The Use of Bangerter Filters in Treating Amblyopia

Paul Harris, OD

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Step 1: Understanding Bangerter Filters

- Prophylactic uses: to prevent Amblyopia, suppression, abnormal retinal correspondence.
- Therapeutic uses: treatment of Amblyopia, orthoptic treatment, Diplopia, Diplopia with monocular Aphakia (with <0.1).
- Can be used as a primary treatment or as alternative treatment in cases where patching therapy is no longer providing further benefits.

Occlusion Foils

- Decrease high spatial frequency data.
- Low spatial frequency information is unaltered.
- Different foils take out more or less information.
- Can be used to balance the use of the two visual channels.

Bangerter Filter VA Equivalents?

BANGERTER

OCCLUSION FOILS

ITEM	VISUAL ACUITY
1.0	~ 20/20
0.8	~ 20/25
0.6	~ 20/30
0.4	~ 20/50
0.3	~ 20/70
0.2	~ 20/100
0.1	~ 20/200
< 0.1	< 20/300
Light Perception	NONE
00	NONE

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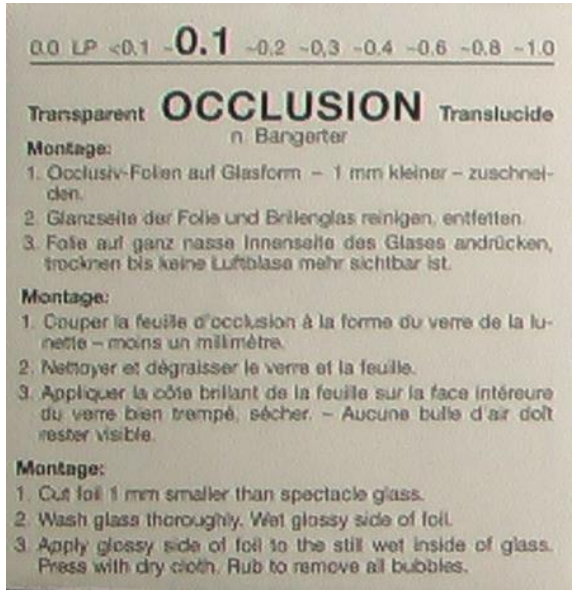

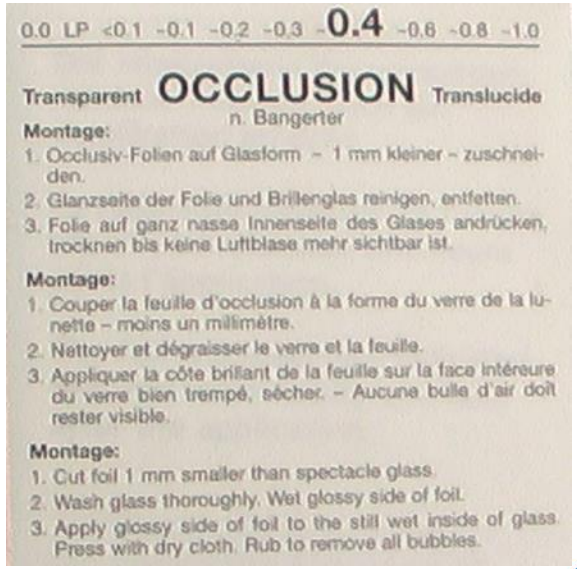

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Bangerter Filter Trial Bar

Ok, I get it but do they really work this way?

- I did a study evaluating two different optotypes. The study had two arms:
  - Plus lens blur: habitual Rx, habitual with +2.00, habitual with +3.00, and habitual with +4.00
  - Bangerter Filter: habitual Rx, habitual with 0.6 foil, habitual with 0.2 foil, habitual with 0.1 foil.
  - 162 subjects in each arm.
- Results:
  - Plus lens arm – as expected
  - Bangerter Filter arm – Houston we have a problem!

Dyop Study SCO Summer Research

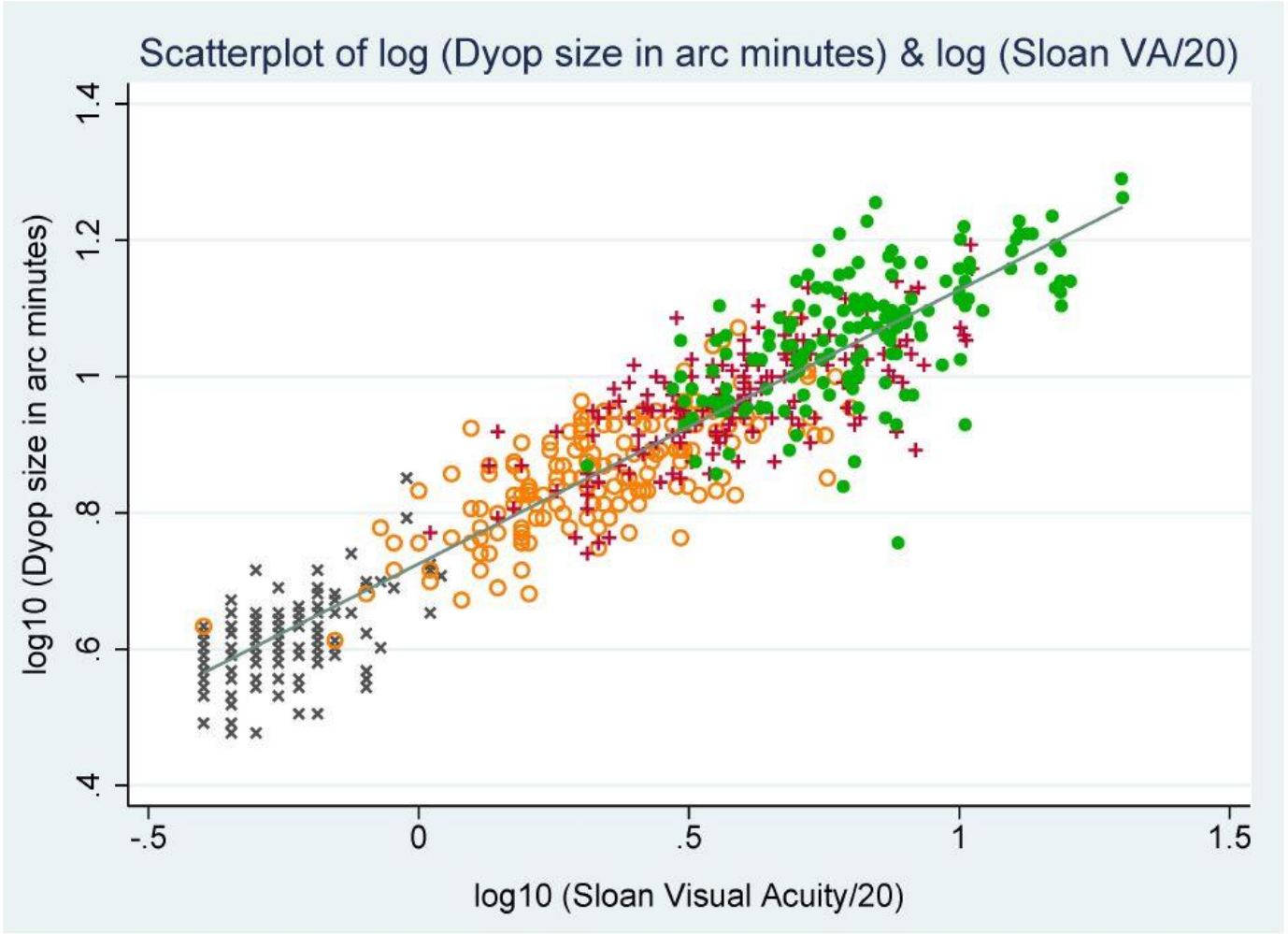

Figure 1: Plot of the log of the Dyop size in arc minutes against the log of the Sloan VA/20. Rx Corrected = Dark Gray (x) +2.00 blur = Orange (o) +3.00 blur = Red (+) +4.00 blur = Green (•)

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Dyop Study SCO Summer Research

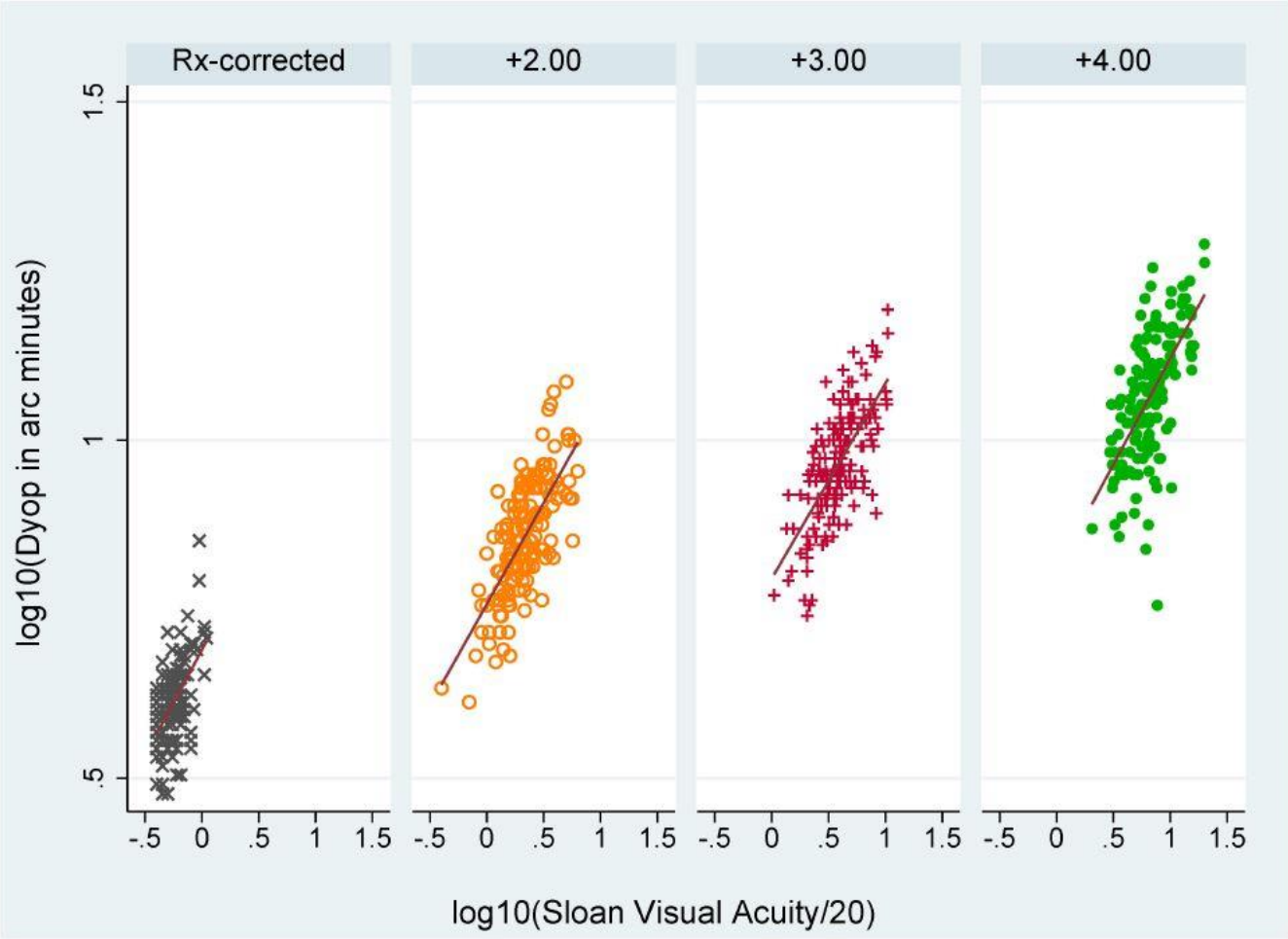

Figure 2: Scatter plots for each of the separate conditions. Correlations were significant to the p <.001 level in all conditions. Pearson correlations for each condition were: Rx Corrected r=.54, +2 blur r=.72, +3 blur r=.72, +4 blur r=.63, overall pooled r=.94.

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Bangerter Filter Results:

Condition	Visual Acuity M&S – Harris Step
Full Rx	20/11.3
Rx + Foil 0.6	20/23.4
Rx + Foil 0.2	20/50
Rx + Foil 0.1	20/40.4

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First thought! Someone goofed. Who?

- Check with students first doing the study: They noticed the numbers this way as they came in.
- Check the glasses: Had I labeled them incorrectly? Got new filters out of supply area and checked by visual inspection. Matches everywhere. Not labeled wrong.
- Check the filters: Maybe they were labeled wrong by the company. Use luminance meter on projected VA chart.

Projected Chart and Luminance Meter Observations

- Looked at plus blur vs. Bangerter
  - Used 20/400 big “E”
  - Luminance meter at 1 Meter distance has 1/3rd of a degree measuring area. Easy to keep locked on an area of the screen when mounted on tripod.
  - Bangerter observations:
    - Black – shifts towards gray
    - White – shifts towards gray
    - No movement of the object
  - Plus observations
    - Contrast changes seem to be only at edges
    - However, the position of the meter when locked down on the horizontal bar of the “E” was no longer pointed at the position on the screen of least luminance????
    - Plus lenses were shifting the location in space of the object.

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The optics of Bangerter Filters

Visual Psychophysics and Physiological Optics

Optical Characterization of Bangerter Foils

Guillermo M. Pérez,[1] *Steven M. Archer,*[2] *and Pablo Artal*[1]

CONCLUSION: The blur resulting from Bangerter filters is qualitatively different from defocus. Whether this difference is of any consequence when these two methods of optical penalization are used for amblyopia treatment remains to be investigated.

(*Invest Ophthalmol Vis Sci.* 2010;51:609–613)
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How measured

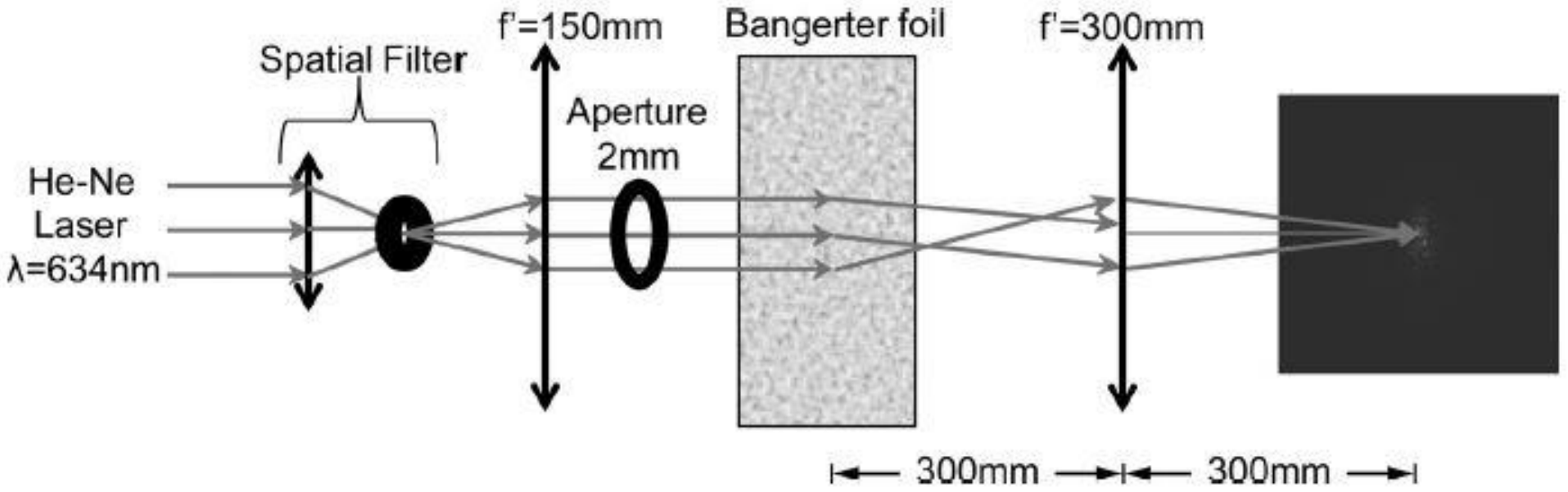

FIGURE 1. Arrangement of optical bench components used to test Bangerter foils.

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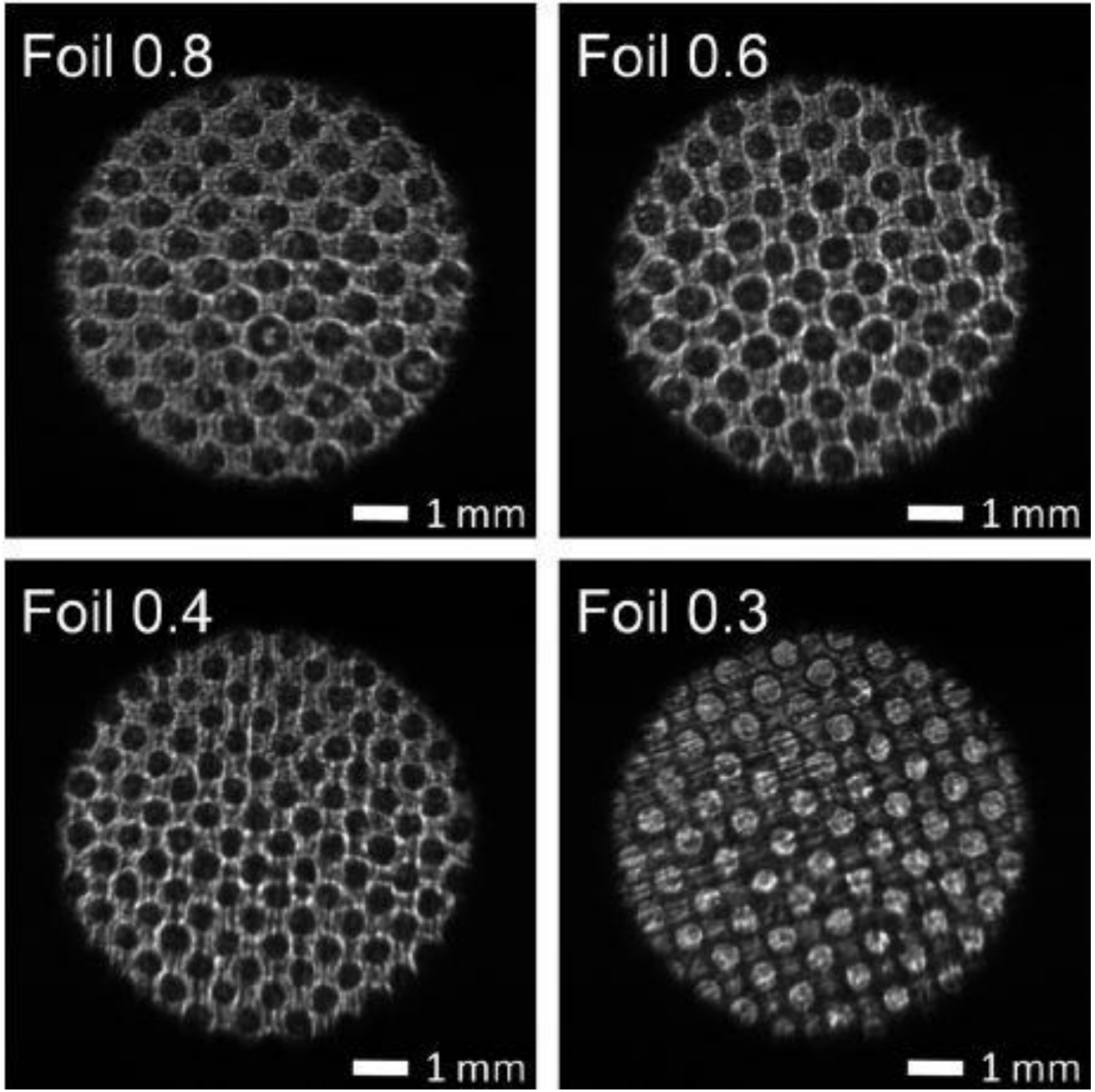
Bangerter Foil Construction



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Target

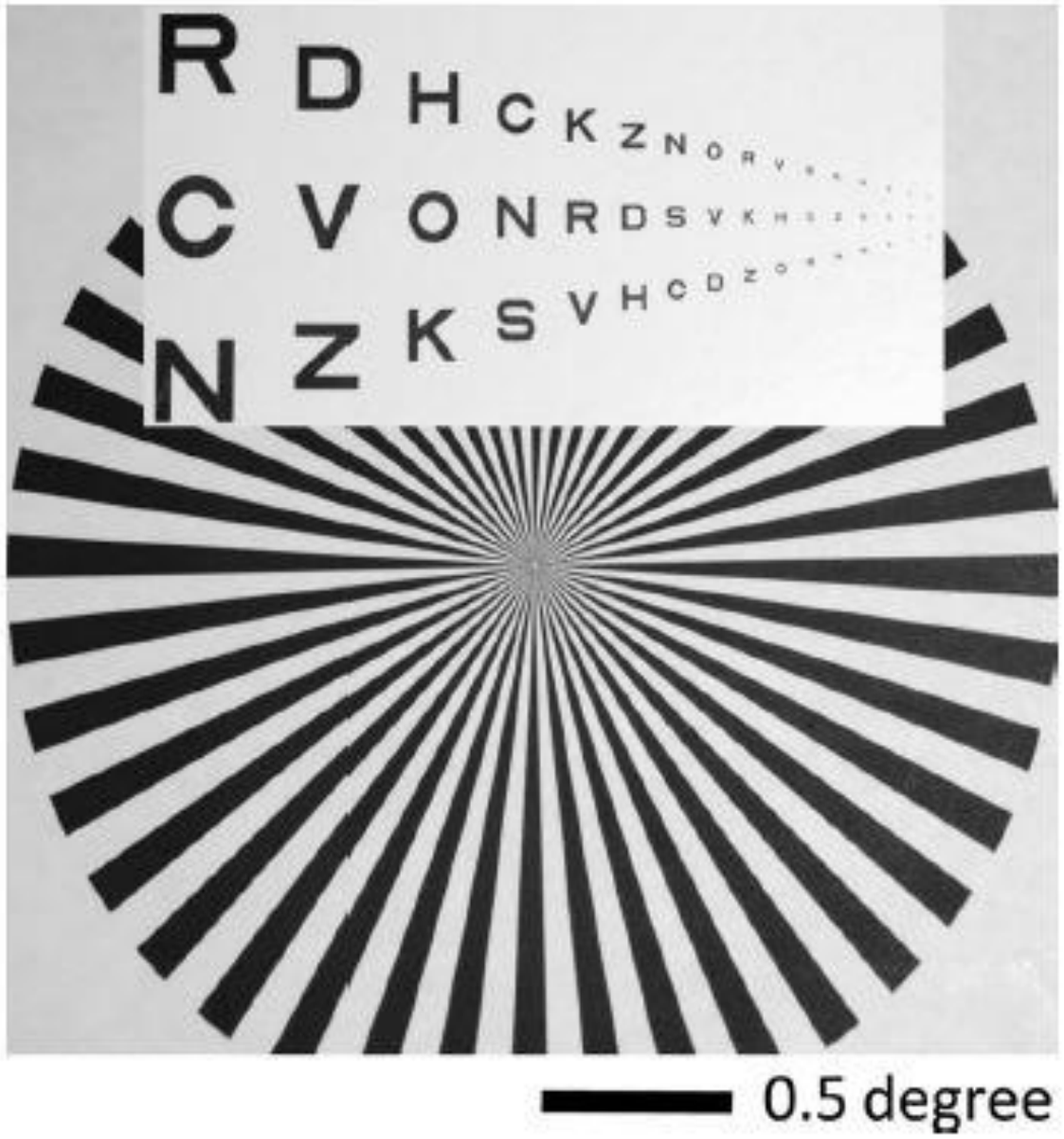

Image degradation as a fraction of the area under the reference MTF (modulation transfer function)

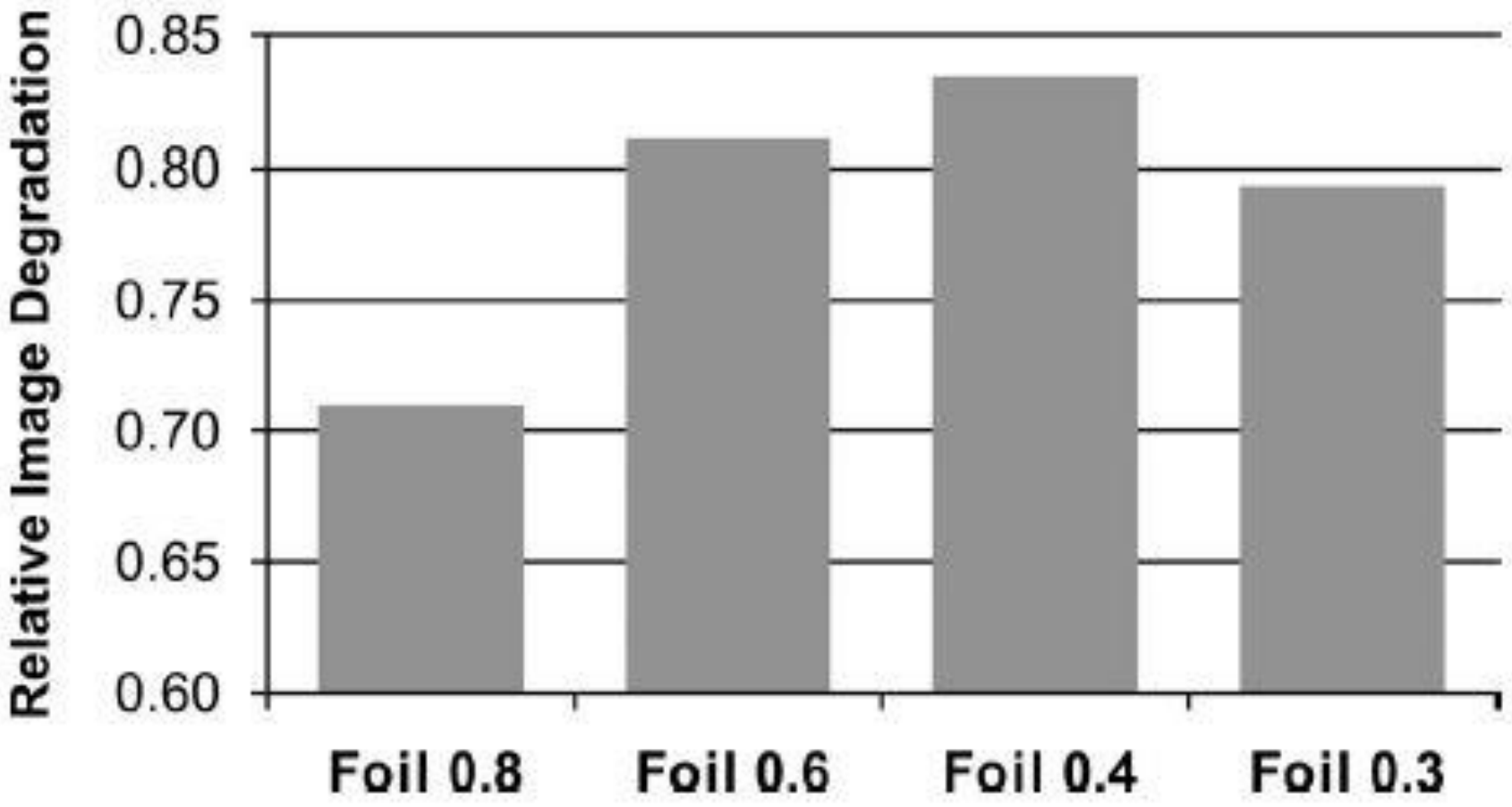

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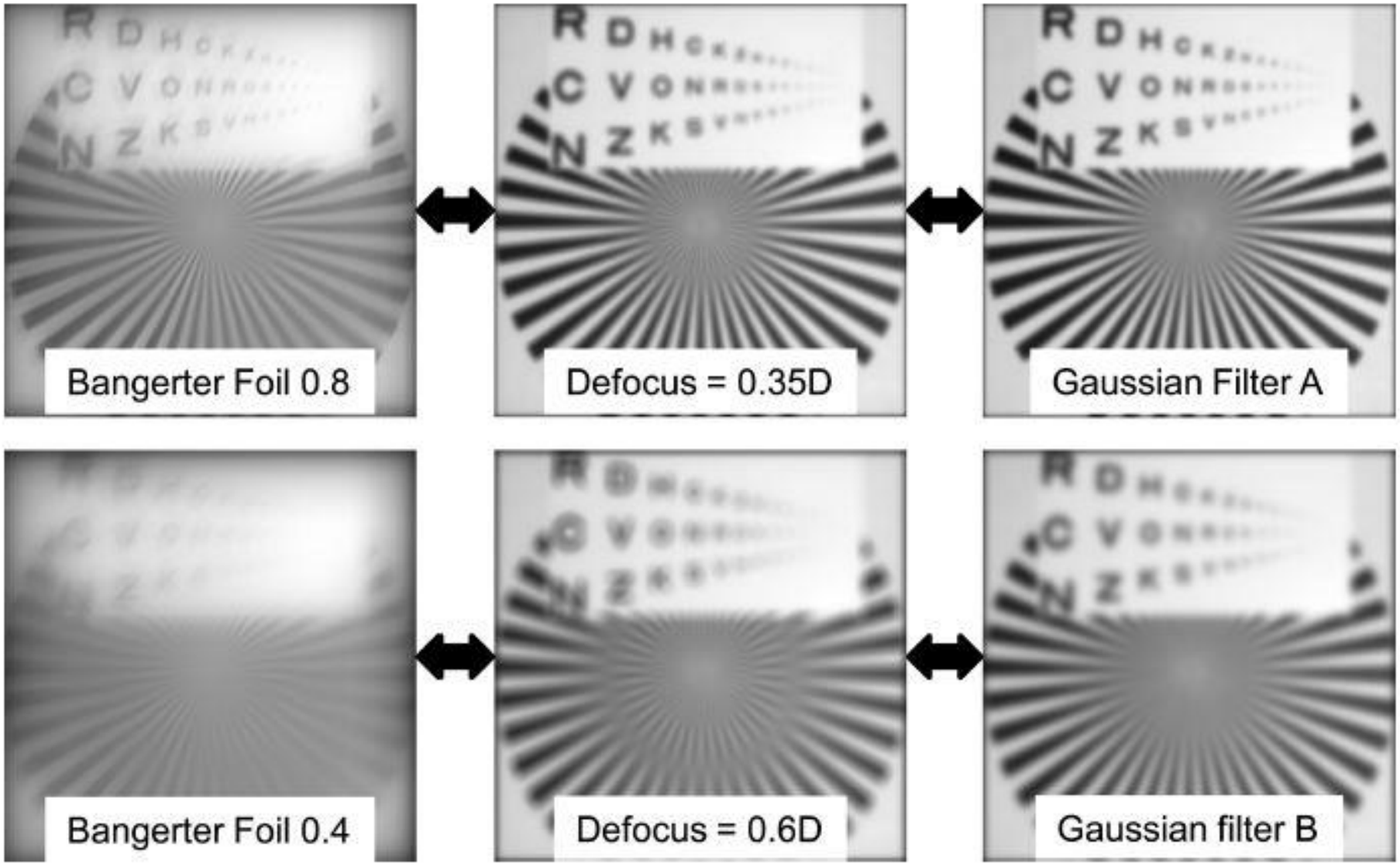
Image degradation comparisons



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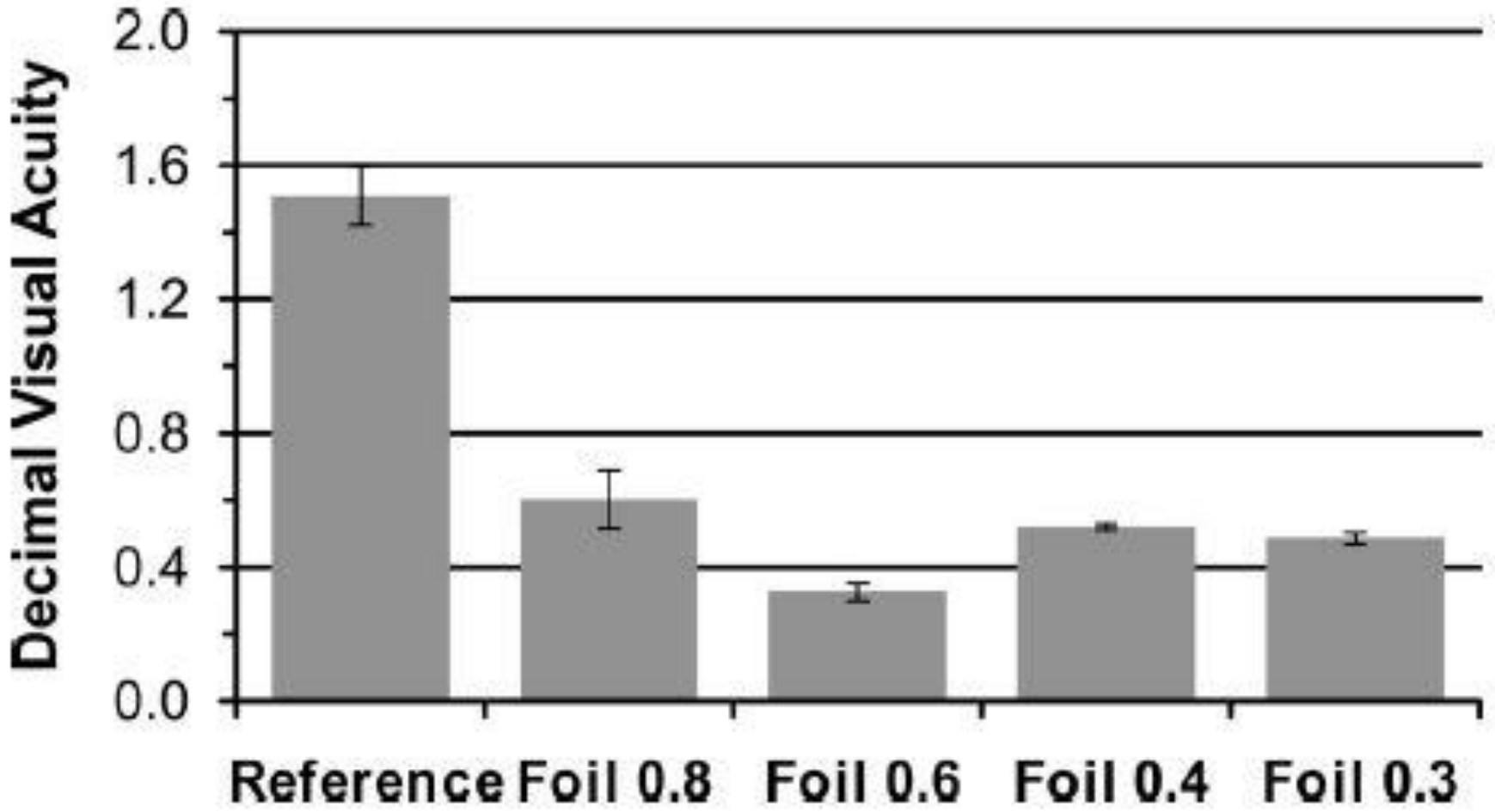
Visual Acuity through several foils (0.3 to 0.8)



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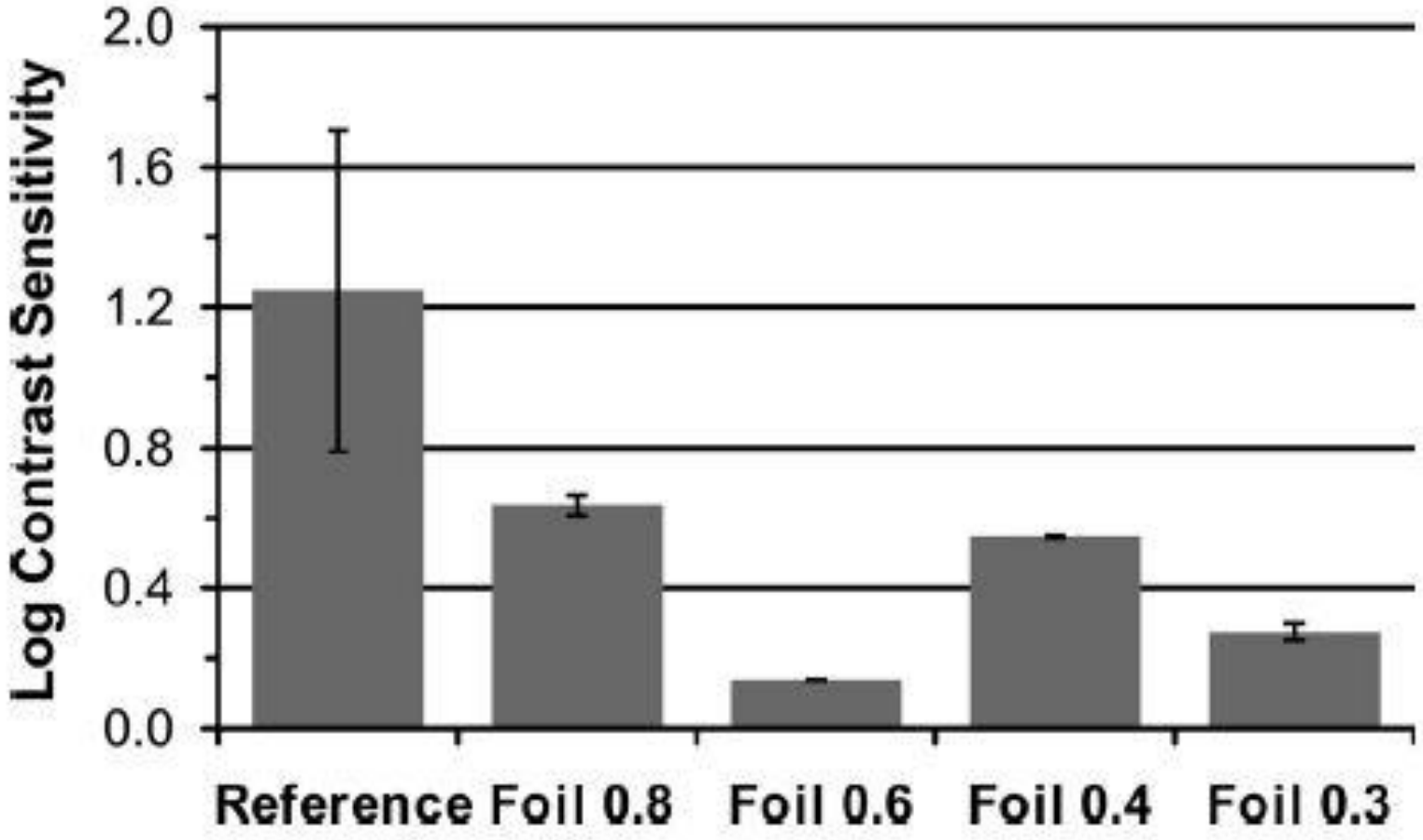
Contrast Sensitivity through several foils (0.3 to 0.8)



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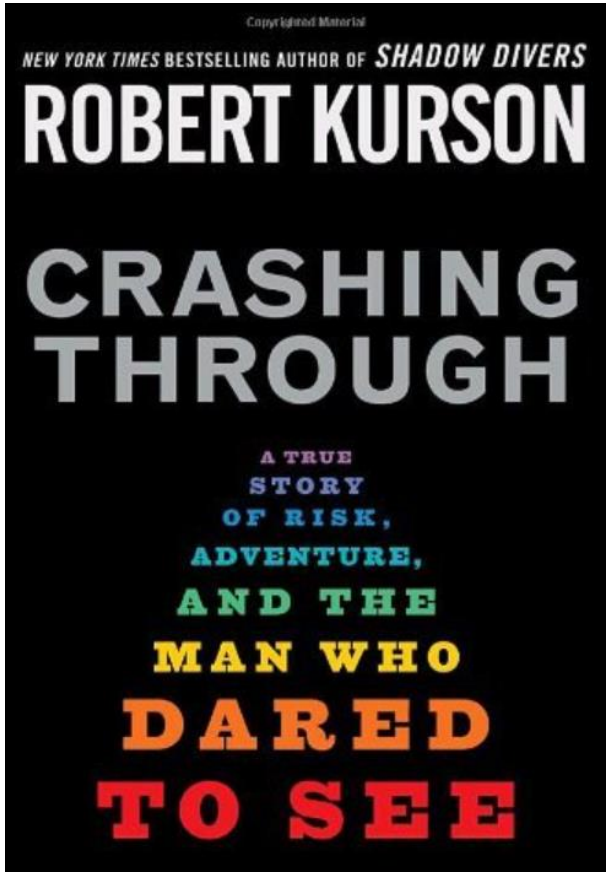
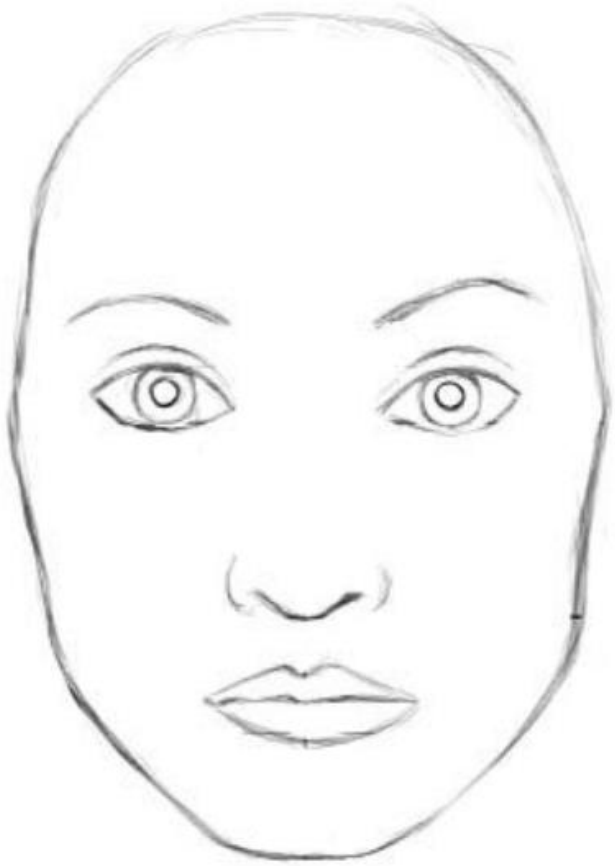
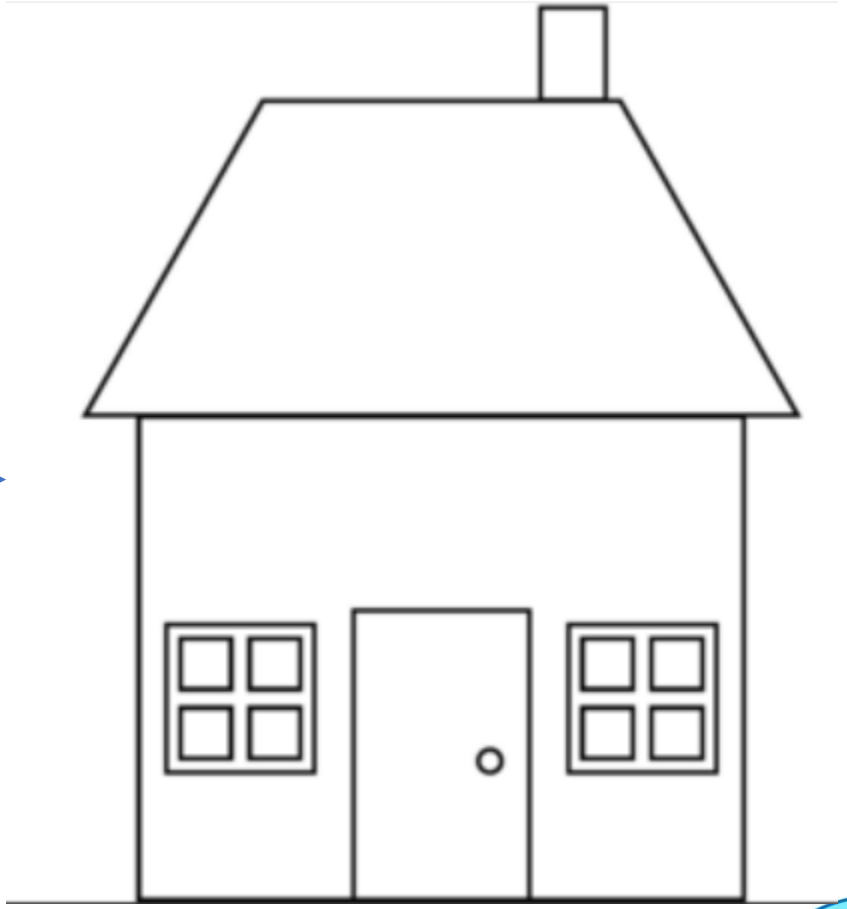
Ione Fine, PhD



Dynamic Tension - morphing





Electrical Stimulation of the Left and Right Human Fusiform Gyrus Causes Different Effects in Conscious Face Perception

Vinitha Rangarajan,[1,2] Dora Hermes,[2] Brett L. Foster,[1,2] Kevin S. Weiner,[2,3] Corentin Jacques,[2,3,4] Kalanit Grill-Spector,[2,3,5] and Josef Parvizi[1,2,5]

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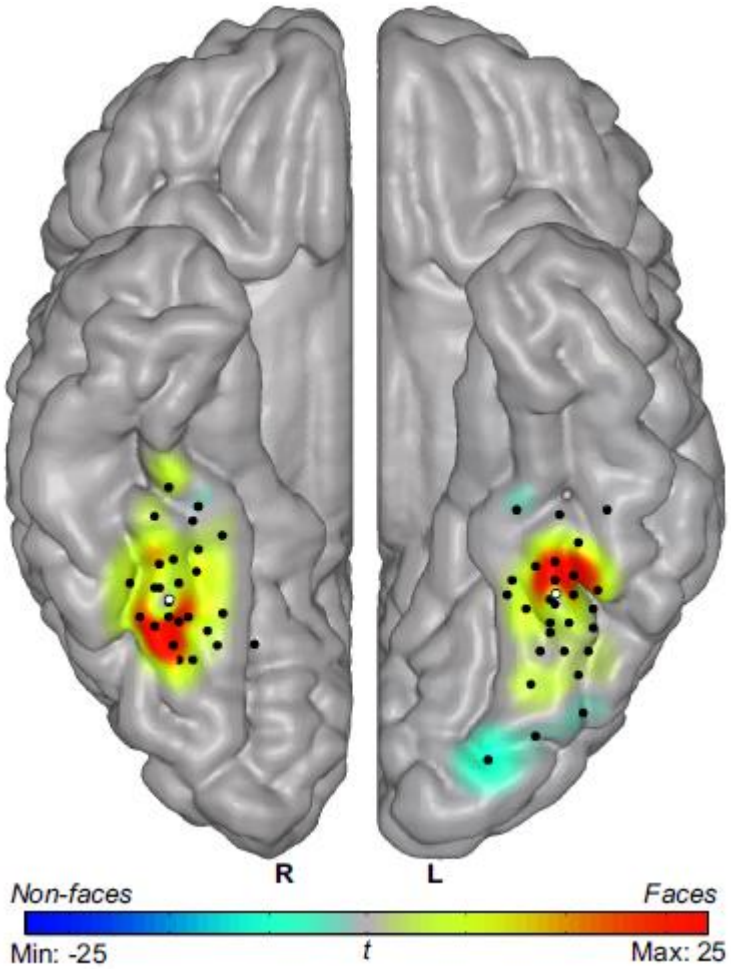

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Response Plots Expected

Stimuli	FACE	FACE - house	face - house	Face - HOUSE	HOUSE
Face Fusiform Gyrus Response	25	5	1	0	0
Shape/Object Detection Response	0	0	1	5	25

Response Plots Actual

Stimuli	FACE	FACE - house	face - house	Face - HOUSE	HOUSE
Face Fusiform Gyrus Response	10	4	30	4	0
Shape/Object Detection Response	0	4	30	4	10

A Lack of Experience-Dependent Plasticity after more than a Decade of Recovered Sight

Elizabeth Huber[1,*], **Jason Webster**[1,*], **Alyssa Brewer**[2], **Donald MacLeod**[3], **Brian Wandell**[4], **Alex Wade**[5], and **Ione Fine**[1]

[1]Department of Psychology, University of Washington, Seattle

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[3]Psychology Department, UC, San Diego

[4]Department of Psychology, Stanford University

[5]Department of Psychology, University of York

Fourteen years ago, MM had monocular vision restored after being blind between age 3 and 46. Tests carried out over two years following the surgery revealed impairments of 3D form, object, and face processing, and an absence of object and face selective BOLD responses in ventral visual cortex. Here we re-examined MM to test for experience-dependent recovery of visual function. Behaviorally, MM remains impaired in 3D form, object, and face processing. Accordingly, we find little to no evidence of the category-selective organization within ventral visual cortex typically associated with face, body, scene, or object processing. We do observe remarkably normal object selectivity within lateral occipital cortex in MM, consistent with his previously reported shape discrimination performance. Together, these findings provide little evidence for recovery of high-level visual function after more than a decade of visual experience in adulthood.

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PEDIG Calibr

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Nonamblyopic eye visual acuity through Bangerter filters

Robert P. Rutstein, OD, MS[a], Nicole C. Foster, MS[b], Susan A. Cotter, OD[c], Raymond T. Kraker, MSPH[b], Dave H. Lee, MD[d], Michele Melia, ScM[b], Graham E. Quinn, MD[e], Susanna M. Tamkins, OD[f], and David K. Wallace, MD, MPH[g,*] for the Pediatric Eye Disease Investigator Group

Methods—Visual acuity with and without a Bangerter filter was measured in the nonamblyopic eye of 186 children with moderate amblyopia who were then treated with either patching or with the Bangerter filters. A 0.2 filter was used for amblyopia of 20/80 and a 0.3 filter for amblyopia from 20/40 to 20/63. For the 89 children randomized to Bangerter filters, visual acuity was also measured in the nonamblyopic eye with and without the filters at both 6 weeks and 12 weeks after initiating treatment.

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PEDIG Results

- **Results—**Mean degradation in visual acuity of the nonamblyopic eye at baseline was 5.1 logMAR lines with the 0.2 filter and 4.8 logMAR lines with the 0.3 filter. The degradation with each filter did not always agree with the manufacturer's specifications. Over time, the amount of degradation with the filters decreased.
- **Conclusions—**The 0.2 and 0.3 Bangerter filters degrade nonamblyopic eye visual acuity sufficiently in amblyopic children. Because the amount of degradation decreases over time, it is recommended to periodically apply a new filter when using this type of amblyopia treatment.

The Effect of Bangerter Filters on Binocular Function in Observers With Amblyopia

Zidong Chen,[1] Jinrong Li,[1] Benjamin Thompson,[2,3] Daming Deng,[1] Junpeng Yuan,[1] Lily Chan,[4] Robert F. Hess,[5] and Minbin Yu[1]

- **Purpose**: We assessed whether partial occlusion of the nonamblyopic eye with Bangerter filters can immediately reduce suppression and promote binocular summation of contrast in observers with amblyopia.
- **Results**: Bangerter filters reduced suppression in observers with amblyopia and induced suppression in controls. Bangerter filters were able to induce normal levels of binocular contrast summation in the group of observers with anisometropic amblyopia. The filters reduced binocular summation in controls.
- **Conclusion**: Bangerter filters can immediately reduce suppression and promote binocular summation for mid/low spatial frequencies in observers with amblyopia.

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Results from studies using filters like a sledgehammer.

Characterization of Bangerter filter effect in mild and moderate anisometropic amblyopia: predictive factors for the visual outcome

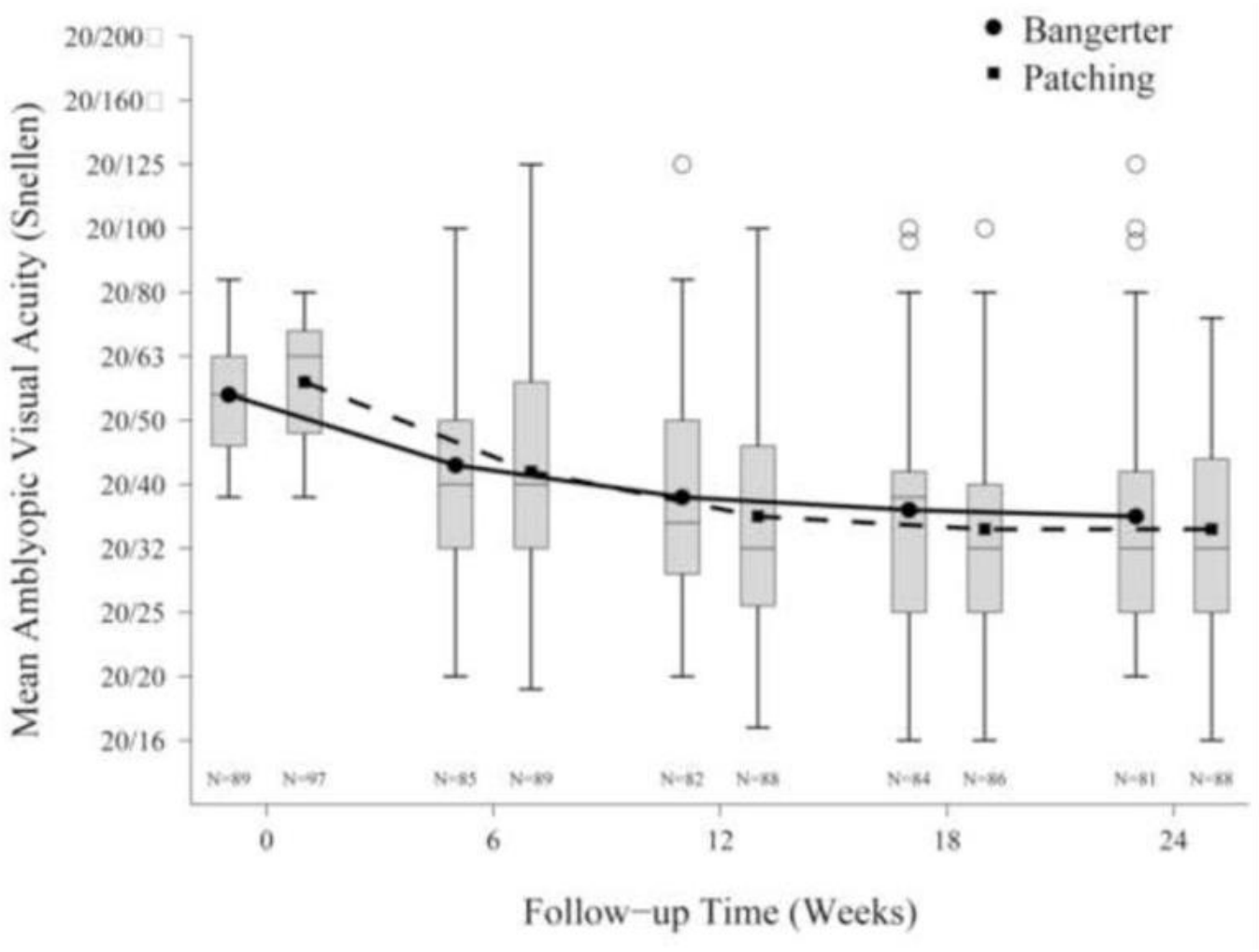
Characterization of Bangerter filter effect in mild and moderate amblyopia associated with strabismus

A randomized trial comparing Bangerter filters and patching for the treatment of moderate amblyopia in children

Binocular versus standard occlusion or blurring treatment for unilateral amblyopia in children aged three to eight years

Meh!

Conclusions: Because the average difference in visual acuity improvement between Bangerter filters and patching was less than half a line, and there was lower burden of treatment on the child and family, Bangerter filter treatment is a reasonable option to consider for initial treatment of moderate amblyopia.



Randomized Controlled Trial

Ophthalmology 2010 May;117(5):998-1004.e6.

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Discussion Points

- Bangerter foils are similar to a Gaussian filter in that they produce essentially monotonically decreasing contrast with increasing spatial frequency
- Alteration of spatial phase is thought to have an important impact on spatial perception
  - The phase shifts that occur for spatial frequencies between the zero crossings in the MTF (modulation transfer function) with defocus do not occur to any substantial degree with Bangerter foils
- Even with considerable defocus, there are still areas of the image that are quite dark and quite bright, whereas the images through a Bangerter filter tend toward a more uniform gray.

Discussion Points

- Though an optotype stroke in the Bangerter filter image may be considerably spread out, the true location of the stroke is always in the center (which is also the darkest point) of the area over which its image is spread.
- With defocus, however, the elements of the stroke can be shifted, with the darkest points sometimes occurring at an edge or in a different location altogether.

Discussion Points

- Compared with Bangerter foils, the spatial uncertainty introduced by defocus may have a distinct interaction with amblyopia, in which a defect of spatial localization or phase perception has been proposed as a component of the visual deficit.
- If specific spatial frequency channels are important, the spurious resolution that occurs with defocus will lead to less consistent suppression of these channels than will occur with a Bangerter filter.

Final Thoughts

- Not all forms of penalization are equal.
- In spite of the variability inherent in Bangerter filters and the fact that they don’t match the supposed visual acuity measures as advertised, they may be superior in titrating penalization in the treatment of amblyopia.

Potential Questions to Ponder

- In regard to the clinical use of Bangerter filters:
  - What level of penalization is needed to activate improved binocularity?
    - Minimal “noise on the line” in the Fellow Eye channel vs.
    - Degrading the primary image to being worse than the “amblyopic” channel?
  - What are the pro’s and con’s of using Bangerter filters vs.
    - Opaque occlusion
    - Other occlusion techniques: nail polish, Scotch tape. etc.
    - Plus lens application
    - Something else?

Thank You.

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