The effects of simulated acuity and contrast sensitivity impairments on detection of pedestrian hazards

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Results from Experiment 1 cont.

Results from Experiment 2 cont.

A VA loss alone did not significantly increase RT nor significantly reduce the proportion of timely responses

However, a CS loss alone did significantly increase RT and marginally reduced the proportion of timely responses

When comparing between the four visual impairment conditions, there was no significant interaction between VA and CS for either detection measure (p > .6)

Combining Experiment 1 and Experiment 2

To determine whether VA and/or CS is the best predictor of RT and proportion of timely responses, model comparison was used for 4 regression models:

General Discussion

In Experiment 1, a simulated VA and CS reduction impaired RT and timeliness, while a VA reduction alone had minimal effects

While there was no significant interaction between VA and CS on RT and timeliness, the model that best predicted behavior included VA and CS

These results are congruent with other studies which have reported that simulated CS reductions impair driving performance to a greater extent than simulated VA reductions (Higgins, Wood, & Tall, 1998)

Our findings suggest that CS, as well as VA, should be assessed when measuring vision for driving licencing - This is especially true in eye diseases such as cataracts where VA may be within the legal limit, but CS is reduced

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Results from Experiment 1

Experiment 1: Effects of VA and CS losses combined

Goal of Exp. 1: How do simulated VA and CS deficits affect RT and timeliness?

Diffusing filters (Bangerter & Murgia, 2010) were used to create CS reductions with VAs still within legal limits for driving

1) How does simulated VA alone affect RT and timeliness?

2) How does simulated CS alone affect RT and timeliness?

Blur (positive) lenses were used to reduce VA without reducing CS

Blur lenses were selected to match the VA of the High and Mid diffusing filters

Results from Experiment 2

In Experiment 1, neither the filters nor the blur lenses had any significant effects on detection rates or car speed

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General methods

Participants drove in a highway setting that included oncoming traffic and curves in a high-fidelity driving simulator (FAAC Corp., Ann Arbor, MI)

Participants completed two practice drives to acclimate to the simulator

12 total pedestrians appeared equally to the left or right of the driver and ran toward the road along a collision course with the participant’s vehicle

Participants were instructed to drive normally, maintain a speed of 100kph, and press the horn as soon as they saw a pedestrian

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Background

Driving is a highly visual task

Vision impairment may adversely affect safe driving (Owsley & McGwin Jr, 2010)

Visual acuity (VA) is the predominant measure used by states to determine whether someone is visually fit to drive (Peli, 2008)

Eye disease may affect other aspects of vision while not reducing VA below state requirements for driving

- Cataracts, diabetes, and macular degeneration reduce both VA and CS

Contrast sensitivity (CS) is not measured by any state, yet has been shown to be a predictor of crash risk (Owsley et al., 2001)

- Better CS is a predictor of driving ability following cataract surgery (Wood & Carberry, 2006) and in drivers with macular disease (Albert et al., 2014)

Studies utilizing simulated vision impairment have found that a large VA reduction is needed in order to produce a similar decrement in driving performance to a relatively small CS reduction (Higgins & Wood, 2005)

We explored the effect of simulated CS and VA reduction on reaction time and the proportion of timely responses to hazards

- Timely response = given the speed of the car and the time of detection, could the driver safely brake to avoid a collision?

Hypothesis: CS predicts detection performance better than VA

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Results from Experiment 2 cont.

Experiment 2: Effects of VA and CS losses alone

Goals of Exp. 2:

1) How does simulated VA alone affect RT and timeliness?

2) How does simulated CS alone affect RT and timeliness?

Blur (positive) lenses were used to reduce VA without reducing CS

Blur lenses were selected to match the VA of the High and Mid diffusing filters

MID = matched to High

High = High from Exp. 1

Snellen Equivalent
20/16
20/25
20/30
20/40
20/63
20/100

LogMAR VA
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

Log CS
1.3
1.4
1.5
1.6
1.7
1.8
1.9

NV
Low
Mid
High

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Reference


