

From *Experimental Aging Research*, 1994,
Vol. 20, pp. 35-43.

***High-Priority Research and Development
Needs for Maintaining the Safety and
Mobility of Older Drivers***

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The increase in the number of older drivers has resulted, in the last two decades, in a series of conferences and workshops that have outlined the magnitude of the "older driver problem." More than 150 research and development recommendations generated by these conferences were rated by a task force of the Transportation Research Board in terms of their relative importance. On the basis of this rating, six major categories of high-priority research and development needs were identified: highway design, vehicle design, licensing and rehabilitation, vision and visual assessment, biomedical issues, and general issues. The current status of research in each of the categories is reviewed, and the most important avenues for future inquiry are outlined.

In the past two decades, concern over the increasing number of older drivers on our nation's highways has grown. Since 1985, several major conferences have been convened for the purpose of describing the nature and magnitude of the so-called older driver problem. Influential reports generated by such conferences have included the AAA Foundation for Traffic Safety's (1985) *Needs and Problems of Older Drivers: Survey Results and Recommendations*, the Transportation Research Board's (TRB's) (1988) *Transportation in an Aging Society: Improving Mobility and Safety for Older Persons* (Special Report 218), and the National Highway Traffic Safety Administration's (1989) *Conference on Research and Development Needed to Improve Safety and Mobility of Older Drivers* (which was also published as two special issues in the journal *Human Factors* in 1991 and 1992). Included among the pages of these reports, as well as those generated from numerous workshops on related topics, were many recommendations regarding future research and development

Based upon a paper presented at the Second International Stein Conference, *Engineering Design for an Aging Society*, Philadelphia, PA, October 23, 1991.

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(R&D) requirements. In the spring of 1991, the TRB's *Task Force on Mobility and Safety of Older Drivers*, with funding from the National Highway Traffic Safety Administration,¹ initiated a study to integrate these recommendations into a prioritized R&D agenda. In this article, I outline the nature of that project and describe some of the preliminary results of a survey conducted to identify the most important R&D issues regarding the older driver.

The process used to establish the proposed R&D agenda consisted of the following steps: First, the principal investigator reviewed the proceedings of conferences and workshops on the older driver that were held throughout North America during the past two decades and identified the research recommendations reported therein. Approximately 150 R&D needs were identified in this manner. Next, members of the TRB Task Force and other experts in the areas of aging and driving rated these items in terms of their relative importance on a 5-point interval scale. On the basis of this preliminary survey, six distinct categories of items emerged as being highest in priority. These categories are discussed in this article. Additional surveys of the TRB Task Force members were conducted to narrow further the list of priorities and develop a consensus R&D agenda for the 1990s. Those findings represent the final recommendations of the Task Force and have been published elsewhere (TRB, 1992).

SURVEY FINDINGS

The six categories of high-priority R&D needs were as follows: highway design, vehicle design, licensing and rehabilitation, vision and visual assessment, biomedical issues, and general issues. The items identified under each of these categories are presented and discussed in the following text.

Highway Design

A review of the literature revealed a number of recommendations for research efforts aimed at improving highway design relative to the emerging needs of older drivers. The three items in the category that were given the highest priority are:

1. Reevaluate the perception-response time models used to establish geometric highway design guidelines and specifications in light of age-related changes in behavioral capacity.

¹This work was sponsored by National Highway Traffic Safety Administration Contract DTNH22-91-P-07323 to the author, who served as principal investigator for the study.

2. Improve nighttime visibility on the highway.
3. Alter the *Manual of Uniform Traffic Controls and Devices* to meet the emerging needs of the older driver population.

Item 1 calls for a renewed examination of the perception-response time models and related design rules used in geometric highway design guidelines and specifications, such as those presented in the American Association of State Highway and Transportation Officials' *Blue Book*. The assumptions regarding the perceptual, attentional, and motor system response times on which minimum "lines of sight" are based may not reflect the diminished capacities of many older drivers. As a result, current highway design standards may lack the cushion needed to optimize the risks:benefits ratio for an ever-graying driving population. The degree to which such design standards should be made more elder friendly needs to be assessed. Another item (Item 2) regarding highway design and older drivers that was given high priority involves the need to understand why older drivers report excessive difficulty with nighttime driving. The purpose of listing this issue was to call attention to the need to develop environmental interventions that could offset these difficulties. Item 3 calls for similar attention to be paid to the *Manual of Uniform Traffic Controls and Devices* (U.S. Department of Transportation, Federal Highway Administration) to determine whether design specifications for the nation's highway signs and traffic control devices meet the sensory and information-processing needs of our oldest drivers. It should be noted that some progress has already been achieved regarding research initiatives aimed at improving highway design in the service of the emerging needs of older drivers (e.g., Mast, 1991).

Vehicle Design

Four high-priority R&D needs in the area of vehicle design were identified by the panel of experts.

1. Develop an anthropometric database on the physical characteristics of the older adult population.
2. Develop enhanced headlamp illumination designs.
3. Apply emerging technologies to the design of vehicle systems that offset age-related declines in motor, sensory, and information-processing abilities.
4. Evaluate the potential impact of intelligent vehicle highway systems technology on driving behavior among the elderly.

Item 1 calls for the development of a database of anthropometric parameters that accurately characterize the elderly population. Such a database would include not only physical dimensions but strength/power curves

for major muscle groups and range-of-motion estimates. These data are needed to optimize vehicle design in terms of entry/egress, seating safety and comfort, safety belt configuration, and placement and configuration of controls.

There was also a call for renewed efforts to improve headlamp lighting systems (Item 2), with special emphasis on the needs and limitations of the aged. Emerging technologies such as high-intensity discharge illumination sources, together with a resurrection of cross-polarizing glare reduction strategies, appear to have the potential for vastly improving nighttime visibility. Item 3 calls for a broadened effort to explore and adapt vehicle technology in the service of offsetting the diminished physiological and behavioral capacities of many older drivers. A programmatic research effort, sponsored by both government and industry, is needed to design vehicle systems that not only foster but extend vehicular use and mobility among reduced-ability populations. Relatedly, Item 4 recommends strongly that emerging programs for the development of an integrated intelligent vehicle highway system include sustained efforts at modeling and satisfying the deceptively complex needs of the elderly population.

Licensing and Rehabilitation

Five of the highest priority R&D needs identified in this study were the following licensing and rehabilitation issues:

1. Investigate the accuracy and thoroughness with which impaired drivers are able to self-monitor and evaluate the nature and extent of their driving-related disabilities.
2. Identify and evaluate the compensatory strategies successful reduced-ability drivers use to maintain mobility.
3. Develop and evaluate improved mature driver training programs.
4. Develop and evaluate a model program for issuing and managing a graded licensing system for impaired drivers.
5. Evaluate the role of road tests for meeting the special assessment needs of many elderly drivers.

Item 1 in the table calls for the systematic evaluation of the hypothesis that older drivers who develop performance problems are aware of those difficulties and modify their driving behavior to compensate for emerging driving-related difficulties. The magnitude of any "older driver problem" ultimately depends on the nature and extent to which impaired drivers engage in accurate self-monitoring and follow-up compensatory behaviors. The extant research literature contains findings that both support and refute this hypothesis. Additional work is needed to identify the domains

of function in which self-monitoring is effective versus those domains of disability in which self-awareness is comprised. Relatedly, Item 2 calls for the identification and evaluation of the effectiveness of varying compensation strategies developed and used by persons with driving-related disabilities. An understanding of such phenomena would provide valuable information for improving training and related intervention programs. R&D Item 3 calls for the systematic evaluation of the content, appropriateness, and efficacy of mature driver training programs. This work is needed not only to justify the resources dedicated to such programs, but also to foster the further development and improvement of training and educational programs for healthy as well as reduced-ability drivers. Item 4 calls for programmatic research aimed at the development of a graded system of licensure that would limit driving access on the basis of specific functional loss, individual needs, and compensatory ability. Although such approaches have been practiced informally in many jurisdictions, an ambitious program of research-based development and comprehensive evaluation is needed to optimize the ability of such systems to meet the mobility needs of a rapidly growing aging population characterized by an increasing incidence of functional disability.

The last R&D need (Item 5) specified in Table 3 calls for new research on evaluation of driving performance via on-the-road testing scenarios. That is, existing work aimed at developing road tests of driving ability has emerged within the context of evaluating healthy, unimpaired, first-time license applicants. However, as the number of older drivers increases, road tests will increasingly be used to evaluate experienced but functionally impaired individuals. It has become apparent that existing road test protocols will need to be modified to optimize their application for evaluating this special population of drivers. In addition, new concerns regarding legal liability issues need to be addressed if and when road tests are used to evaluate drivers diagnosed with severe cognitive impairment (e.g., senile dementia).

Vision and Visual Assessment

Vision and visual assessment issues include:

1. Evaluate the need for age-specific schedules in license renewal and assessment of visual function.
2. Study the efficacy of the useful field of view test and other tests of visual attention in identifying at-risk drivers.
3. Identify the sensory, attentional, and cognitive factors that mediate the nighttime driving difficulties encountered by the elderly.

Item 1 calls for the establishment of age-specific test-retest interval schedules for license renewal. Cross-sectional and longitudinal visual acuity data suggest that young and middle-aged drivers may not need to be screened as often as is the current practice in most jurisdictions, but older drivers may need to be screened on a more frequent basis than is currently the case. If age-specific test schedules are to be adopted, they must be firmly based on empirical data. The results of data-based studies needed to implement such policies have yet to be made available to licensing administrators. The panel of experts surveyed in the present study failed to assign highest priority status to previously identified R&D concerns involving the visual screening areas of dynamic visual acuity, low-luminance (nighttime) acuity, glare resistance, contrast sensitivity, and the comprehensive assessment of the visual field. Instead, they were more concerned with higher order visual/perceptual skills that recently have been shown to be related to both advancing adult age and increased risk of vehicular accidents (i.e., the useful field of view test). This changing focus represents an evolutionary shift in the field of driver assessment over the past 5 years. As such, Item 2 calls for continued research on the efficacy of the useful field of view test in identifying older adults at risk of being over-involved in driving accidents due to perceptual/attentional deficits (e.g., Ball & Owsley, 1991). Finally, Item 3 calls for additional research aimed at identifying the reasons why older drivers report difficulty driving at night—a problem that may contribute significantly to decreased mobility and productivity among this segment of the population.

Biomedical Factors

The category of biomedical factors includes the following issues:

1. Identify and mitigate the factors contributing to the increased injury vulnerability of elderly vehicular accident victims.
2. Study how age-related disease, comorbidity, and functional disability combine to affect driving performance.
3. Study the effects of commonly prescribed drugs on driving performance among the elderly.

Item 1 calls for a programmatic research initiative to reduce the crash vulnerability of elderly motor vehicle occupants. When older drivers are involved in accidents similar in type and magnitude to those experienced by younger drivers, they are more likely to die or suffer severe disability than their younger counterparts. This appears especially true for drivers age 75 and older—the fastest growing demographic group (Barr, 1991). Research is needed to identify the physiological, biomechanical, and

behavioral factors (e.g., seatbelt use) that contribute to the increased crash vulnerability of the elder vehicle occupant. Once identified, these factors need to be translated into automobile design guidelines and standards to improve the survivability of older individuals.

Item 2 calls for research to develop a better understanding of the relationship between functional limitations due to age-related disease and driving performance, driving safety, and driving mobility. Such an increase in research effort will necessarily involve comprehensive functional assessment protocols together with the development of a severity-of-illness index (e.g., Waller, 1992). Item 3 calls for research on the effects of commonly prescribed drugs on older persons' driving performance. At present, such data have been obtained only from samples of young subjects. Unfortunately, because of complex age-related changes in pharmacokinetics and pharmacodynamics (e.g., Ray, Gurwitz, Decker, & Kennedy, 1992), it is exceedingly difficult to generalize findings obtained from young populations to older drivers.

General Issues

This last category of high-priority R&D needs contains four broad topics, several of which are related to categories presented previously.

1. Develop performance-based criteria for driving assessment.
2. Identify the characteristics of at-risk elderly drivers.
3. Investigate the role of age-related cognitive deficits on driving safety and performance.
4. Evaluate the potential role of part-task driving simulators in the assessment of reduced-ability drivers.

At the top of this list is a call for the development of performance-based research criteria for the study of driving behavior and driving safety. Much of the current research on driving and driving safety is dominated by accident-based criteria. Although high in face validity, accident-based criteria are limited in terms of precision, statistical power, and investigative control. Considerable effort is needed to develop alternative evaluative criteria, based on dynamic and continuous performance, as derived from comprehensive models of the driving task. Such efforts are essential if age differences in driving safety are to be understood and ultimately mitigated. Item 2 calls for epidemiological and laboratory research aimed at uncovering the risk factors that predispose subpopulations of older drivers toward overinvolvement in vehicular accidents. Despite the limitations of analyses using accident-based criteria, such analyses will continue to be useful in descriptive efforts to characterize age differences in driving behavior.

Item 3 calls for a programmatic effort to study the relationship between age-related changes in cognitive capacity and driving behavior and safety. Advanced adult age is associated with various declines in attentional and cognitive skills. Among normal healthy adults these declines are relatively mild, but among those suffering from common age-related pathologies, such as dementia of the Alzheimer's type, these changes may be severe. Little is known about the relationship between such cognitive declines and the ability to operate an automobile safely and effectively (e.g., Kaszniak, Keyl, & Albert, 1991). Given the large number of dementia cases anticipated as the number of older drivers doubles over the next few decades, such work represents a critical precursor to the development of age-appropriate driver licensing and screening protocols.

The final R&D need listed in Table 6 calls for the development and evaluation of driving simulator technology as a tool for the assessment of reduced-ability older individuals. The increasing speed and power of personal computers, combined with rapidly decreasing costs, has placed realistic, interactive video-based driving simulators within reach of the assessment community. The availability of such systems holds great potential for the evaluation of special populations of drivers—such as dementia patients—without the costs and risks of a road test. Relatively inexpensive, programmable simulated driving protocols also would be powerful tools for the development and validation of comprehensive models of driving performance that would have utility toward achieving many of the R&D goals already discussed in this article.

CONCLUSION

The absence of an R&D topic from the list of items presented herein is not necessarily a reflection on its importance. Many highly critical research needs were excluded because steps have already been taken to begin investigation in those areas. An example of such an area is highway design. Several critical R&D issues related to improving highway design in the service of meeting older drivers' needs were not mentioned in this report because recent initiatives funded by the Federal Highway Administration are already underway (Mast, 1991). Finally, the comments rendered in this article are solely attributable to the author and should not be taken to represent the opinions or findings of the TRB.

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