PP-107

The Integration of Visual, Proprioceptive, and Vestibular Cues for Balance and Navigation After Concussion: A Virtual Reality Study

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1 BACKGROUND

- Around 3.8 million concussions occur annually in the U.S [1].
- ~25% of treated cases report balance issues after 1 year [2].
- Impaired sensory integration may underlie these persistent balance problems.
- Sensory integration deficits have been shown to affect walking-based navigation in other populations [3].
- No prior work has examined how concussion affects the relationship between balance and navigation via sensory integration.

How do concussions impair the integration of visual, proprioceptive, and vestibular information in balance and navigation tasks?

2 METHOD USING THE HTC VIVE PRO EYE

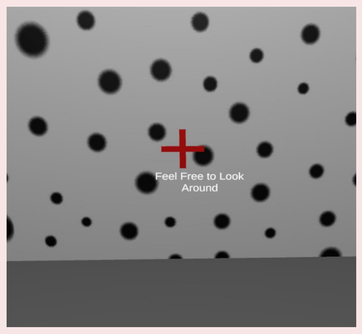
Participants: All completed 2 tasks in VR

12 participants with concussions ($M_{post\ injury}$ = 44.1 days; M_{age} = 26.8; M_{NSI} = 32.5)

19 healthy controls (No concussions in 3 years; M_{age} = 21.7; M_{NSI} = 6.3)

SENSORY ORGANIZATION TASK (SOT)

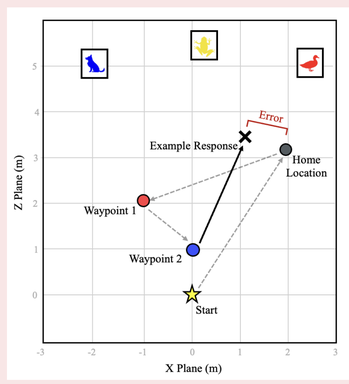
- We adapted the traditional SOT task into a virtual environment (VE) to measure static balance.

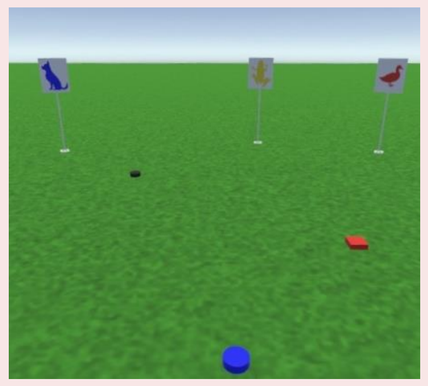


- Participants with concussions completed 2 trials, controls did 3 trials, across the following conditions:

SOT Condition	Manipulation	Ground Type	
		Firm	Foam
Normal Vision	No manipulation to the VE	Con. 1	Con. 4
No Vision	Screen in HMD went black	Con. 2	Con. 5
Fixed Vision	The VE became static at the start of the trial	Con. 3	Con. 6

NAVIGATIONAL HOMING TASK





- Participants walk to three target locations and returned to where they remembered the first target.
- Completed 8 trials in each condition:

Homing Condition	Manipulation
Vision Only	Spun in swivel chair to disable encoded self-motion cues
Self-Motion Only	Signs in VE removed
Combined Cues	No manipulation

3 RESULTS

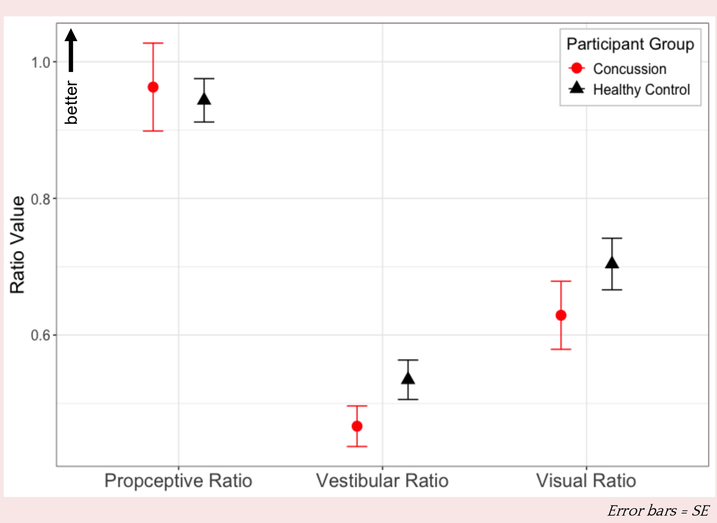
SOT RESULTS

- SOT ratios were calculated using the path length of head position.

Proprioceptive Ratio: $\frac{\text{Cond. 1 } (all\ cues)}{\text{Cond. 2 } (no\ vision, firm)}$

Vestibular Ratio: $\frac{\text{Cond. 1 } (all\ cues)}{\text{Cond. 5 } (no\ vision, foam)}$

Visual Ratio: $\frac{\text{Cond. 1 } (all\ cues)}{\text{Cond. 4 } (normal\ vision, foam)}$



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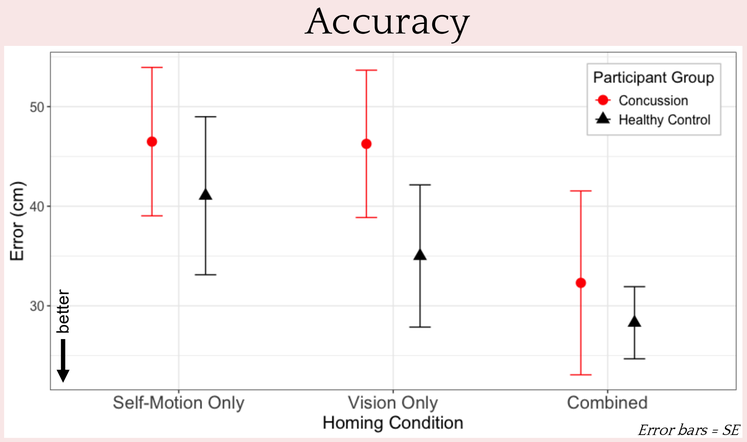
HOMING TASK RESULTS

Accuracy



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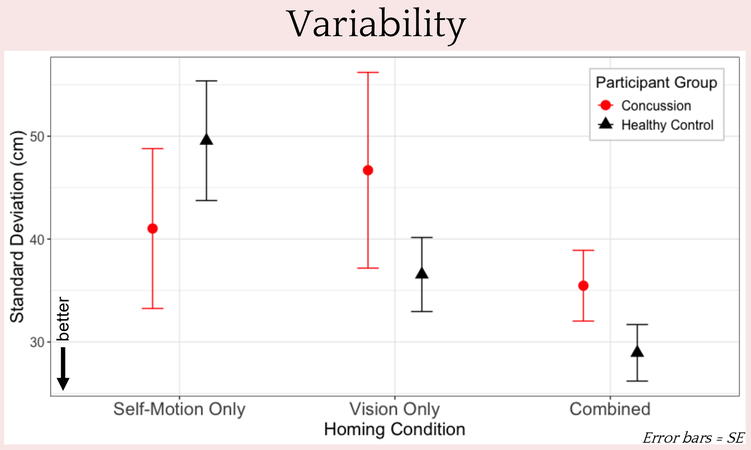
Variability



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4 DISCUSSION

- Data collection is still ongoing.
- Preliminary results suggest people with concussions use single sensory cues differently than controls in both balance and navigation.
- In navigation, similar performance under multiple cues suggests concussion participants may benefit more from sensory integration.
- Additional data collection and analyses will allow for investigation into the relationships between performance on these two tasks.

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[3] Bates, S. L., & Wolbers, T. (2014). How cognitive aging affects multisensory integration of navigational cues. Neurobiology of aging, 35(12), 2761-2769.

ACKNOWLEDGEMENTS

This research is funded by the National Center for Medical Rehabilitation Research within NICHD/NIH (R21HD110713; MPIs: Fino & Creem-Regehr) and the NSF Graduate Research Fellowship Grant No. 2139322.