

# Psychology Professor Embarks On New Journey With Old Dominion's Driving Simulator

BY ELIZABETH O. COOPER



Some have been climbing behind the wheel for decades, having seen the rise and decline of such classics as the Edsel and the Mustang, as well as the advent of power steering and anti-lock brakes. Others are new to the road and its multitude of rules, the ink on their drivers' licenses barely dry and the thrill of tooling down the highway still fresh in their minds when they turn the ignition and turn on the CD player. But whether they have little or no experience or years of driving under their proverbial seat belts, both novice and seasoned motorists are considered at high risk for accidents.

To assess the fitness and skills of both older and younger drivers and to determine how to best assist them, Old Dominion researcher Carryl L. Baldwin is using the General Electric I-Sim driving simulator installed last year in the Department of Psychology in a range of research projects. Baldwin, an assistant professor of psychology, is studying drivers' perceptual and cognitive abilities when they get behind the wheel. She uses a variety of neurophysiological assessment techniques including EEG and ERP, as well as neuropsychological tests to investigate how drivers react to various road conditions. Her current research in this area is funded by NASA Langley Research Center, and the results will be used to examine how well different neurophysiological assessment techniques are able to measure the mental workload of pilots.

### Helping Drivers Improve Their Road Skills

Baldwin is also working on a number of in-vehicle driving aids that may help both younger and older drivers improve their driving performance.

"When collisions are calculated in terms of the number of miles driven, we see much higher rates for both younger and older drivers," Baldwin notes. "Younger drivers do not have enough experience to be knowledgeable about potential hazards and tend to take more risks. Older drivers' collisions tend to involve perceptual/cognitive errors. They may look, but not see a vehicle in their peripheral vision, or they may misjudge the speed of an oncoming car before making a left turn. Sensory and cognitive abilities decline with advanced age. Self regulation of driving habits, such as not driving in adverse weather or during heavy traffic, allows many older adults to drive safely well into advanced age. However, some older drivers may have mild cognitive impairment or early stage Alzheimer's disease and may not yet be aware that their driving performance is impaired."

The I-Sim is a self-contained unit with three 40-inch television monitors, each powered by a separate computer. Each computer displays an interactive, wrap-around view of the road in front and to each side of the driver, who sits in a padded, bucket seat with the seat belt securely fastened. Inset views on each of the screens serve as side- and rearview mirrors, and driving controls are just like those found in the latest automobile models. The unit can simulate hundreds of different situations involving a variety of civilian, public safety, public transportation and long-haul freight

vehicles in virtually any combination of weather, light and traffic. Drivers can travel through rural mountainous roads, suburban freeways, downtown intersections, complete with construction zones and other environments. There are also varying weather conditions, including rain, fog, snow and sunshine. During adverse weather such as ice storms, the vehicle seems to slide around on the road.

With statistics showing that vehicular crashes are a leading cause of death in people under age 30 and technological advances in computing systems, driving research is a growing area in human factors research. Baldwin has been involved with it for six years, having originally become interested in methods used to assess older adults' fitness to drive. "There is tremendous variability in the perceptual and cognitive abilities of people over the age of 65. Older drivers may perform well under normal driving conditions, but some may lack the attention capabilities necessary to react to unexpected events. Finding methods of identifying these at-risk drivers that are not based on arbitrary age cutoffs continues to be a challenge to the driving research community."

Drivers over the age of 65 are the fastest growing segment of the American driving population. "More older adults are getting or maintaining their licenses, and they are driving more miles than their counterparts of previous generations. The move to suburbs has resulted in many older adults living in areas where public transportation systems are lacking or nonexistent. In order to gain access to medical care, as well as meet their social and recreational needs, most older adults rely on their personal automobile as their primary form of transportation."

Age-related changes in sensory and cognitive abilities that are essential to safe driving can begin as early as age



The I-Sim can simulate hundreds of driving situations at no risk to drivers.



**Carryl L. Baldwin is an assistant professor of psychology at Old Dominion University.**

50, but there is tremendous variability in individuals. Some drivers begin experiencing visual problems as early as their 40s, and later age-related cognitive decrements may be compounded by such sensory impairments.

“In general, the rate of cognitive slowing begins to be noticed around age 60 and increases with advancing age. We really don’t tend to see much of an increased crash rate in the general population until drivers get above 70,” Baldwin notes. “But there is great variability. A substantially large segment of the older population maintains cognitive and physical fitness. It is not appropriate to say we should establish some strict cutoff and say people can’t drive after a specific age.”

### **Helping Drivers Steer Clear of Accidents**

Older drivers generally have less ability to accurately judge depth and velocity, and experience a decrease in peripheral vision or useful field of view (UFOV). These perceptual changes can increase crash risk, particularly when drivers are making maneuvers like left turns. However, promising new research suggests that many older drivers can be trained to improve their perceptual and cognitive abilities. In addition, new in-vehicle technologies such as collision avoidance systems, which provide advance notice of potential hazards, may help compensate for age-related declines. Baldwin’s research on these systems involves examining which stimuli are most effective in alerting the driver to an impending crash. “It’s critical to find a warning system that informs rather than startles the driver,” she says.

Collision avoidance systems, which use radar or laser sensory techniques to measure temporal headway distance between the vehicle and another object, are becoming standard in high-end vehicles, the types that older drivers as a group would be more likely to afford. If a driver comes

close to hitting another vehicle or an object, the system sets off a warning.

“The challenge is mapping the appropriate urgency level and determining when to warn drivers,” Baldwin says. “You certainly wouldn’t want systems with high false alarm rates that are always going off even when the hazard level is low. That would be extremely annoying, and drivers would eventually learn to ignore or perhaps even disable the system.”

Baldwin has been working on a system that presents a series of auditory and visual alerts which intensify in urgency as the hazard level increases. The system can also be used to train drivers to increase their

following distance. Recent empirical research suggests that these enhanced collision avoidance systems can also train younger drivers to avoid tailgating. She hopes to receive funding this summer to investigate the impact of these enhanced collision avoidance systems on aiding driving performance in older adults, particularly drivers experiencing mild cognitive impairment or who are in the early stages of Alzheimer’s disease. The driving simulator provides a safe environment in which to examine these new technologies.

### **Helping Drivers Find Their Way**

The GE I-Sim also provides opportunities to conduct research on navigational in-vehicle displays, which enable drivers to not only get from one place to another, but also to form a cognitive map of the area in which they’re traveling. Baldwin and her colleagues are exploring different types of visual map displays and auditory guidance instruments to determine which are more beneficial. She is studying how these displays affect drivers’ speed and lane position variability, as well as their overall distraction level and ability to notice road hazards. Previous research suggests that both older and novice drivers benefit more from auditory guidance rather than visual maps.

“Visual maps require drivers to take their eyes off the road to look at a map, but you’re looking at it under the umbrella of driver distraction such as cell phones, in-vehicle devices and everyday things such as eating and talking to other people.” Baldwin adds that many accidents stem from drivers trying to navigate in unfamiliar environments. “They’re driving, but they’re trying to look for street signs for where to turn. The navigational assists can offset some of that load, but we need to make sure we’re not adding to the distractions.”

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Baldwin says that adding an audio component to visual displays helps all drivers, especially older and younger motorists. “Older drivers take longer to switch their attention from one thing to another and are more easily distracted, whereas middle-aged drivers find it easier to look down at a map and swiftly focus their attention back to the road. Novice drivers spend a lot more time focusing their attention inside the vehicle to monitor their speed and other vehicle controls. These tasks have not yet become automatic for the novice driver like they have for more experienced drivers.”

She adds that less experienced drivers have their own unique set of problems. “They tend to take greater risks and haven’t yet learned what things to pay attention to. By age 20 to 25, they’ve gained some experience but they tend to be more risk-taking. Their accidents typically involve driving at excessive speeds, tailgating, passing when they don’t have time to make it, as well as being distracted by the CD or stereo system.”

Navigating through unfamiliar areas is a particular driving challenge for both younger, inexperienced drivers as well as older drivers. In an effort to make driving through unfamiliar areas safer for these high-risk groups, Baldwin is collaborating with Hiroshi Furukawa, assistant professor in the Institute of Information Sciences and Electronics at the University of Tsukuba at Tsukuba, Ibaraki, Japan. They are examining the impact of different types of in-vehicle navigational aids on driving performance and people’s ability to develop a cognitive map of an unfamiliar area.

Furukawa recently came to Old Dominion to use the I-Sim to investigate how visual and audio maps may be designed to help drivers develop survey knowledge and is working with Baldwin to cognitively model how drivers form survey knowledge of their surroundings. Existing navigational display systems give point-by-point directions along a set route, such as “Drive two blocks and turn left on Front Street.” Such information is



annoying to motorists who prefer survey-type instructions that enable them to form a cognitive map in their heads. Survey-style navigators want to know where they are going in relationship to their surroundings and the overall layout of the area. They want to be able to build a cognitive map of their new environs.

“Some people tend to be very good at developing survey knowledge,” Baldwin explains. “In general, males tend to be more skilled at developing survey knowledge than females, who tend to prefer point-by-point or route methods for finding their way around. Females tend to want to follow very specific directions.”

Survey-style directions give a global representation of an area. “They’re going to get a better sense of where they are in terms of the overall layout of the area. This may help explain the age-old question of why men hate to stop to ask for directions, and women will stop to get directions. If you’re following point-by-point style and you get lost, you have no choice but to stop to ask for directions. If you’re using survey style, you have a general sense of where you are. You may be able to figure out how to get back on track or how to find an alternative route.”

Old Dominion’s Driving Research Lab also has outfitted the I-Sim with neurophysiological recording equipment to record electroencephalogram (EEG) and event-related potential (ERP), which can detect brain wave patterns in drivers in response to different driving situations and events. Such information can be used to observe driver fatigue, mental workload and spatial navigation ability.

The Psychology Department’s driving simulator is a very useful tool for studying a wide range of driving behaviors and new in-vehicle technologies in a safe and effective manner. Baldwin and her colleagues believe their current research will make important strides in enhancing the safety of our nation’s transportation system.