Older Adults and Driving: Steering Control, Lane Change, and Collision Detection

Bobby Nguyen, B.A., Jennifer Teves, M.S., and Rui Ni, Ph. D.

Department of Psychology, Wichita State University, Wichita, Kansas

Why is it important to study driving among older adults?

- According to the National Highway Traffic Safety Administration, there has been an 18% increase in older drivers from 1996 to 2006.
- Drivers 16-25, and 65+ years of age have the highest driver fatality rates.
- In 2001, 42.7% of fatal crashes involved two moving vehicles.

Figure 1. Driver Fatality Rates by Age and Sex, 1969.

General Purpose

The general purpose of these experiments is to determine how different visual information affect performance of older adults in three driver-related tasks: steering control, lane-change, and collision detection.

General Methods

Participants

- 19 participants 60 years old and above were recruited for these experiments. There were 6 males and 13 females.
- Most of the participants are residents of Larksfield Place, a retirement community in Wichita, KS.

Apparatus

- The displays will be presented on a Dell PC computer system. The visual angle of the display will be 11 deg by 19 deg, with the refresh rate at 60Hz and the resolution at 1920 by 1080.
- Participants will view the displays binocularly at a distance of 3 meters from the screen.
- Steering was measured using a Logitech GT Driving Force steering wheel and gas pedal.

Stimuli

- Stimuli will be generated using C++ and Open Graphics Library (OpenGL) in the Microsoft® Visual Studio® 2008 Professional Edition environment, unless noted otherwise.
- Steering Control Experiment: The stimuli consisted of bright dots on a darker ground plane. Dot perturbation was based on the summation of sine waves. The background had an average luminance of 16 cd/m².
- Lane Change Experiment: The display is composed of a textured ground, a roadway, a strip of road with a double yellow line projected along the length of the roadway. A gray sphere approaches the observer and the screen turns dark at the end of each display.

Collision Detection Experiment

Procedure

The task of the participants is to detect if the approaching object will end up in a collision or non-collision. The participants entered a response at the end of each display. There were 20 and practice sessions before participants proceeded to the actual experiment. The experiment had 4 blocks with 40 trials each.

Results

- A 2 x 3 within-subjects factorial ANOVA was conducted on the sensitivity scores of participants. Sensitivity (A’) scores were obtained using the average proportion of hits and false alarms of the participants’ responses.
- There were 2 levels of display duration (3 sec. & 7 sec.) & 4 levels of speed between object and observer (stationary observer, same speed, faster observer, slower observer).
- There was a significant main-effect for display duration, F (1, 15) = 17.18, p < .01 indicating greater sensitivity on the 7 sec. displays than the 3 sec. displays across the 4-speed conditions.

The same statistical analysis was conducted on the Response Bias (B”) scores. The data indicated a significant interaction effect between duration and speed variables, F (3, 48) = 4.59, p < .01. This means that when it comes to response bias, the effects of the different speed between object and observer interacted with the effects of display duration.

Conclusion

STEERING CONTROL: The results of the experiment indicate a decline in driving performance as dot density and contrast level decreases. Driving performance was worst for the 25 dots, low contrast condition. The best performance was observed in the 125 dots, high contrast condition. The non-significant interaction indicates that dot density and contrast level have additive effects.

LANE CHANGE: The results of the experiment did not indicate a correlation between lane changing performance and visual acuity and contrast sensitivity. This may be due to the optimal viewing conditions of the display. Further, correlations were not found between lane change performance and the cognitive assessments. This may be explained by the possibility that task was a measurement of attention and motor control, neither of which were directly measured in the cognitive assessments.

COLLISION DETECTION: The result of the collision detection experiment on older adults indicated a decline in sensitivity (A’) of older adults in detecting collision in displays that have shorter duration (3 sec.) compared to displays that last longer (7 sec.). Moreover, response bias (B”) appears to be higher in shorter duration displays compared to longer duration displays. Display duration appeared to have a more pronounced effect on performance in displays where the observer is moving (same speed, slower, or faster than the sphere) compared to displays where the observer is stationary. It is very interesting to find that mean sensitivity scores did not decline as a function of observer speed; this means that older adults were sensitive to the constant bearing information that was only present in collision displays across different conditions.

References