Peripheral depth estimation of disparity-defined targets

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Purpose

People with central vision loss (CVL) depend on peripheral vision, which has lower contrast sensitivity, resolution acuity, and stereoacuity. Although retinal scotomata are typically asymmetric, the level of functional impairment is generally based on binocular acuity, which is determined primarily by the smaller scotoma. Visually-guided actions in the real world also depend on depth perception, which requires overlapping binocular visual fields to detect disparity. We previously showed that asymmetric scotomata impair binocular contrast summation (Alberti et al, 2017), here we examine how asymmetric scotomata affect stereoscopic acuity and fixation stability.

Methods

Scotoma: Gaze-Contingent asymmetric binocular scotomata were simulated with circular Pink Noise patches independently centered on the fovea of each eye. The diameters of the scotomata were 4°, 9° or 14° and were presented in all 6 unique binocular permutations.

Equipment: Dichoptic presentation was controlled with nVidia shutter glasses (72Hz per eye) and a Eyelink II eyetracker (500Hz per eye).
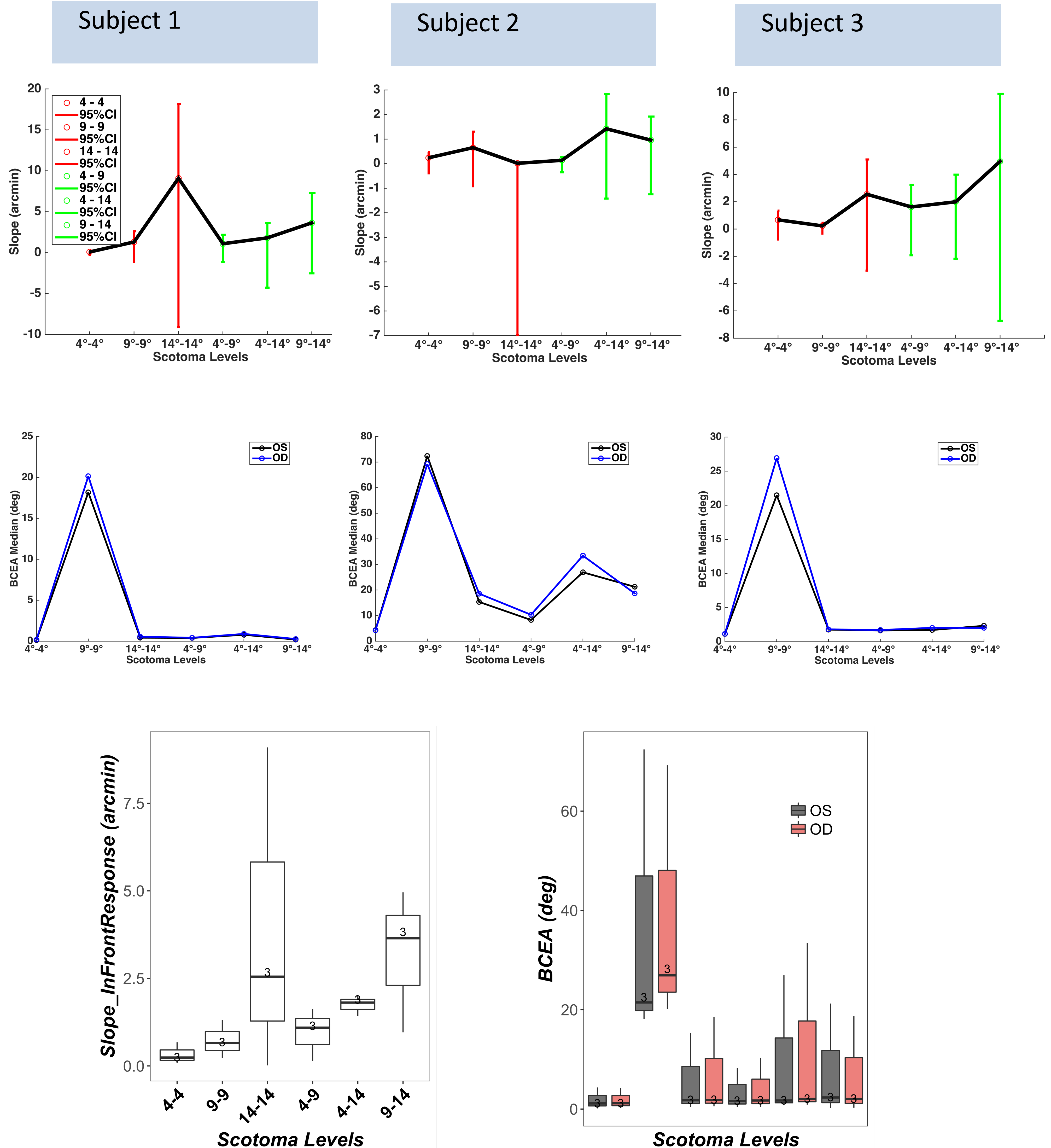
Task: The depth target was a horizontal sinusoidal depth modulated random dot (17 arcmin) grating (9° width). Stereoacuity was assessed with a 2AFC task (in front vs behind the screen). Horizontal disparity was controlled by two independent staircases for crossed and uncrossed disparities. Stimulus duration was 1 sec. Fusion was necessary to perceive depth and motor fusion was visually checked by the experimenter.

Participants: 3 normally-sighted volunteers.
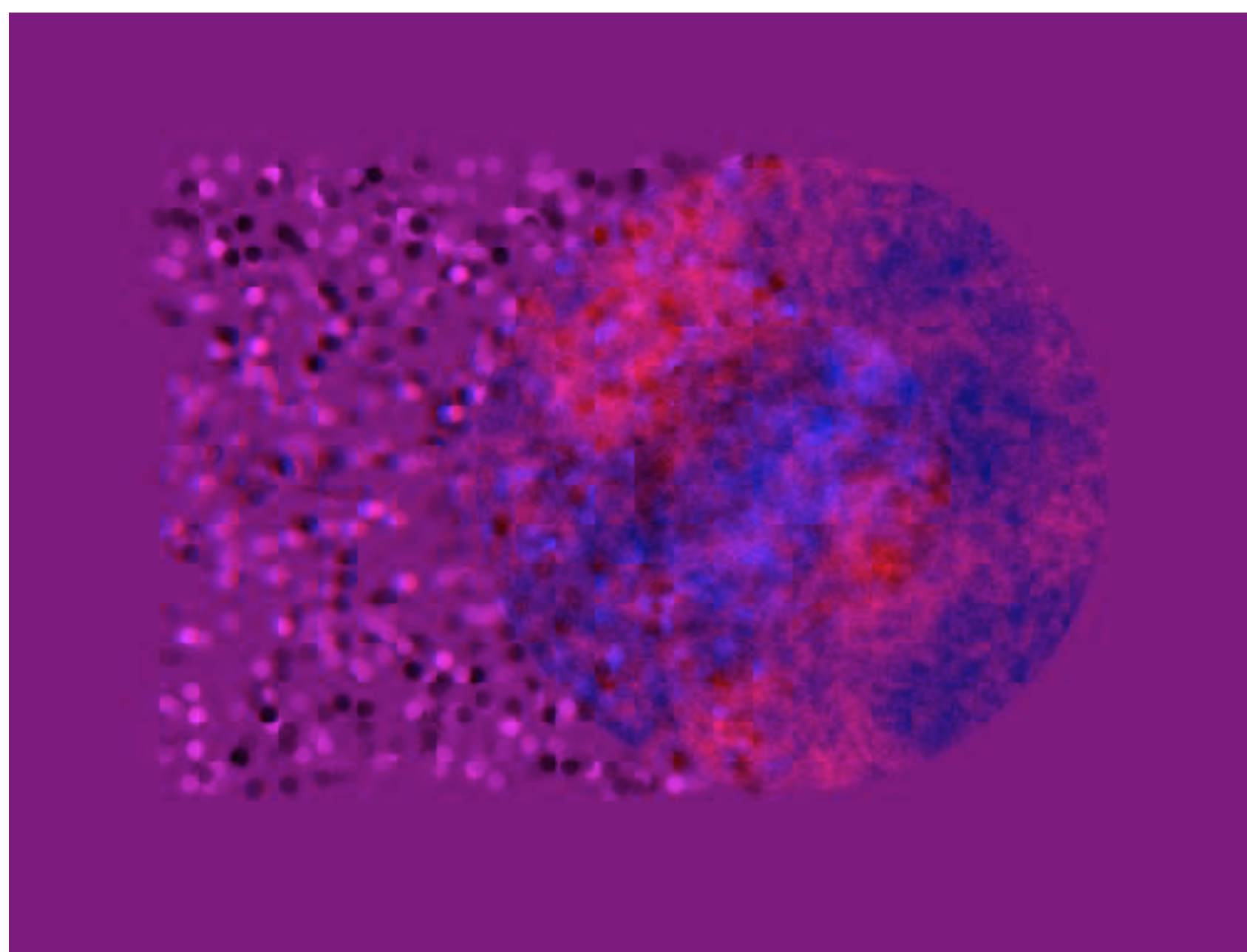
Random Dot Grating with overlapping Binocular Scotomata. Use the anaglyph 3D glasses to perceive depth and to check the asymmetric scotomata simulation!

Commercial Relationships: None

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Results

Subject 1

Subject 2

Subject 3

Stereoacuity decreases as scotoma size increases.

For asymmetric scotomata stereoacuity is worse than that of the larger scotoma.

Conclusions

- The level of depth impairment increases with scotoma size and depends on the size of the larger monocular scotoma, suggesting that visually-guided behavior in 3D environments is overestimated by best binocular acuity.

- Fixation stability (BCEA) is lower for symmetric medium size scotomata, possibly impairing stereoacuity.

References:

- Alberti C.F., Bex, P. (2017). Do oculomotor adaptations to a volume scotoma provide functional benefits for binocular vision? ARVO Abstract.