

Psychosocial aspects of driving transitions in elders with low vision

Amy Horowitz DSW
Kathrin Boerner PhD
Joann P. Reinhardt PhD

Arlene R. Gordon Research Institute, Lighthouse International
111 East 59th Street, New York, NY 10022, USA
e-mail: ahorowitz@lighthouse.org

A. Horowitz, K. Boerner, J.P. Reinhardt, Psychosocial aspects of driving transitions in elders with low vision, Gerontechnology, 2002; 1(4): 262 - 273. Although it has been suggested that the decision to stop driving is complex, there has been little research addressing the psychosocial influences on this decision. Two exploratory studies were conducted focusing on the psychosocial aspects of driving among older adults who are visually impaired. Results from multivariate analyses in Study 1 (n = 453) indicated that being older, female, more severely visually and functionally impaired, and urban residence were independently related to driving cessation. Qualitative findings from Study 2 (n = 47) suggested that the meaning ascribed to driving may influence the decision-making process. Further, family members may play a more influential role over time. A conceptual framework, based on models of health behavior change, is proposed that could guide future research on driving. Such work would facilitate a better understanding of the transition from driver to ex-driver, which could then inform interventions for older adults and their families faced with this critical decision.

Keywords: driving, vision impairment, older adults, psychosocial factors, social support

One of the most difficult issues faced by older persons, especially those who experience chronic age-related impairments, is whether or not to continue driving. More than simply a way to accomplish daily tasks, driving is imbued with a host of psychological meanings, including one's sense of autonomy, independence, and self-worth¹⁻². Giving up driving, for many older adults, is often experienced psychologically as the first step towards a downward spiral of dependency. Available evidence indicates that driving cessation is, in fact, associated with a significant decrease in out-of-home activities³, and with increased feelings of depression, regret and isolation³⁻⁶. Not surprisingly, older adults experiencing age-related health declines typically resist giving up driving as long as they

possibly can, although many do self-regulate their driving behaviors (e.g., not drive at night)^{4,7} in what has been called a 'cessation continuum'⁸.

Decisions about driving are especially salient for the growing numbers of older adults who experience age-related vision problems. It is estimated that from 13% to 20% of persons age 65 years and older have a self-reported functional vision problem, even when wearing corrective lenses⁹⁻¹⁰. Given the importance of vision for safe driving, it is not surprising that poor vision emerges as one of the most common health-related reasons for giving up driving in studies of community-based older adults^{8,11-12}. Yet, many people with vision

problems do continue to drive. In fact, one national study found that 63% of adults age 55 and older who self report severe vision problems were still driving¹³.

Although it has been suggested that the decision to stop driving is complex and motivated by a range of factors⁸, there has been surprisingly little research addressing the psychosocial influences on this decision. Rather, most prior research has focused on issues related to risk factors for unsafe driving and accidents¹⁴⁻¹⁶, the assessment of driving skills¹⁷⁻¹⁸, and identifying the socio-demographic and medical factors associated with driving cessation and self-regulation^{7,19}. The psychosocial and environmental context in which older adults make decisions about driving and implement self-regulatory practices has received much less research attention.

In this paper we address these important issues in three ways: First, a brief overview of existing research regarding predictors of driving cessation is presented. Second, we focus on the circumstances of visually impaired older adults, presenting findings from two recent studies conducted by the authors. Third, we provide a discussion of the implications for further research, as well as a proposition for a conceptual framework, based on models of health behavior change, that can be applied to future research to better understand the processes of driving cessation and self-regulation among older adults.

PREDICTORS OF DRIVING CESSATION: THE STATE-OF-THE-ART

Most prior research studies on driving cessation among older adults have focused on medical and socio-demographic factors, and have reported relatively consistent findings. Former drivers, as compared to current drivers, were more likely to be older²⁰⁻²¹, female, to report poorer health, multiple health conditions and/or greater functional disability²⁰⁻²³, to be unmarried, and to live in larger households²².

In a recent study on driving cessation⁸, the most common reason reported by participants for no longer driving involved a specific medical condition. At the same time, however, ex-drivers actually had fewer medical conditions than current drivers, although they did have lower levels of self-reported health. Based on these findings, the authors suggested that the decision to stop driving may have been more based on an individual assessment of capabilities than on a medical diagnosis. Campbell, Bush, and Hale²⁴ also noted that while certain medical conditions are associated with driving cessation among elders, half of those who have these conditions continued to drive, and that the decision to cease driving is complex rather than solely dependent on medical problems.

A few studies of driving cessation have begun to look at social and environmental factors that influence the decision-making process. Johnson and colleagues conducted two studies, one with an urban⁶ and one with a rural⁵ population, that retrospectively examined how individuals came to the decision to stop driving. Among urban older adults who had forfeited a driver's license⁶, three primary factors seemed to contribute to this decision: level of importance of family and friends in making this decision; impact of the decision on quality of life; and availability of a support network to assist with transportation after loss of the license. In both the rural and the urban samples, support from family and friends was significant in the decision to stop driving, with friends reported as being more influential than family. Consistent with this latter finding, friends were also perceived as more empathetic and more willing to assist with transportation.

In contrast, in a study of urban drivers living in retirement communities, Persson²⁵ found that few stopped driving because of their family's advice. However, data from focus groups conducted with family and friends of older people²⁶ indicate that the former did see themselves playing an active role, and

were more likely to intervene in an older person's driving behavior when reporting the belief that the older driver was in imminent danger to him or herself or to others, the belief that they were responsible for the older person and would be his/her caregiver at some point, and/or feeling able to overcome feelings of guilt if they had to make a decision over the older person's objections.

Professionals, especially physicians, may also play an important role in the older adult's decision to stop driving. However, there is evidence that physicians often do not address this topic with their elder patients²⁷. In a similar vein, Persson²⁵ found that only about one-third of the older adults studied reported talking to their doctor before they stopped driving, and few reported that they stopped because of his or her advice. Rather, most elders in this study reported that they stopped driving when a threshold was reached after an accumulation of self-regulatory behaviors, such as not driving at night or in heavy traffic.

Empirical evidence regarding the role of environmental factors, specifically the availability of alternative public or private transportation, is even more scarce. While it would appear logical that the presence of transportation options can be crucial to the timing of driving transitions and to maintaining a satisfactory quality of life after driving cessation, preliminary findings do not necessarily support this conclusion. Burkhardt¹ collected focus group data from older persons age 70 to 95 years old in three different states and found that while many participants said they would use public transportation if available, convenient, and reliable, few who lived in areas with viable transportation options actually used them. However, having viable options was seen as psychologically useful, even if one does not use them, as they represent the capacity to travel without having to depend on others. Yet, other evidence indicates that older persons who live in households with more adults are more likely

to stop driving^{22,28}, suggesting that older persons may give up driving more easily when family members are available to provide alternative transportation.

Overall, we may conclude that the available research on the influence of family, friends, professionals, and transportation alternatives on the transition from driver to ex-driver is both limited and inconsistent. This 'state of the art' is an indication of the fact that this is a fairly new area of research, and suggests the need for explorative and in-depth investigation to deepen our understanding of the critical issues that characterize the transition from driver to ex-driver.

DRIVING TRANSITIONS: THE SITUATION OF OLDER PEOPLE WITH VISION IMPAIRMENTS

As noted earlier, the issue of driving is especially salient for older people who experience an age-related vision impairment. Yet, of the few studies that have addressed psychosocial aspects in the context of driving cessation, even fewer have focused specifically on this group of older adults. In order to examine the factors that are associated with driving cessation in this population, we first analyzed baseline data from a larger longitudinal study of older adults with vision impairments. In a second step, we conducted a pilot study that was designed to explore the personal, social, and environmental context of decision-making about driving among older adults with vision impairments. These studies are described in the following sections.

STUDY ONE: FACTORS ASSOCIATED WITH DRIVING CESSATION

Study Methodology

The data for the present analysis on driving cessation are drawn from an ongoing, five-year, longitudinal investigation on 'Disability, Depression and Rehabilitation in Vision Impaired Elders' (A. Horowitz, PI, J.P. Reinhardt, Co-PI, NEI R01 EY12563-04). The study participants are first-time applicants for vision rehabilitation services, age 65 years

and older, who are interviewed at baseline and at 6, 12 and 18 months follow-ups. Although not designed as a study of driving, all participants were asked if they ever drove, and if so whether they were currently driving or not.

From the total baseline sample ($n = 604$), only those participants who ever drove were selected for the present analyses. This resulted in a subsample of 453, out of which 358 were ex-drivers (79%) and 95 (21%) were current drivers. Participants in the subsample who ever drove differed from those who never drove by being more likely to be male ($\chi^2(1) = 71.2$; $p < .001$), white ($\chi^2(1) = 11.5$; $p < .001$); married ($\chi^2(1) = 24.4$; $p < .001$), to live with someone ($\chi^2(1) = 4.3$; $p < .05$), to live in a suburban or rural area ($\chi^2(1) = 23.4$; $p < .001$), and to have higher levels of education ($t = -6.4$; $p < .001$). However, there was no significance difference between these two groups with regard to age.

Interviews of approximately 90-120 minutes were conducted in the participants' homes. The average age of participants was 80 years, and ranged from 62 to 99 years. Forty-two percent were women, 88% white, 47% married, 41% lived alone, and 53% lived in an urban area. Twelve percent of the older adults who lived in an urban area were still driving, as opposed to 30% of those who lived in a suburban or rural area ($\chi^2(1) = 24.82$; $p < .01$). The category 'urban' included participants living in one of the five New York City boroughs. 'Suburban/rural' referred to the surrounding counties within a 100 mile radius.

Measures

Selected, relevant measures from the larger study were used in the present analyses. Single item indicators were used to assess socio-demographic variables (age, gender, race, education, employment status, and urban/suburban residency). Vision loss severity, measured with the Functional Vision Loss scale²⁹, assessed the extent to which

vision loss causes difficulty in specific areas (e.g., reading, recognizing faces). Functional disability in activities of daily living (ADL) was measured with a modified version of the OARS Multidimensional Functional Assessment Questionnaire³⁰. Seven personal and 11 instrumental activities were measured on a 4-point rating scale (ranging from 'does task with no difficulty' to 'needs help to do task') and summed for a measure of ADL disability. Participants also rated their health on a 5-point scale ranging from very poor (1) to excellent (4).

Three indicators of psychological well-being were examined. Depressive symptomatology was assessed with the 20-item Center for Epidemiological Studies Depression Scale (CES-D)³¹. Environmental mastery was measured using the 9-item subscale of Ryffs & Keyes³² six-dimensional scale of psychological well-being. Domain-specific well-being was assessed with a modified, 14-item version of the *Adaptation to Vision Loss Scale* (AVL)³³. The AVL scale assesses the extent to which the person accepts vision loss in a realistic manner, has a positive attitude towards the potential for learning skills that compensate for vision loss, and has a positive outlook towards continuing relationships with sighted family and friends.

Several indicators of social support were also examined. Single items were used for marital status and living arrangements. Contact with support system members was measured on a 7-point scale (daily to less than once a year) separately for children, other relatives, and friends. Participants were also asked to assess both the overall availability of informal assistance and the overall adequacy of the help they received from their family and friends, each on a four-point rating scale.

The only data available on environmental conditions relevant to driving in the larger study was whether the participant lived in an urban or suburban/rural area within a 100-mile radius.

Findings

First, bivariate analyses were conducted to identify potential consequences of driving status (Table 1). Consistent with prior research, former drivers evidenced more negative psychological status. That is, no longer driving was significantly associated with worse adaptation to vision impairment, more depressive symptomatology, and lower levels of environmental mastery. In terms of social relations, driving status was not related to the frequency of contact with either children or other relatives, but former drivers did have significantly less frequent contact with their friends. This suggests that while social interaction with close kin may not be

negatively effected by driving cessation, the more voluntary nature of friendship does make it more dependent upon the older adult's independent ability to travel. Looking at the socio-demographic and health-related factors associated with driving (Table 2), former drivers were significantly more likely to be female, have lower levels of education and poorer perceived income adequacy. Driving cessation was also related to poorer vision status, greater functional disability, and lower self-rated health. These findings were generally consistent with prior research described earlier. Former drivers also appeared to be disadvantaged in terms of social support. That is, driving cessation was

Table 1. Bivariate Correlation of Driving Status with Psychological Status and Social Integration Variables*

Variable	r
Adaptation to vision loss	.26§
Depressive symptoms	-.12†
Environmental mastery	.29§
Contact with children	.03
Contact with other relatives	.00
Contact with friends	.12†

*Driving Status (current driver = 1).

† $p < .05$, ‡ $p < .01$, § $p < .001$

Table 2. Bivariate Correlations of Driving Status with Demographic, Social Support, and Functional Variables*

Variable	r
Gender (female)	-.15‡
Age	-.08
Race (white)	-.07
Education	.14‡
Income adequacy	.13‡
Employment status (employed)	.05
Marital status (married)	.15‡
Living arrangements (not alone)	-.10†
Residency (urban)	-.23§
Perceived adequacy of informal help	-.08
Perceived availability of informal help	.12†
Vision loss severity	-.33§
Functional disability	-.39§
Self-rated health	.10†

*Driving Status (current driver = 1)

† $p < .05$, ‡ $p < .01$, § $p < .001$

related to being unmarried, greater likelihood of living alone, and lower ratings of perceived availability of assistance from family and friends when needed. There was no association, however, between driving status and perceived adequacy of social support. Finally, in terms of environmental context, no longer driving was significantly associated with living in urban areas, compared to suburban/rural environments.

A logistic regression model was employed that examined the effects of socio-demographic, health, social support, and environmental variables on driving status (Table 3). Both age and gender emerged as significant predictors of driving behavior. Higher age was associated with a reduction in the likelihood of continuing to drive; a 5% reduction with every year of increased age. Women were 63% less likely to report that they were still driving compared to men. There was also a significant effect for urban residency. As one may expect, participants who lived in an urban area were 80% less likely to continue driving than those who lived in suburban or rural areas. Furthermore, both vision status

and functional disability showed a significant effect on driving behavior. For every unit increase in vision loss severity, there was a 13% decreased likelihood of driving. Similarly, for every unit increase in functional disability, there was a 19% decreased likelihood that a participant would continue to drive. The fact that visual status as well as functional disability emerged as significant highlights the important, independent role that vision impairment severity plays in differentiating drivers from ex-drivers. On the other hand, race, educational level, employment status, income adequacy, living arrangements, health, as well as support availability and adequacy did not emerge as significant independent predictors. It should also be noted that because age emerged as significant in the multivariate analyses, while it was not significant in the bivariate analyses, we examined the data for possible interactions between age and other variables in the model. None of the interaction terms tested, however, were significant.

Although the overall classification rate of our model was relatively high (84%), this was

Table 3. Logistic Regression on Prediction of Driving Status. List wise n = 426.*

Variable	B	SE	Wald	df	Odds Ratio	95% C. I.+ for Odds Ratio	
						Lower	Higher
Age	-.05	.02	4.89§	1	.95	.91	.99
Gender (female)	-.99	.34	8.35‡	1	.37	.19	.73
Race (white)	.91	.55	2.67	1	2.48	.84	7.35
Education	.07	.10	.48	1	1.07	.88	1.30
Income adequacy	.08	.18	.19	1	1.08	.76	1.55
Employment status (employed)	-.18	.51	.12	1	.84	.31	2.27
Living arrangements (not alone)	.18	.33	.30	1	1.20	.63	2.30
Residency (urban)	-1.59	.32	23.88	1	.21	.1	1.39
Perceived adequacy of support	.12	.13	.87	1	1.12	.88	1.43
Perceived availability of support	-.02	.12	.04	1	.98	.78	1.23
Self-rated health	-.05	.20	.07	1	.95	.65	1.39
Vision loss severity	-.14	.06	4.50‡	1	.87	.77	.99
Functional Disability	-.21	.04	32.98	1	.81	.75	.87

-2 Log Likelihood = 292.02/Model $\chi^2(13) = 149.92, p < .01$

*Driving Status (current driver = 1).

+C. I. = Confidence Interval

‡p < .05, §p < .01, ||p < .001

primarily a function of the model's predictive power in explaining the situation of those who no longer drove (92% correct). For current drivers, on the other hand, the model had a predictive value that was only slightly better than chance (52%). Thus, the variables in this analysis provided little understanding of the situation of those who continued to drive, and therefore gave limited insight into the process that may characterize the transition from driver to ex-driver. As a result, these findings suggest the potential benefit of further examining the personal, social and environmental context of driving behaviors and decision-making.

STUDY TWO: PERSONAL, SOCIAL AND ENVIRONMENTAL CONTEXT OF DRIVING

An exploratory study, collecting primarily qualitative data, was conducted to generate hypotheses regarding how potential factors, beyond socio-demographic and health characteristics, may play a role in the transition from driver to ex-driver.

Study Methodology

Participants for this study (n = 47) were recruited from individuals who had recently completed services at a comprehensive vision rehabilitation agency serving the Greater New York area. One-third of the participants (32%) were current drivers and two-thirds (68%) were no longer driving. The average age was 68 years (ranging from 45 to 95 years), 55% were female, and 76% were white. Thirteen (87%) of the 15 current drivers rated their best corrected vision as either fair or poor. Data were collected via telephone interviews comprised of primarily open-ended questions addressing the personal, social and environmental context within which older visually impaired adults make decisions about driving. Major areas of interest that were covered in the interview included: The subjective meaning of driving – participants responded to two open-ended questions: what about driving is/was important to you, and what would/does it mean to no longer drive?; Availability of alternative

transportation – respondents were asked whether or not subways/buses, paratransit, and/or taxis were available, to what extent they were used, and whether family and/or friends were available to drive them when needed; Role of others in decision-making – respondents were asked if they spoke to anyone in their family about their driving, who they talked to, what they talked about, and whether they did anything as a result of these discussions. The same questions were asked regarding friends, doctors, and other professionals. The narratives yielded from these open questions were recorded verbatim, imported into a software program for qualitative analysis³⁴, and analyzed using the open coding strategy as described within the methodology of grounded theory³⁵. A team of three coders discussed the adequacy of codes derived from the data and were able to reach consensus through this process.

Findings

Meaning of driving

Five recurring themes emerged from the two open-end questions on the meaning of driving: Mobility (64%), Independence (64%), Belonging (57%), Enjoyment (17%), and the Ability to Help Others (9%).

Responses categorized as Mobility had references to activities such as the ability to go to work, to go to doctor's appointments, to buy the things one needs, and the ability to just go from one place to another. A typical comment was '*It was important to get my stuff, to do shopping, to go to church. It was important for a lot of stuff I did*' (59 year old man). The category Independence includes direct statements referring to independence, as well as statements expressing fear of dependence and feeling trapped. For example, a 56 year old woman who no longer drove said '*I feel like I'm in jail. I lost my independence, my self-esteem, and my personality*'. Belonging reflected the feeling that driving gave them a place in the world, while not driving meant the loss of identity. For example: '*I am no longer part of society that*

is identified with an automobile. I'm not part of the card member society. I used to use my drivers license as identification purposes to cash my checks. It's a symbol of inclusion and I am excluded because I no longer have mine' (55 year old woman). The category Enjoyment is reflected in quotes such as 'I loved to drive' (80 year old woman), and 'To travel. I used to travel a lot.' (59 year old woman).

While the first four themes focused more on the needs of the participants themselves, the last focused on the ability to help others. This was expressed in statements such as 'The fact to help out is important for me and when I couldn't drive I couldn't help out so much.' (55 year old man). Thus, the need to give to others, as well as to take care of oneself, emerged as a potentially important consideration in understanding the importance of driving to some older adults.

Taken as a whole, the five themes underscore that driving is not simply a means to accomplish instrumental tasks. Rather, it seems to carry personal meanings in terms of the individuals' view of themselves and their place in the larger social community.

Alternative Transportation

Forty percent of the participants felt that their family and friends were available all or most of the time when they needed to be driven somewhere, while the rest of the participants felt this help was available only occasionally or not at all. Furthermore, in terms of actual behavior, approximately three-fifths (59%) reported they got all the help they needed from family and friends when they needed to get somewhere. There were no differences between current drivers and ex-drivers in terms of perceived informal support in this context. Neither were there differences between current and ex-drivers on the availability of formal transportation options. All participants reported that taxis and paratransit was available to them in their neighborhoods, and 75% reported that pub-

lic transportation such as buses and subways were also available. Thus, these pilot data suggest that it is more than the simple availability of alternate means of transportation that differentiates those who drive from those that have made the decision to stop.

Involvement of family, friends and professionals

A majority of participants (62%) reported talking to at least one person in or outside the family about issues related to driving. However, only 25% did so with their spouse, and only one-third of participants reported having discussions with their children (36%). In contrast, over two-fifths spoke to friends (43%), and another two-fifths had conversations with their eye doctor about driving (43%). Discussions seemed to center around both the adequacy of the older adults' vision and concerns of others about the elder's driving. For example, a 55 year old talking about a discussion with his wife said, 'She asked whether I'm still ok to drive. We discussed the necessity of driving. If she is with me in the car she helps to navigate a bit'. Or the 80-year old woman referring to her conversation with her children, 'It was discussed whether I should drive, how much and to which places I should drive. Their opinion is, that I should drive less and less and perhaps stop it soon'.

Interestingly, however, most participants reported not to have changed anything as a result of these discussions. In fact, a number of participants (34%) explicitly mentioned that they did not change anything despite the fact that they themselves or the person they talked to thought such changes were necessary. At the same time, others (6%) did report making changes in driving behaviors after discussing the issue another time with a different person. This suggests that driving cessation is a process that takes place over time, rather than a single event in time.

In sum, the findings from this qualitative exploratory study, coupled with those from

our quantitative analyses on driving cessation, suggest that the decision to stop driving is a dynamic process reflecting the interplay among an individual's personal, social and environmental resources. These resources may influence both the processes of driving self-regulation and cessation, as well as the outcomes of those processes. Most importantly, the ideas and insights generated by this pilot research provide useful information to guide the design of future research.

DISCUSSION

In both of the studies presented in this paper, we have attempted to test a broader approach to the study of driving behavior and decision-making among older adults, specifically those experiencing an age-related vision impairment. In the quantitative study, our findings were consistent with prior research in identifying age, gender, functional disability, and vision impairment severity as significant independent factors associated with driving status. Furthermore, geographic location in terms of urban versus suburban/rural areas, with all that this implies in terms of necessity of driving, also emerged as an independent factor associated with driving. While none of the social support variables retained significance in the multivariate analyses, we were limited by the fact that we only had very general indicators of social support that were not specific to attitudes or behaviors regarding the older adult's driving. However, the data from the qualitative study do suggest that family and friends are consulted about driving decisions and may have a growing influence over time. Thus, longitudinal research is clearly critical if we are to capture the dynamic nature of the driving cessation 'continuum' and the many actors that may play a role at various points along the continuum and at different times in the process. Simply, driving cessation needs to be conceptualized as a process, rather than as an event.

The qualitative study highlighted that driving is interrelated, in both pragmatic and sym-

bolic ways, to a wide range of an individual's activities and personal pursuits. This points to the need for an overarching conceptual framework to understand how these interrelationships impact on the decision to stop driving and the consequences of that decision.

Because driving represents a behavior that can become a health risk when the drivers' vision deteriorates, the modification of driving habits or actual driving cessation can be conceptualized as a change in health behavior. This is similar to the decision to change one's diet or stop eating certain kinds of foods that contribute to health problems. Theories of health behavior change try to explain under what conditions a person is willing and able to change his or her health behavior³⁶⁻³⁸. Specifically, a recent model of health behavior change, the Health Behavior Goal (HBG) model, advanced by Maes and Gebhardt³⁸ emphasizes the importance of a person's goal structure, the possibility of conflicting goals, as well as other personal and environmental forces that can either facilitate or block a change in behaviors that have become a health risk. The main hypothesis to be drawn from the model is that the target health behavior is more likely to be reached if it is consistent with one's personal goal structure. There is evidence from several studies demonstrating the critical role of competing goals in predicting health behavior change³⁹⁻⁴⁰.

Because driving is a behavior that often constitutes a means to reach other personal goals (e.g., being able to accomplish tasks), the focus on the personal goal structure of the individual seems particularly important in the context of driving and aging. Our findings regarding the meanings of driving lend support to this idea in suggesting that, for many older adults, decisions about driving are related to what is important in their daily lives, which seems to reflect the concept of personal goals. Furthermore, in addition to the emphasis on personal goals, the HBG-

model explicitly takes into consideration personal resources (e.g., age, gender, educational level) and environmental (e.g., events, interventions) sources of change, as well as the perceived influence of a person's social environment. Thus, this model provides a fitting framework that helps formulate hypotheses about a person's tendency for self-regulative driving behavior, and to make predictions with regard to the course and adaptiveness of the transition from driver to ex-driver among older adults with age-related vision impairment.

Finally, our future research models must take into consideration the technological resources that will become increasingly available to coming cohorts of older drivers who, in turn, will become progressively more comfortable with the use of technology in their daily lives. Such resources include not only the use of bioptic telescopes by visually impaired drivers that are currently allowed for licensure in the majority of U.S. states, but other automotive technology currently available as well as under development such as navigation systems, proximity sensors, night vision systems, and special mirrors for reversing maneuvers. Interestingly, these emerging technologies hold both promise and concern for older drivers.

Enhanced systems using infrared/thermal imaging technologies for night vision may extend the length of time older visually impaired persons can safely drive at night, thus increasing their mobility and independence. The incorporation of proximity sensors that give a auditory signal when too close to another object when backing up can also be extremely helpful for older drivers.

However, to the extent that navigation systems rely on visual information, older adults with vision problems will derive little benefit. Furthermore, Meyer and Coughlin⁴¹ have noted special concern about these systems for older drivers in general due to normal, age-related changes in sensory and cognitive

functions that may result in the need for more time to process information and to engage in multitask activities. For example, taking ones eyes off the road to read information from an in-vehicle navigation system represents a significant distraction from driving. Given that the effects of transient glare are even more prolonged in older compared to younger individuals⁴², adjusting to the abrupt change in light level that occurs when glancing from a video display to the road under current light conditions can also be problematic. Thus, it is important to evaluate the user interfaces for these new technologies to ensure safe usage. In particular, the relative advantage of a visual versus auditory interface needs to be explored. Most important is the need to include older drivers, including those with normal age-related sensory changes and those with sensory impairments due to age-related diseases, in real-world testing of these new devices so that poor design and impractical technologies are eliminated⁴¹. Systems that are made safe for older drivers will be safe for all drivers, while the reverse is not necessarily true.

Once it is determined that advanced technologies can be safely utilized by persons with age-related impairments such as vision loss, then these technologies will have the potential to lengthen the transition from driver to ex-driver. The psychosocial and environmental factors that inform this transition could also be affected by these technologies. Support and encouragement on the part of family members may facilitate acquiring and learning to use advanced, in-vehicle technologies.

Thus, the comprehensive approach that we have advocated, encompassing personal, social, and environmental resources, must also incorporate the ongoing contributions of technology within this framework, if we are to best understand the transitional process of moving from driver to ex-driver and the impact of this process on an individual's well-being.

Acknowledgements

The authors would like to thank Dr. Mark Brennan for statistical consultation, Dr. Kent Higgins for his insights on emerging technologies, the graduate students and interviewers who worked on the two studies for their assistance with data collection, and the older study participants who shared their lives with us in the hopes of better assisting others with vision impairment. Some of the research reported in this paper was supported by a grant from the National Eye Institute, NEI R01 EY12563-04.

References

1. Burkhardt JE. Limitations of mass transportation and individual vehicle systems for older persons. In: KW Schaie, M Pietrucha, editors, *Mobility and transportation in the elderly*. New York: Springer; 2000; pp 97-123
2. Owsley C, McGwin G. Vision impairment and driving. *Survey of Ophthalmology* 1999; 43(6): 535-550
3. Marottoli RA, Mendes de Leon CF, Glass TA, Williams CS, Cooney LM, Jr., Berkman LF, Tinetti, ME. Driving cessation and increased depressive symptoms: prospective evidence from the New Haven EPESE. *Established Populations for Epidemiologic Studies of the Elderly* [see comments]. *Journal of the American Geriatric Society* 1997; 45(2):202-206
4. Fonda SJ, Wallace RB, Herzog AR. Changes in driving patterns and worsening depressive symptoms among older adults. *Journal of Gerontology B Psychological Science and Social Sciences* 2001; 56(6):S343-S351
5. Johnson JE. Rural elders and the decision to stop driving. *Journal of Community Health and Nursing* 1995; 12(3):131-138
6. Johnson JE. Urban older adults and the forfeiture of a driver's license. *Journal of Gerontology Nursing* 1999; 25(12):12-18
7. Ball K, Owsley C, Stalvey B, Roenker DL, Sloane ME, Graves M. Driving avoidance and functional impairment in older drivers. *Accident Analysis and Prevention* 1998; 30(3):313-322
8. Dellinger AM, Sehgal M, Sleet DA, Barrett-Connor E. Driving cessation: what older former drivers tell us. *Journal of the American Geriatric Society* 2001; 49(4):431-435
9. Havlik RJ. Aging in the eighties: Impaired senses for sound and light in persons age 65 years and over. NCHS, *Advance Data Vital and Health Statistics of the National Center for Health Statistics*. Hyattsville: National Center for Health Statistics; 1986; p 125
10. The Lighthouse Research Institute. *The Lighthouse National Survey on Vision Loss: The experiences, attitudes, and knowledge of middle-aged and older Americans*. New York: The Lighthouse; 1995
11. Gilhotra JS, Mitchell P, Ivers R, Cumming RG. Impaired vision and other factors associated with driving cessation in the elderly: the Blue Mountains Eye Study. *Clinical and Experimental Ophthalmology* 2001; 29(3):104-107
12. Rabbitt P, Carmichael A, Jones S, Holland C. When and why older drivers give up driving. Hampshire: AA Foundation for Road and Safety Search; 1996
13. Horowitz AH, Brennan M, Reinhardt JP. Prevalence and predictors of driving among older adults with self-reported vision impairment. Poster presented at the Annual Scientific Meeting of the Gerontological Society of America, Cincinnati, Ohio; 1997
14. Ball K, Owsley C. Identifying correlates of accident involvement for the older driver. *Human Factors* 1991; 33(5):583-595
15. Ivers RQ, Mitchell P, Cumming R. Sensory impairment and driving: The Blue Mountain Eye Study. *American Journal of Public Health* 1999; 89:85-87
16. Owsley C, Ball K, McGwin G, Jr., Sloane ME, Roenker DL, White MF, Overley ET. Visual processing impairment and risk of motor vehicle crash among older adults. *JAMA* 1998; 279(14):1083-1088
17. Ball K, Rebok GW. Evaluating the driving ability of older adults. *Journal of Applied Gerontology* 1994; 13(1):20-38
18. Marottoli RA, Richardson ED. Confidence in, and self-rating of, driving ability among older drivers. *Accident Analysis and Prevention* 1998; 30(3):331-336
19. Forrest KY, Bunker CH, Songer TJ, Coben JH, Cauley JA. Driving patterns and medical conditions in older women. *Journal of the American Geriatric Society* 1997; 45(10):1214-1218
20. Gallo JJ, Rebok GW, Lesikar SE. The driving habits of adults aged 60 years and older. *Journal of the American Geriatric Society* 1999; 47(3):335-341
21. Marottoli RA, Ostfeld AM, Merrill SS, Perlman GD, Foley DJ, Cooney LM. Driving cessation and changes in mileage driven among elderly individuals. *Journal of Gerontology* 1993; 48(5): S255-S260
22. Chipman ML, Payne J, McDonough P. To

- drive or not to drive: the influence of social factors on the decisions of elderly drivers. *Accident Analysis and Prevention* 1998; 30(3): 299-304
23. Hakamies-Blomqvist L, Wahlstrom B. Why do older drivers give up driving? *Accident Analysis and Prevention* 1998; 30(3): 305-312
24. Campbell MK, Bush TL, Hale WE. Medical conditions associated with driving cessation in community-dwelling, ambulatory elders. *Journal of Gerontology* 1993; 48(4): S230-S234
25. Persson D. The elderly driver: deciding when to stop. *Gerontologist* 1993; 33(1): 88-91
26. Sterns HL, Sterns R. Social structures and processes in public and private transportation. In: KW Schaie, M Pietrucha, editors, *Mobility and transportation in the elderly*. New York: Springer; 2000; pp 125-143
27. Hakamies-Blomqvist L, Henriksson P, Falkmer T, Lundberg C, Braekhus A. Attitudes of primary care physicians towards older drivers: A Finnish-Swedish comparison. *Journal of Applied Gerontology* 2002; 21(1):58-69
28. Kington R, Reuben D, Rogowski J, Lillard L. Sociodemographic and health factors in driving patterns after 50 years of age. *American Journal of Public Health* 1994; 84(8):1327-1329
29. Horowitz AH, Teresi JE, Cassels LA. Development of a Vision Screening Questionnaire for older people. *Journal of Gerontological Social Work* 1991; 17(3/4):37-56
30. Center for the Study of Aging and Human Development. *Multidimensional functional assessment: The OARS methodology*. 1 Edition. Durham: Duke University; 1975
31. Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement* 1997; 1:385-401
32. Ryff CD, Keyes CL. The structure of psychological well-being revisited. *Journal of Personality and Social Psychology* 1995; 69(4):719-727
33. Horowitz AH, Reinhardt JP. Psychosocial adjustment to vision in development of the adaptation to age-related vision loss scale. *Journal of Visual Impairment & Blindness* 1998;92:33-44
34. Muhr T. *Atlas/ti for Windows: Visual qualitative data analysis, management, & model building [computer software]*. Berlin: Scientific Software Development; 1997
35. Glaser B, Strauss A. *The discovery of grounded theory*. Chicago: Aldine; 1967
36. Rosenstock IM. *The health belief model and preventive health behavior*. *Health Education Monographs* 1974;2:354-386
37. Ajzen I. *From intentions to actions: A theory of planned behavior*. In: Kuhl J, Beckman J, editors, *Action-control: From cognitions to behavior*. Heidelberg: Springer; 1985
38. Maes S, Gebhardt W. *Self-regulation and health behavior*. In: Boekarts M, Pintrich PR, Zeidner M, editors, *Handbook of self-regulation*. New York: Academic Press; 2000; pp 343-368
39. Gebhardt WA, Maes S. *Competing personal goals and exercise behaviour*. *Perceptual and Motor Skills* 1998; 86(3 Pt 1): 755-759
40. McKeenman D, Karoly P. *Interpersonal and intrapsychic goal-related conflict reported by cigarette smokers, unaided quitters, and relapsers*. *Addictive Behaviors* 1991;16:543-548
41. Meyer J, Coughlin, JF. *Older drivers and new in-vehicle technologies: Promises and challenges*. *The Public Policy and Aging Report*; 2001; 11(4):11-14
42. Higgins KE, White JM. *Transient adaptation at low light levels: Effects of age*. In: *Proceedings-Vision at Low Light Levels: EPRI/LRO Fourth International Lighting Research Symposium*. EPRI, Palo Alto, CA: Consolidated Edison, Co. of New York, Bronx, NY, and Osram-Sylvania Products, Inc., Danvers, MA: TR-110738; 1999; pp 173-185