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Enhancing the Effectiveness of Safety Warning Systems for Older Drivers

People 65 and older are the fastest growing segment of the U.S. population and the fastest growing sector of the driving population. When compared to other age groups, older drivers are overrepresented in intersection crashes (Subramanian & Lombardo, 2007; Braitman, Kirley, Chaudhary, & Ferguson, 2007), and approximately half of the charges in fatal intersection crashes are for failure to obey the traffic control device. Prior research suggests that driving performance tends to diminish with age and can be attributed to factors such as declines in vision, hearing, reaction time, cognitive function, and motor abilities. An in-vehicle system that can aid drivers at greater risk of crashes may considerably reduce the number of fatalities as the driving population ages. This project explored an in-vehicle warning system for failure-to-obey (running a stop sign or stop light) violations.

Method

The experimental design used 36 participants from three age-related groups; "middle-normal"(25-55), "older normal"(>65) and "older at-risk"(>65) drivers. The participants were assigned two levels of vehicle system presence (present and not present). The protocol included a screening for general health and driving criteria and a process to classify potential participants as "normal" or "at risk" based on their scores relating to cognitive impairment and health and mobility factors that are related to crash risk in older drivers. Participants completed one 25-minute drive in a the NADS-1 (National Advanced Driving Simulator) at the University of Iowa on an urban and arterial four-lane road network with a posted speed limit of 35 mph. During the simulator drive, they passed through several controlled intersections.

An intersection violation warning system, which was present for half the participants, was designed to provide alerts when a driver was likely to violate a red light or stop sign at an intersection. The system used vehicle location, traffic signal state, and timing to determine probability of violation. The system alert included three display components: a visual icon, an auditory alert, and a brake pulse. Following the simulator drives, participants completed short surveys about their experience in the simulator.

Figure 1. Tree-obstructed stop sign at intersection.

Figure 2. Truck-obstructed stop light at intersection.

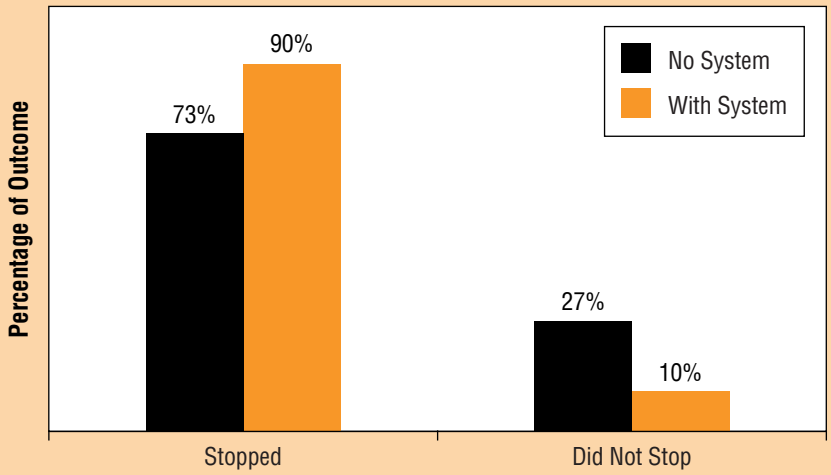
Figure 3. Unobstructed stop sign at intersection.

Conclusions

There was a significant overall benefit associated with the presence of the warning system. There were nearly three times more did-not-stop outcomes without the system (27%), than when the system was present (10%); see Figure 4. This was particularly true in situations where the presence of stop sign or the state of a traffic light would be more difficult for drivers to detect.

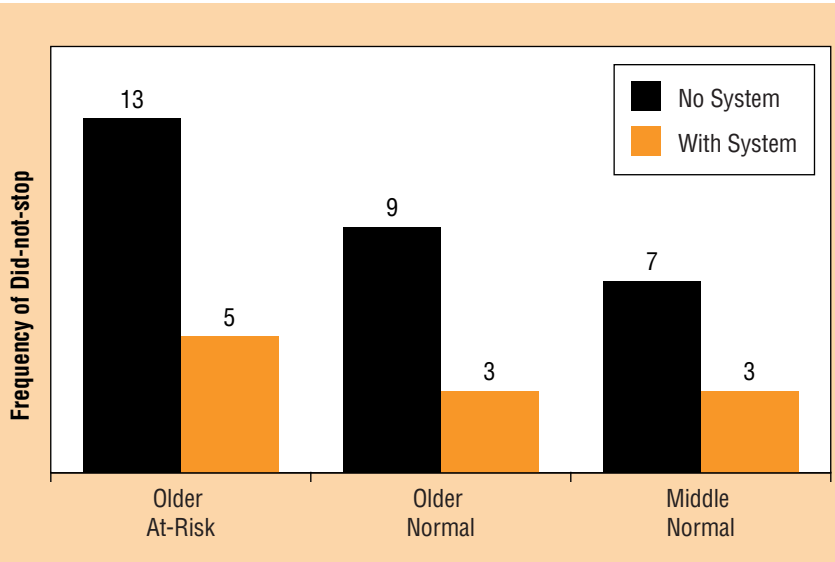
"There were nearly three times more did-not-stop outcomes without the system (27%) than when the system was present (10%)."

Figure 4. Frequency of outcome by system presence



It is possible that drivers most at risk of crashes may benefit most from the presence of the system as implied by the greatest change in did-not-stop outcomes in the older at-risk group, see Figure 5, even though the trend did not reach statistical significance.

Figure 5. Frequency of outcome by age-risk group



The benefit associated with the system was also seen in the stopping position data. Participants who experienced the system warning stopped instead of driving through the intersection, resulting in more stops past the stop bar, but before the collision zone.

There was also a general perception among those who experienced the system that the system improved driving safety (1.94/5[1]) and that it aided drivers in driving more carefully (2.28/5[1]). Whereas, those who did not experience the system tended to disagree that the system would make driving safer (3.67/5[1]) and disagreed it would help them drive more carefully than they normally would (3.11/5[1]). The disagreement with these statements by those who did not experience the system may indicate that experiencing the system reveals its benefit to users. The positive perception of the system coupled with the benefit seen in did-not-stop outcomes indicates that an intersection violation warning system would be welcomed and used by drivers.

The results of this study will be used to develop better crash warning interfaces for the broad range of drivers, including those who are older, who will be using the technology. One program with that focus is the Human Factors for IntelliDrive (HFID) program. HFID is focused on developing effective interfaces for the various IntelliDrive applications that do not increase driver distraction. The HFID program will be able to leverage the results of the current study in assessing driver needs.

Design recommendations based on this work are limited; however, the safety benefit seen here shows a CICAS-V type (Maile et al., 2008) warning system worked well for both older and younger drivers. However, it should be noted that the system implemented here differed from the CICAS-V recommendations in some ways. Specifically, the minimum speed for alert was lowered to 5 mph rather than 15 mph and the brake pedal did not depress during the brake pulse.

Limitations

It should be noted that this experimental design and protocol included simple situations at intersections and did not examine potential unintended consequences of the presence of the system. The data from this study are from a first-time single use of the system. How drivers would respond to the system over time is unknown and over-reliance is a possibility. It is also not clear from this work how drivers would respond to the warning system in more complex situations such as intersections with cross traffic present, the presence of tailgating vehicles, and the presence of pedestrians crossing the road at intersections. Additionally, only one system specification was used and systems using different alert timings and combinations may not show the same benefits. This study showed a system benefit; however there are a number of untested conditions (traffic situations, systems differences, levels of system experience) which could produce differing levels of safety impact.

1 Likert-type 5-point scale: 1=strongly agree, 2= mildly agree, 3=agree and disagree equally, 4= mildly disagree, 5=strongly disagree

References

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Maile, M., Ahmed-Zaid, F., Caminiti, L., Lundberg, J., Mudalige, P., & Pall, C. (2008, October). Cooperative Intersection Collision Avoidance System Limited to Stop Signs and Traffic Signal Violations - Midterm Phase 1 Report. DOT HS 811 048. Washington, DC: National Highway Traffic Safety Administration. Available at http://www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2008/811048.pdf

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This Vehicle Safety Research Note is a summary of the technical research report: *Enhancing the Effectiveness of Safety Warning Systems for Older Drivers* (DOT HS 811 417). This report can be downloaded free of cost on the Vehicle Safety Research section of NHTSA's Web site (www.nhtsa.gov).

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