

Correct blur and accommodation information is a reliable cue to depth ordering

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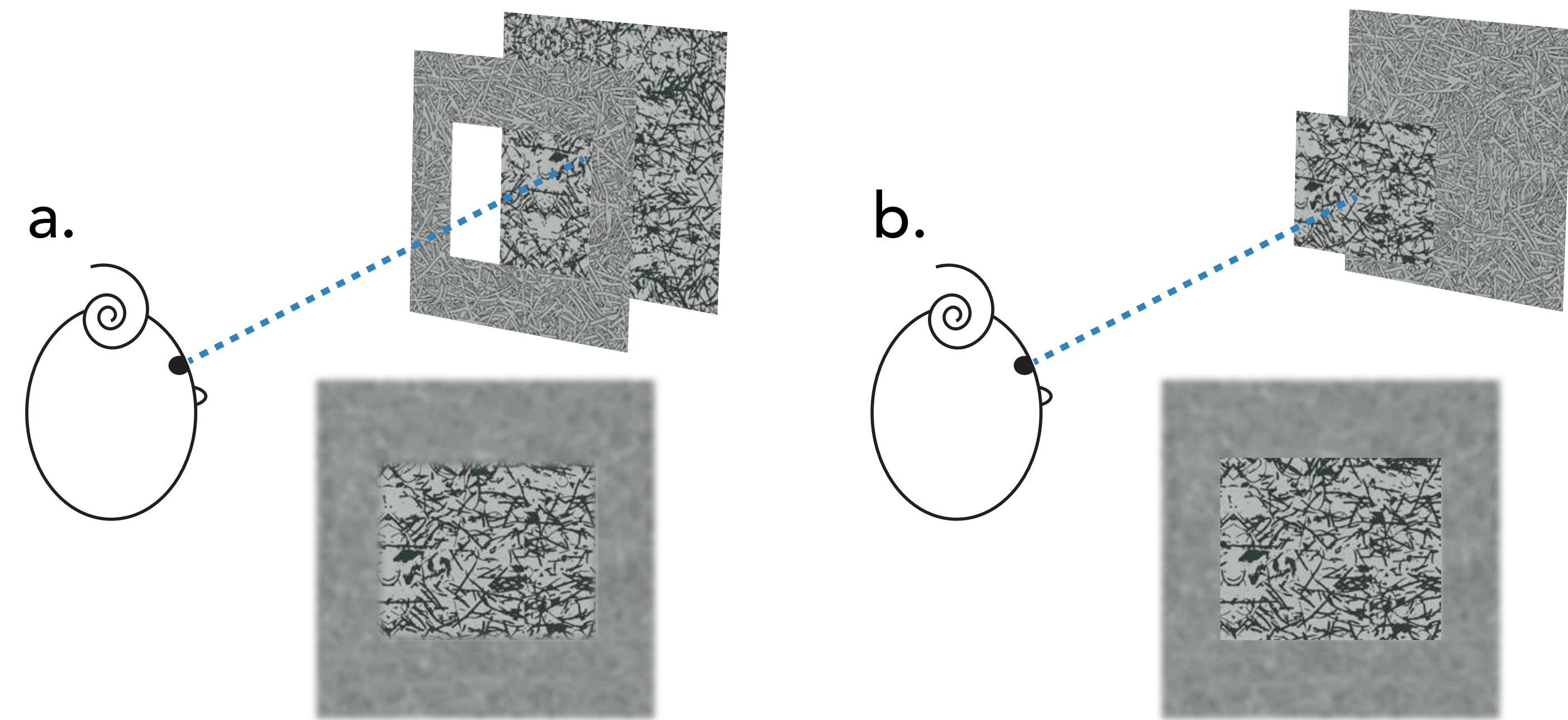
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Motivation

Blur & Occlusion

Occlusion edge blur used as cue to depth ordering (Marshall et. al).



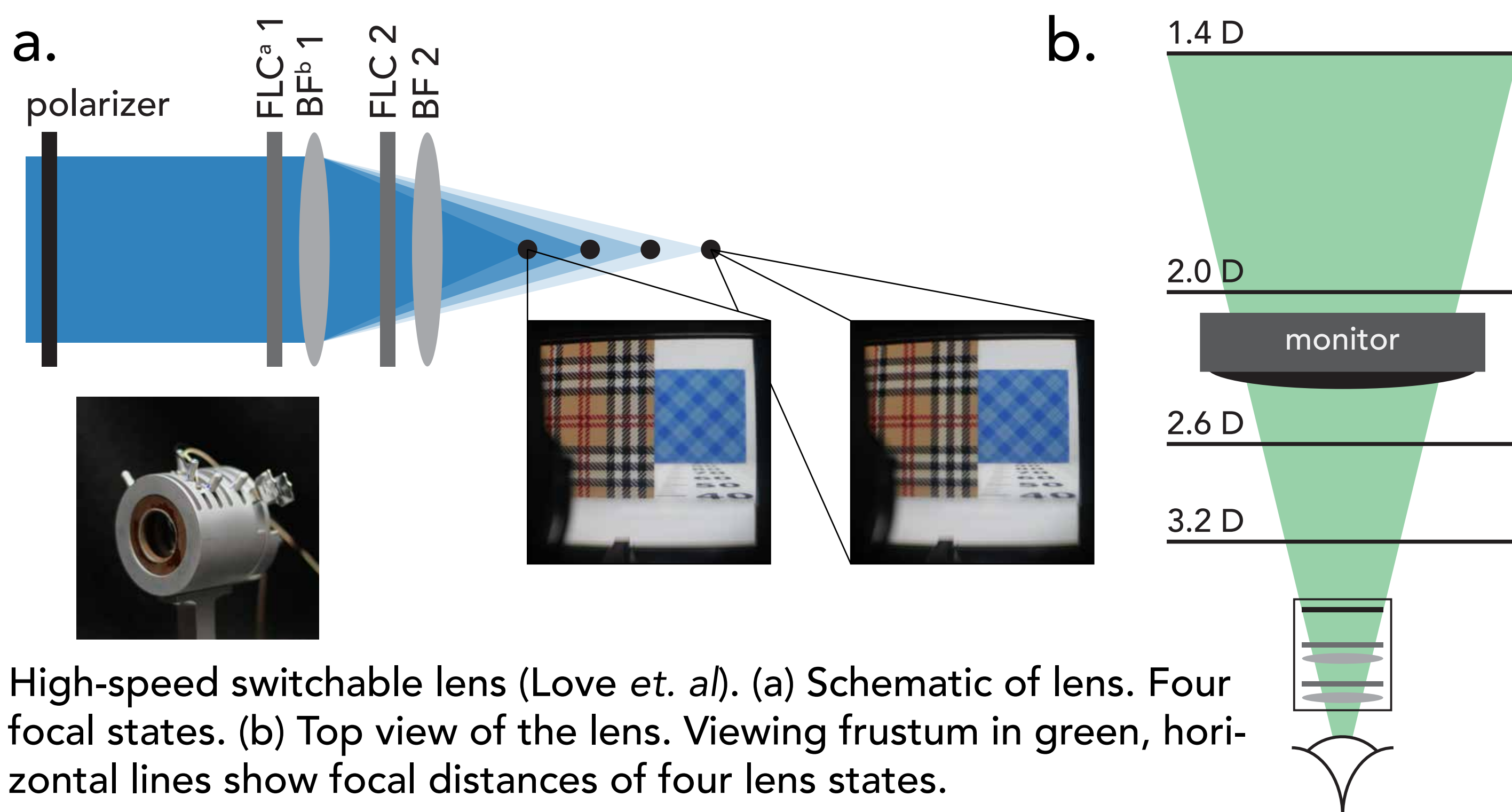
Ecological relationship between blur and occlusion. (a) Eye focused on far plane seen through aperture. (b) Eye focused on near plane. Blur of occlusion boundary identical to blur of near surface.

Bias: sharp boundary, blurred texture perceived in front.

Limitations:

- correct blur only if viewer accommodates to display screen.
- unrealistic blur.

Accommodation



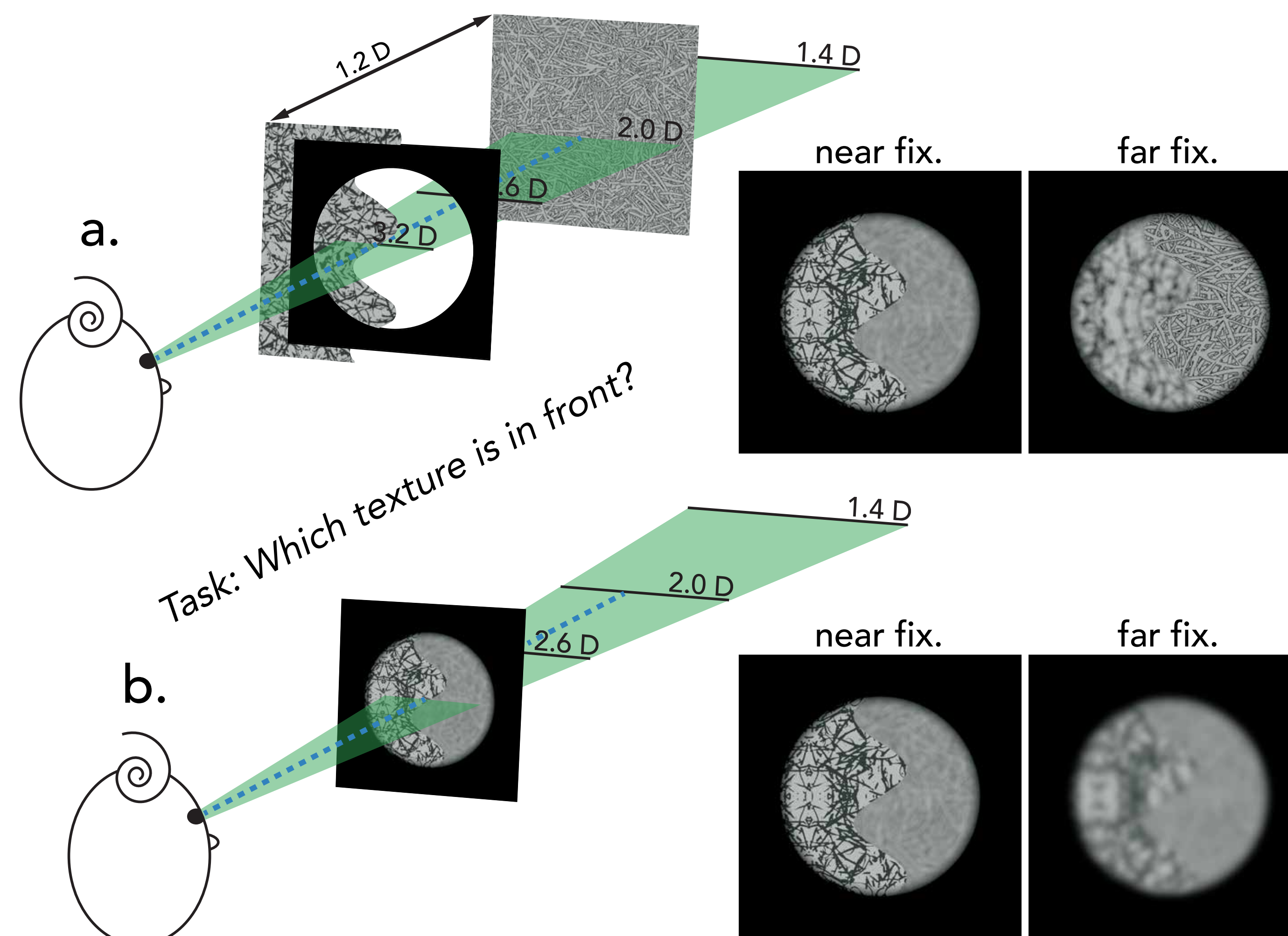
High-speed switchable lens (Love et. al). (a) Schematic of lens. Four focal states. (b) Top view of the lens. Viewing frustum in green, horizontal lines show focal distances of four lens states.

Question

- Improved performance with correct accommodation cues?
- Reduction in individual biases with correct accommodation cues?

Experiment 1

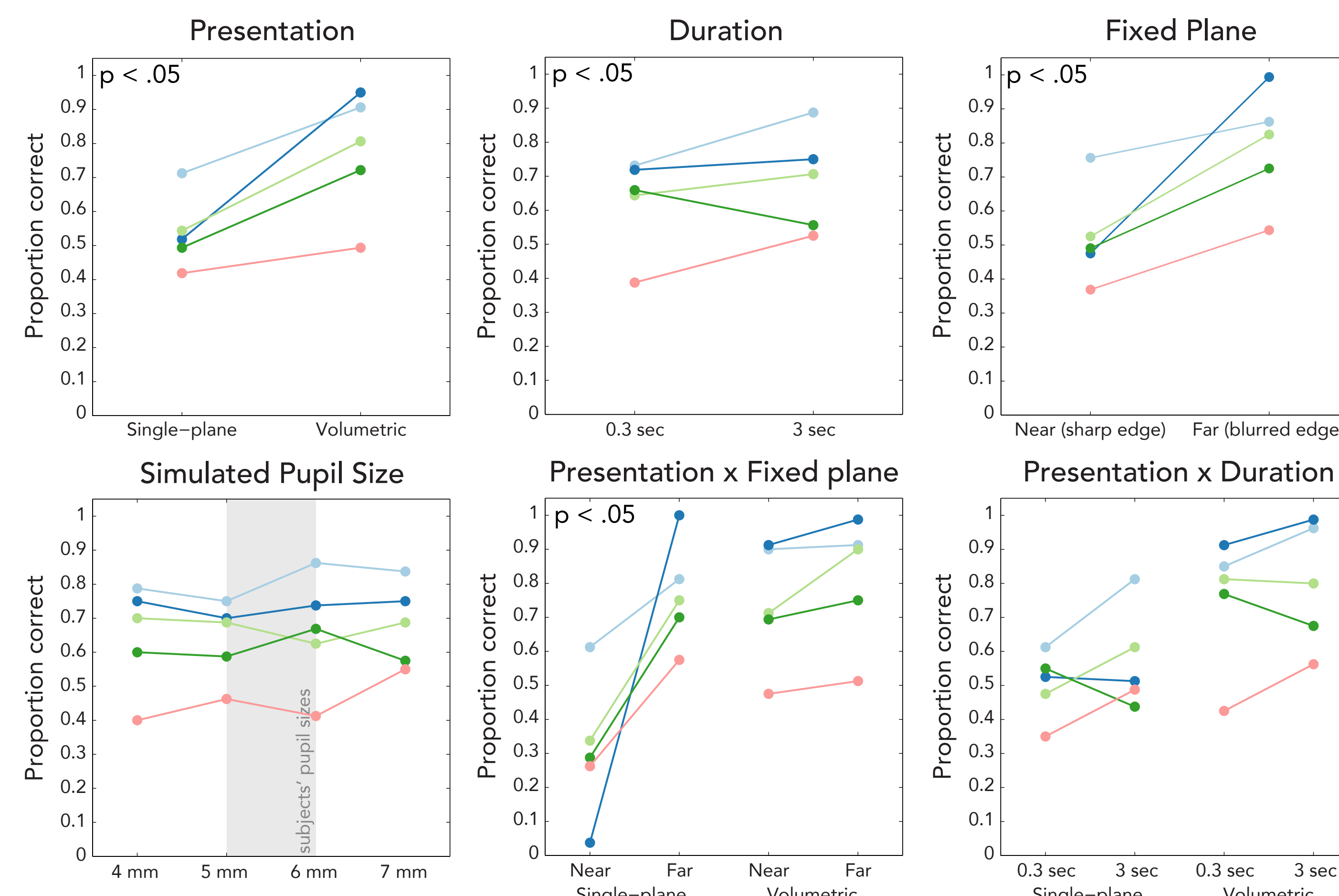
Methods



Stimuli used in Experiment 1. (a) Volumetric presentation: two flat textures (chosen among four) displayed in separate focal planes (distance 1.2 D), blur produced by accommodation. (b) Single-plane presentation: two flat textures displayed in same focal plane, artificially rendered blur (1.2 D). Monocular presentation.

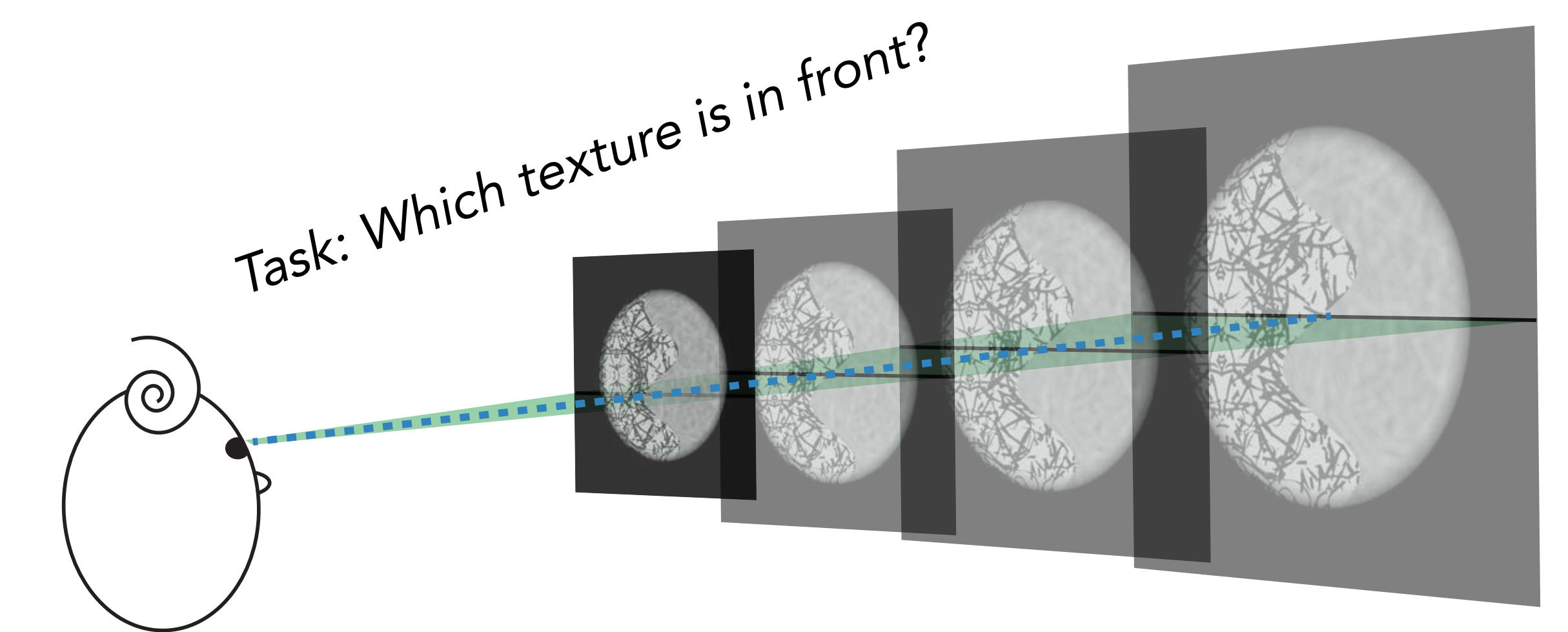
Results

ANOVA: Presentation * Duration * Fixed Plane * Simulated Pupil Size



Experiment 2

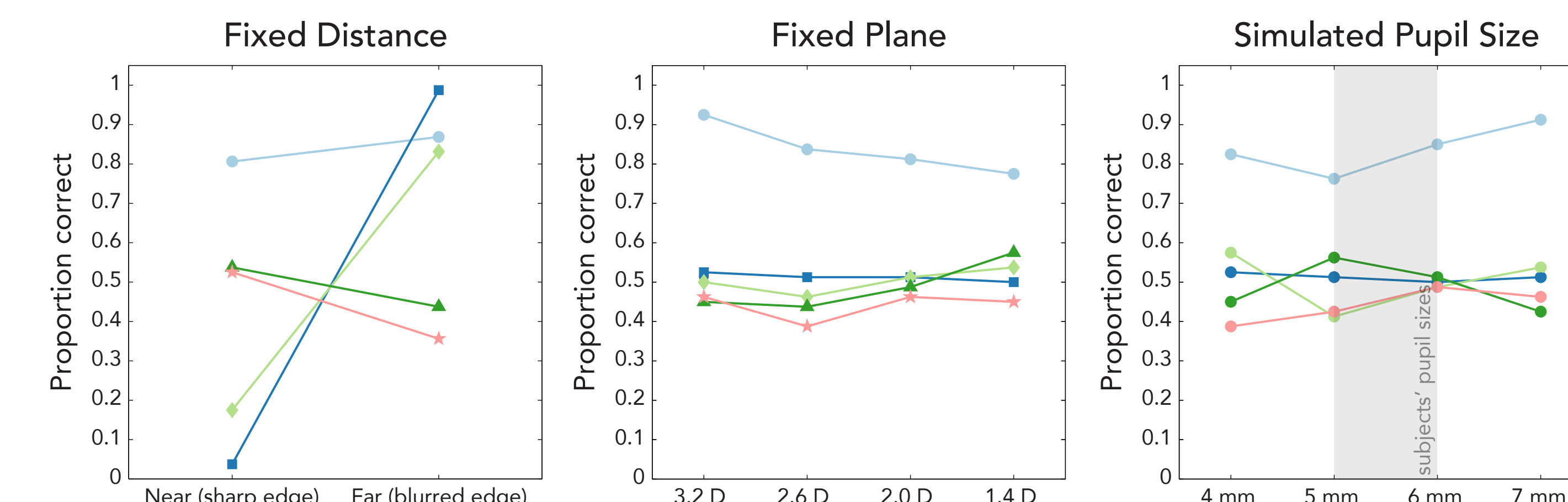
Methods



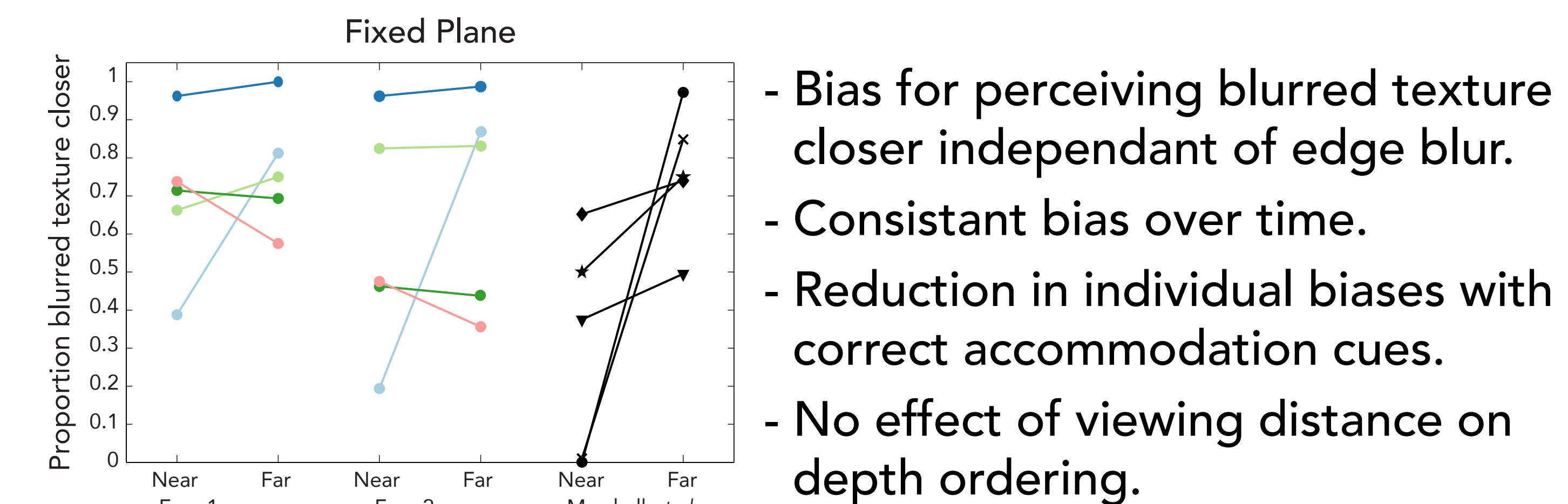
Viewing configuration in Experiment 2. Single-plane presentation: two flat textures displayed in same focal plane (3.2, 2.6, 2.0 or 1.4 D), artificially rendered blur (1.2 D). Monocular presentation.

Results

ANOVA: Fixed Distance * Fixed Plane * Simulated Pupil Size



Discussion



- Bias for perceiving blurred texture closer independent of edge blur.
- Consistent bias over time.
- Reduction in individual biases with correct accommodation cues.
- No effect of viewing distance on depth ordering.

References

Love, Hoffman, Hands, Gao, Kirby, & Banks. (2009) High-speed switchable lens enables the development of a volumetric stereoscopic display. *Optics Express*, 17, 15716-15725.
 Marshall, Burbeck, Ariely, Rolland, & Martin. (1996) Occlusion edge blur: a cue to relative visual depth. *J. Opt. Soc. Am. A* 13, 681-688.

^a Ferroelectric liquid-crystal polarization switch, ^b Birefringent lens