not a hazard as the fellow eye is not blocked.

(BINOCULAR visual field of a monocular bioptic. The area of overlap of the left eye's physiological blind spot and the ring scotoma remains unseen)

Complex Conditions

- Observers can use the fellow (non-telescope eye) to detect objects presented in the ring scotoma area on simple backgrounds used in conventional perimetry.[2-4]
- The difference in image size (magnified view through bioptic, unmagnified view with fellow eye) may cause rivalry or suppression on complex backgrounds.
- Using a bioptic while driving requires active viewing (reading signs).
- Greater attentional load associated with active viewing may reduce the ability of the fellow eye to detect objects in the ring scotoma area.

Research Questions

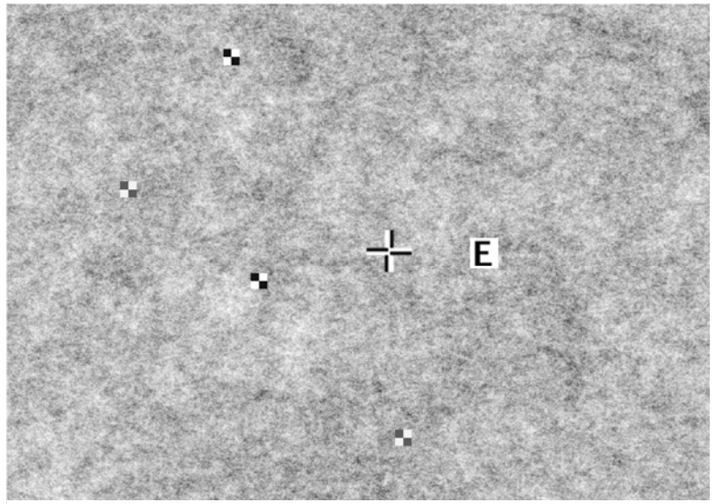
1. What effect does a MONOCULAR bioptic have on the ability of the fellow eye to detect stimuli presented in the ring scotoma area?
2. What effect does background complexity (plain, structured noise) have on this ability?
3. What effect does task (passive, active) have on this ability?
4. What effect does experience using a bioptic have?

Parameters

- **Background**
  - **Simple:** Gray
  - **Structured:** $(1/f)^{0.75}$ noise (similar characteristics to natural scenes)
- **Stimulus**
  - 1° 2x2 black and white checkerboard
- **Fixation Targets**
  - **Passive:** looking at bipolar cross (0.5° thick, 2.9° length and height)
  - **Active:** reading letters changing every 2 s (black letters on white square)
    - With bioptic letters were 0.7° or 1.0°
    - Without bioptic letters were 1.8° or 2.2°

Natural Scene – not used

Not used because visibility of stimuli varies across the image.

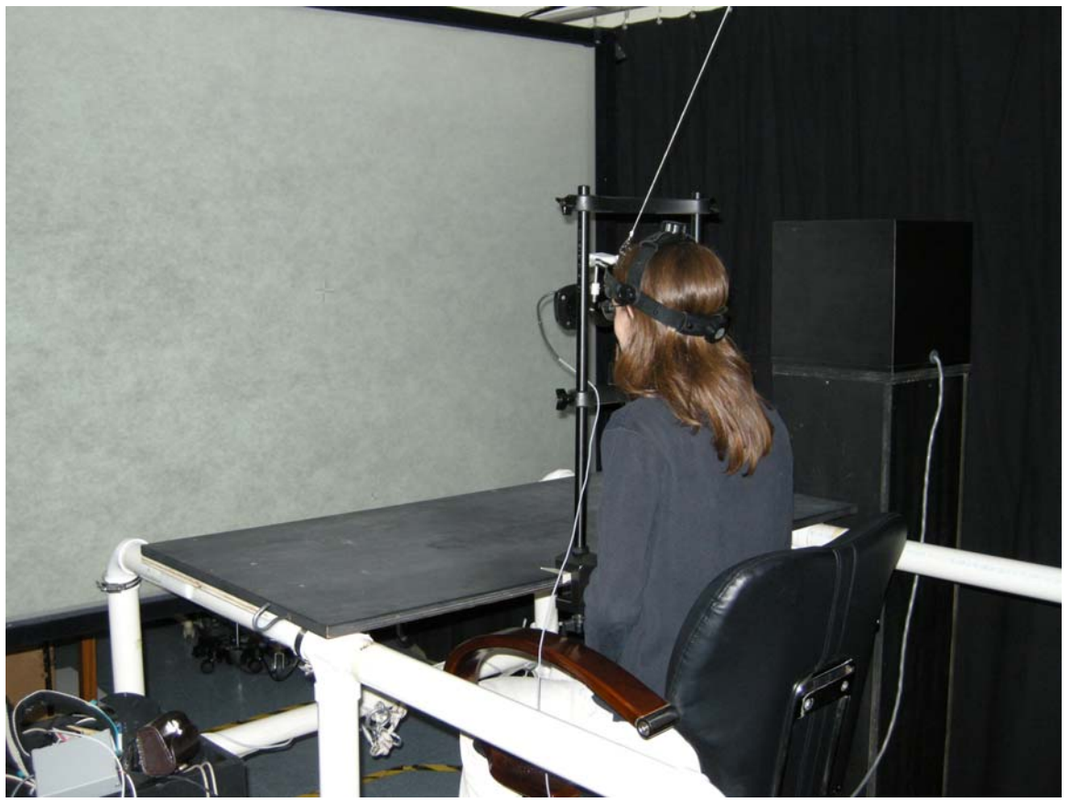


$(1/f)^{0.75}$ noise image - used

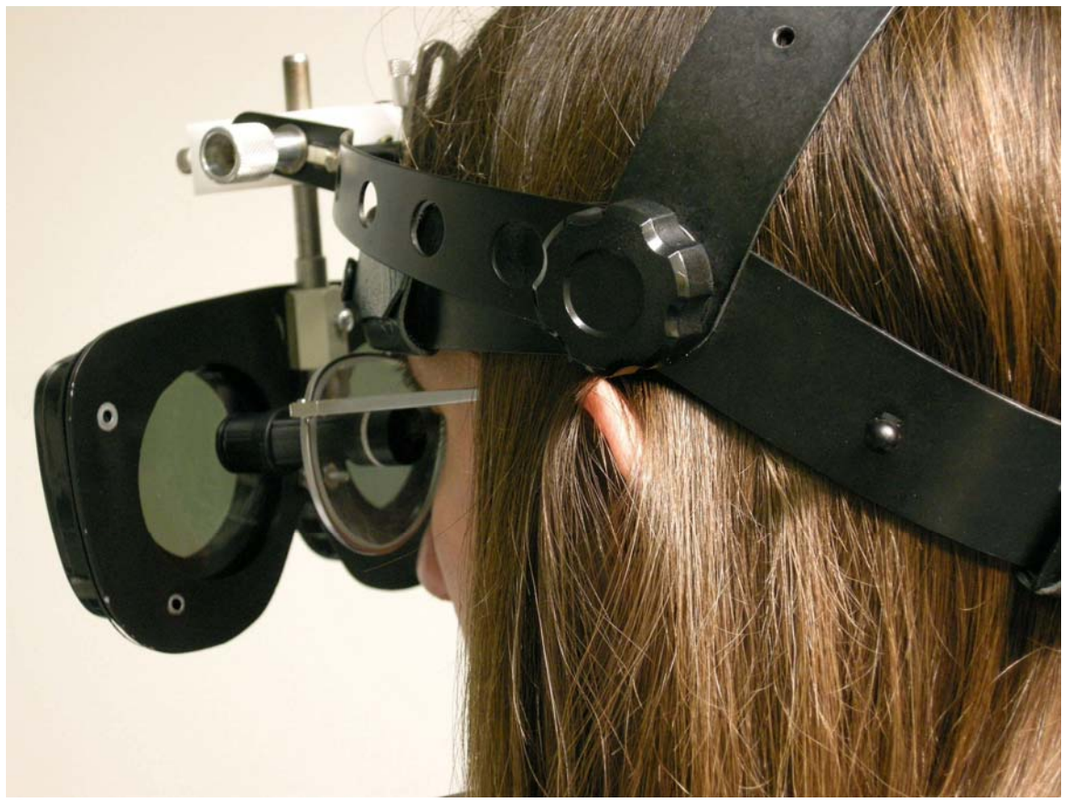
Used because stimuli are almost equally visible across the noise image.

Apparatus

- Visual fields were measured using a novel dichoptic perimeter,[5] allowing us to map what each eye sees under **BINOCULAR** viewing.



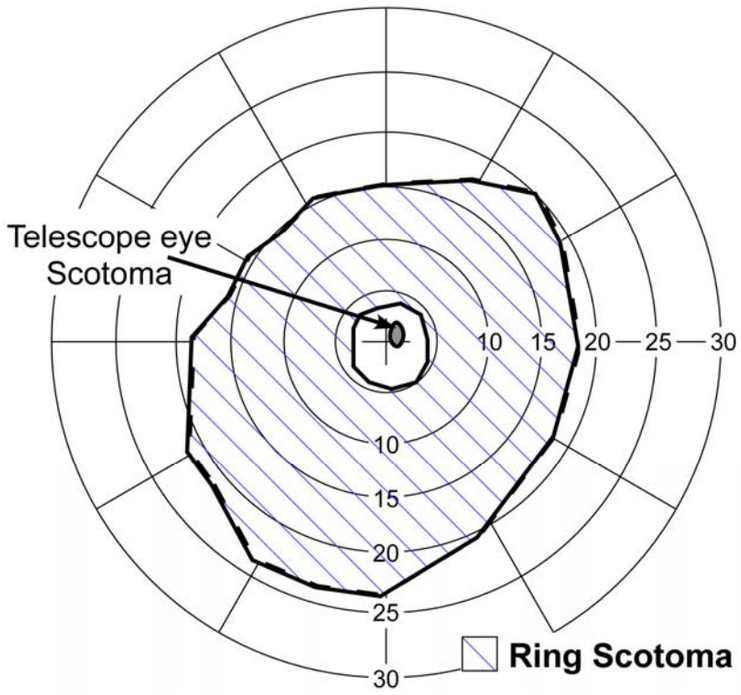
Subjects sat 1 m from the screen where the fixation target and stimuli were presented.

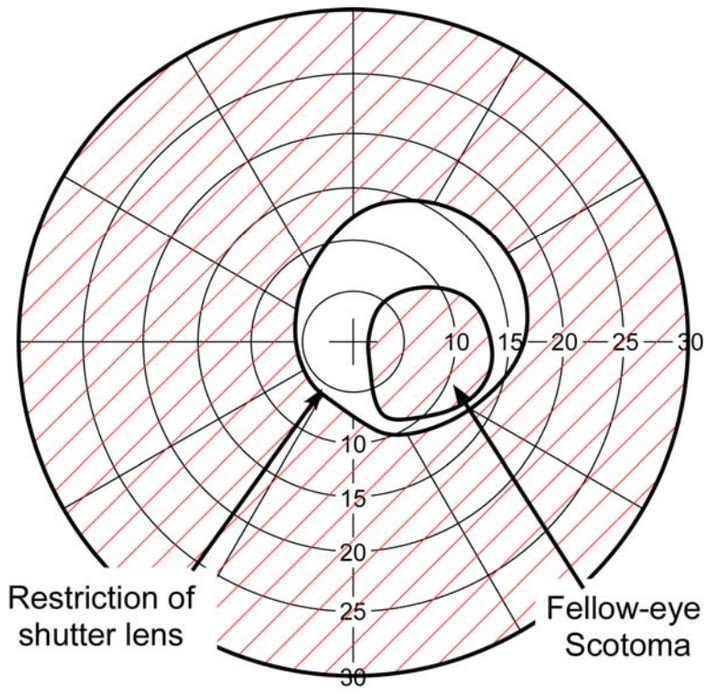


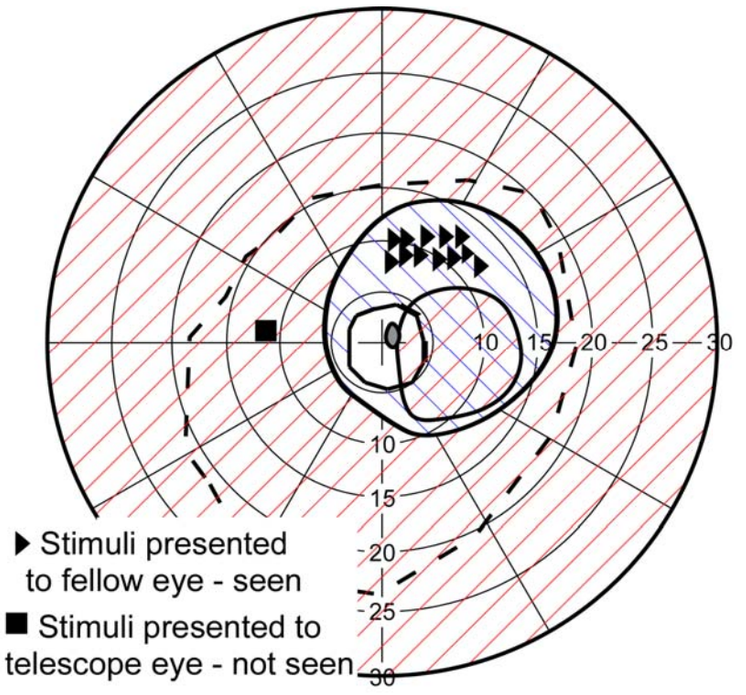
Subjects wore a modified indirect ophthalmoscope headband with shutter lenses suspended forward for the telescope to fit behind.

Visual Fields with Bioptic

Bilateral AMD subject wearing an Ocutech 3x mini bioptic on left eye







Monocular viewing without shutter lenses
Ring scotoma of the telescope. The patient's scotoma appears minified through the bioptic.

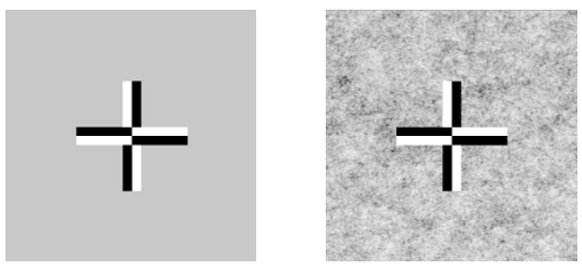
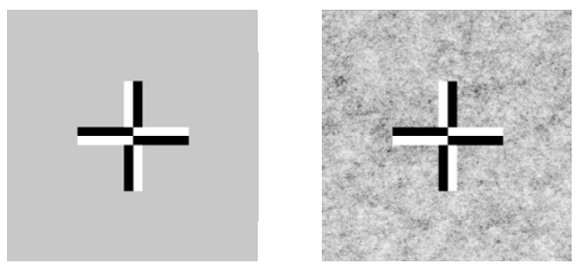
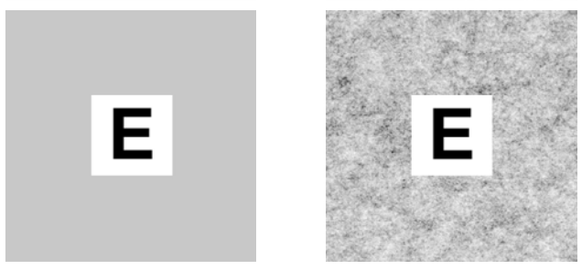
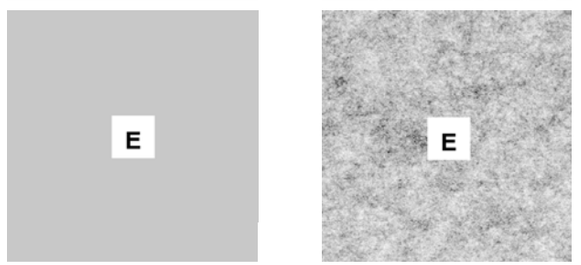
Binocular viewing with shutter lenses
Fixation and background to both eyes

Target to fellow eye only
Patient's fellow-eye scotoma and the restriction in visual field size due to the shutter lens.

Target to fellow eye then telescope eye Stimuli were positioned in the ring scotoma area in an area seen by the fellow eye.

Fellow-Eye Detection Test

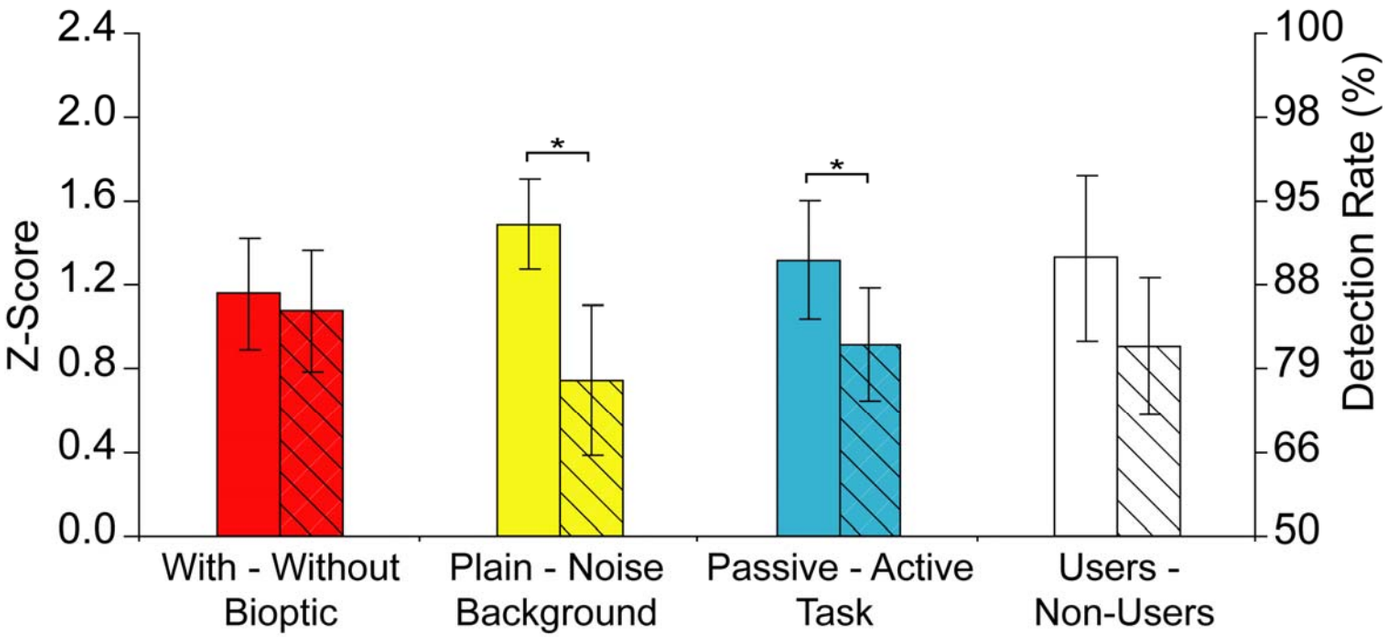
- 65 static stimuli per condition – 5 repetitions at each of 13 locations
  - 60 stimuli shown to fellow eye only in 12 locations
  - 5 shown to telescope eye only as a check (not included in analysis)
  - Duration: 250ms Grace period: 600ms to respond
  - Presented in random order with variable time delay between presentations
- Background and fixation targets shown to both eyes

8 conditions counterbalanced order	Fixation Targets	
	Without Bioptic	With Bioptic
	Plain Gray $(1/f)^{0.75}$ noise	Plain Gray $(1/f)^{0.75}$ noise
Passive		
Active		

Results – Fellow-Eye Detection

- No significant difference in detection performance with and without a bioptic
- Significantly lower detection on the noise background
- Significantly lower detection in the active task
- Trend for bioptic users to have higher detection than non-users (p=0.102)

*p<0.05



Errors bars are the 95% confidence interval of the mean

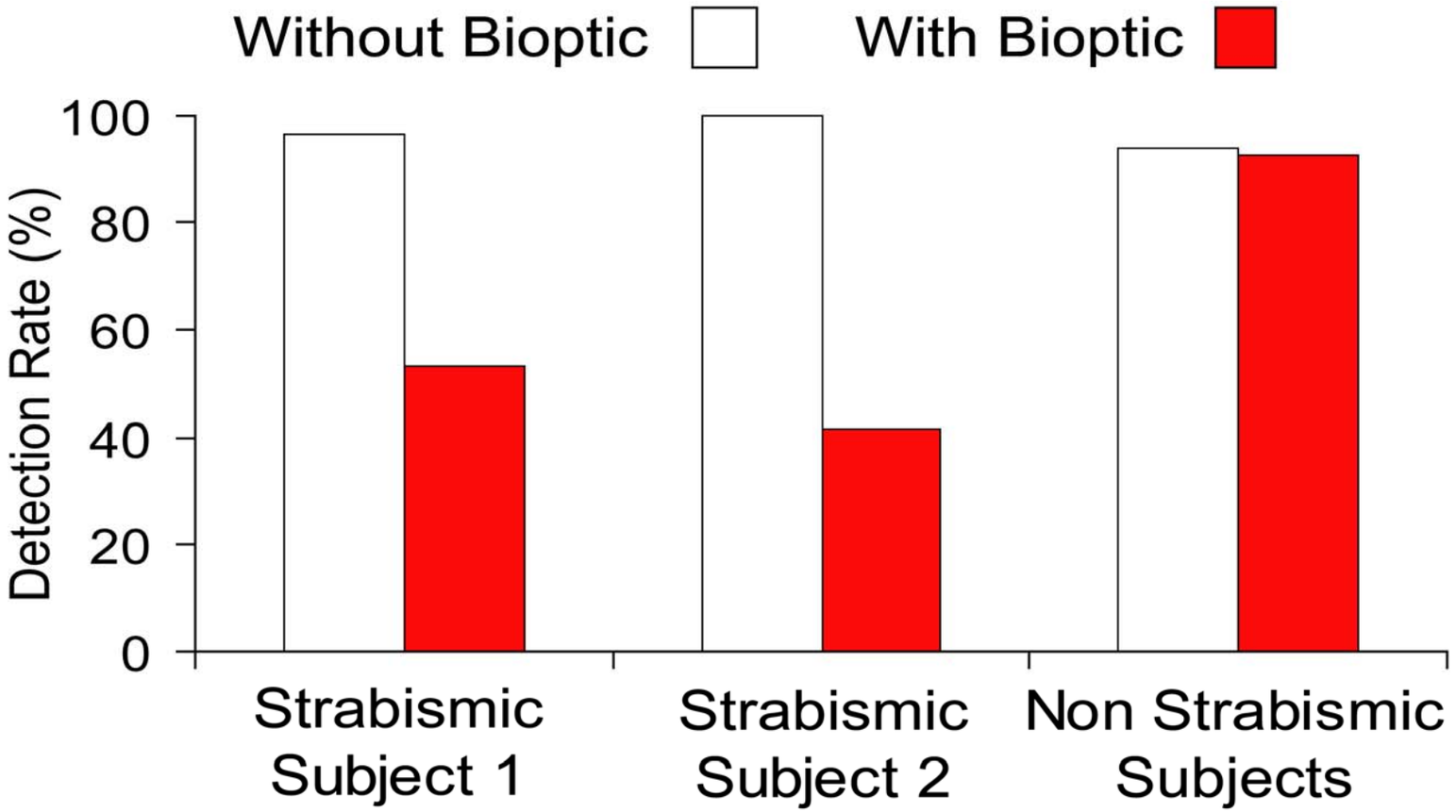
Participants

- **19 participants with reduced visual acuity (20/50 to 20/200)**
  - **10 bioptic users having used a bioptic in the last year**
    - **Median time using bioptic = 6.5 years (range 0.7 to 37 years)**
  - **9 non users with no experience using a bioptic**
    - **7 with no strabismus, 2 with strabismus**
- **7 of the 19 participants had central field loss with median scotoma diameter 16°**

	Bioptic Users n=10	**Non-Users** n=7
Age, yrs Median (range)	52 (44 to 82)	53 (21 to 77)
Telescope Eye VA Median (range)	20/68 (20/45 to 20/103)	20/96 (20/74 to 20/123)
Fellow Eye VA Median (range)	20/87 (20/69 to 20/113)	20/121 (20/115 to 20/126)

Results – Strabismic subjects

Fellow eye detection test - gray background 75% contrast stimulus.



Strabismic subjects: lower fellow-eye detection with bioptic than without
Non-strabismic subjects: similar fellow-eye detection with and without bioptic

Conclusions 1

- Both bioptic users and non-users were able to use the fellow eye to detect stimuli presented in the ring scotoma area on a structured background while engaged in an active viewing task through a monocular bioptic telescope.

- Caution should be used when prescribing bioptics for strabismic subjects.
    - They did not completely suppress the fellow-eye but detection was 50% lower with bioptic.

- Conventional perimetry is not sufficient to test detection ability in relation to complex driving conditions.
    - Detection performance was lower on the more complex background.

- We plan to test fellow-eye detection with a bioptic in more natural conditions with motion video and intermittent bioptic use.

Conclusions 2

This is the first study to show fellow-eye detection ability with a monocular bioptic in conditions more complex than conventional perimetry.

Our results provide preliminary evidence that a ring scotoma may not be a hazard when driving with monocular telescopes.

Acknowledgements

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References:

1. **Peli E, Peli D. *Driving With Confidence: A Practical Guide to Driving With Low Vision*. Singapore: World Scientific; 2002.**
2. **Fetchenheuer I, Peli E, Woods RL. Functional visual fields of monocular bioptic telescopes (abstract). *The 7th International Conference on Low Vision: Activity and Participation.* 2002:81.**
3. **Lippmann O, Corn AL, Lewis MC. Bioptic telescopic spectacles and driving performance: A study in Texas. *JVis Impair Blind.* 1988;82:182-187.**
4. **Peli E. Functional fields of bioptic telescopes: Implications for driving (abstract). In: International BiOptic Driving Conference; London, UK; 2004.**
5. **Woods RL, Apfelbaum HL, Peli E. DLP-based dichoptic vision test system. *J Biomed Optics.* 2010;15:1-13.**