More Than Meets the Eye: Spatial Updating Under Simulated Central Vision Loss in Virtual Reality

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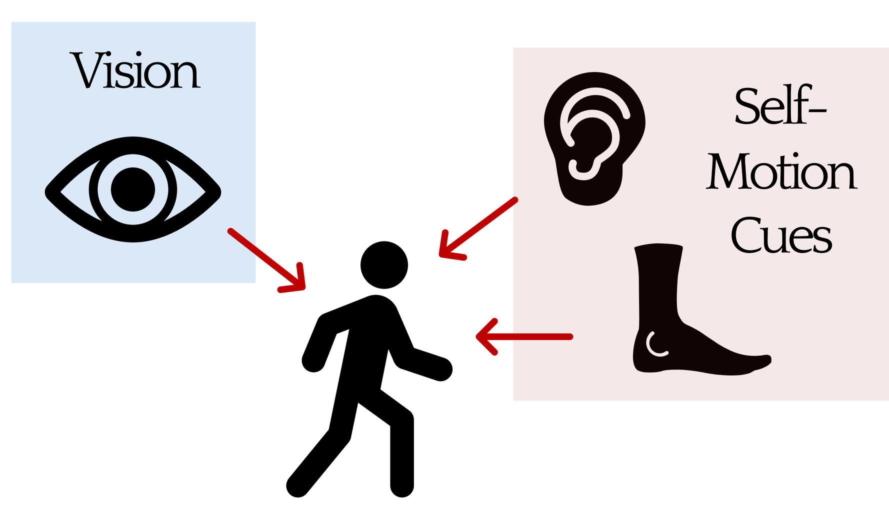
1 BACKGROUND

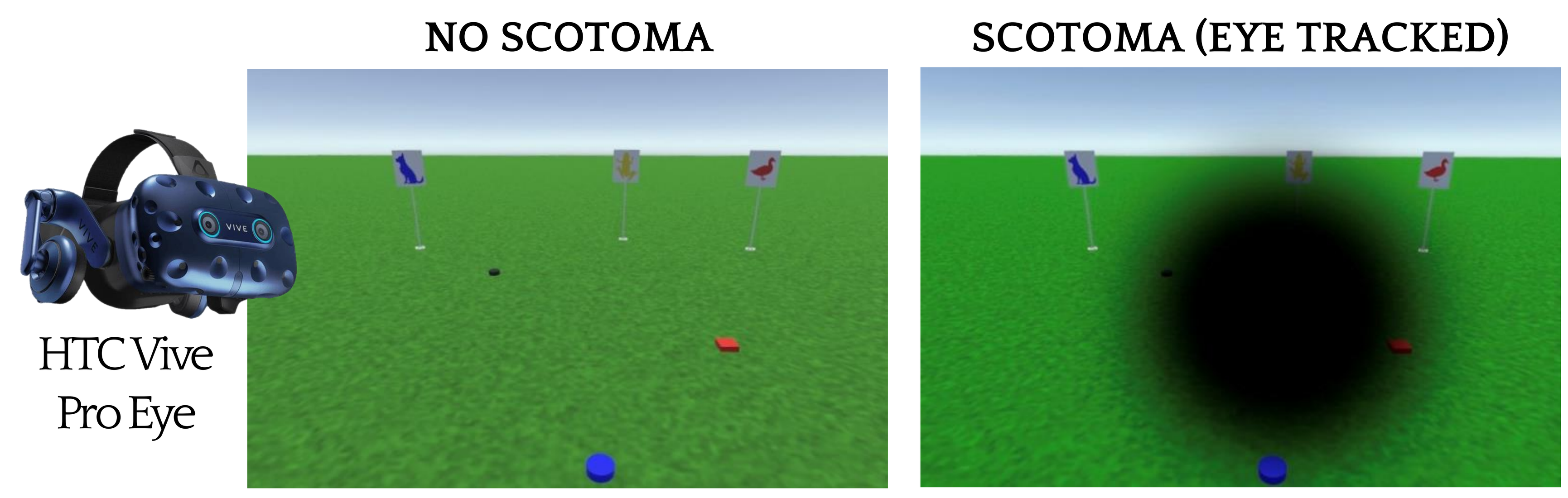
- 6 million people in the U.S. are living with low vision [1].
- Central vision loss (a scotoma) is a hallmark of macular degeneration and other retinal disorders, leaving peripheral visual information intact.
- Navigation relies on integrating vision and body-based self-motion cues (e.g., proprioception, vestibular input) [2].

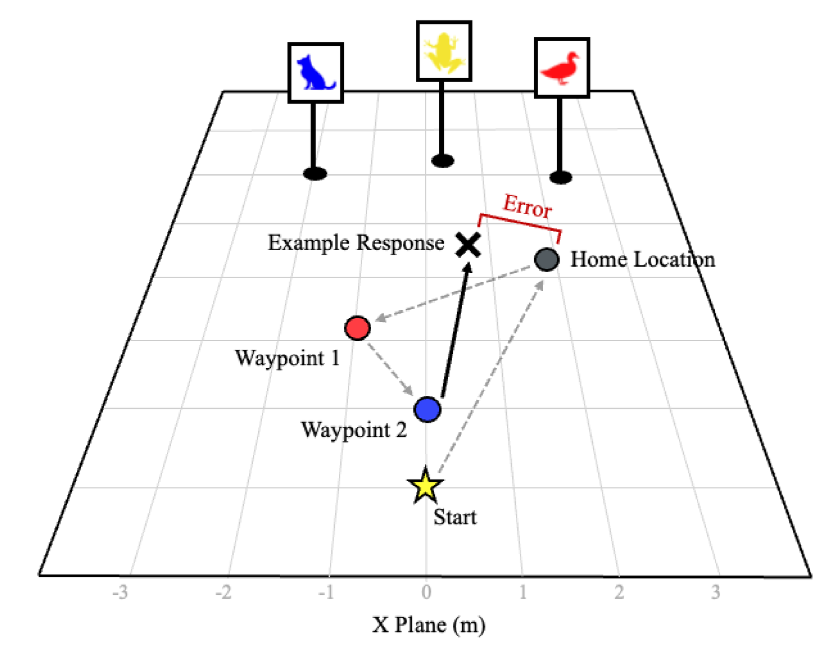


How does simulated central vision loss affect sensory integration during navigation in virtual environments?

2 METHODOLOGY

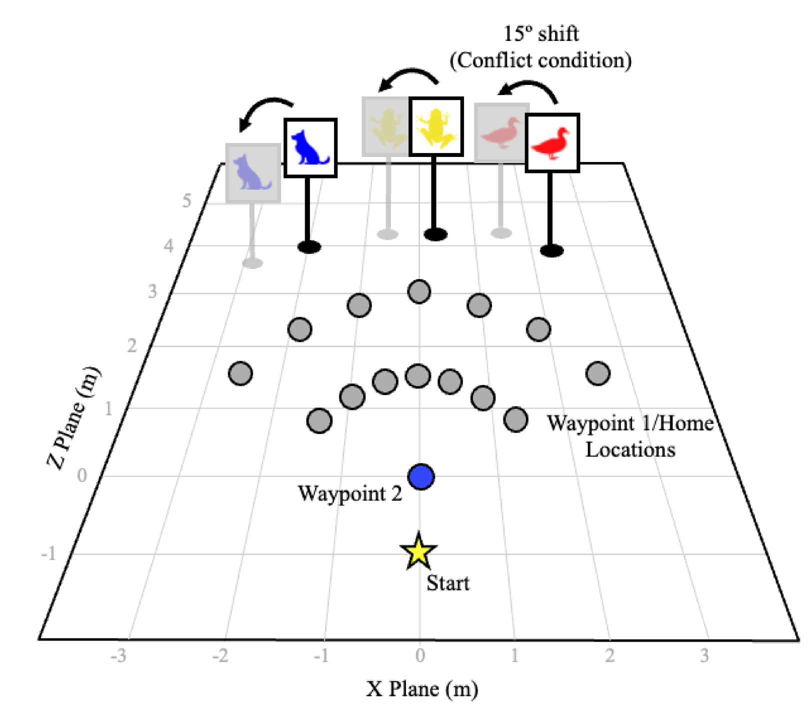
- **Participants** (N= 18; M_{age} = 18.9) completed a VR homing task under two scotoma conditions (blocked and randomized):





- **Homing task:** Participants walk to three ground targets, are blindfolded at the third for sensory manipulation, and then attempt to walk back to the first target from memory.
- **Sensory conditions:** Participants completed 8 trials in each of the 4 sensory conditions (32 trials in each scotoma condition):

Sensory Condition	Manipulation
Vision Only	Spun in swivel chair to disable encoded self-motion cues
Self-Motion Only	Signs in environment removed
Consistent Cues	No manipulation
Conflicting Cues	Signs shifted 15° to the left

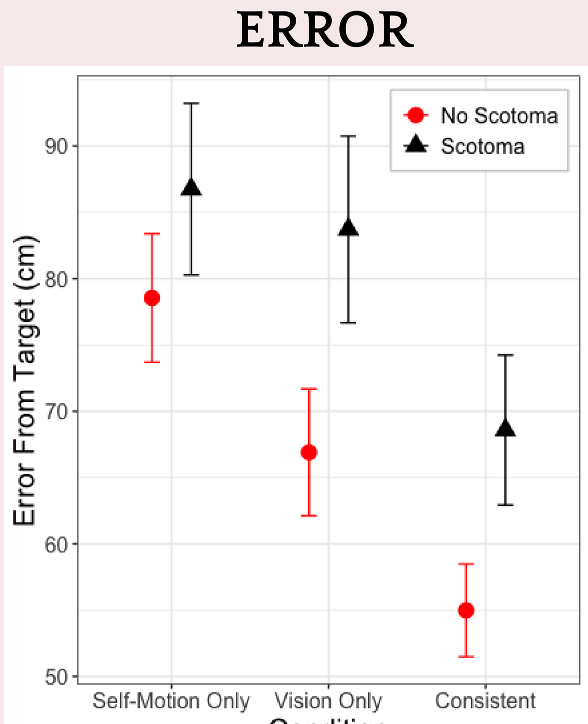


3 RESULTS

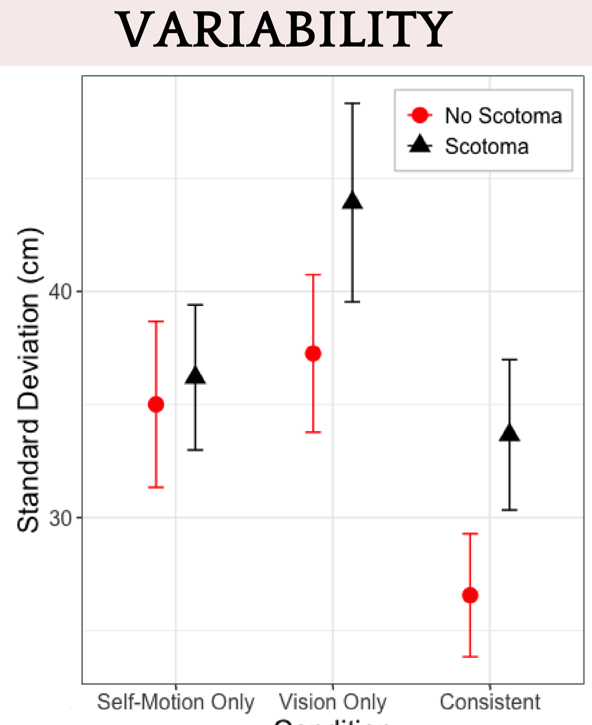
NAVIGATIONAL PERFORMANCE

- **Error** (inverse of accuracy) increases with the scotoma across all sensory conditions.
- **Variability** increases with a scotoma in the vision only condition but remains similar with self-motion or multisensory cues.

ERROR



VARIABILITY

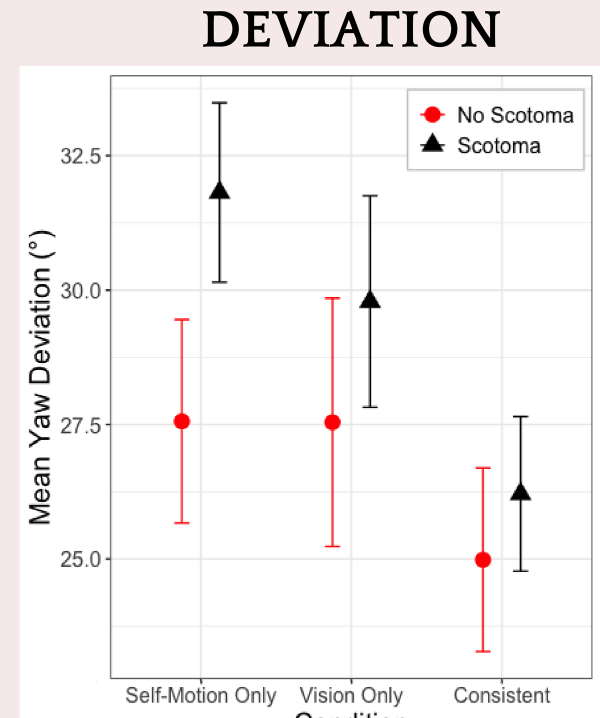


Error bars = SE

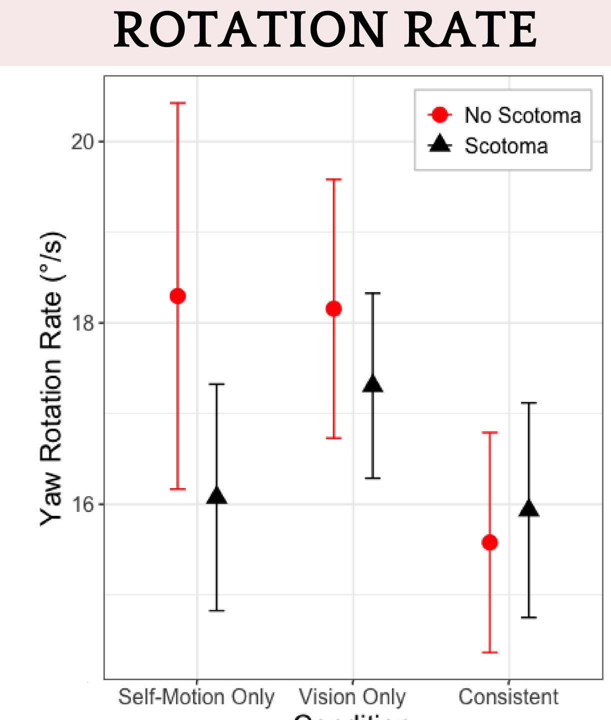
HEAD MOVEMENTS

- **Yaw deviation** increases with the scotoma showing head orientation was less aligned with direction of walking.
- **Yaw rotation rate** was lower with a scotoma, indicating less head turns while walking.

DEVIATION



ROTATION RATE



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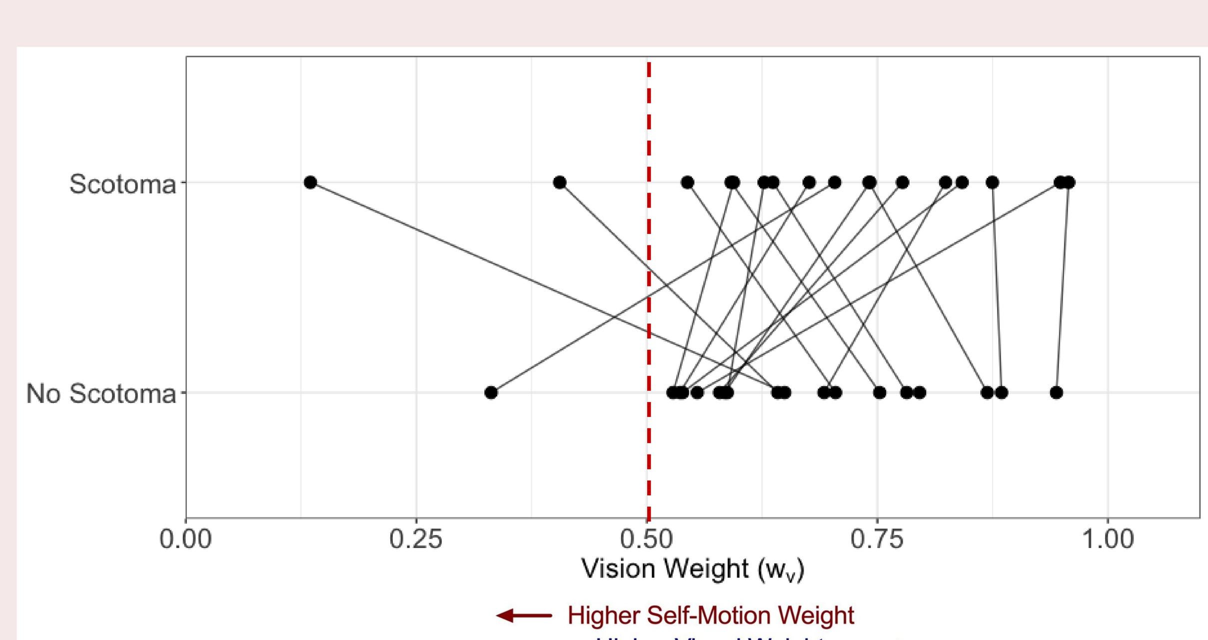
CUE COMBINATION

- Visual weighting, or the perceptual importance of vision, can be calculated by studying the homing error in the conflict condition when self-motion and landmark cues specify different locations (d) [2]:

$$w_v = \frac{1/d_v}{1/d_v + 1/d_{sm}} = \frac{d_{sm}}{d_{sm} + d_v}$$

- Greater variability in **visual weights** in the scotoma condition suggests individual differences in adapting to reduced visual input.



4 DISCUSSION

- Increased error and variability with central vision loss reflect reduced spatial cue reliability and impairments in multisensory integration.
- Navigators may compensate for central vision loss by adjusting head movements to maximize peripheral visual input.
- Simulations cannot fully replicate real-world low vision experiences at the neural or behavioral level [3].
- Future work will:
  - Assess optimal cue combination across the scotoma conditions
  - Compare simulated vs. real low vision to test generalizability

SCAN ME
for a digital copy of this poster and a video of the experimental procedure

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