Extended Wearing Trial of Peripheral Prism Device for Homonymous Hemianopia

Robert G. Giorgi[1], Russell L. Woods[1], Robert B. Goldstein[1]
Eli Peli[1], Tamara Bond[2] & Randy D. Easton[2]

[1] *The Schepens Eye Research Institute, Harvard Medical School, Boston, MA*
[2] *Department of Psychology, Boston College Chestnut Hill, MA*

ARVO 2004 Annual Meeting

Abstract

Purpose: Homonymous hemianopia (the loss of vision on the same side in each eye) impairs patient ability to navigate and walk safely. We evaluated a novel, prism field-expansion correction for hemianopia in an extended-wearing trial (Peli, 2000 *Optom Vision Sci*, 77:453). The impact of the prisms on several measures was evaluated. **Methods:** 11 subjects with complete hemianopia (4 left; 7 right) with neither visual neglect nor cognitive decline participated in the 7-visit study. To extend the horizontal visual field, subjects' spectacles were fitted with both upper and lower Fresnel prism segments (40 PD) across the lens on the side of the visual loss only. Subjects were asked to wear these Peripheral Prism glasses as much as comfortably possible for the duration of the study, which averaged 9 (range: 5 to 12) weeks. Adaptation to the change in perceived direction through the prisms was evaluated at 4 of 7 visits. Way-finding (walk safely to directed locations) and cognitive mapping in an unfamiliar environment (large shopping mall) and perceived quality of life were evaluated at the start and end of the study. **Results:** *Visual Field*: About 20° field expansion in upper and lower quadrants was demonstrated for all subjects (binocular perimetry, Goldmann V4e). *Perceived Direction*: 2 subjects demonstrated a transient adaptation, and conscious adaptation to the change in visual direction produced by the prism. *Clinical Success*: Subjects reported wearing the glasses for an average of 4.1 $\pm$ 4.0 hours/day. At the end of study, 6 of 11 subjects reported benefit and that they would continues wearing the device. 1-3 months after study end, 5 of these 6 subjects reported still habitually wearing the aid. *Mall*: Way-finding and cognitive mapping had improved at the end of the study, but this appears to have been a practice effect. *Quality of Life*: At study end, reduced difficulty with noticing obstacles to the side ($p=0.07$) and moving in stores ($p=0.12$), but increased difficulty with curbs ($p=0.06$) was reported. **Conclusion:** Peripheral Prism glasses provided reported benefit (usually in obstacle avoidance) to about half the subjects in the study. The limited improvement in measured functional performance may have been due to insensitive measurement techniques, a study wearing period that was too short, or suggests that additional training is required.

Support: NIH EY12890

BACKGROUND

- Homonymous Hemianopia (loss of one half the visual field on the same side in both eyes) may occur due to stroke, head injury or brain surgery.
- Hemianopic field loss impairs patient mobility and navigation ability.
- The most common optical treatment for hemianopia, binocular sector prisms, relocates rather than expands the field-of-view.
- Peli's (2000) Peripheral Prism device:

  - Expands rather than relocates lateral visual field in upper and lower segments.
  - Provided benefit to 9 of 12 patients in obstacle avoidance, but,
  - Success was self-reported; no functional performance measures were made.

PURPOSE: To evaluate the functional benefit to wearers of the Peripheral Prism device.

How was this assessed ?

- Binocular Visual Field (Goldmann Perimetry V4e).
- Perceived Visual Direction (Pointing Task-Adaptation).
- Walk through a shopping mall (Way-Finding & Cognitive Mapping).
- Street-Crossing (Perceived Safe to Cross).
- Quality Of Life Questionnaires (QOL).
- Clinical Success (Continue to wear device at study end & 3-month follow up).

Selection, Clinical Procedures & Timeline

Subjects: 11 subjects who met the following *selection criteria* participated in the 7-visit study.

- Complete Homonymous Hemianopia (central 60°) by Goldmann Perimetry (V4e).
- Negative for Visual Neglect (Line Bisection Test (Shenkenberg, 1980) & Bells Test (Vanier, 1990)).
- Negative for Cognitive Decline by Mini-Mental State Exam (Folstein, 1975).
- Visual Acuity 20/50 or better in each eye.
- Able to walk unaided for at least 1 hour.

Subjects recruited: Via local clinicians & by self-referral response to lab webpage.

		Time in weeks	
Visit	Clinical Procedures Performed at Visit	Planned	Actual average & (range)
1: Selection	Visual field; Neglect and Cognitive Testing; Preferred Walking Speed (PWS); QOL Questionnaires	-2	-4 (0 to -9)
2: Mobility	Way-Finding; Cognitive Mapping; Street Crossing	-1	-2 (0 to -6)
3: Upper Segment	***Upper*** Prism fitting & Training; Visual Field; Visual Direction	0	---
4: Lower Segment	***Lower*** Prism fitting & Training; Visual Field; Visual Direction; Clinical Interview	1	1 (1 to 2)
5: Performance assessment	Clinical Interview; Visual Direction	2	3 (2 to 6)
6: Mobility	Way-Finding; Cognitive Mapping; Street Crossing	5	6 (5 to 9)
7: Final	Clinical Interview; Visual Field; Visual Direction; QOL Questionnaires	6	9 (5 to 12)

Peripheral Prism Glasses & Visual Fields

- Upper and lower 40 prism-diopter Fresnel segments were fitted base out to the subject's spectacles on the side of the field loss (Fig. 1).
- Each prism provided visual field expansion of roughly 20° horizontal extent in the upper and lower periphery while allowing an unmodified field-of-view through the central portion of the lens.
- ***All*** subjects in the study demonstrated 20° field expansion in both upper and lower quadrants (Fig.3).

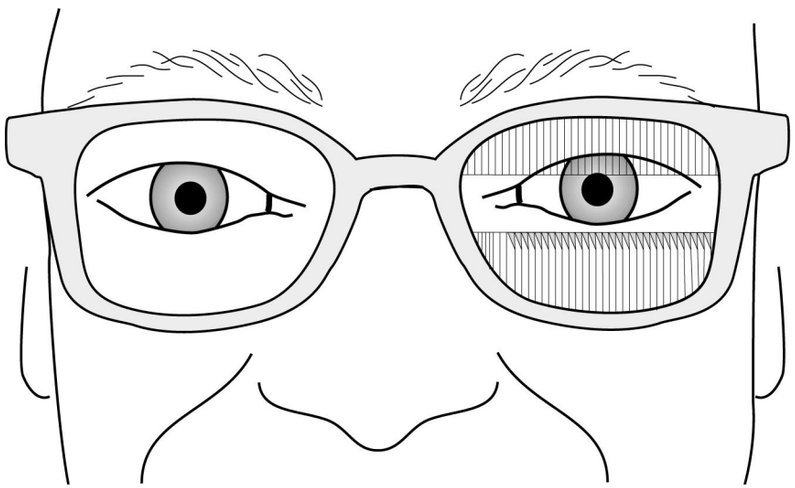

Fig. 1. Peripheral Prism segments placed base out on left spectacle lens of a left hemianopic subject.

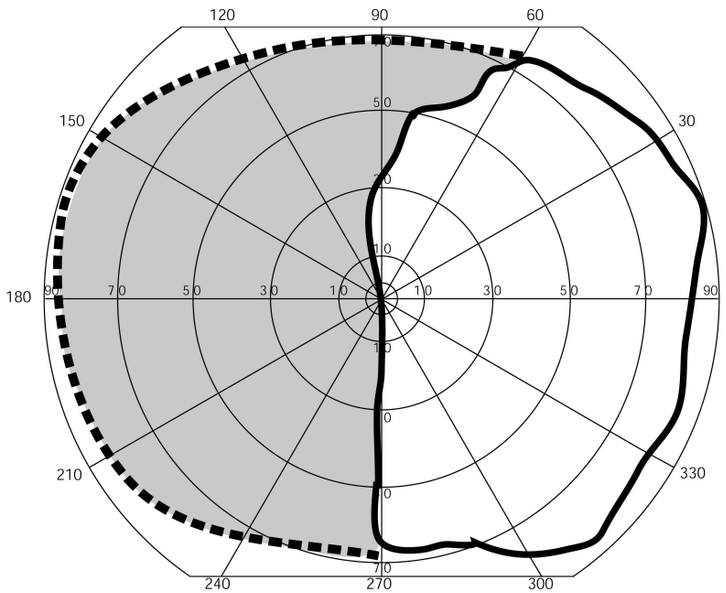

Fig. 2. Binocular visual field of a left hemianopic subject. Seeing hemifield enclosed by solid line. Dashed line represents extent of normal visual field.

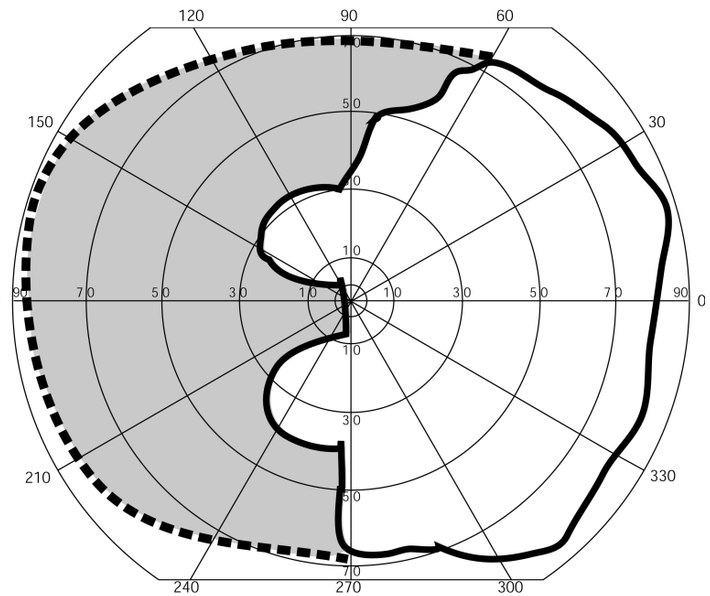

Fig. 3. Binocular visual field of the same subject wearing upper and lower Peripheral Prism segments and showing 20° field-expansion.

Perceived Visual Direction

Question: Prisms displace perceived visual direction. Can subjects adapt to a change in visual direction after extended wearing of the monocular Peripheral Prisms? (Fig. 4)
Kohler (1964) showed adaptation to partial binocular prisms in constant wear.

Procedure: Subjects seated 1m from rear projection screen. While looking at central fixation cross, pointed to targets presented to Peripheral Prism (arm not visible), outside prism (but in blind hemifield) and corresponding areas in seeing hemifield (Fig. 5 inset).

Result: No (real) adaptation of perceived Visual Direction.

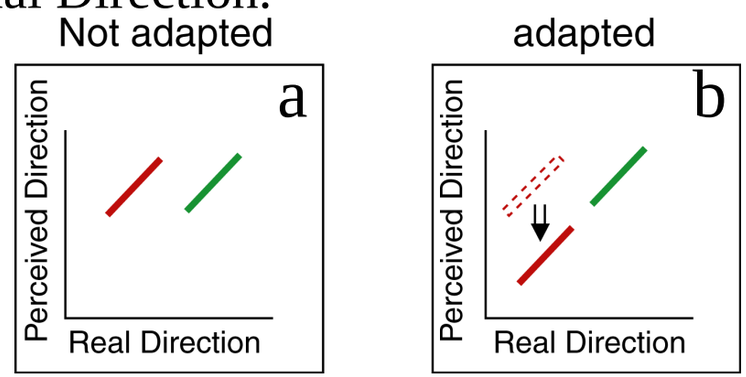

Fig. 4. Theoretical (a) before and (b) after adaptation to the change in perceived direction effected by extended wearing of the Peripheral Prism device.

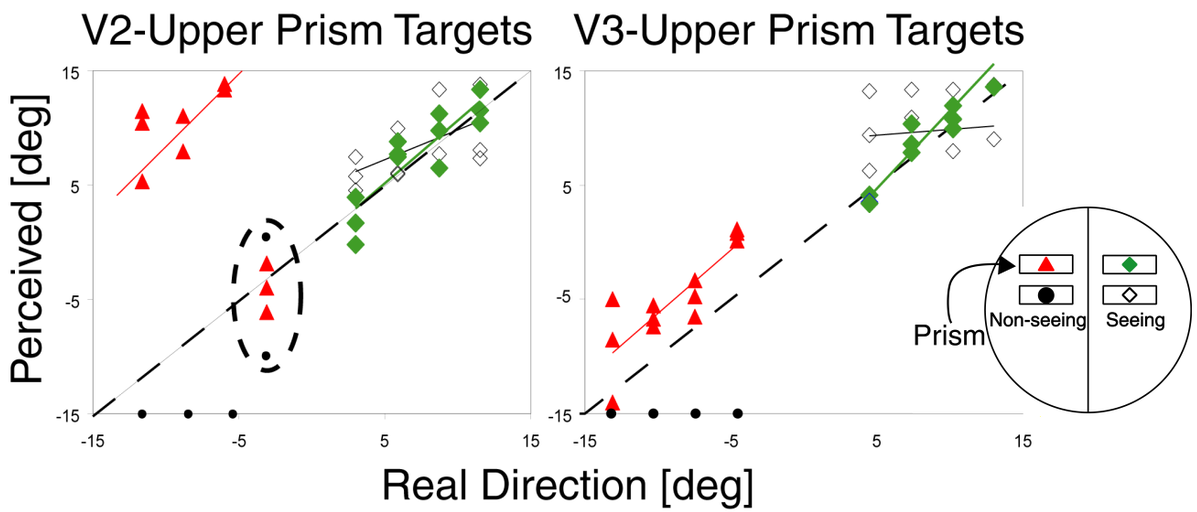

Fig. 5. Actual data. A left hemianope demonstrate conscious adaptation to Peripheral Prism one week (V3) after upper segment fitting (V2). This effect disappeared at re-testing one week later. Three subjects demonstrated this effect. Encircled points reflect “peeking” by lateral scanning.

Clinical Success

Question: Did subjects experience sufficient benefit from the Peripheral Prism device to continue wearing this aid in their day-to-day activities following the study?

Procedure: A clinical interview at the end of study (V7) and 3-months later included questions about perceived benefit and difficulties experienced with Peripheral Prism spectacles.

	End of Study	3-Months
"… still wearing the glasses?"	6 of 11	5 of 6
"… experience any benefit(s) with the glasses?"	7 of 11	5 of 6
"... difficulties attributable to glasses?"	9 of 11	5 of 6
"…would you pay $1000.00 for the permanent Peripheral Prism glasses?"	3 of 11	3 of 6

Walk through a Mall

Question: Do the Peripheral Prisms aid subject mobility and navigation ability?

Procedure: *Way-finding task*: Walk and search for each of 4 way-points along a shopping mall, stopping at each way-point (see fig.7). *Cognitive Mapping*: At end of mall walk, point from X to each of the 4 way-points. Post-test compared "Real" 40 diopter prism with 1 diopter "Mock" prism.

Summary: Effects may be due to learning.

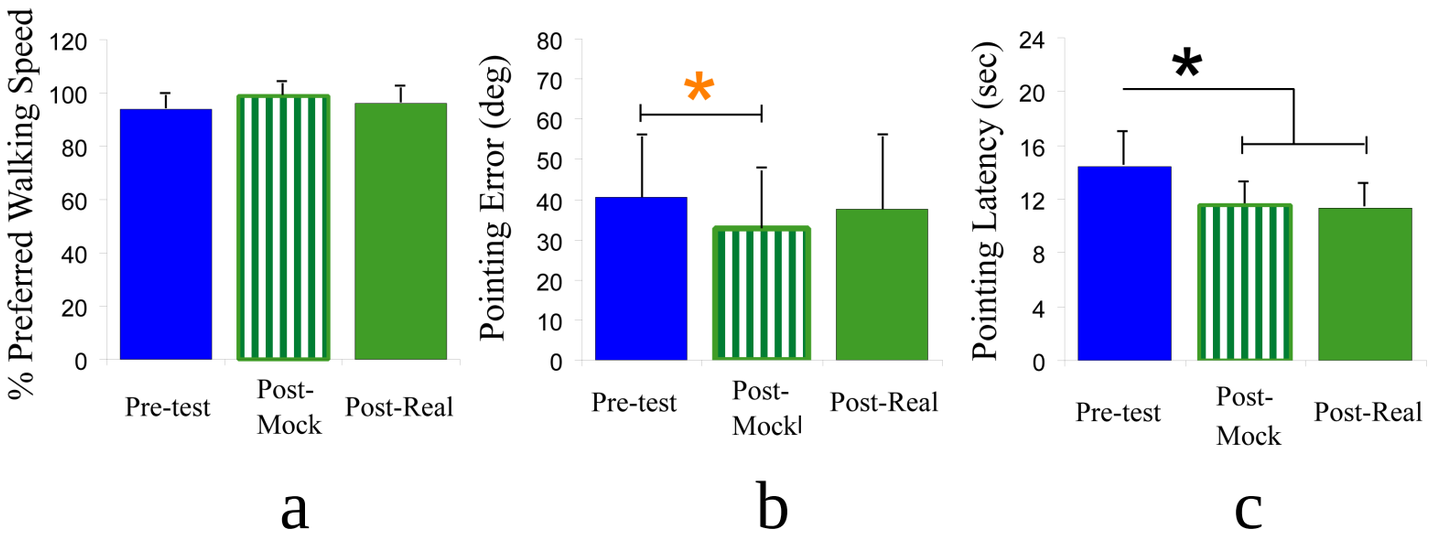

Fig. 6. Behavioral measures (a) Walking Speeds (b) Pointing Error *p=.10, and (c) Pointing Latency *p=.05. Error bars are SEM.

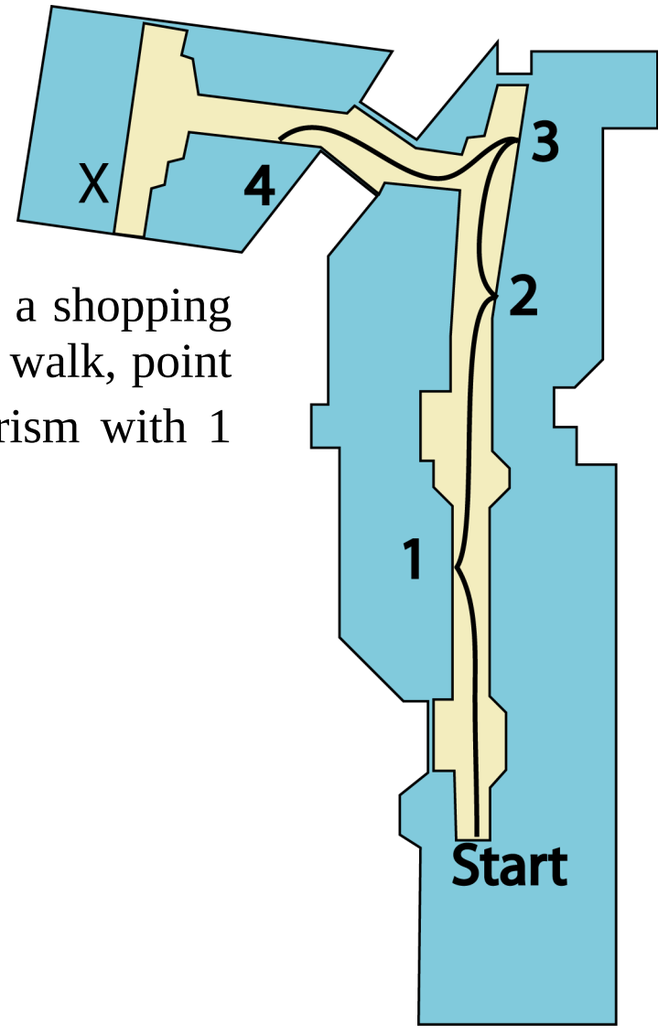

Fig. 7. The four way-points are indicated on the map of the shopping mall for one of three possible routes. The star indicates the location from which subjects pointed to each of the four way-points.

Quality of Life

Quality of Life was assessed at Visit 1(before receiving the glasses) and again at Visit 7 (after completing the wearing trial).

1. Independent Mobility Questionnaire (IMQ) (Turano, 1999)
2. NEI Visual Function Questionnaire (VFQ) (Mangione, 1998)

VFQ and IMQ scores were transformed using Rasch Analysis (Massof, 1998).
Comparisons between Visit 1 and Visit 7 were made both by question and overall.

Results: Slight differences were found on 3 of 35 mobility related questions.

VFQ Question #10	*"difficulty noticing objects to the side while*	Decreased: Z_8: 1.82 p=0.07
IMQ Question #6	*"moving about at stores?"*	Decreased: Z_8: 1.54 p=0.12
IMQ Question #16	*"Stepping off curbs"*	***Increased: Z_8: 1.86 p=0.06***

Summary: Small changes in QOL.

CONCLUSIONS

- Field was expanded for all subjects.
- Peripheral Prism device provided benefit to one-half of the study participants.
- Most of these subjects still wearing device at 3-month follow up.
- Benefit usually reported as obstacle avoidance while walking.
- No adaptation to change in visual direction observed over the course of the study.

ACKNOWLEDGMENTS

Frans Van de Velde and Ken Sato performed SLO. Darrick Wright and Beezy Benson assisted with mobility assessments at the mall. Referring clinicians, Drs Rizzo, Gunter, Ferrucci, Lessell and Trempe.

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