

DEVELOPMENT OF A NOVEL OPTICAL AID FOR PEOPLE WITH SEVERELY RESTRICTED VISUAL FIELDS

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BACKGROUND

- A visual field of 10° or less impairs mobility (e.g. walking).
- Existing visual aids have not been widely successful.
- Peli (1999, 2001) proposed a novel spectacle-based prism device that expands the visual field – the Trifield lens.
- We describe the concept, the development of the Trifield lens, and pilot testing with two subjects.

The Trifield lens provides an expanded visual field for all directions of gaze.

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EXISTING VISUAL AIDS

- Minifying lens/telescope, e.g. the amorphic lens (Figure 1)
- Prisms, e.g. InWave™ lens (Figure 2)

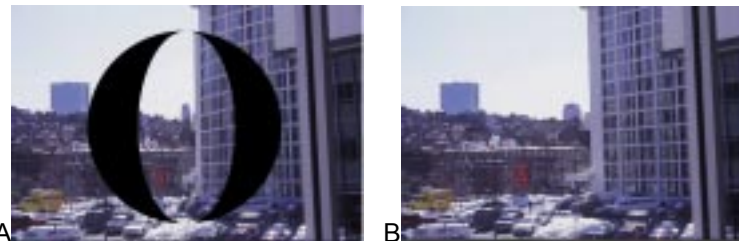


Figure 1. (A) Simulated view through amorphic lenses. (B) Compare to the original view. Note that amorphic lenses are worn binocularly.

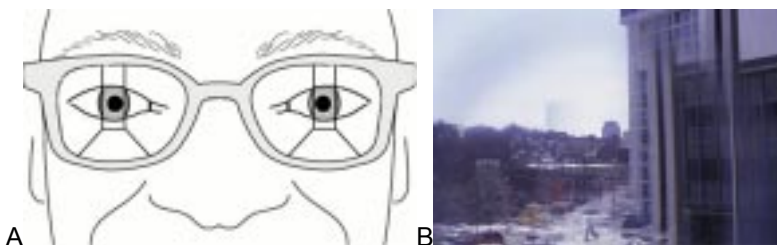


Figure 2. (A) InWave™ lenses are fitted binocularly. (B) Optical scotomata at the prism apices are shown in a photograph through an InWave™ lens, that can be compared to figure 1B, the original view.

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TRIFIELD GLASSES

- Better eye has unmodified (i.e. normal) view; “worse” eye wears Trifield lens (figure 3). Note that the Trifield lens is only worn over one eye (monocular).

- Trifield lens: Two prisms, separated by a vertical junction, fitted apex to apex.

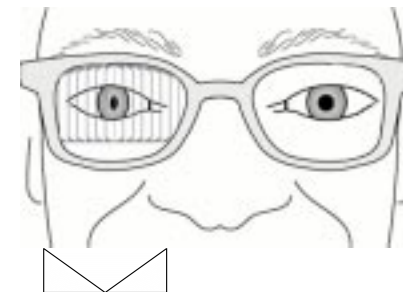


Figure 3. Trifield glasses fitted apex to apex with Fresnel prisms. Base to base prisms is an alternative fitting that we have tried.

- Each prism expands the visual field (figure 4).
- Only on primary gaze are both prisms used. Due to eye movements, usually only one prism is effective at a time.



Figure 4. Binocular visual field with Trifield lens worn on the right eye of subject H. Both prisms 25Δ.

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ABSTRACT

Purpose: A visual field of 10° or less impairs mobility. To assist in this situation Peli (1999, 2001) proposed a novel spectacle-based prism device that expands the visual field. Here we describe the development of the Trifield lens and pilot testing with two subjects.

Methods: Two prisms, separated by a vertical junction (like a Franklin bifocal) are fitted apex to apex over the “worse” eye. The better eye has a conventional correction. The prism eye receives visual information shifted laterally from the direction of gaze by the prism. The direction of shift depends on the prism, and the prism is determined by the direction of gaze. Prism power must be sufficient to avoid diplopia. Phoria correction must be included in the prism power, such that the prism powers are often asymmetric.

Results: Visual field expansion was demonstrated using perimetry. Fresnel prisms caused a reduction in VA of the two retinitis pigmentosa (RP) subjects that was greater than found for normally-sighted subjects. Collaboration with manufacturers now allows us to provide the prisms in

conventional lenses. Failure to prescribe correct prism powers (field measurement or phoria) resulted in diplopia. Even with correct prism power, subjects were unable to determine the direction of field expansion. In other words, they detected objects, but did not know on which side they were. We are testing tinted prisms to provide spectral information that may be associated with direction. Neither subject demonstrated adaptation of visual direction, a perceptual integration of the Trifield device, but the tints may help. Fitted clip-on sunglasses improved cosmesis and provided glare reduction required by people with RP.

Conclusions: Trifield lenses provided some benefit to two subjects, by giving warning of nearby objects. However, neither subject demonstrated full adaptation to the field expansion with altered perception of visual direction. A larger study is about to commence to objectively evaluate the impact on walking, visual direction and quality of life.

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PATIENT'S VIEW

- A simulation of the appearance on primary gaze is shown in figure 5. Note that only on primary gaze do three views combine. Usually only two views are seen with the same visual direction.
- Two objects seen in the same visual direction is 'confusion' (not diplopia).
- Prism power is greater than visual field width so that there is no overlap of the normal and the prism views. Prism power must be sufficient to avoid diplopia.

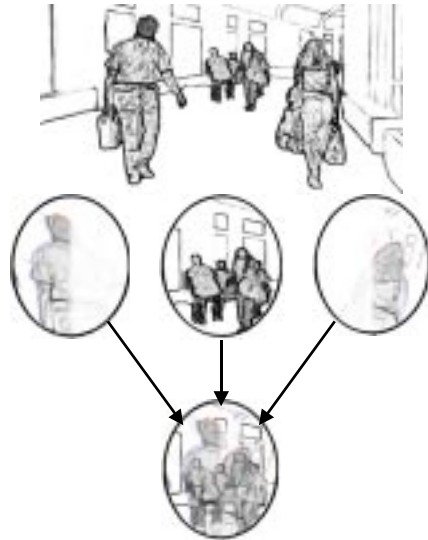


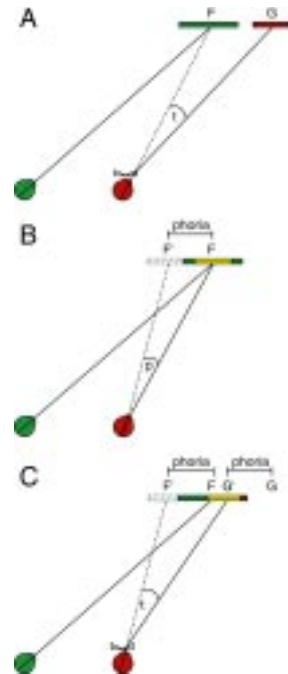
Figure 5. Simulation of the Trifield view on primary gaze (lower panel). Upper panel shows original view. Middle panel shows the three views.

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EFFECT OF PHORIA

- Trifield lens wearers go into phoria position (relative alignment of the eyes), and hence the prism power required on each side is different (figure 7).
- Prism powers are often asymmetric. Failure to prescribe correct prism powers (visual field measurement or phoria) resulted in diplopia.

Figure 7. Patient looking to the right at the point F. (A) When looking through Trifield glasses (with no phoria), the prism deviates the light (angle t) so that the right eye looks in the direction of G. Visual fields are shown as the red and green bars. Note that the visual fields do not overlap. (B) With esophoria the right eye would turn in to look in the direction of F'. Overlap of the visual fields is shown as yellow. (C) Trifield lenses as in (A), except that the patient has the esophoria shown in (B). Due to the phoria, the right eye looks in the direction G'. Note that this causes overlap of the visual fields, and hence diplopia. Modification of the Trifield prism power will avoid diplopia.



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MAKING TRIFIELD GLASSES

Fresnel Prisms (figure 3)

- inexpensive, immediately dispensed, easy to modify, flexible power.
- Glare, reduced contrast, reduced visual acuity.

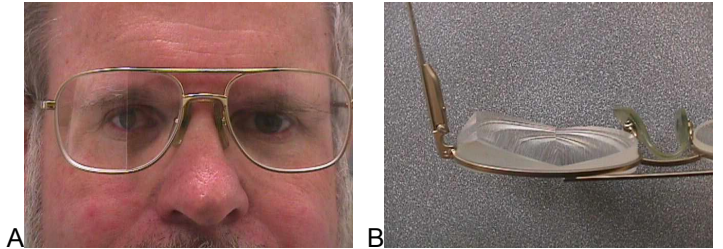


Figure 6. Trifield lenses in CR39 (A) worn by subject H; and (B) top view of these glasses.

CR39 Lenses (figure 6)

- expensive, complex, weight, better appearance, good visual acuity and contrast.

VISUAL FIELDS

- What is an appropriate target size?
- Patients report double vision of extended objects, even when there is no true diplopia.

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PERCEIVED VISUAL DIRECTION

- While objects were detected in the expanded field, neither subject could determine the direction of field expansion.
- Adaptation of visual direction, a perceptual integration of the Trifield lens, was not found (figure 8).

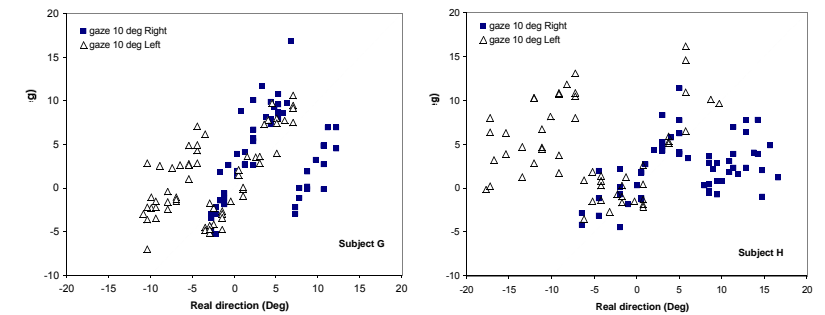


Figure 8. Neither subject modified their perceived visual direction of objects seen with the Trifield lens to match the real visual direction. If that had occurred, the objects seen with the Trifield lens (i.e. the clusters of points to the right and left) would have been along the dashed 1:1 line shown for the central ("normal") field.

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SPECTRAL MULTIPLEXING

TINT

- Tinted prisms (figure 9) may provide spectral information that may be associated with direction (Kohler, 1964).
- A relatively dark tint was required to make the color difference apparent.

SUNGLASSES

- Fitted clip-on sunglasses improved cosmesis and provided glare reduction required by people with RP (figure 9b).



Figure 9. (A) The most recent Trifield lenses have prisms tinted green on the left and red on the right. These small frames allow for relatively thin lenses and (B) an additional clip-on sunglass, an important addition for people with retinitis pigmentosa.

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CONCLUSIONS

Trifield lenses provided some benefit to two subjects, by giving warning of nearby objects and helping when searching for objects. However, neither subject demonstrated full adaptation to the field expansion with altered perception of visual direction. A larger study is about to commence to objectively evaluate the impact on walking (safety and navigation), visual direction and quality of life.

Hence:

Many design changes were implemented.

The Trifield device was useful to two subjects.

Further evaluation of more subjects has begun.

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SUMMARY

- So far, success has been partial. It seems that patients had an extension of the visual field, providing early warning, but have not learnt the real direction of objects seen with the Trifield lens.

FUTURE EVALUATIONS

We have begun studies to evaluate:

- Real world mobility (walking in a shopping mall).
- Street crossings (without entering the roadway!)
- Virtual walking (a simulation of the shopping mall, with obstacles that we can control).
- Quality of life (vision and mobility factors).

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