Analysis of gaze and pedestrian eccentricity explains differences in detection of stationary and approaching pedestrians by drivers with hemianopia

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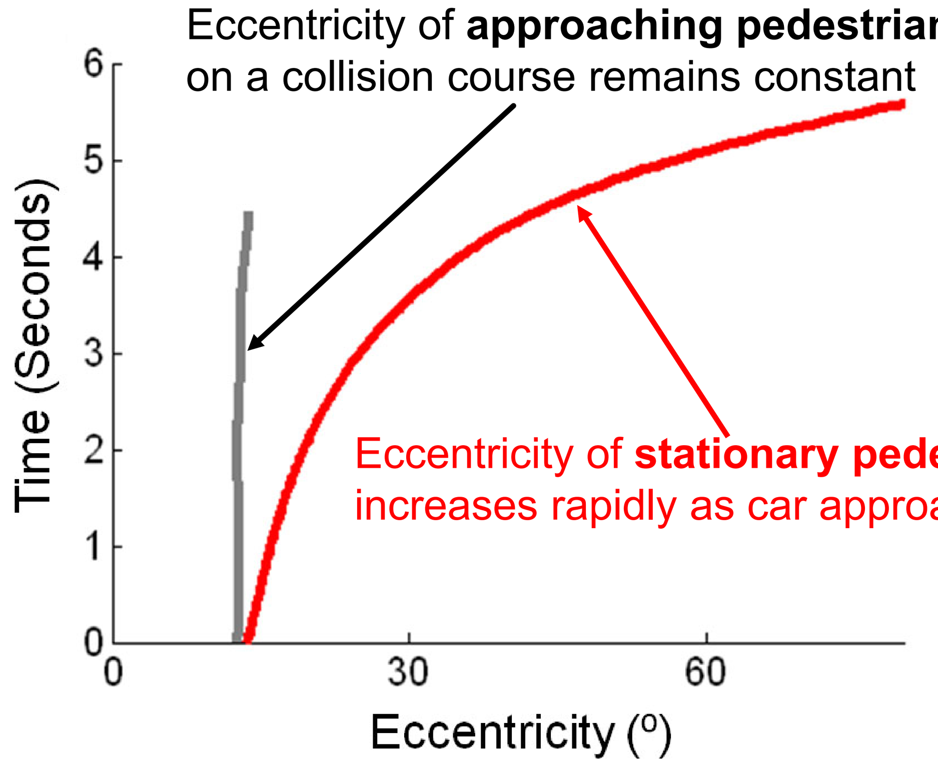
Introduction

- Drivers with hemianopia had high miss rates for pedestrians on their blind side.[1,2]
- If the pedestrian is at 14° in the blind hemifield, a driver with hemianopia needs to scan at least 14° into blind hemifield to see the pedestrian.
- An approaching pedestrian on a collision course remains within the range of a 14° scan for longer than a stationary pedestrian



Predictions

- More time available for gaze to reach an approaching than a stationary pedestrian:
  - ➢ Time of intersecting/closest gaze will be later
  - ➢ Miss rates will be lower
  - ➢ But reaction times will be longer

Methods

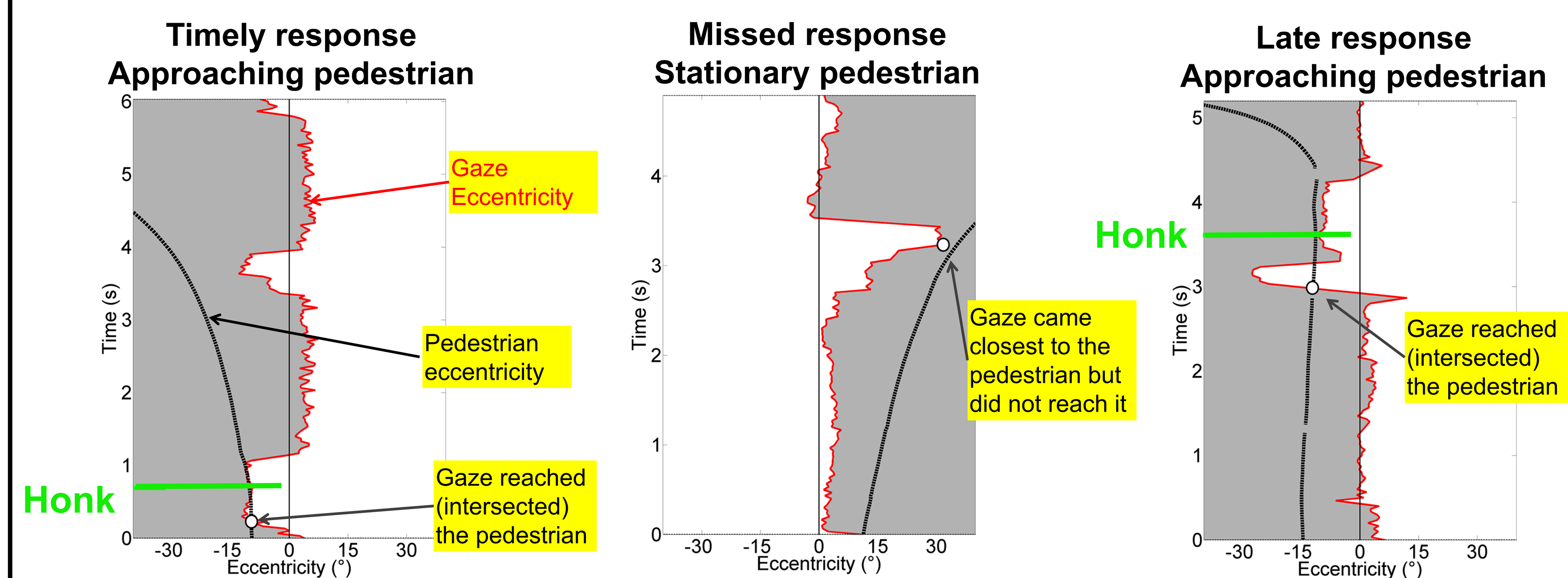
- 12 participants with complete hemianopia
- 26 stationary pedestrians on blind side at 14°
- 26 approaching pedestrians on blind side at 14°
- Drive at 30 mph (city) or 60 mph (highway)
- SmartEye remote IR gaze tracking system

Driving simulator

Press the horn when pedestrian is seen

Determining time of intersecting/closest gaze

(From pedestrian appearance to gaze intersecting or coming closest to the pedestrian)

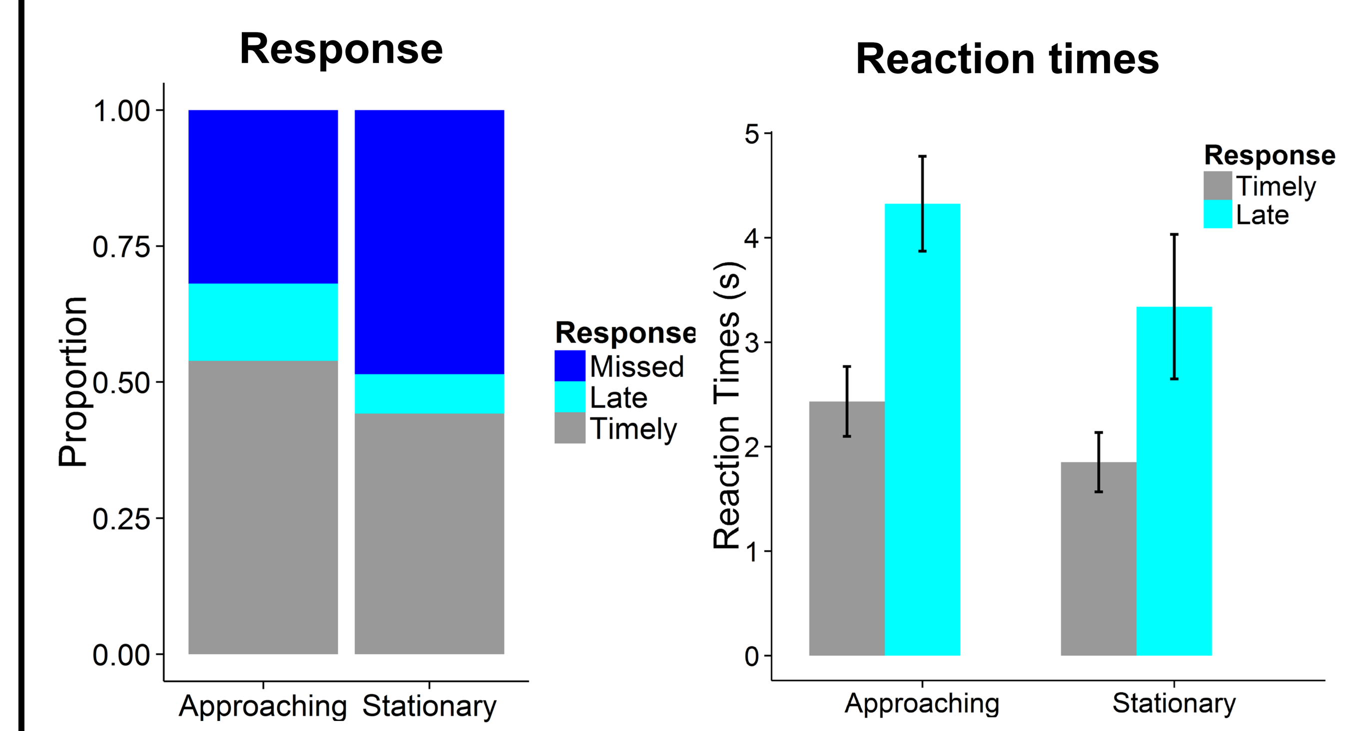


S1: left hemianopia — Pedestrian seen < 1 s after appearance

S2: right hemianopia — Pedestrian not seen

S3: left hemianopia — Pedestrian seen ~ 3 s after appearance

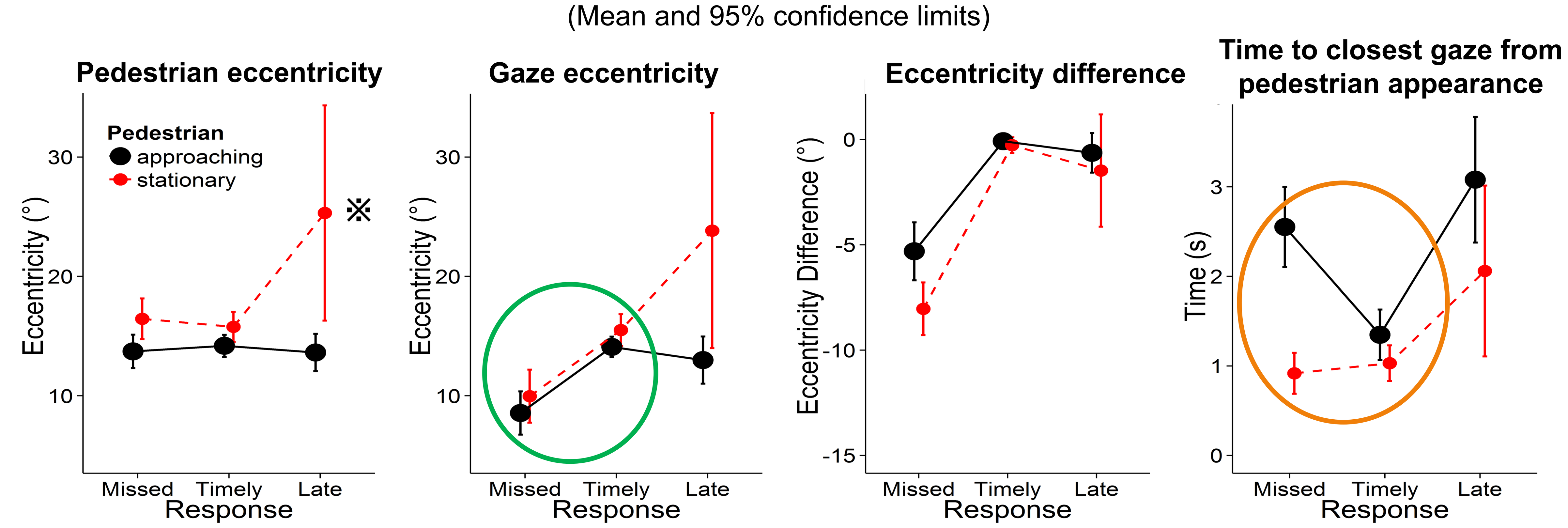
Response to blind side pedestrians



Approaching pedestrians:
Fewer misses
More late responses
Longer reaction times

Measures at time of intersecting/closest gaze on blind side

(Mean and 95% confidence limits)



Pedestrian eccentricity: Lower eccentricity for approaching

Gaze eccentricity: No differences between approaching and stationary except for late responses

Eccentricity difference: When missed, gaze further from stationary pedestrians

Time to closest gaze: Time to closest gaze later for approaching, especially for misses

※ Note: there were only a small number of late responses (10 for stationary and 20 for approaching)

Conclusions

- Interaction of gaze and pedestrian eccentricity determined miss rates

Stationary pedestrians

- Higher miss rates because increasing pedestrian eccentricity
- Either seen soon or not seen

Approaching pedestrians

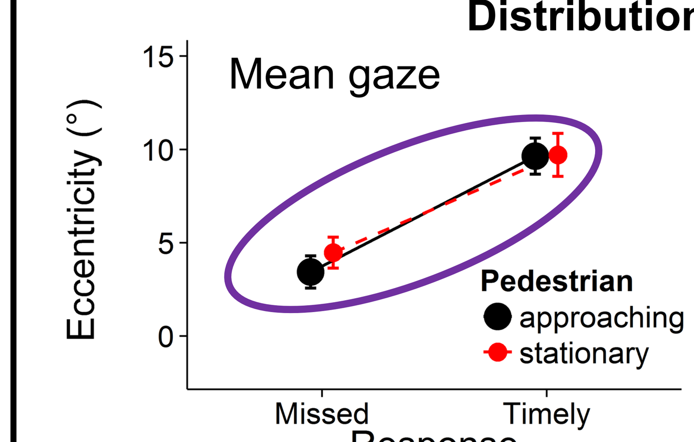
- Maintained ~14° eccentricity for longer:
- Lower miss rates
  But longer reaction times
  And more late responses

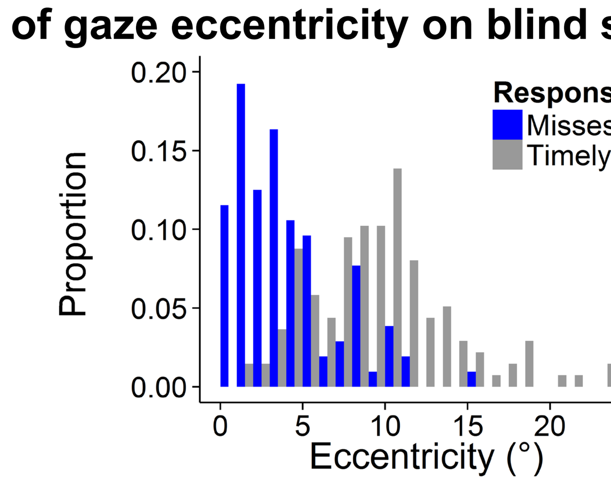
Gaze measures predict response

Timely responses associated with larger gaze eccentricity on the blind side:
- At time of intersecting gaze (β = 0.1, p = 0.03)
- And overall blind side mean gaze eccentricity (β = 0.50, p = 0.0001)

Longer reaction times associated with longer time to intersecting gaze
- (β = 0.93, p = 0.001)

Distribution of gaze eccentricity on blind side





Gaze data included from pedestrian appearance to:
- honk for timely responses
- disappearance for misses

1. Bowers AR, Mandel AJ, Goldstein RB, Peli E (2009). IOVS, 50(5): 5137.
2. Alberti, CF,, Peli E, Bowers AR (2014). IOVS, 55(1): 369.

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