Simulator driving with hemianopia: detection of static and moving pedestrians

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Driving with hemianopia

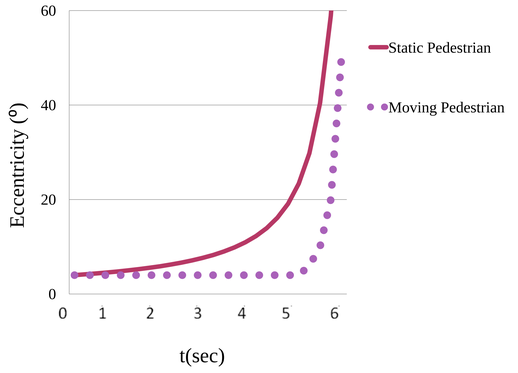
Homonymous Hemianopia (HH): loss of one half of the visual field on the same side in both eyes.

HH causes difficulty in detecting objects on the blind side. People with HH are not allowed to drive in 22 states in USA (Peli & Peli,2002).

Previous driving simulator study:
only 45% of pedestrians on blind side were detected
BUT pedestrians were stationary
(Bowers et al., 2009)

Stationary pedestrians eccentricity increases as the car approaches (i.e., pedestrians appearing in the blind field go deeper into the blind field)

Pedestrians moving on a collision course towards the car heading direction maintain an approximately constant eccentricity with respect to the car (Regan & Suneeti Kaushal, 1994).



Hypothesis

Blindside detection rates will be higher for moving pedestrians than for static pedestrians, especially at larger eccentricities

Methods

- 4 persons with left HH
- 2 persons with right HH

High-fidelity driving simulator
(field: 225° horizontally, 32° vertically)
Eye and head movements recorded with SmartEye remote IR tracking system

Pedestrian detection task

Two simulator sessions (order counterbalanced):

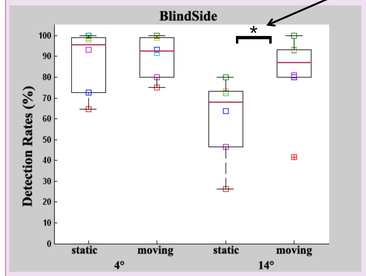
- Static pedestrians (n = 60) in one session
- Moving pedestrians (n = 60) in the other session
  Walked on a collision course with driver's car, but stopped at edge of travel lane

Initial appearance locations:
-14°, -4°, 4°, and 14° relative to car heading

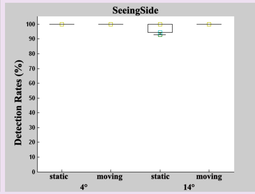
Participants pressed the horn as soon as they saw a pedestrian

- Other traffic on the road
- 2 highway drives (60mph) and 3 city drives (30mph) in each session

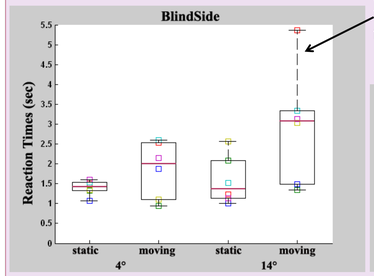
Detection rates



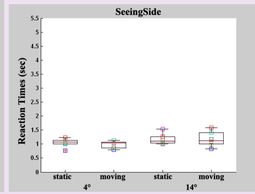
At 14° on the blindside:
Detection rates were higher for moving than static pedestrians



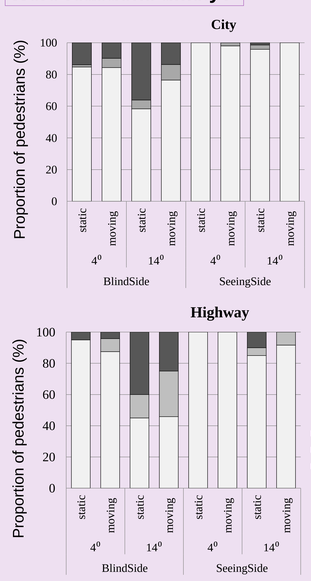
Reaction times



At 14° on the blindside:
Trend for longer reaction times for moving than static pedestrians



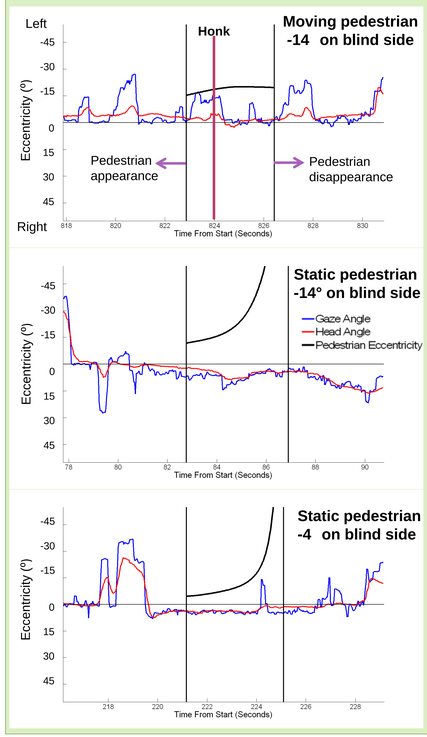
Were reactions timely?



Untimely reactions were responses that would have been too late to avoid a collision if the pedestrian had walked into the travel lane

Highway - at 14° on blindside
Proportion of missed detections was lower for moving than static
But: the proportion of untimely reactions was higher
Overall: similar proportion (~45%) of timely reactions for moving and static

Scanning patterns – participant with left HH



Eye scans to left
Detection

No eye scan to left
No detection

Eye scan to left but not far enough
No detection

Conclusions

- Detection rates were higher for moving than static pedestrians on the blind side.
- Although the proportion of failed detections was lower in the moving condition, the proportion of untimely reactions was higher
- Although the more constant pedestrian eccentricity in the moving condition provided more time for detection, it did not assure timely reactions.

References

1. Peli E, Peli D (2002). Driving with confidence: a practical guide to driving with low vision. Singapore, New Jersey, London, Hong Kong: World Scientific Publishing Company.
2. Bowers AR, Mandel AJ, Goldstein RB, Peli E (2009). Driving with hemianopia, I: Detection performance in a driving simulator. Invest Ophthal Vis Sci, 50(5): 5137.
3. Regan D, Suneeti Kaushal (1994). Monocular Discrimination of the Direction of Motion in Depth. Vis Res, 34(2): 163.

Acknowledgements

Support : NIH Grant EY12890 (EP) and EY018680 (ARB).