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Developing and evaluating the efficacy of an educational intervention to promote self -regulatory behavior among high -risk older drivers: A primary prevention approach.

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DEVELOPING AND EVALUATING THE EFFICACY OF AN EDUCATIONAL INTERVENTION TO PROMOTE SELF-REGULATORY BEHAVIOR AMONG HIGH-RISK OLDER DRIVERS: A PRIMARY PREVENTION APPROACH

by

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Older drivers have a disproportionately high rate of crash involvement that has been linked to age-related declines in visual function. However, many older drivers with visual deficits meet the legal requirements for licensing, despite impairments that elevate crash risk. Therefore, KEYS (Knowledge Enhances Your Safety) was developed to assist high-risk older drivers in coping with impairment by promoting safety through self-awareness of vision impairment and the adoption of self-regulatory behaviors. Four hundred and two high-risk older drivers were randomly assigned to either usual eye care or a usual care plus education group. A baseline and 6-month posttest assessment was conducted to test the efficacy of the educational curriculum in terms of attitudes and perceptions toward vision and driving, the performance of self-regulatory practices, and driving exposure (i.e., days, miles, places, trips per week). At baseline, 80% of older drivers acknowledged they would feel more protected against crashes if they avoided hazardous driving situations (night, rain, alone, left-turn, parallel parking, interstate, heavy traffic, rush-hour). Yet, 75% of the sample reported never or rarely avoiding such situations. A total of 194 older drivers participated in the educational curriculum based on the tenants of the Social Cognitive Theory, Health Belief Model, Transtheoretical Model, Principles of Self-Regulation, and Regulatory Self-Efficacy. At posttest, those who participated in the educational curriculum demonstrated an increase in self-perceptions of vision impairment, perceived a greater number of benefits to the performance of self-regulatory behaviors, and demonstrated more characteristics of the Action/Maintenance stage of change. When compared to controls, drivers who received education reported a higher frequency of avoiding challenging driving situations (i.e., left-turns) and reported a higher frequency of performing self-regulatory behaviors (i.e., making 3 right turns). Additionally, those participating in the educational sessions reported significantly fewer days, fewer places, and fewer trips made per week than those not participating in education. These findings suggest that visually impaired older drivers can benefit from educational interventions that promote self-regulation. This intervention serves as an example of a primary prevention approach focusing on the specific human behaviors performed by the driver in order to prevent crashes before they happen.

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INTRODUCTION

Mobility, especially by way of the automobile, has become an essential component of the American lifestyle. Our dependence on the automobile has increased over the past 40 years as populations have shifted residency from the city to more remote suburban areas (Underwood, 1992). Automobile dependency is further exacerbated by the lack of viable transportation alternatives to move individuals within rural and urban areas in order to conduct activities of daily life. Through the years, driving a car has expanded its value beyond a simple method of transportation from one location to another. In fact, driving is often viewed as a symbol of personal freedom and has become essential to the independence and mobility of many individuals (Underwood, 1992). However, adverse outcomes associated with driving, such as crashes, injury, and death, have become a significant public health concern, especially for older drivers who have a disproportionately high rate of crash involvement (National Highway Traffic Safety Administration, 1995).

Older Drivers

Older adults represent the most rapidly growing segment of the driving population in the United States in both the total number of drivers and the total number of miles driven per year (National Highway Traffic Safety Administration, 1989; Owsley, 1997; Retchin & Anapolle, 1993). There are currently more than 23.6 million people age 70 years and older in the United States, and the number is growing rapidly. From 1985 to

1995, this older segment of the population grew 2.3 times as fast as the total population (National Highway Traffic Safety Administration, 1997). At this rate, it is expected that by the year 2024, one in four drivers will be over age 65 (Eberhard, 1996; Transportation Research Board, 1988). Driving is important to the mobility of older adults with almost 90% relying on the private automobile for the majority of their transportation needs (Martinez, 1995).

Older adults, typically defined as those 60 years of age and older, are at an increased risk for adverse outcomes resulting from driving. Older drivers have a higher crash involvement rate per mile driven than all other age groups, except drivers under the age of 25 years (Massie, Green, & Campbell, 1997; Transportation Research Board, 1988). Concern is also elevated for this population of drivers based on the evidence that, if older drivers are involved in a crash, they are more likely than younger drivers to be seriously injured or killed (Evans, 1991; National Highway Traffic Safety Administration, 1993). In fact, motor vehicle accidents and injuries are the leading cause of injury-related deaths for older adults 65 to 74 years of age in the United States and the second leading cause after falls in those 75 years of age and older (Eberhard, 1996; Evans, 1991). When driver fatality rates are calculated per driver, the highest rates are found among both the youngest and oldest drivers (Transportation Research Board, 1988). However, these circumstances change when fatalities are calculated per mile driven. When compared with the fatality rate for drivers 25 to 65 years old, the fatality rate for teenage drivers per mile driven is only four times as high, while the fatality rate for older drivers per mile driven is 17 times as high (National Highway Traffic Safety Administration, 1993). The National Highway Traffic Safety Administration (1993) reported that individuals over age 70 years were the only segment of the population to show an increase in traffic fatality rate per 100,000 people in the last 10 years. Thus, the adverse consequences of crash involvement have a significant, yet disproportionate, impact on the health of this population.

Approaches to Crash Prevention

The prevention of negative health outcomes traditionally occurs at three levels: primary, secondary, and tertiary (Kaplan, 2000; Price, Cowen, Lorion, & Ramos-McKay, 1988). Primary prevention involves actions such as healthy lifestyle behaviors that will prevent the onset of disease. Secondary prevention refers to the early detection, diagnosis, and subsequent treatment of the health condition to prevent further disease maturation. Tertiary prevention involves care aimed at delaying disease progression to ensure optimal function in performing daily activities in the presence of an irreversible health condition (Kaplan, 2000). Numerous programs have been successful in reducing morbidity and mortality of certain health conditions when using this prevention framework (Sleet, 1984). In the field of traffic safety, these prevention efforts can be conceptualized as before, during, and after an adverse crash event (Evans, 1990, 1994).

Interventions at the secondary level of crash prevention focus on the protection of the occupant during a crash event (Evans, 1991). Human factors and automobile design innovations aim to reduce the severity of crashes and subsequent injury an individual may incur during a crash event. Safety engineers are concerned with the study of vehicle structures and the transfer of energy when vehicles collide with other objects. Side door beams, air bags, seat-belts, head restraints, and roof crush resistance are examples of structural features that attempt to reduce the force of impact on the individual (Evans, 1991).

At the tertiary level of crash prevention, health professionals are most concerned with the treatment of the older driver after a crash event has occurred, a priority among geriatric populations, who are disadvantaged due to their diminished physiologic state and are five to six times more likely than younger people to die from the same injury event (Mandavia & Newton, 1998; Schwab & Kauder, 1992). The goal at the tertiary level is to prevent chronic disability resulting from crash injury and to ultimately return the older driver to independent living. Interventions implemented at the tertiary level of prevention target emergency care personnel in efforts to reduce the length of time the injured driver spends at the crash scene or to reduce the time the driver spends in transport to a trauma facility (Schwab & Kauder, 1992). Interventions have also targeted hospital staff and trauma surgeons focusing on methods to expedite the treatment of the patient once they reach the hospital setting (Mandavia & Newton, 1998).

Primary	**Secondary**	**Tertiary**
Operator Behavior	Occupant Protection	Crash Team Services Trauma Care
Prevent Crash Event (Hazard Avoidance)	Prevent Injury (Seatbelt; Airbag)	Prevent Chronic Disability (Emergency Care; Surgery)
Before	**During**	**After**

Figure 1. Crash prevention levels.

A primary prevention perspective on crash involvement requires a shift in focus from external factors (i.e., the automobile, trauma services) to the internal factors of driver behavior (Evans, 1990). Thus, primary prevention interventions focus on the behavior of the operator in terms of the specific maneuvers that will prevent a crash event before it happens. Health promotion efforts encompass a continuum of efforts from preventing disease at one end (i.e., primary) to decreasing functional dependence on the other (i.e., tertiary), and efforts at either end should be viewed as legitimate and appropriate goals (Bloom, 1996; Kaplan, 2000; Minkler, 1984; Price et al., 1988).

When crash antecedents are examined, the individual driver is identified as the sole or contributing factor in 94% of vehicle collisions, emphasizing the significant role that human behavior plays in crash involvement (Evans, 1996; Treat, 1980). Primary crash prevention can be categorized under the auspices of health-protection, a distinct component of health promotion, in that it focuses on actions that people take to reduce their own vulnerability to harm to protect current healthy states (Harris, 1979; Walker, Volkan, Sechrist, & Pender, 1988; Weinstein, 1987, 1993). Based on these and other findings (Evans, 1990), educational efforts to intervene at the primary level of individual driver behavior have gained attention as a method of improving traffic safety.

There is evidence that primary prevention interventions can be successful in promoting positive lifestyle changes among older adults (Best & Cameron, 1986; Omenn, 1990; Orlandi, 1987). For example, in several studies, older individuals with physiologic conditions learned to utilize illness self-management techniques that reduced risk and ultimately improved health (K. Lorig, Laurin, & Holman, 1984; K. R. Lorig et al., 1999; Rowe & Kahn, 1998). In another study, older adults with heart disease who participated in educational classes learned to better react to physical symptoms in order to protect against the adverse event of a heart attack (Clark, Janz, Dodge, & Sharpe, 1992). Similarly, older adults who were educated on techniques to prevent falls reported fewer falls over a 1-year period compared to those who did not receive any education (Wagner et al., 1994). Even in the absence of illness, older adults have demonstrated their ability to modify their current health behaviors to promote health. For example, older adults who attended health promotion classes learned to make positive changes in their eating and exercise habits which had a significant impact on improving their health and quality of life (Higgins, 1989). These findings demonstrate that individuals maintain their interest as well as their ability to learn behaviors that protect health status throughout the life course.

Older Drivers at Highest Risk

The disproportionate rate of crash occurrence in the older adult population has been attributed to age-related declines in functional capabilities. Older adults experience a higher prevalence of visual impairments, cognitive impairments, or both that can hinder the ability to safely operate a motor vehicle (National Highway Traffic Safety Administration, 1997; Owsley & Sloane, 1990). Vision impairment may result from several normal age-related changes, for example, the eye's pupil does not grow larger in darkness; the lens loses its focusing ability (presbyopia); and the crystalline lens becomes thicker, yellowed, and more opaque, resulting in blurred vision. These changes cause a reduction in the amount of light reaching the retina which can decrease acuity and contrast sensitivity (Owsley & Sloane, 1990). Age-related changes in visual acuity make it more difficult for older adults to focus clearly from a distance, making sign recognition and hazard avoidance more difficult. Most states have visual requirements for licensure which include visual acuity (i.e., 20/40 to 20/60) and the extent of the visual field (i.e., 110°; Shipp & Penchansky, 1995). Peripheral vision changes make it more difficult for older drivers to detect objects from the sides, such as cars pulling out from side streets and driveways. With respect to contrast sensitivity, older adults require twice the contrast than do younger adults (Owsley & Sloane, 1990), and it is more difficult for older drivers to adapt to darkness and recognize objects under low lighting conditions, such as driving at night. Age-related declines in these types of visual abilities have been linked to crash involvement (Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Johnson & Keltner, 1983; Kline et al., 1992; Owsley, Ball, Sloane, Roenker, & Bruni, 1991). Specifically, those with poor peripheral vision have collision rates twice as high as those with normal peripheral vision due to limitations in the ability to visually search the driving environment (National Highway Traffic Safety Administration, 1996; Owsley, Ball, et al., 1998). Research also demonstrates that older drivers with visual processing deficits (e.g., slowed visual processing speed, divided attention problems) are more likely to be involved in future crashes (Owsley, McGwin, & Ball, 1998).

Research has also linked crashes and diminished cognitive capabilities in older drivers (Cooper, Tallman, Tuokko, & Beattie, 1993; Goode et al., 1998; Owsley et al., 1991). Driving relies on the ability to visually process multiple environmental stimuli as well as the cognitive capacity to draw correct inferences from incoming information and formulate the appropriate response (Ball, Roenker, & Bruni, 1990; McCloskey, Koepsell, Wolf, & Buchner, 1994; Owsley et al., 1991). Reaction time is one example of visual/

cognitive functions in terms of how quickly and accurately a person can obtain information, make a decision under stress, and translate the decision into action to avoid a crash (Ball et al., 1993). A significant number of hazardous errors made by the visually and cognitively impaired driver occur while changing lanes, merging, approaching intersections, turning left, or stopping (Dobbs, Heller, & Schopflocher, 1998; [DOT] Department of Transportation, 1997; Transportation Research Board, 1988). These errors may result from impaired comprehension or confusion when sorting through multiple visual and cognitive stimuli presented in cluttered environments. A recent research initiative compared the performance of drivers with cognitive impairment to drivers who had no cognitive impairment. Findings revealed that those with cognitive impairment made more hazardous errors while driving than did the groups with no cognitive impairment (Dobbs et al., 1998).

It is important to remember that not all older adults age in the same way. Some may not experience changes in vision and cognition, and, thus, not all older drivers are unsafe on the road. However, with driver behavior as the predominant factor in majority of crashes (Evans, 1996), those who do experience impaired capabilities that hinder safe operation of a motor vehicle pose a substantial threat to themselves and public safety. License revocation may be the only option for those older drivers with severe, irreversible functional impairments. However, many older drivers with visual processing problems meet the legal requirements for licensing despite having deficits that elevate crash risk. Older drivers, like most drivers, rely on driving as a primary mode of transportation (Martinez, 1995). Therefore, it has become increasingly important to develop interventions for older drivers who maintain driving privileges while coping with functional limitations that increase the risk of crash involvement.

Previous Driver Education Programs

Many educational programs have been developed over the years to address the unique driving issues faced by older drivers (Beno, 1981). To date, there are four comprehensive programs developed for older drivers that are recognized at the national level. The most popular, the 55-Alive Mature Driving Program, was developed by the America Association of Retired Persons (AARP). This program, established in 1979, was the first classroom driver refresher course for drivers 50 years of age and older. Today, approximately 1% of all drivers over the age of 50 years in the nation, over 5 million drivers, have participated in this course. The program involves 8 hr of classroom training including a review of rules of the road and safe maneuvers. The curriculum provides information regarding common physical changes that impact driving, such as vision, hearing, and reaction time, as well as the effects of alcohol and medication use. Participants also review the proper use and maintenance of their vehicle (American Association of Retired Persons, 1997).

The Mature Driver Improvement Program in California is another educational program designed to improve the safety of older drivers (Janke, 1994). This program was established in 1987 to encourage older drivers residing in California to update their driving knowledge in a classroom environment. The curriculum is similar to the 55-Alive program covering areas such as the impact of vision and hearing on driving, the effects of medication and alcohol on driving, and the use of safety devices such as seatbelts. In addition, this program includes information about how to plan travel times and routes and how to make critical decisions in dangerous or unexpected situations.

The AAA has developed the Safe Driving for Mature Operators program which consists of a similar 8-hr classroom curriculum which addresses safe driving practices, safety devices, and the effects of alcohol and medication (AAA, 1998). Some states provide the opportunity for course participants to take physical tests, such as brake reaction time test, acuity, peripheral vision, depth perception, and color vision tests. In some cases, course participants are offered a 90-min on-road evaluation and are given a confidential "report card" which states the results of their performance (AAA, 1998).

The National Safety Council (1997) has developed the Coaching the Mature Driver program. This 6-hr curriculum is similar in focus addressing the effects of aging and driving and the importance of compensating for age-related changes in physical and mental function. Thus, a primary feature of this intervention is to promote defensive driving. The course is also delivered in a classroom setting (National Safety Council, 1997).

Little is known about the efficacy of older driver education because these initiatives tend to lack formal evaluation. The AAA Safe Driving for Mature Operators and the National Safety Council Coaching the Mature Driver programs have focused their evaluation efforts on process measures, such as the number of individuals attending the course rather than evaluating the course in terms of actual driver performance. To date, the only two older driver programs formally evaluated to include traffic safety outcomes are the AARP 55-Alive and the California Mature Driver Improvement (MDI) Program. The results of the evaluation of these two older driver education programs were quite similar. Both the 55-Alive and the MDI programs were successful in improving participants' knowledge of driving maneuvers and rules of the road. However, in the end, the 55-Alive program was not successful in demonstrating improvements in driver safety by reducing the crash rate of the participants (McKnight, Simone, & Weidman, 1982). The MDI program was successful in reducing the number of citations for participants; however, the crash rate for participants actually increased (Janke, 1994). Similar findings have emerged from formal evaluations of driver education programs in other populations. The Dekalb County Driver Education Project is the most comprehensive experiment in novice driver education (Ray, Sadof, Weaver, Brink, & Stock, 1980; Smith, 1987; Stock, Weaver, Ray, Brink, & Sadof, 1983). The study evaluated the use of a training curriculum that included 32 hr of classroom instruction, 16 hr of simulation instruction, 16 hr of driving range instruction, 3 hr of collision avoidance instruction, and 3 hr of on-road instruction (Lund, Williams, & Zador, 1986). The notable strength of this study is the randomized control trial design to evaluate the primary safety outcome of crash involvement. However, this large scale study failed to demonstrate a net safety benefit in terms of crash reduction. As a result of these findings, many novice driver education programs across the country lost their financial support ([TIRF] TESOL International Research Foundation, 1991)

The only program to demonstrate any type of educational impact on the outcome of crash events was the Texas Driver Improvement Program (Edwards & Ellis, 1976). This program targeted habitual violators of all ages who had experienced high rates of traffic citations and crashes. The course curriculum consisted of 10 hr of classroom education. In the end, the only group to demonstrate a reduction in crash involvement was the group of drivers 25 to 34 years of age, the age group with the lowest overall risk of crash involvement (Massie et al., 1997; National Highway Traffic Safety Administration, 1995). This program evaluation is yet another example of a failed attempt to impact safety outcomes among groups at high risk for crash involvement.

Perhaps it is not that these educational programs are ineffective but only that they failed to demonstrate an impact on the outcome of crash involvement, a distal outcome that lies at the end of a continuum of driving behaviors. Prior programs were successful in demonstrating an increase in the knowledge of safety maneuvers; however, safety outcomes, such as reduced crash rates, are not likely if such knowledge is not applied to daily driving behavior. Knowledge is typically at the most proximal end of the continuum, and previous older driver programs have incorporated a knowledge and attitude component in their education evaluation (Janke, 1994; McKnight et al., 1982). The focus on the knowledge component has a great deal of face validity in that drivers who cite the correct information regarding driver safety and rules of the road may be expected to make safer maneuvers when behind the wheel. It is well documented that knowledge, the orientation with facts, is a critical component in behavior change (E. A. Locke & Bryan, 1966; E. Locke, Cartledge, & Koeppel, 1968; Simons-Morton, Green, & Gottlieb, 1995). Without knowledge, individuals may be unaware about their risk for crash involvement and may not have the information needed to know how to alter their behavior. The two older driver programs that have been evaluated demonstrate success in promoting gains in participant knowledge (Janke, 1994; McKnight et al., 1982). However, the programs did not demonstrate an educational impact on crashes. It could be argued that knowledge lies at one end of a driving behavior continuum while crashing lies on the other end. Therefore, knowledge gains are necessary to begin the change process, yet may not be sufficient to impact the behaviors that reduce crashes at the opposite end of the driving behavior change continuum (Kohler, Grimley, & Reynolds, 1999).

The health education literature contains several theoretical models that outline predisposing, enabling, and reinforcing factors that serve as antecedents to behavioral outcomes (Ajzen & Madden, 1986; Bandura, 1986b; Becker et al., 1977; Best & Cameron, 1986; J. O. Prochaska, 1991; Rosenstock, 1990). This literature indicates that there are a host of factors that span the continuum of driving behavior that may provide evidence of movement toward the ultimate outcome of crash prevention. Yet, little is known regarding the impact that driver education can have on the behavioral antecedents to crash involvement because previous older driver programs focused on knowledge and crash rates alone. Therefore, a driver education program based on the literature of empirical research regarding the elements of human behavior and how it might be changed is essential (Bandura, 1977, 1982; Mischel, Cantor, & Feldman, 1996; J. D. Prochaska & DiClemente, 1992; I. M. Rosenstock, 1974). Thus, the purpose of this project is to design, implement, and evaluate the efficacy of an educational program in terms of established theoretical components, namely, those outcomes which lie on the more proximal end of the driving behavior continuum.

Theoretical Models of Human Behavior

The inclusion of a theoretical framework cannot ensure intervention success; however, there is a great deal of evidence to support the benefits of utilizing theoretical models as a framework for educational programs. For example, theoretical models furnish a conceptual foundation which serve to (a) provide insight into how program information should be communicated to participants, and (b) outline a relationship between constructs in order to facilitate an understanding of how program components should interact to promote behavior change (Kohler et al., 1999). Thus, theoretical models provide practical guidance for the delivery as well as the subsequent evaluation of an educational program.

Behavior change is thought to occur as a result of (a) the acquisition of knowledge and (b) the adoption of a new behavior (Bandura, 1986b). Prior research has demonstrated that older adults can acquire knowledge through driver education (Janke, 1994; McKnight, et al., 1982), yet the mechanisms by which education facilitates the process of adopting new safe driving behaviors is less clear. According to the Social Cognitive Theory (SCT), the adoption of new behaviors depends on (a) motivational conditions, (b) self-regulatory skills, (c) the confidence in one's ability to exert the effort, and (d) prerequisite knowledge and skills (Bandura, 1977, 1986b; Kohler et al., 1999). The framework of theoretical constructs is depicted in Figure 2.

Motivational conditions. Motivational conditions refer to the emotions and impulses that stimulate an individual to engage in a given action and can be guided by health beliefs (Ferrini, Edelstein, & Barrett-Conner, 1994; Kirscht, 1974; R. Kelly, Zyzanski, & Alemagno, 1991; Strain, 1991). Thus, the Health Belief Model (HBM) and the Transtheoretical Model (TTM) are two models that are chosen to guide our understanding of these health beliefs and motivating factors. The HBM (I. Rosenstock, 1960; I. M. Rosenstock, 1974, 1990) postulates that individuals will engage in preventive

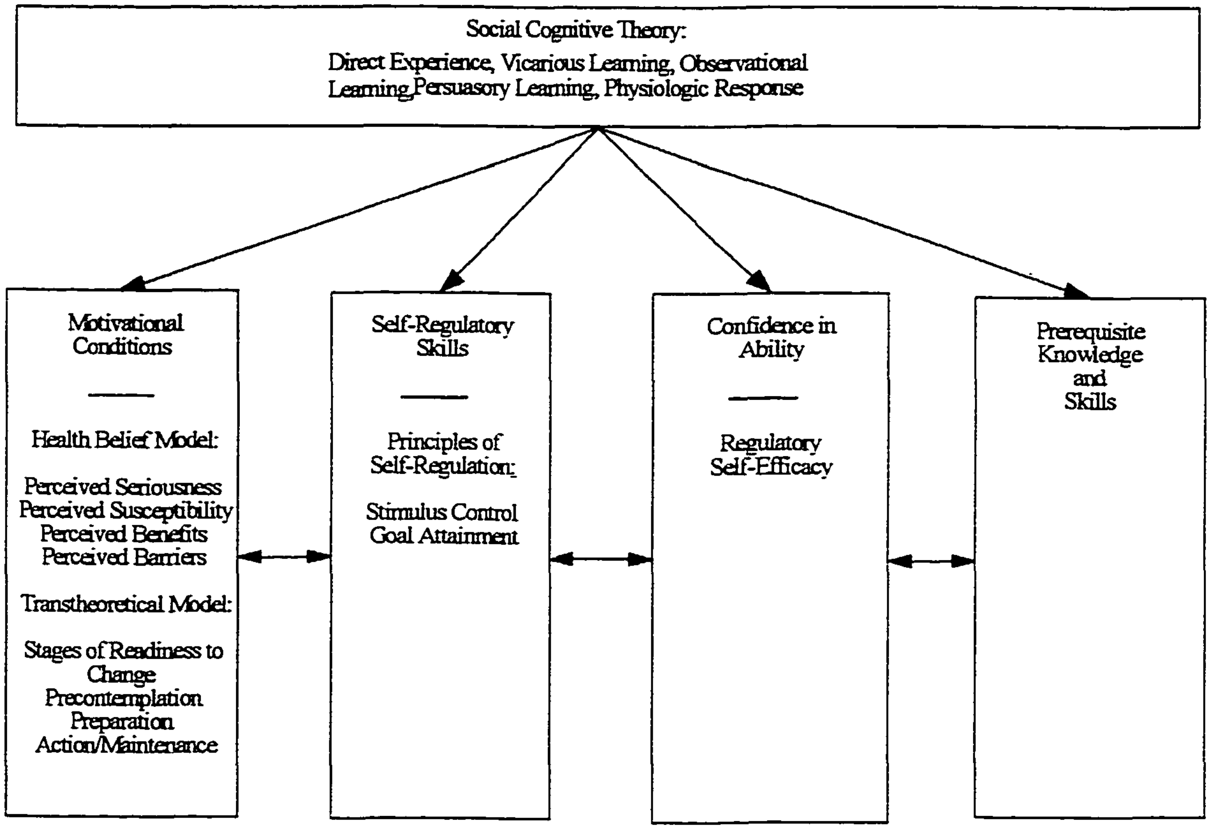

Figure 2. Theoretical foundations of intervention curriculum.

behaviors if they perceive a threat, that is, if they feel susceptible to the outcome and believe the outcome will have serious, life-threatening consequences. The HBM also postulates that an individual must perceive that there are benefits to engaging in a particular behavior and that these benefits must outweigh any perceived barriers to the completion of these actions. When applied to the protective behaviors of safe driving, the HBM constructs postulate that, if the driver does not feel susceptible to crash involvement or does not perceive crashes as a serious, life-threatening event, the adoption of preventive self-regulatory behaviors is unlikely. Similarly, if barriers, such as lack of alternative transportation, outweigh the benefits of being protected from crash involvement, the adoption of preventive self-regulatory behaviors is unlikely. Thus, interventions should focus on increasing perceptions of susceptibility and seriousness while reducing barriers and increasing benefits to the adoption of safe driving practices.

Research has consistently demonstrated significant relationships between the HBM constructs and preventive behaviors (Janz & Becker, 1984; Kirscht, 1974) and the application of this model in interventions targeting older adults is on the rise. This work demonstrates that increasing age does not diminish the relationship between health beliefs and health behaviors (Ferrini et al., 1994). For example, prior work has supported the role of health beliefs in older adults' use of health services (Strain, 1991). Women who participated in mammography screening had significantly higher scores on seriousness and benefits and had significantly lower scores on barriers than those not participating in mammography (Champion, 1994; Fulton, et al., 1991). There is evidence that educational interventions can be effective in changing perceptions among older adult populations with respect to these HBM constructs. For example, education was successful in increasing perceived susceptibility and perceived severity of AIDS among older adults (Rose, 1996).

The TTM can also guide our understanding of the motivational conditions that contribute to behavior change (J. O. Prochaska, DiClemente, & Norcross, 1992; J. O. Prochaska, DiClemente, Velicer, Ginpil, & Norcross, 1985). The foundation of the TTM lies in the recognition that individuals vary in their level of motivation or readiness to engage in new behaviors. According to this model, there are five specific stages that individuals may cycle through in the process of adopting a new behavior: (a) precontemplation, in which the individual is not considering the adoption of a new behavior in the distal future; (b) contemplation, in which the individual begins to consider the process of adopting the behavior in the near future; (c) preparation, in which the individual experiments with the new behavior for adoption in the immediate future; (d) action, in which the individual actually performs the new behavior on a routine basis; and (e) maintenance, in which the individual continues the performance of the new behavior, typically for at least 6 months (J. O. Prochaska et al., 1992). Movement through these stages of change are not always linear. At times the path is more circular as individuals re-enter earlier stages or relapse (J. Prochaska, 1991; J. O. Prochaska & DiClemente, 1983).

The behaviors most widely studied in terms of formal evaluation under the TTM framework are smoking cessation, low-fat diets, and exercise behaviors (Kohler et al., 1999). The TTM has been utilized to identify participants' levels of readiness in order to deliver a tailored message (Kohler et al., 1999). For example, one researcher developed self-help manuals based on the TTM and delivered a tailored message to assist individuals with the smoking cessation process (Pallonen, Leskinen, Prochaska, Kaariainen, & Salonen, 1994). By identifying the individual level of motivation and meeting them at their current level of readiness, individuals moved through the stages toward the Action and Maintenance of smoking cessation at a faster rate (Pallonen et al., 1994).

There is evidence of a link between health beliefs as outlined by the HBM and the stages of the TTM. In one study, the HBM constructs of susceptibility, seriousness, benefits, and barriers were significantly different across stage of readiness to participate in mammography screening (i.e., Precontemplation, Contemplation, and Action/ Maintenance; Champion, 1994). Based on these findings, the constructs of the HBM and TTM were chosen to facilitate the understanding of the factors that motivate the adoption of a new behavior and to guide the delivery of a tailored message for the high-risk older driver according to their own levels of readiness to adopt self-regulatory practices.

Self-regulatory skills. Self-regulation describes the process of self-guided thoughts, feelings, and actions (Maes & Gebhardt, 2000). The primary component in self-regulation is the "self," meaning that regulatory skills are initiated by internal resources (Mischel et al., 1996). Because primary prevention of crash outcomes relies on the characteristics of the driver (i.e., behavior) rather than organizational factors (i.e., vehicle and roadway design, trauma services), this individualized model is an essential component of this driver education program.

It has been postulated that a key to human behavior is the concept or ideas people have about themselves and their experiences (Kelly, 1955). Self-regulation consists of constructive alternativism which states that, while people may not be able to change events in the external environment, they do have the potential to construe or conceptualize them differently and to view events in a new way (G. A. Kelly, 1955). Thus, individuals have the capability to alter a situation by "constructing" an "alternative" outcome and viewing the event in a new way (Maes & Gebhardt, 2000). When applying these principles to driving behavior, this model postulates that individuals may not always have control over the driving environment (i.e., amount of traffic, weather, lighting), yet they do have the internal capacity to evaluate a situation as dangerous or safe (G. A. Kelly, 1955; Mischel et al., 1996). If viewed as dangerous, the individual then needs self-regulatory skills, the internal capacity to identify alternative strategies and the personal motivation needed to engage in actions that will prevent an adverse outcome such as crashing. Under this premise, self-regulation can be thought of as a form of stimulus control where the individual utilizes internal strategies to alter the personal impact of an external event (Mischel et al., 1996; Tobin, Reynolds, Holroyd, & Creer, 1986). The role of education is to assist drivers in learning to evaluate external driving situations as dangerous or safe and to identify when and how to regulate their own behaviors to safer situations.

The internal regulatory strategies described above are guided by the set of values and personal goals unique to each individual (Maes & Gebhardt, 2000; Mischel et al., 1996) . The operative word is "personal" in that each goal is organized into a hierarchy determined by the level of importance to the individual, the perceived level of difficulty in achieving the goal, and the perceived length of time it would take the individual to successfully attain the goal (Maes & Gebhardt, 2000). Interventions guided by the principles of self-regulation would assist individuals in defining their own personal goals and arranging these goals by level of personal importance. Research has demonstrated that setting goals for risk reduction can be effective in changing behavior (Alexy, 1984; Dubbert & Wilson, 1984; Maes & Gebhardt, 2000). In one study, those who participated in education that focused on goal setting and counseling had more positive outcomes in the areas of diet and aerobic exercise than those who did not receive goal-oriented education (Mayer et al., 1994).

According to the principles of self-regulation, goals are differentiated by the individual across several domains, which include (a) higher-order versus lower-order, (b) approach versus avoidance, and (c) reactive versus active (Maes & Gebhardt, 2000). The first category is used to organize the hierarchy of the individual's personal goals. Higher-order goals refer to goals theoretically at the top that represent the optimization of self, such as safety, health, well-being, and personal growth, and thus provide the individual with an overall purpose for conducting all behaviors (Maes & Gebhardt, 2000; Mischel et al., 1996). Lower-order goals are more specific subgoals, for example, reducing the frequency of driving at night or reducing speed by 5 miles per hour. Yet, the cumulative success of lower-order goals plays a significant role in achieving the higher-order goals of driving safety (Mischel et al., 1996).

The principles of self-regulation also postulate that, when setting goals, individuals make a distinction between approach goals, defined as movement toward a desired outcome, or avoidance goals, defined as movement away from an undesired outcome (Maes & Gebhardt, 2000). For example, the promotion of exercise in order to have better cardiovascular health could be interpreted by the individual as "approaching" better overall health or "avoiding" an adverse outcome, such as a heart attack. Similarly, the driver in this project may set goals consistent with approaching traffic safety through self-regulation or to engage in protective behaviors in order to avoid an adverse outcome, such as crashing. A third category refers to the process of having a reactive or active orientation to goal setting. An example of reactive orientation would be the practice of setting goals to avoid night driving only after a crash occurred at that time. Primary prevention interventions focus on the promotion of active orientation, that is setting goals to prevent the adverse outcome of crashing from occurring a priori (Maes & Gebhardt, 2000).

Once goals are set, the individual must initiate and sustain the self-regulatory process. Self-regulation is best sustained through internal feedback in terms of self-monitoring to evaluate progress toward a goal (Maes & Gebhardt, 2000). For driving behavior, self-monitoring may include activities, such as counting the number of nights each week driving is avoided, to ascertain progress toward the self-regulatory goal of not driving at night. There is evidence that self-monitoring can aide in goal attainment. In one study, those who used self-monitoring manuals had higher smoking quit rates than those who received information alone (Clark & Zimmerman, 1990).

Confidence in ability. Education also plays a pivotal role in promoting regulatory self-efficacy, an individual's own judgment of their confidence in the ability to engage in self-regulatory behaviors on a regular basis (Bandura, 1996). Interventions intended to promote self-efficacy have been effective in changing behavior across a variety of health domains (Schwarzer, 1992) and have been found to be highly predictive of persistence and performance of various tasks (Lent & Hacket, 1987; Schunk, 1989; Meichenbaum &

Smart, 1971; Strecher, DeVillis, Becker, & Rosenstock, 1986). In one study targeting older patients with chronic obstructive pulmonary disease, compliance with an exercise regimen was significantly increased through training that promoted self-efficacy for walking exercise behaviors (Kaplan, Atkins, & Reinsch, 1984).

Prerequisite knowledge and skills. Prerequisite knowledge and skills, also referred to as "behavioral capabilities" in the SCT, refers to the current level of knowledge and skill that the individual has at the time of the educational session (Bandura, 1977, 1986b). Educational programs delivered to older drivers must account for the existing understanding and ability of the individual to conduct the driving task resulting from their experienced driver status.

A comprehensive understanding of evidence-based theory can lead to well-developed program components that can enhance program delivery. In addition, if a program is designed based on theoretical models, it can then be evaluated based on key theoretical constructs, further strengthening the ability to determine the mechanisms of program efficacy. For driving this is particularly ideal because there have been few comprehensive evaluations conducted to date, resulting in limited insight into the multi-faceted domains of driving behavior.

KEYS Intervention Goals and Objectives

Based on the magnitude of the public health problem and the age-associated risk, the utility of education among older adult populations, and the need for primary prevention initiatives based on theoretical understanding of human behavior, an educational intervention has been developed for visually impaired older drivers at high risk for crash involvement. This intervention is unique in that it targets high-risk older drivers, a population not targeted by previous driver education programs. This intervention is also unique in that it is designed to test the efficacy of delivery in a clinical setting in a one-on-one format, an alternative to the community classroom method used in previous driver education initiatives.

The KEYS (Knowledge Enhances Your Safety) educational curriculum for high-risk older drivers is designed to not only promote the orientation with fact, but also expand upon previous programs by promoting behavioral strategies drivers can utilize to translate acquired knowledge into real-world driving practices. The curriculum was developed to address the unique needs of older drivers who maintain driving privileges while coping with functional limitations that increase crash risk. Driving cessation is not the focus of this intervention because the target audience includes those who are at risk due to diminished functional ability, yet remain legally licensed to drive. Rather, the goal of the intervention is to provide older drivers with strategies to reduce harm and increase safety, while allowing them to maintain mobility in order to continue to perform activities necessary for daily living.

Studies show that older drivers have the most misconceptions regarding the risk of having a collision (Evans, 1991; National Highway Traffic Safety Administration, 1989). Prior research has demonstrated that those who are unaware of their own visual and cognitive limitations tend not to take preventive action (Martinez, 1995). However, there is evidence that older drivers who are aware of their visual deficits will compensate for their impairments by modifying their driving behavior (Ball et al., 1998; Schlag, 1993; Stutts, 1998). For example, older drivers who had been told by an eye care specialist they had an eye disease tended to self-regulate by avoiding difficult driving situations such as driving at night (Owsley et al., 1991; Owsley, Stalvey, Wells, & Sloane, 1999). Therefore, the primary goal of this educational intervention is to promote awareness of visual impairment and the adoption of self-regulatory behaviors.

Prior research demonstrates that the risk of crash involvement is highest when driving at night, driving in the rain, making a left-turn across oncoming, driving in heavy traffic, driving on the interstate, driving in rush hour traffic, and driving alone (National Highway Traffic Safety Administration, 1995, 1997; Owsley & McGwin, 1999; Owsley et al., 1999), all of which can present challenges to a driver both visually and strategically. However, there is evidence that the avoidance of these driving situations in conjunction with reduced driving exposure may be effective in reducing crash risk (Hakamies-Blomqvist, 1993; Lefrancois & D'Amours, 1997). Therefore, the intervention goal to promote self-awareness of visual impairment and hazard avoidance through the use of compensatory strategies, such as self-regulation, may serve as a mechanism to prevent adverse driving outcomes in this population of high-risk older adults.

METHODS

Selection of Theoretical Framework

There is a vast array of health education literature which outlines the constructs of theoretical models and describes their applications across a wide variety of health behaviors (Best & Cameron, 1986; Kohler et al., 1999). However, because there is no indication that previous older driver education programs utilized evidence-based theoretical models in the program's development or evaluation, there were no precedents to follow in this project. Several models were examined in terms of primary components and behavioral outcomes. The theories selected to guide this intervention were based on three primary factors: (a) a focus on the individual, (b) a compatibility with the intervention goals to promote awareness and self-regulation, and (c) the support of prior research on the utility in promoting behavior change. The resulting theoretical framework for KEYS was based on a combination of the tenets of several models: the SCT (Bandura, 1977, 1986b), the HBM (I. M. Rosenstock, 1990), the TTM (J. O. Prochaska & DiClemente, 1992), the Principles of Self-Regulation (Mischel et al., 1996), and Regulatory Self-Efficacy (Bandura, 1986a).

A detailed description of the process by which these theoretical models were implemented in the KEYS older driver education intervention is found in the second manuscript.

Participants

Drivers over 60 years of age who were legally licensed to drive in the state of Alabama and who had been involved in a crash in the year prior to enrollment were identified through the Alabama Department of Public Safety, the state agency in charge of compiling crash records. High-risk older drivers included in this sample were defined as those who had visual acuity and visual processing deficits, a high level of driving exposure, and a history of crash involvement. Visual deficits were defined as having either visual acuity between 20/30 and 20/60 (the state's legal limit for licensure) or visual processing impairment of 40% or greater reduction in useful field of view or both. With respect to driving exposure, participants were required to be current drivers who drove on average 5 to 7 days or 100 miles or more each week or both. A history of crash involvement was defined as being the driver in at least one crash reported to the state in the prior year. Individuals with a Mini-Mental Status Examination (MMSE) score less than 23 were not included in the study.

Design

This study followed an experimental design with subjects randomly assigned to one of two groups: (a) a usual care control group or (b) a usual care plus educational intervention group. The overall study design is presented in Figure 3.

All crash-involved drivers living in the Birmingham metropolitan area (i.e., Jefferson County and surrounding counties) were contacted first by letter, which was followed by a telephone call, to determine eligibility in terms of age and driving exposure. Qualified participants were then invited to visit the Clinical Research Unit at the University of Alabama at Birmingham to determine further eligibility.

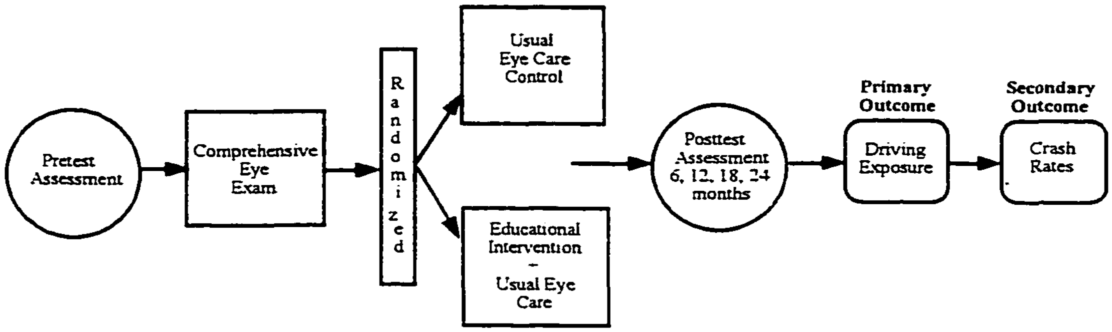

Figure 3. Overall study design

All individuals who met the inclusion criteria for visual function, driving exposure, and mental status received a comprehensive examination by an eye care specialist who provided "usual care." Any treatment options, if available, were offered to the individual. Participants were not randomized until after the examination by the eye care specialist to allow the exclusion of individuals who received treatment and no longer met the inclusion criteria for high-risk. As part of usual care, the eye care specialist must discuss the impact of visual impairment on activities of daily living, such as driving, following the guidelines of the Preferred Practice Plan of the practice field (i.e., Optometry, Ophthalmology). After usual care, those randomized to the intervention group participated in two education sessions, which included an initial 2-hr visit, followed by a booster session 1 month later. Posttest assessments were administered by telephone to both groups at 6, 12, 18, and 24 months. This design allows for the immediate as well as long-term comparisons between intervention and control groups. However, this project focused only on the baseline and 6-month assessments. Table 1 provides a list of the measures administered at baseline and 6-month posttest assessments.

Table 1

Pretest and 6-Month Posttest Measures

Pretest assessment (in-clinic)	6-month posttest assessment (telephone)
Visual acuity	
Visual processing (UFOV)	
Mental status	
General health, depressive symptoms	
Driving exposure	Driving exposure
Driving difficulty	Driving difficulty
Driving avoidance	Driving avoidance
Driver perceptions and practices	Driver perceptions and practices

Measures

Visual acuity impairment was measured by the ETDRS letter chart which provides an acuity reading of 20/10 to 20/200 (Ferris, Kassoff, Bresnick, & Bailey, 1982). Visual processing impairment was measured by the Visual Attention Analyzer (Ball & Owsley, 1992), which provides a composite useful field of view score. Higher percent reduction in useful field of view indicates slower speed of visual processing and impaired attentional skills. All visual performance measurements were made while subjects wore their habitual optical correction, defined as the correction they typically wore while driving.

Mental status was evaluated by the MMSE (Folstein, Folstein, & McHugh, 1975), a brief mental status test frequently used in clinical and research settings. This 10-min screening test provides a composite score of cognitive function that reflects performance in domains such as orientation, memory, attention, language, commands, spatial ability, and drawing. Composite scores range from 0 to 30, with higher scores representing higher functioning.

General health and depressive symptomology were also measured because these constructs have been known to affect older adults' performance of instrumental activities of daily living such as driving (National Highway Traffic Safety Administration, 1989). This information is included to enable the further characterization of this sample of older drivers. General health was assessed by asking subjects if they have problems in 17 areas (e.g., heart, cancer, diabetes, stroke), and if so, to what extent they are bothered by the condition on a 3-point scale 1 (not bothered at all), 2 (bothered a little), 3 (bothered a great deal). This instrument was derived from one used in a prior study on eye disease and quality of life (Steinberg et al.,1994) and utilized in previous older driver research (Owsley et al., 1999). To generate a comorbidity index, each medical condition present was weighted by the "bothersome score," and all were summed. Lower numbers indicate fewer/less bothersome comorbid conditions.

The presence of depressive symptoms was assessed by the Center for Epidemiological Studies-Depression Scale (CES-D; Radloff & Teri, 1986). Patients were asked to rate 20 items based on how often they felt that way in the last week. Responses included "rarely or none of the time, some of the time, much of the time, or most or all of the time," which were scored from 0 to 3, respectively. Total scores ranged from 0 to 60 with a higher number indicating more depressive symptoms.

Driving exposure and driving difficulty were assessed by the Driving Habits Questionnaire (DHQ; Owsley et al., 1999) which was used to determine enrollment eligibility and also served as an outcome measure in this study. Driving exposure was determined by asking subjects to report the average number of days driven per week and where they drive in a typical week. A detailed assessment of the number of places traveled to, number of trips made, and the total number of miles driven in a typical week was calculated. The detailed assessment of places, trips, and mileage provided in the DHQ is a notable improvement to traditional open-ended driving exposure questions and allows investigators to be more confident in the accuracy of the data obtained. Driving difficulty was assessed by asking participants to rate the degree of difficulty 5 (no difficulty), 4 (a little difficulty), 3 (moderate difficulty), 2 (extreme difficulty), 1 (so difficult I no longer drive in that situation), they have driving in each of eight specific driving situations (night, rain, driving alone, high-traffic, parallel parking, left turns, rush hour, interstate). A composite score of driving difficulty was computed based on the responses to all eight items and scaled on a 100-point scale [(mean score - 1) x 25]. Lower composite scores indicated a greater degree of perceived difficulty.

Driving avoidance was measured by asking subjects to report the extent to which they purposely avoided driving situations that place the greatest demand on visual processing abilities. Subjects were asked if they avoided each of eight driving situations during the past 3 months (night, rain, driving alone, high-traffic, parallel parking, left turns, rush hour, interstate) and, if so, how often they avoided these situations on a 5-point scale 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always). A driving avoidance subscale was created by summing response values across all 8 items which created a score ranging from 8 (never avoid the situation) to 40 (always avoid that situation).

The Driver Perceptions and Practices Questionnaire (DPPQ) was developed as part of this study to further evaluate participants' general knowledge, attitudes toward vision, and driving behavior because there were no previous instruments to address these domains. This questionnaire is based on the research literature on established theoretical models of health behavior change. The items were created to address the following domains: impact of vision on driving, general driving attitudes (Siebrecht, 1941), the perceived severity of a crash (Given & Given, 1983), susceptibility toward crash involvement (Robertson, 1977; I. M. Rosenstock, 1974), benefits and barriers to the performance of self-regulatory practices (Grimley, Riley, Bellis, & Prochaska, 1993; I. M. Rosenstock, 1990), current performance of self-regulatory strategies (Sandra Rosenbloom, personal communication, 1998), regulatory self-efficacy (Grembowski et al., 1993; R. Kelly et al., 1991) and stage of change (J. O. Prochaska, Velicer, DiClemente, & Fava, 1988; Rollnick, Heather, Gold, & Hall, 1992). Questions were guided by these sources and were then modified to address the specific behavior of driver self-regulation targeted in this study.

Principal components analysis revealed the following DPPQ subscales: self-perceptions of vision (i.e., current rating of vision, vision can change enough to affect driving), general driving attitudes (i.e., driving is a matter of personal freedom, the occurrence of a crash is a matter of chance, each driver is the best judge of his or her own driving abilities), perceived threat (i.e., severity, susceptibility to crashes due to vision, susceptibility to crashes due to nature of driving task), perceived barriers (i.e., external sources as in lack of public transportation, dependence on others as in not having anyone else to drive, personal desire as in not wanting to ask others to drive), perceived benefits to self-regulation (i.e., would feel safer if situations were avoided), regulatory self-efficacy (i.e., how hard it would be to avoid night driving), stage of change (Precontemplation, Preparation, Action/Maintenance), and current performance of self-regulatory behaviors (i.e., making three right turns instead of a left). Alpha reliability coefficients for each subscale are provided in Table 2. The DPPQ instrument is included in the Appendix of the first manuscript.

Table 2

Reliability of DPPQ Subscales

DPPQ subscale	Cronbach's alpha
Self-perception of vision impairment	0.223
Perceived threat	
Severity	0.546
Susceptibility/vision	0.623
Susceptability/general	0.390
Perceivedbarriers	
External sources	0.603
Personal desire	0.459
Dependency on others	0.328
Perceived benefits	0.611
Regulatory self-efficacy	0.835
Stage of change	
Precontemplation	0.544
Preparation	0.451
Action/maintenance	0.446

Research Questions Addressed in Manuscripts

The following research questions are addressed in the following manuscripts.

Manuscript 1: What are the self-perceptions and current driving practices as they exist in a population of legally licensed older drivers who are at high-risk for crash involvement due to crash history, high levels of driving exposure, and visual functional deficits?

Manuscript 2: What were the strategies by which theoretical models of human behavior were utilized to develop the KEYS educational curriculum for visually impaired older drivers? To what extent did this theory-based curriculum impact constructs, such as self-perceptions of vision impairment and motivation to self-regulate?

Manuscript 3: What is the efficacy of a theory-based educational intervention for visually impaired older drivers in translating perceptions and motivation into real-world driver performance outcomes (i.e., driving difficulty, performance of self-regulatory practices, avoidance of hazardous situations, and reduced driving exposure)?

SELF-PERCEPTIONS AND CURRENT PRACTICES OF HIGH-RISK OLDER DRIVERS: IMPLICATIONS FOR DRIVER SAFETY INTERVENTIONS

by

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ABSTRACT

Many older drivers with visual problems meet the legal requirements for licensing despite having functional impairments that elevate crash risk. In a sample of visually impaired older drivers, over half believed that their vision was not likely to cause them to crash. Eighty percent acknowledged they would feel more protected against crashing if they avoided certain driving situations. However, 75% of the sample reported never or rarely avoiding such situations (e.g., left-turns, interstate highways). Almost 70% of drivers reported high self-efficacy in their ability to self-regulate and use alternative strategies. These data imply that behavioral interventions promoting compensatory strategies of self-regulation may be useful in maintaining mobility while improving the safety of high-risk older drivers. These findings serve as baseline for our ongoing study evaluating whether an educational intervention will increase self-regulation and improve older driver safety.

INTRODUCTION

Driving is important to the mobility of older adults with almost 90% relying on the private automobile for the majority of their transportation needs (Martinez, 1995). Older adults represent the most rapidly growing segment of the driving population in the United States in both the total number of drivers and the total number of miles driven per year (Massie, Green & Campbell, 1997; National Highway Traffic Safety Administration, 1989; Owsley, 1997; Retchin & Annapole, 1993). It is expected by the year 2024 that one in four drivers will be over the age of 65 years (Transportation Research Board, 1988). However, adverse outcomes associated with driving, such as crashes, injury, and death, in this population have become a significant public health concern. Older adults have a higher crash involvement rate per mile driven than all other age groups, except drivers under the age of 25 years old (Transportation Research Board, 1988). Concern is further elevated for this population as older drivers involved in a crash are more likely than younger drivers to be seriously injured or killed (Evans, 1991; National Highway Traffic Safety Administration, 1993).

The increased risk for crash involvement among older drivers is thought to be attributed to age-related declines in performance capabilities. Older adults experience a higher prevalence of visual and cognitive impairments that can hinder the ability to safely operate a motor vehicle (National Highway Traffic Safety Administration, 1993; Owsley & Sloane, 1990). Driving relies on sensory function, the ability to visually process multiple environmental stimuli, and the cognitive capacity to draw correct inferences from incoming information in order to formulate the appropriate response (Ball, Roenker & Bruni, 1990; McCloskey, Koepsell, Wolf, & Buchner, 1994; Owsley & Sloane, 1990). Age-related declines in visual and cognitive abilities have been linked to crash involvement (Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Cooper, Tallman, Tuokko, & Beattie, 1993; Goode, et al., 1998; Johnson & Keltner, 1983; Kline, 1986; Owsley, Ball, Sloane, Roenker, & Bruni, 1991). Specifically, those older drivers with visual processing deficits were more likely to be involved in future crashes (Owsley, et al., 1998). Driving cessation can significantly reduce the personal mobility of older adults. Therefore, it has become increasingly important to develop interventions that will reduce the crash risk of older drivers and enhance public safety without restricting individual mobility.

Crash Prevention Among Older Drivers

Motor vehicle collisions have often been referred to as "accidents," a misnomer that suggests crash events happen without cause. In fact, adverse motor vehicle events can be attributed to specific human actions and physical events (W.C. Klein & Bloom, 1997). Therefore, crashes may be prevented if human actions could be modified. Prevention of motor vehicle collisions in the older adult population traditionally occurs at three levels: primary, secondary, and tertiary. At the tertiary level, health professionals are concerned with the medical treatment of the older driver after a crash has occurred in order to prevent chronic disability and return the older patient to independent living (Mandavia & Newton, 1998; Schwab & Kauder, 1992). At the secondary level, the human factors of roadway and automobile design are targeted in order to protect the occupants during a crash and reduce the severity of injury (Evans, 1991). Primary prevention efforts target the specific operator behaviors that cause crashes with the overall goal of preventing crashes a priori.

When primary prevention is mentioned in the context of health promotion, thoughts typically gravitate toward lifestyle behaviors, such as nutrition, exercise, or smoking cessation, in attempts to prevent disease. However, health promotion encompasses a wide variety of interventions on multiple levels designed to facilitate behavioral changes conducive to health (Minkler, 1984). Health-protective behavior is a distinct component of health promotion in that it focuses on protecting current healthy states through the avoidance of specific hazards that could produce harm to an individual (Harris & Guten, 1979; Walker, Volkan, Sechrist, & Pender, 1988; Weinstein, 1993, 1987). The protective behavior of self-regulation requires the individual to avoid the hazards of dangerous driving situations in order to protect against potential harm resulting from crash involvement. Thus, the promotion of health-protective behaviors can serve as a mechanism of primary prevention of motor vehicle crashes.

The efficacy of health protection programs among older adult populations has been debated in the literature (Branch & Jette, 1984; Omenn, 1990; Schweitzer, et al., 1994). However, many research studies have demonstrated that older adults do benefit from health promotion initiatives by learning to make positive lifestyle changes late in life that protect their health status (Best & Cameron, 1986; Higgins, 1989; Orlandi, 1987). Even in the presence of chronic illness, research has indicated that education can improve physiologic conditions to the point of reducing risk (Rowe & Kahn, 1998). In a study by Clark, Janz, Dodge, and Sharpe (1992) older adults with heart disease learned to better react to physical symptoms that protect them against a heart attack. Similarly, Wagner and colleagues (1994) found that older adults learned to prevent future falls through the practice of preventive strategies. These studies demonstrate that individuals maintain their interest as well as the capacity to learn new ways of protecting their health status throughout the life span.

Intervention Rationale

Of all age groups, drivers over 50 years of age had the most misconceptions regarding their risk of having a collision (Evans, 1991). License revocation may be the only option for those older drivers with severe, irreversible functional impairments. However, many older drivers meet the legal requirements for licensing and still have visual deficits that elevate crash risk. Thus, this study is based on several key concepts.

There is evidence that those who are unaware of their own limitations often fail to take preventive action, which can place them at higher risk for crash involvement (Martinez, 1995). There is also support for the opposite finding that drivers who are aware of their visual deficits will compensate for their impairments by modifying their driving behaviors (Ball, et al., 1998; Owsley et al., 1991; Owsley, Stalvey, Wells, & Sloane, 1999; Schlag, 1993). Some older drivers may not experience significant visual or cognitive limitations, and not all older drivers are unsafe on the road. But with driver behavior as the primary factor in 94% of crashes (Evans, 1996), those who do experience impaired capabilities that hinder safe operation of a motor vehicle pose a substantially greater threat to public safety than other drivers. Therefore, the purpose of this paper is to examine the extent to which high-risk older drivers are aware of their visual impairment, the self-regulatory practices, if any, they currently perform, and the perceptions older adults have regarding driving behavior change. The results reported here will serve as a baseline for an intervention study that evaluates whether education promoting self-awareness and self-regulation among high-risk older drivers will change driving behavior and improve safety.

METHODS

Subjects

Drivers over 65 years of age who were legally licensed to drive in the state of Alabama and who had been involved in a crash in the prior year were identified through the Alabama Department of Public Safety, the state agency in charge of compiling crash records. High-risk older drivers included in this sample were defined as those who had visual acuity or visual processing deficits or both, a high level of driving exposure, and a history of crash involvement. Visual deficits were defined as having either visual acuity between 20/30 and 20/70, the state's legal limit for licensure, or visual processing impairment of 40% or greater reduction in useful field of view (Ball et al., 1990; Owsley et al., 1998). With respect to driving exposure, participants were required to be current drivers who drove on average 5 to 7 days or 100 miles or more each week or both. A history of crash involvement was defined as being the driver in at least one crash reported to the state in the prior year. Individuals with a Mini-Mental Status Examination (MMSE) score less than 23 were not included in the study.

All crash-involved drivers living in the Birmingham Metropolitan area (i.e., Jefferson County and surrounding counties) were contacted first by letter, which was followed by a telephone call. Individuals who met the inclusion criteria for age, driving status, and driving exposure in the telephone interview were invited to visit the Clinical Research Unit in the Department of Ophthalmology at the University of Alabama at Birmingham for further evaluation of eligibility. Those who refused were asked to answer a few questions about their health and vision functioning. This information allowed us to examine selection bias on key variables. The study protocol was approved by the Institutional Review Board for Human Use at the University of Alabama at Birmingham.

Protocol

After the purpose of the study was explained, each subject was asked to sign a document of informed consent before being enrolled in the study. Demographic data were confirmed through interview including birth date, race, gender, and contact information. The protocol was divided into two parts, visual functional assessment and questionnaires, both of which were examiner-administered.

Visual acuity impairment was measured by the ETDRS letter chart (Ferris, Kassoff, Bresnick, & Bailey, 1982). Visual processing impairment was measured by the Visual Attention Analyzer (Ball & Owsley, 1993), which provides a composite useful field of view score. Higher percent reduction in useful field of view indicates slower speed of visual processing and impaired attentional skills. All visual performance measurements were made while subjects wore their habitual optical correction, the correction they typically wore while driving.

Driving behavior was measured by the Driving Habits Questionnaire (DHQ) (Owsley et al., 1999), which provides information on driving exposure, driving space, and driving avoidance. This measure was used to calculate eligibility and also served as an outcome measure in this study. Driving exposure was measured by asking subjects to report the average number of days driven per week and where they drive in a typical week. A detailed assessment of the number of places traveled to, number of trips made, and the total number of miles driven in a typical week was conducted. The detailed assessment of places, trips, and mileage provided in the DHQ makes notable improvements to traditional open-ended exposure questions and allows investigators to be more confident in the accuracy of the data obtained. Driving space refers to the distance subjects typically drive into their environment away from their home base over the past year (e.g., within the neighborhood, neighboring towns, more distant towns, outside the state). Subjects answered 1 (Yes) or 0 (No) as to whether they had driven to the designated region in the past year. A summary score of driving space is computed by summing scores across all items (0 to 6) where higher scores indicate a larger driving space. Driving avoidance was measured by asking subjects to report the extent to which they purposely avoided driving situations that place the greatest demand on visual processing abilities. In a supplement to the DHQ, subjects were asked if they avoided one of eight driving situations during the past 3 months (i.e., rain, alone, left turns, rush hour, high traffic, interstates, parallel parking, night) and if so, how often they avoided these situations on a 5-point scale: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), or 5 (always).

Mental status was evaluated by the MMSE (Folstein, Folstein, & McHugh, 1975), a brief mental status test frequently used in clinical and research settings. This 10-min screening test provides a composite score of cognitive function that reflects performance in domains such as orientation, memory, attention, language, commands, spatial ability, and drawing. Composite scores range from 0 to 30, with higher scores representing higher functioning.

General health and depressive symptomology were also measured because these constructs have been known to affect older adults' performances of instrumental activities of daily living such as driving (National Highway Traffic Safety Administration, 1989). This information is included to enable the further characterization of this sample of older drivers. General health was assessed by asking subjects if they have problems in 17 areas (e.g., heart, cancer, diabetes, stroke), and, if so, to what extent they are bothered by the condition on a 3-point scale of 1 (not bothered at all), 2 (bothered a little), or 3 (bothered a great deal). This instrument was derived from one used in a prior study on eye disease and quality of life (Steinberg et al., 1994). To generate a comorbidity index, each medical condition present was weighted by the "bothersome score" and all were summed. Lower numbers indicate fewer comorbid conditions.

The presence of depressive symptoms was assessed by the Center for Epidemiological Studies-Depression Scale (CES-D; Radloff & Teri, 1986). Patients were asked to rate 20 items based on how often they felt that way in the last week. Responses included "rarely or none of the time, some of the time, much of the time, or most or all of the time," which were scored from 0 to 3, respectively. Total scores ranged from 0 to 60 with a higher number indicating more depressive symptoms.

If individuals met the inclusion criteria following the in-clinic interview (i.e., visual function, driving exposure, and mental status), two additional questionnaires pertaining to vision and driving were administered. The National Eye Institute-Visual Function Questionnaire (NEI-VFQ-25; Mangione, Berry, et al., 1998; Mangione, Lee, et al., 1998) was administered to assess participants' awareness of their own visual impairments. This instrument was designed to measure vision-targeted health-related quality of life and to determine the nature of problems with vision-related functioning. This instrument has several subscales including general health, expectations, well-being and distress, ocular pain, general vision, near, distance, color, peripheral vision, driving, dependency, role limitations, and social factors. For the purposes of this analysis, results will be limited to the general vision subscale as a measure of participants' awareness of visual impairments.

The Driver Perceptions and Practices Questionnaire was developed as part of this study to further evaluate participants general knowledge and attitudes toward vision and driving across several domains. This questionnaire is based on prior research and theoretical models of health behavior change established in the literature. The instrument measures the following domains: impact of vision on driving, general driving knowledge, concern for health and safety (Harris & Guten, 1979), attitudes toward driving and crash prevention (Seibrecht, 1941), the perceived severity of a crash (Given & Given, 1983), susceptibility toward crash involvement (Prochaska, DiClemente, Velicer, Ginpil, & Norcross, 1985; Robertson, 1977), benefits and barriers to the performance of self-regulatory practices (Grimley, Riley, Bellis, & Prochaska, 1993; Rosenstock, 1990), the performance of self-regulatory strategies (Sandra Rosenbloom, personal communication, 1998), helping relationships (Zimmerman & Conner, 1989), regulatory self-efficacy (Grembowski et al., 1993; R. Kelly, Zyzanski & Alemagno, 1991), and stage of change (Rollnick, Heather, Gold, & Hall, 1992). Questions were guided by these sources and were then modified to address the specific behavior of driver self-regulation targeted in this study. The final questionnaire including all items, and responses are provided in the Appendix. This measure was administered at the initial visit to the clinic in order to determine baseline perceptions and practices. The questionnaire will be administered a second time 6 months following participation in the educational intervention to evaluate the effectiveness of the educational program. To answer the research questions addressed here, results will be limited to the following domains evaluated at baseline: impact of vision on driving, concern for health and safety, attitudes toward driving and crash prevention, the perceived severity of a crash, susceptibility toward crash involvement, benefits and barriers to performing self-regulatory practices, the performance of self-regulatory strategies, and regulatory self-efficacy.

Data Analysis

Visual characteristics and driving habits of the sample were described using measures of central tendency. The mean, the range expressed as minimum and maximum values, and standard deviation were reported. Trends in driving perceptions and practices were examined by calculating the percentage of the sample choosing a given response to an item. Difference of proportion and chi-square analysis were used to test whether the observed results were different than what would be expected by chance ($\alpha = 0.05$; two-tailed).

RESULTS

Sample Characteristics

Subjects in this study ($N = 402$) were an average of 74 years of age ($SD = 6$) and were 23% African American and 77% White. The sample was 69% male and 31% female. Although there is a higher percentage of males in this sample, the distribution is consistent with the population of crash-involved drivers from which they were recruited where males have higher rates of crash involvement than females (National Highway Traffic Safety Administration, 1995). Eighteen percent of our subjects had both visual acuity impairment (between 20/30 and 20/60) and visual processing impairment ($\geq$ 40% reduction in useful field of view). Seven percent had visual acuity impairment and no visual processing deficits. Seventy-five percent had slowed visual processing speed and visual attention deficits with visual acuity better than 20/30. Drivers had a high amount of driving exposure ($M = 6.4$, $SD = 0.91$ days each week; $M = 252$, $SD = 319$ miles each week) and had good mental status (M = 27.3, SD = 1.8). Overall, subjects were in good health (M = 6.5, SD = 4.5) and reported few depressive symptoms (M = 6.7, SD = 5.8).

Driving exposure. In addition to days and miles driven each week, subjects reported traveling to an average of six places (SD = 1.8) and making an average of 16 trips (SD = 9.2) each week. The extent to which subjects avoided eight specific driving situations (expressed as percentages of the total sample) is presented in Figure 1. Notice that the percentage bars are highest on the left-hand side of each graph, which represent approximately 75% of drivers in this sample who reported never or rarely avoiding challenging driving situations (i.e., left turns, interstates, rain, high traffic). The intervention designed for future evaluation in this sample utilizes educational techniques to move older drivers to the right of the graph in the direction of self-regulation.

Vision impairment. Ninety-one percent of the sample agreed that the eyes can change enough as one grows older to affect the ability to drive, and 89% of subjects believed that individuals would be able to notice when their vision changes. Yet, almost 70% of older drivers in this sample rated their vision as excellent or good (see Figure 2) despite results of objective visual acuity and visual processing tests that identified performance impairment.

Driver perceptions and practices. Table 1 displays results for the Driver Perceptions and Practices items. Results were evaluated using difference of proportion and chi-square analysis. With respect to subjects' concerns for health and safety, almost

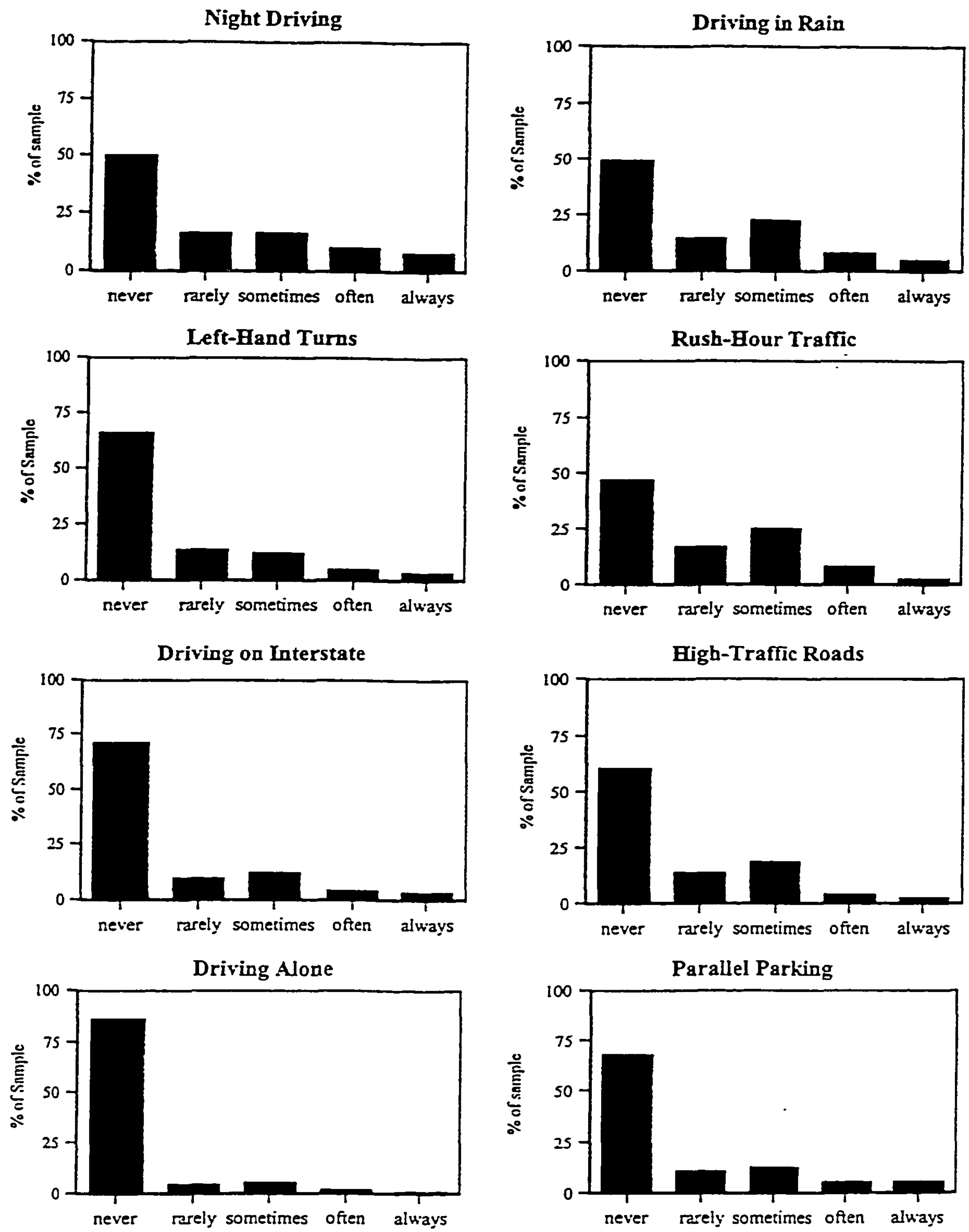

Figure 1. Frequency of situation avoidance.

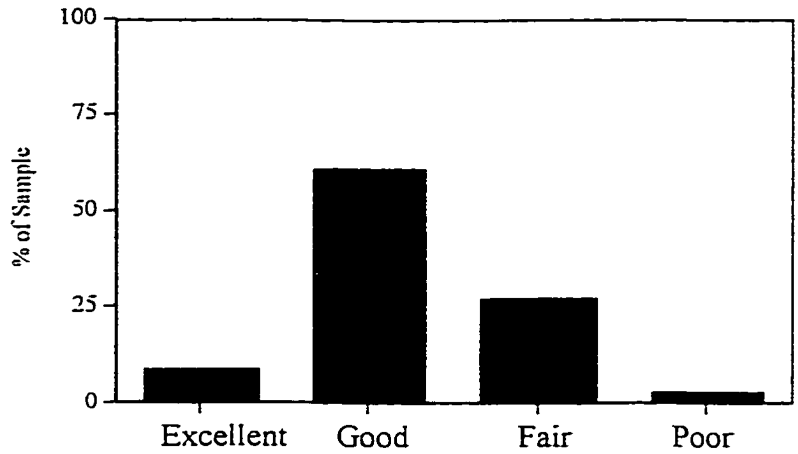

Figure 2. Self-rated eyesight.

all subjects considered good health important and indicated that it was important to actively take precautions that would improve their safety, with over half reporting always considering ways to improve their safety. Eighty-three percent of drivers held the attitude that some drivers should be denied the right to drive. With respect to crashes, 88% of drivers in this sample felt that drivers should be concerned with preventing crashes, and 76% felt that crashes were not due to chance and could in fact be avoided. Sixty-six percent felt that chances of having a crash were the same regardless of time or situation. Sixty-one percent of drivers in this sample did not want to plan when or where they drove, and 63% wanted to be able to get in the car and go somewhere whenever they wanted. In terms of perceived difficulty, 82% did not perceive any problem and reported having no difficulty handling challenging driving situations. With respect to perceived severity, 99% of these drivers perceived that crashes were a very serious event, even when compared to other events such as falling and the like. Participants were split almost equally in their perceived susceptibility to crash as a result of vision impairment (49%

Table 1

Driver Perceptions and Practices

	% of sample	
Knowwldege of vision impairment	Agree	Disagree
Eyes can change enough to affect driving	91	9
Individual will notice when vision changes	89	11
Concern for health and safety	Important	Not important
Good health is important to me	99	1
I feel it is important to take safety precautions	99	1
	Always	Not always
I think of ways to improve my safety	53	47
Attitudes toward driving	True	False
No person should be denied the right to drive	17	83
Should not be concerned with preventing crashes	12	88
Crashes should be regarded as unavoidable	24	76
It does not matter when or where you drive, chances of crash are same	34	66
I should not have to plan when and where I drive	39	61
I should be able to get in the car and go whenever	63	37
I do not have any difficulty handling situations	82	18
Perceived severity of crashes	Serious	Not serious
How serious is having a crash to you?	99	1
How serious is crash compared to other event?	99	1
Perceived susceptibility to crashes	Likely	Not likely
How likely to have crash due to vision?	49	51
Compared to others, how likely to have crash?	56	44
How likely to be in crash in challenging driving situations?	60	40
How likely to be injured if in a crash?	87	13
Perceived benefits	Agree	Disagree
Changing my driving habits could reduce chances of being in crash	67	33
Feel more protected against crash if I avoided challenging situations	80	20
Perceived barriers	Agree	Disagree
Changing where drive not possible, public transportation is not available	75	25
Changing where drive not possible, friends and family are unavailable	57	43
Changing where drive not possible given lifestyle and places I go	54	46
Changing where I drive is not possible, other people need me to drive	36	64

Likely versus 51% Not Likely), but when the respondent was asked to compare themselves to others of the same age with similar vision, a slightly higher number (56%) felt they were likely to be involved in a crash. This finding suggests that drivers may not be convinced that vision is the variable that impacts their own driving safety. Sixty percent felt it was likely for them to have a crash when driving in challenging driving situations, and 87% perceived they were likely to be injured if involved in a crash. These findings indicate that older drivers may feel more susceptible to injury than to crash involvement. Many older drivers acknowledged the benefits to self-regulatory behavior, with 67% admitting that changing their driving habits is an action that could reduce their chances of being in a crash, and 80% reporting they would feel more protected against crashing if they avoided certain challenging driving situations. However, barriers to self-regulatory behavior were reported, including lack of public transportation (75%), few relatives or friends who could drive (57%), lifestyle (54%), and others' dependence on them to drive (36%).

While Figure 1 displays the extent to which older drivers in this sample avoided driving situations, Table 2 lists the percentages of drivers who say they perform actual self-regulatory strategies (i.e., intentionally waiting until rain stopped before driving, making three right turns to avoid left). Notice that the lowest percentages are under the "often" category.

On average, over half the sample reported never or rarely practicing these specific maneuvers to avoid dangerous driving situations, yet the majority of older drivers reported confidence in their ability to do so, indicating high self-efficacy. When asked how hard it would be to use a specific self-regulatory strategy to avoid one of eight driving situations (e.g., night, rain, interstates, left turns), almost 70% of subjects indicated that it would not be hard at all to practice these strategies on a more frequent basis. Older drivers' levels of regulatory self-efficacy are displayed in Figure 3.

Table 2

Performance of Specific Self-Regulatory Strategies

Self-regulatory pactice	% of sample			
	Never	Rarely	Sometimes	Often
Wait until rain stopped before driving	18%	18%	45%	19%
Ask someone to ride to avoid driving alone	32%	32%	29%	7%
Look for open lot to avoid parallel parking	37%	24%	26%	13%
Make three right turns instead of left turn	50%	26%	20%	4%
Find alternate route to avoid interstate	43%	21%	28%	4%
Plan routes to avoid high traffic areas	22%	15%	45%	18%
Schedule trips to avoid rush-hour	46%	20%	27%	7%
Schedule events in day to avoid night	23%	13%	35%	29%

DISCUSSION

The purpose of this analysis was to examine the extent to which older drivers were aware of their visual impairments, the self-regulatory practices, if any, they currently perform, and the perceptions older adults have regarding driving behavior changes. Prior research has demonstrated that those who do not recognize their own vision impairments are more likely to continue poor driving habits, whereas those who do acknowledge their vision impairments tend to modify and adjust their driving (Ball et al., 1998). Older drivers in this sample appear to fall in the first group. All subjects were visually impaired, yet the majority did not acknowledge their own limitations and the impact it has on driving safety despite beliefs that they would notice when such changes occurred.

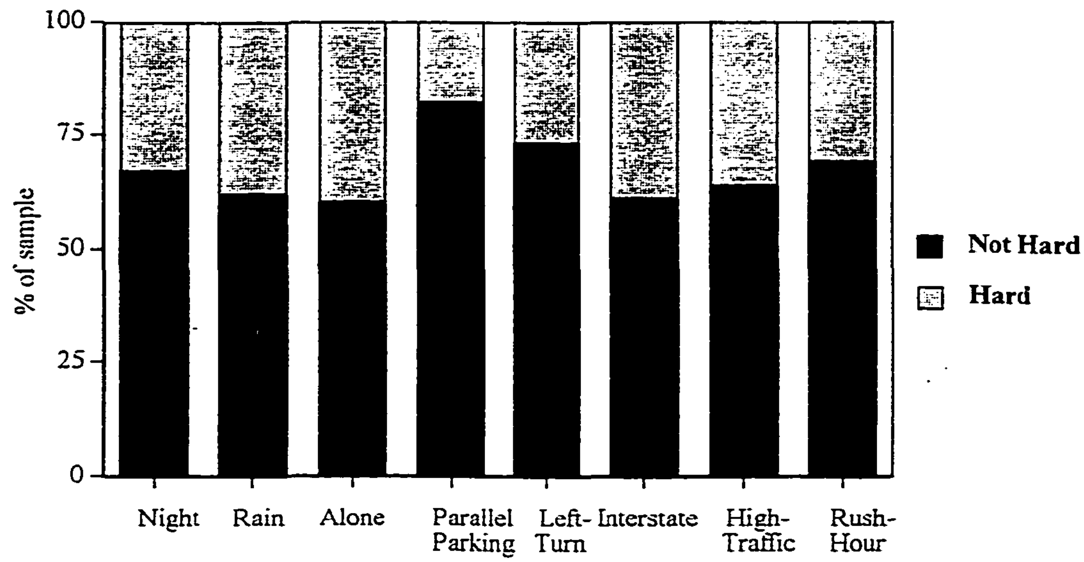

Figure 3. Regulatory self-efficacy.

There is evidence from prior research that self-reported visual function and performance-based measures are correlated (B. E. Klein, Klein, Lee, &Cruichshanks, 1999), suggesting that older drivers in this sample may lack the skills need to recognize functional limitations. The next phase of this project will focus on the evaluation of an educational program designed to promote these behavioral skills.

A substantial number of crashes could be prevented, yet the actions necessary to avoid crashes were not typically performed by this group. Over three fourths of these high-risk older drivers did not self-regulate by avoiding driving situations that place the greatest demand on visual processing abilities, and the majority rarely performed specific alternative driving strategies. Yet, despite their lack of performance, the majority felt that self-regulation would protect them from crash involvement, and most were confident in their abilities to perform alternative driving strategies in order to avoid high-risk driving situations on a regular basis.

According to theoretical models of behavior (Bandura, 1986; Rosenstock, 1990; Schwarzer, 1992), these high-risk older drivers possessed characteristics that indicate they are poised and ready to make driving behavior changes. These older adults were concerned about their health and perceived the importance of taking safety precautions, they believed that crashes can be prevented, and they believed that crashes are more likely to occur in certain driving situations. Yet despite these perceptions, these drivers took no action to protect themselves from the adverse outcomes of crash involvement. Most older drivers in this study did not perform self-regulatory actions on a regular basis yet had high self-efficacy in their ability to do so.

Self-efficacy refers to the beliefs and expectations about one's ability to perform actions that will influence the environment (Mischel, Cantor, & Feldman, 1996). This judgment will help to determine when, where, and how one will try to exert self-regulatory behaviors. According to these theoretical constructs, older drivers, such as those in our sample, who are confident in their abilities to perform compensatory strategies will be more likely to attempt the performance of protective behaviors. Interventions intended to promote the construct of self-efficacy have been effective in changing behavior across a variety of health domains (Schwarzer, 1992) and have been found to be highly predictive of persistence and performance of various tasks (Lent & Hacket, 1987; Meichenbaum & Smart 1971; Schunk, 1989; Stretcher, Devillis, Becker, & Rosenstock, 1986). In one behavioral intervention targeting community-dwelling older adults, self-efficacy was found to be protective against declines in functional status

(Mendes de Leon, Seeman, Baker, Richardson, & Tinetti, 1996). Because drivers in this sample reported such high regulatory self-efficacy, we can be optimistic regarding the likelihood they will modify their driving practices to protect against crash involvement.

Older adults in this sample do perceive the seriousness of crash involvement, yet they do not perceive themselves as susceptible. These results are consistent with prior research that some older drivers with visual deficits are less aware of their own limitations (Martinez, 1995) and may have misguided perceptions regarding their visual abilities and the impact they have on driving performance. The Health Belief Model (HBM; Rosenstock, 1990) emphasizes the importance of perceptions in the process of deciding to take health protective action. A perception is something that a person believes to be true, regardless of whether it is actually true. The HBM model postulates that individuals will engage in preventive behaviors if they perceive they are susceptible to the outcome and whether they believe the outcome will have serious consequences. Interventions targeting the constructs of the HBM have been effective in changing behavior in older adults. For example, a health education program targeting older adults was successful in increasing overall knowledge, perceptions of severity, and perceptions of susceptibility to AIDS (Rose, 1996). The HBM also stresses the importance of maximizing perceived benefits while minimizing perceived barriers in order to encourage preventive action. Most older drivers in this sample recognized the benefits of self-regulation yet cited several barriers to changing their driving habits. Thus, interventions that address these barriers are likely to be useful in promoting self-regulation strategies for safe driving.

Behavior theorists argue that self-regulation is the mechanism of choice when the goal is to bridge the gaps between one's intention to be safe on the road and the actions necessary to protect the individual from harm (Mischel et al., 1996). Self-regulation, the internal processes individuals utilize to control their behaviors, has been a primary focus of study in the field social behavior. Kelly (1955) argued that, while people may not be able to change events in the external environment, they always have the potential to construe or conceptualize them differently or to view events in a new way. According to self-regulation theory, an individual needs skills to scan and interpret the environment and to create alternative actions. Such skills will allow individuals to exert more control on an external situation and to reduce the stress of that event (Karoly, 1993). According to this theory, older drivers need skills to observe the driving environment differently and to create alternative actions. For example, older drivers must first recognize how visual processing impairment can hinder the ability to judge the speed and distance of oncoming vehicles in a left-hand turn situation. Older drivers can then create and practice alternative strategies, such as making three right turns around the next block in order to reduce the visual processing demands of the situation and subsequently avoid potential harm. Our future work will evaluate the extent to which an educational intervention is effective in promoting compensatory self-regulation strategies such as these.

The changes in longevity and the improved health status of the aging population over the past few decades have created more opportunities for prevention interventions at primary, secondary, and tertiary levels in the older adult population. Our efforts fall under the auspices of primary prevention, which is concerned with preventing predictable outcomes of crashing in order to protect existing states of health and functioning. The research on behavior theories, which define components of protective action, has evolved over time to create the body of knowledge that makes primary prevention in older adults achievable (Bloom, 1996; Klein & Bloom, 1997; Price, Cowen, Lorion, & Ramos-McKay, 1988). Our program promoting health protective behavior focuses on preventing crashes before they happen and not just the treatment after an adverse crash event has occurred. The theoretical constructs described here provide a framework for achieving our health education goals, which are to transfer the responsibility for driver safety from external sources (e.g., trauma care and vehicle design engineers) to the hands of the individual driver. In this case, responsibility translates into self-awareness of impairment and self-regulation of driving on the part of the high-risk older driver.

As the percentage of elders in our population increases, there will be more older drivers on the road who must compensate for diminished performance capabilities. Driving cessation can drastically reduce personal mobility and therefore should not be the only options for older drivers who experience age-related changes in performance capabilities. License revocation and loss of driving privileges may be the only safe option for those drivers with severe, irreversible functional impairments. Yet, many older drivers maintain their driving privileges while experiencing less severe age-related deficits that increase the risk of crash involvement. Thus, an intervention that promotes self-regulation and the use of compensatory strategies is one candidate mechanism to increase the safety of these drivers without significantly restricting their personal mobility. This strategy is important for improving the public health of this population as well as all other drivers on our roadways.

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Appendix

Driver Perceptions and Practices Questionnaire

Impact of Vision on Driving:

Responses (1-5): Acuity, Contrast Sensitivity, Depth Perception, Peripheral Vision, Visual Processing

1) Your ability to see small objects, details or patterns is:

2) Your ability to determine whether objects are closer to you than other objects is:

3) Your ability to detect the difference in black, white and shades of gray is:

4) Your ability to see objects when they are not straight in front of you is due to:

5) Your ability to identify and call the name of objects that you are looking at refers to:

6) Your eyes can change enough as you grow older to affect your ability to drive.

7) An individual will be able to notice when their vision changes.

Responses (6-7): Strongly Agree, Agree, Disagree, Strongly Disagree

General Driving Knowledge:

8) One of the greatest influences on having an accident is:

Responses: Poor condition of road (potholes), Lack of signs/directions for drivers, Individual driver error, Poor highway/intersection design, Lack of enforcement of traffic laws by police.

9) The fastest growing group of drivers in the United States is:

10) The only group of people to have an increase in the number of traffic fatalities in 10 years is:

Responses (9-10): Teenage drivers (16-25), Young adults (25-40), Middle age (40-65), Older (65+)

11) The most frequent accident involving a driver over age 65 occurs while:

Responses: driving alone, driving in the rain, making a left turn, driving at night

12) The average time required for reaction to driving hazards is approximately 2 seconds.

Responses: Strongly Agree, Agree, Disagree, Strongly Disagree

Concern for Health and Safety

13) All things considered, good health is important to me.

Responses: Very Important, Somewhat Important, Not Important

14) I think about ways to improve my safety.

Responses: Never, Rarely, Sometimes, Often, Always

15) I feel that it is important to take precautions that would improve my safety.

Responses: Very Important, Somewhat Important, Not Important

Attitudes Toward Driving

Responses: Strongly Agree, Agree, Disagree, Strongly Disagree

16) The drivers of automobiles are best qualified to judge their own physical fitness to drive cars.

17) No person should be denied the right to drive an automobile.

18) Every motorist should be required to pass a driving-skill test once in five years to continue to drive.

19) Drivers who take chances eventually become the expert drivers.

20) Persons with many years of driving should not be required to submit to examination in later years.

21) Because "things just happen" one should not be concerned with the prevention of accidents.

22) The occurrence of accidents is a matter of chance and should be regarded as unavoidable.

23) Possession of a drivers license is evidence of the ability of the individual to drive safely.

24) The sturdy construction of automobiles assures my safety at any speed.

25) It doesn't matter where you drive, chances of having an accident are the same.

26) I should not have to plan when and where I drive.

27) Changing the way I drive would take too much thought, I don't want to think about my driving.

28) I should just be able to get in the car and go somewhere whenever I feel like it.

<u>Perceived Severity</u>

Responses: Not Serious at all, Somewhat Serious, Very Serious

29) How serious is having a car accident to you?

30) How serious is having a car accident compared to another type of accident (i.e.,fall)?

<u>Perceived Susceptibility</u>

Responses: Not Likely, Somewhat Likely, Extremely Likely

31) How likely is it for you to have a car accident while driving because you have a vision impairment.

32) Compared to other people your age with your vision, how likely would are you to be in a crash?

33) How likely would it be to be in a crash when driving in challenging driving situations?

34) How likely are you to be injured if you are involved in a traffic accident?

Perceived Barriers

Responses: Strongly Agree, Agree, Disagree, Strongly Disagree

35) Changing where I drive is not possible given my lifestyle and the places I need to go.

36) Changing where I drive is not possible because of how I get from one place to another.

37) Changing when and where I drive is not possible because other people count on me to drive them.

38) Changing when and where I drive is not possible because public transportation is not available to me.

39) Changing when and where I drive is not possible because I don't want to use public transportation.

40) Changing when and where I drive is not possible because friends/family members are unavailable.

41) Changing when and where I drive is not possible because I don't want family/friends to drive.

Perceived Benefits

Responses: Strongly Agree, Agree, Disagree, Strongly Disagree

42) Changing my own driving habits is something that I could do to reduce chances of being in a crash.

43) I would feel more protected against having an accident if I avoided challenging driving situations.

44) Other friends/family members would feel more protected, safer if I avoided situations.

Current Self-Regulatory Practices

Responses: Would you (a-d): Never, Rarely, Sometimes, Often

45) You plan to go to Wal-Mart,when you get ready to leave, you notice that it is raining.

a) go out anyway, but drive very slowly b) ask someone else to drive you

c) wait until the rain shower stopped d) decide not to go out

46) You plan to run a few errands one afternoon but you are alone.

a) go out alone and drive very carefully b) ask someone else to drive you

c) ask someone else to ride with you d) decide not to go

47) You are going to shop for a birthday gift in row of shops. You need to park the car.

a) parallel park at a meter on the street b) ask someone else to drive you

c) look for a parking lot so you can pull in d) decide not to shop there

48) You reach an intersection and need to turn left. There is only a green light.

a) wait for a break in traffic and turn left b) have someone else to drive you

c) make right turns, go around the block d) decide not to turn left

49) You are invited to a friend's house for dinner but your friend lives on the south side of town The best way for you to get there is to drive on the interstate.

a) drive on the interstate b) ask someone else to drive you

c) find an alternate route d) decide not to go to dinner

50) You are invited to meet someone at the mall and there is a great deal of traffic.

a) stay in the right lane near the entrances b) ask someone else to drive you

c) choose a time that is the least congested and go d) decide not to go to the mall

51) You need to go to the grocery store but when you get ready to go, it is 4:30p.m.

a) go to your regular grocery store b) ask someone else to drive you

c) wait until after 6:00 to go to the store d) decide not to go to the store

52) You are invited to attend a club meeting, but it begins at 8 p.m.

a) drive yourself to the meeting b) ask someone else to drive you

c) try to attend a meeting scheduled during day d) decide not to go to the meeting

Helping Relationships

Responses: Strongly Agree, Agree, Disagree, Strongly Disagree

53) I would expect my family to support changes I made regarding where I drive.

54) I would expect my friends to support changes I made regarding where I drive.

Regulatory Self-Efficacy

Responses: Very Hard, Somewhat Hard, Not Hard at All

55) How hard would it be for you to drive during daylight hours instead of at night?

56) How hard would it be for you to do most of your driving when it is not raining?

57) How hard would it be for you to drive with someone in the car with you instead of driving alone?

58) How hard would it be for you to park in parking spaces instead of parallel parking?

59) How hard would it be for you to make right turns instead of left turns across traffic?

60) How hard would it be for you to do most of your driving on city streets or main roads instead of driving on the interstates or the expressway?

61) How hard would it be to drive on roads with little traffic instead of high traffic roads?

62) How hard would it be for you to drive at times other than rush-hour?

Stages of Change

Responses: Strongly Agree, Agree, Disagree, Strongly Disagree

63) I don't think I have any difficulty handling challenging driving situations.

64) I try to avoid certain situations when I drive.

65) I think I am a good driver, but I know there are situations that can be challenging.

66) Sometimes I think I should avoid certain driving situations.

67) It is a waste of time for me to think about which driving situations would be challenging.

68) I have just recently started avoiding challenging driving situations.

69) Other people talk about being a safe driver, but I am safe because I avoid challenging situations.

70) I am at the point where I should think about ways to avoid certain driving situations.

71) Some driving situations can be dangerous at times.

72) There is no need for me to think about my driving.

73) I avoid challenging driving situations now.

74) Avoiding certain driving situations would be pointless for me.

THE DEVELOPMENT OF A THEORY-BASED EDUCATIONAL INTERVENTION CURRICULUM TO PROMOTE SELF-REGULATION AMONG HIGH-RISK OLDER DRIVERS

by

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ABSTRACT

KEYS (Knowledge Enhances Your Safety) is an educational curriculum developed to address the unique needs of older drivers who maintain driving privileges while coping with visual functional limitations that increase the risk for crash involvement. The primary goal of the intervention is to promote driver safety through self-awareness of vision impairment and the adoption of self-regulatory behaviors. This paper discusses the theoretical framework of this intervention program and describes the development and implementation of the KEYS curriculum based on the tenants of the Social Cognitive Theory, Health Belief Model, Transtheoretical Model, Principles of Self-Regulation, and Regulatory Self-Efficacy. A baseline and 6-month posttest evaluation conducted to test the efficacy of education in terms of theoretical construct outcomes revealed that those who participated in the educational intervention increased their self-perceptions of vision impairment, perceived a greater number of benefits in the performance of self-regulatory behaviors, and exhibited more characteristics of the Preparation and Action/Maintenance stages of change. These findings indicate that high-risk older drivers can benefit from educational interventions that promote self-awareness and self-regulation of driving. Future work will evaluate the efficacy of the KEYS educational curriculum in promoting safety among high-risk older drivers in terms of reduced crash risk.

INTRODUCTION

Older adults, like most adults, rely on the personal automobile as the primary mode of transportation (National Highway Traffic Safety Administration, 1993), and, thus, driving cessation would severely reduce the personal mobility of these persons.

However, the adverse outcomes associated with driving, namely crashes, injury, and death, are disproportionately high among the older adult population (National Highway Traffic Safety Administration, 1995). Therefore, it has become increasingly important to develop interventions that provide older drivers with strategies to reduce harm and increase safety, while allowing them to maintain mobility in order to continue to perform activities necessary for daily living. Crash involvement among older adults has been directly linked to visual processing impairments (Johnson & Keltner, 1983; Kline, 1986; Owsley, Ball, Sloane, Roenker, & Bruni, 1991; Owsley & Sloane, 1990; Owsley, Ball et al., 1998). Many older drivers meet the legal requirements for licensing despite having visual deficits that elevate crash risk. However, with driver behavior as the predominant factor in over 90% of crashes (Evans, 1996), those who do experience impaired visual capabilities pose a substantial threat to public safety. These findings serve as the rationale for the development of an educational intervention for older drivers who are visually impaired yet legally licensed to drive and a priority driving population at high risk for crash involvement. The purpose of this paper is to describe the process of developing, implementing, and evaluating the efficacy of a theory-based intervention for high-risk older drivers. The ultimate goal of this intervention is to promote self-regulation as a mechanism to reduce crash risk and enhance public safety without significantly restricting personal mobility.

The educational intervention described here builds upon previous older driver education programs (AAA, 1998; Janke, 1994; McKnight, Simone, & Weidman, 1982; National Safety Council, 1997) by using a theoretical framework to motivate the programs' structure. To date, only two older driver education programs have been formally evaluated, and, in both cases, the outcome measures included knowledge gained, specifically, what facts the driver learned from participation in the educational program. Evaluating knowledge as a primary outcome has a great deal of face validity in that drivers who cite the correct information regarding driver safety and rules of the road may be expected to make safer maneuvers when behind the wheel. Both the AARP's 55-Alive Mature Driver program and the California Mature Driver Improvement program were successful in improving participants' knowledge of driving maneuvers and rules of the road (Janke, 1994; McKnight et al., 1982). Yet in the end, neither program was successful in demonstrating a reduction in the crash rate of program participants (Janke, 1994; McKnight et al., 1982). It may not be that these educational programs are actually ineffective, only that these programs failed to demonstrate an impact on the outcome of crash involvement, a distal outcome that lies at the end of a continuum of driving behavior. A driver may demonstrate an increase in the knowledge of safety maneuvers; however, safety outcomes, such as reduced crash rates, are not likely if such knowledge is not applied to daily driving behavior. A focus on knowledge and crash rates alone fails to account for the many other intermediate constructs outlined by theory known to play a significant role in the adoption of preventive behaviors (Bandura, 1977, 1982; Mischel, Cantor, & Feldman, 1996; J. C. Prochaska & DiClemente, 1992; I. M. Rosenstock, 1974). Thus, the purpose of this intervention evaluation is to examine the efficacy of an educational program in promoting change with respect to theoretical components which lie in the more intermediate level of the driving behavior continuum.

Intervention Goals and Objectives

KEYS (Knowledge Enhances Your Safety), developed for high-risk older drivers, is designed to not only promote the orientation with facts but also to also train drivers to utilize behavioral skills in translating acquired knowledge into real-world driving practices. Awareness of vision impairment, for example, is one construct known to play a key role in whether an individual engages in preventive actions (Martinez, 1995; Owsley et al., 1991; Schlag, 1993; Stutts, 1998). Furthermore, there is evidence that those who are aware of visual deficits will adopt self-regulatory driving practices (Ball et al., 1998; Owsley, Stalvey, Wells, & Sloane, 1999). The self-regulatory behaviors promoted in this intervention are the avoidance of situations where the risk of crash involvement is highest (i.e., driving at night, driving in the rain, making a left turn across oncoming traffic, driving in heavy traffic, driving on the interstate, driving in rush-hour traffic, and driving alone), all of which can present challenges to a driver both visually and strategically (National Highway Traffic Safety Administration, 1997; Owsley & McGwin, 1999; Owsley et al., 1999). There is further evidence that the avoidance of these driving situations in conjunction with reduced driving exposure may be effective in reducing crash risk (Hakamies-Blomqvist, 1993; Lefrancois & D'Amours, 1997). Therefore, the primary goals of this educational intervention are to promote awareness of visual impairment and the adoption of self-regulatory behaviors as a mechanism to prevent adverse driving outcomes in this high-risk population.

This intervention is unique in that it was designed to be delivered in a clinical setting in a one-on-one format, an alternative to the community classroom methods utilized in previous driver education initiatives. The eye clinic was chosen because vision problems are relatively prevalent among the elderly, and thus older adults frequently seek the services of eye clinics. The eye clinic, therefore, seemed a priori like a natural milieu for this intervention. The clinical setting also provides the opportunity for actual functional evaluations (e.g., acuity test) and carries with it the credibility of expert opinion (i.e., eye care specialists) that serves to strengthen the quality of the educational message. Because the level of vision impairment varies within each individual, the one-on-one format also facilitates the tailoring of the intervention to the needs of each person.

METHODS

Participants

High-risk older drivers included in this sample were defined as those age 60 years and older who were legally licensed to drive in the state of Alabama and had visual acuity or visual processing deficits or both, a high level of driving exposure, and a history of crash involvement. Visual deficits were defined as having either visual acuity between 20/30 and 20/60 (the legal limit for licensure in Alabama; Ferris, Kassoff, Bresnick, & Bailey, 1982) or visual processing impairment of 40% or greater reduction in useful field of view (Ball & Owsley, 1992). With respect to driving exposure, participants were required to be current drivers who drove on average 5 to 7 days or 100 miles or more each week. A history of crash involvement was defined as being the driver in at least one crash reported to the state in the prior year as identified through the Alabama Department of Public Safety, the state agency in charge of compiling crash records. Individuals with a Mini Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) score less than 23 were not included in the study.

Protocol

All crash-involved drivers living in the Birmingham metropolitan area (i.e., Jefferson County and surrounding counties) were contacted first by letter, which was followed by a telephone call. Individuals who met the inclusion criteria for age, driving status, and driving exposure in the telephone interview were invited to visit the Clinical Research Unit in the Department of Ophthalmology at the University of Alabama at Birmingham for further evaluation of eligibility (e.g., the presence of visual deficits and mental status). The study protocol was approved by the Institutional Review Board for Human Use at the University of Alabama at Birmingham. After the purpose of the study was explained, each subject who met the inclusion criteria was asked to sign a document of informed consent before being enrolled in the study.

Design

This study had an experimental design with participants randomly assigned to one of two groups: (a) a usual care control group or (b) a usual care plus educational intervention group. All participants received usual care, which consisted of a comprehensive examination by an optometrist. As part of usual care, the eye care specialist discussed the impact of any diagnosed visual impairment on the activities of daily living, such as driving, as he or she normally would during any clinical visit. Potential participants whose vision impairment could be reversed through treatment (e.g., refractive error correction) were not enrolled in the study. After usual care, those randomized to the intervention group participated in two educational sessions, which included an initial 2-hr visit, followed by a "booster" session 1 month later.

Curriculum Development: Selection of Theoretical Framework

The inclusion of theory cannot ensure intervention success; however, theoretical models furnish a conceptual foundation which serves to (a) provide insight into how program information should be communicated to participants and (b) outline a relationship between constructs in order to facilitate an understanding of how program components should interact to promote behavior change (Kohler, Grimley, & Reynolds, 1999). Because there is no indication that previously described older driver education programs were motivated by established theoretical models in program development or evaluation, there were no precedents to follow in this study. A detailed discussion of the health education theories relevant to this study is beyond the scope of this paper. However, the following descriptions are included to provide a brief overview of the chosen theoretical framework and to facilitate a discussion of the process by which theory is translated into practice.

Behavior change occurs as a result of both the acquisition of knowledge and the adoption of a new behavior (Bandura, 1986b). Prior research has demonstrated that older drivers can acquire knowledge (Janke, 1994; McKnight et al., 1982), yet less is known about the process of translating knowledge into the adoption of new safe driving behaviors. This intervention is developed according to the Social Cognitive Theory (SCT; Bandura, 1977, 1986b; Kohler et al., 1999), which states that the adoption of new behaviors depends on (a) motivational conditions, (b) self-regulatory skills, (c) the confidence in one's ability to perform the behavior, and (d) prerequisite knowledge and skills. The theoretical framework for this intervention is depicted in Figure 1.

Motivational conditions. Motivational conditions refer to the emotions and impulses that stimulate an individual to engage in a given action and is said to be guided by health beliefs (Ferrini, Edelstein, & Barrett-Conner, 1994; R. Kelly, Zyzanski, & Alemagno, 1991; Kirscht, 1974; Strain, 1991;). The Health Belief Model (HBM) (I. Rosenstock, 1960; I. M. Rosenstock, 1974, 1990) postulates that individuals will engage in preventive behaviors if they perceive a threat (i.e., they feel susceptible to the outcome and believe the outcome will have serious, life-threatening consequences). The HBM also postulates that an individual must perceive that there are benefits to engaging in a particular behavior and that these benefits outweigh any perceived barriers to the completion of these actions. Research has consistently demonstrated significant relationships between the HBM constructs and preventive behaviors (Fulton et al., 1991; Janz & Becker, 1984; Kirscht, 1974), and educational interventions have been effective in changing perceptions of older adults with respect to these constructs (Rose, 1996).

The Transtheoretical Model (TTM; J. O. Prochaska, DiClemente, & Norcross, 1992; J. O. Prochaska, DiClemente, Velicer, Ginpil, & Norcross, 1985) postulates that individuals can be differentiated into five levels of motivation or readiness to engage in new behaviors: (a) precontemplation, in which the individual is not considering the adoption of a new behavior in the distal future; (b) contemplation, in which the individual begins to consider the process of adopting the behavior in the near future; (c) preparation, in which the individual experiments with the new behavior for adoption in the immediate future; (d) action, in which the individual actually performs the new behavior on a routine basis; and (e) maintenance, in which the individual continues the performance of the new behavior, typically for at least 6 months (J. O. Prochaska et al., 1992). This model has a

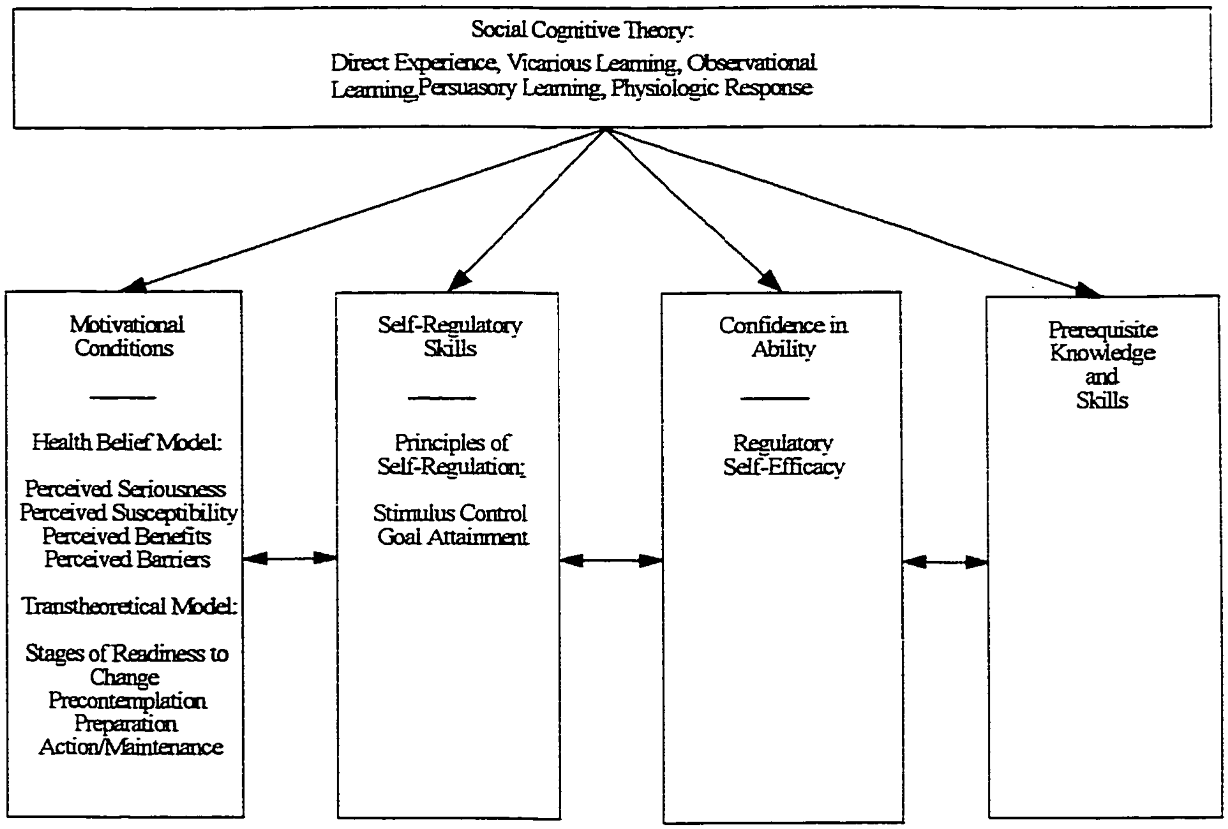

Figure 1. Theoretical framework.

great deal of utility in the delivery of an individualized intervention. For example, researchers in one study found that self-help manuals that matched individuals' current levels of readiness were instrumental in moving individuals toward the Action and Maintenance of smoking cessation at a faster rate (Pallonen, Leskinen, Prochaska, Kaariainen, & Salonen, 1994).

Self-regulatory skills. Self-regulatory skills refer to the ability of the individual to refrain from a negative behavior and to engage a new behavior (Bandura, 1977, 1986b) using the internal resources of the "self" (G. A. Kelly, 1955; Mischel et al., 1996; Tobin, Reynolds, Holroyd, & Creer, 1986). The primary source of regulatory skills is the individual's own set of personal goals (Maes & Gebhardt, 2000; Mischel et al., 1996). The operative word is personal in that each goal for safety is set according to the level of importance to the individual, the perceived level of difficulty in achieving the goal, and the perceived length of time it would take the individual to successfully attain the goal (Maes & Gebhardt, 2000). Research has demonstrated that setting goals for risk reduction can be effective in changing behavior (Alexy, 1984; Dubbert & Wilson, 1984; Maes & Gebhardt, 2000; Mayer et al., 1994). Therefore, the role of education is to assist the driver in goal setting and to promote methods to monitor progress toward goal attainment.

Regulatory self-efficacy. Regulatory self-efficacy refers to the individuals' perceived levels of confidence in their abilities to refrain from the practice of unsafe behaviors and to engage in the practice of new safe behaviors consistently over time

(Bandura, 1982, 1986a, 1996; Mischel et al., 1996). Interventions intended to promote self-efficacy have been effective in the achievement of behavior change goals across a variety of health domains (Schwarzer, 1992) and have been found to be highly predictive of persistence and performance of a given action (Lent & Hacket, 1987; Meichenbaum & Schunk, 1989; Smart, 1971; Strecher, DeVillis, Becker, & Rosenstock, 1986). Therefore a key goal of education is to promote the individuals' perceived levels of confidence in their abilities to achieve self-regulatory goals.

Prerequisite knowledge and skills. Prerequisite knowledge and skills, also named "behavioral capabilities" in the SCT, refers to the current level of knowledge and skill that the individual has at the time of the educational session (Bandura, 1977, 1986b). Educational programs delivered to older drivers must account for the existing understanding and abilities of the individuals to conduct the driving tasks resulting from their veteran driver status.

Implementation: Application of Theoretical Framework

Guided by the theoretical constructs described above, the KEYS curriculum is divided into three main components: (a) an informational component outlining the risks and benefits to motivate the individual, (b) a skill-building component to promote the adoption of self-regulatory behaviors, and (c) a confidence-building component to facilitate the maintenance of self-regulation (Bandura, 1977). The intervention was delivered in two educational sessions which occurred approximately 1 month apart. The education was delivered to each driver in a one-on-one session with a health educator (BTS).

Informational component. The first session began with a discussion of the participants' eye examinations received prior to enrollment. This action falls under the SCT category of persuasory learning techniques where the individual is provided with specialized information from an expert (Bandura, 1986b), in this case, information previously provided by the eye care specialist and now reviewed again by the health educator. The educator discussed visual acuity, eye disease and functional ramifications if detected, and treatment recommendations as indicated on the examination report. The primary purpose of providing information was to increase self-awareness of vision impairment and the impact the impairment can have on driving ability. Slide photographs were presented to aid in the communication of vision-specific information. Definitions of acuity, contrast sensitivity, depth perception, peripheral vision, and visual processing were discussed because they are commonly affected by age-related changes and are among the most essential visual components in the driving task (Owsley, Ball, et al., 1998; Owsley, McGwin, & Ball, 1998; Owsley & McGwin, 1999; Owsley & Sloane, 1990). Under the guidance of the HBM (Rosenstock, 1990), each definition was followed by a description of the mechanisms by which impairment can increase susceptibility to crash involvement. For example, a diagram of the eye was shown to demonstrate the mechanism by which an impairment (i.e., cataract) can hinder visual abilities (i.e., clouding of the lens which blocks light and leads to blurred vision) and lead to crash involvement (i.e., does not see stop sign at intersection and hits another car). The educator again followed the tenants of the SCT (Bandura, 1986b) by prompting drivers to infer knowledge from direct experiences that pertain to vision and driving. When discussing peripheral vision (i.e., side vision), for example, the driver was asked to infer knowledge from direct experiences, such as cars suddenly appearing from the side. The educator utilized strategies to deliver the message according to the motivational levels outlined by the TTM (J. Prochaska, 1991), where those in earlier stages benefit most from awareness and those in later stages who have a prerequisite recognition of their vision impairment benefit most from reinforcement.

After visual terms were discussed, the driver was given the opportunity to take an actual visual function test (acuity or visual processing). Because all participants had some level of vision impairment prior to enrollment, all performed poorly when tested. This action served to further promote awareness of the level of vision impairment to the high-risk older driver.

Skill-building component. After conveying information on vision impairment and its impact on driving ability, the education shifted to promote the skills needed to translate acquired information into real-world driving practices. According to the Principles of Self-Regulation, skills are needed to first evaluate a situation in terms of whether it is dangerous or safe (Maes & Gebhardt, 2000; Mischel et al., 1996). If the situation is evaluated as dangerous, the driver must then have skills to identify strategies and to engage in actions to avoid the dangers of the situation. Drivers were presented with photos of seven specific driving scenes (night, rain, intersections, interstates, rush hour, heavy traffic, alone) known for their high incidence of crashes and visually challenging characteristics (National Highway Traffic Safety Administration, 1995; Owsley & McGwin, 1999). For each slide presented, drivers were asked to evaluate the scene and identify the potential dangers of the situation in terms of visual risk factors (i.e., low light at night), road design (i.e., two lanes of oncoming traffic at a left turn intersection), and other traffic hazards (i.e., cars pulling out from side streets). Following the evaluation of each scene, the driver was then asked to identify specific self-regulatory maneuvers that can be used to avoid the dangers identified. Each driver was encouraged to list all potential self-regulatory strategies that came to mind relying primarily on direct experience and inferred knowledge from his or her own driving history (Bandura, 1986b). Slide photographs were utilized to facilitate skill building through observational learning as each participant reviewed photographs and observed the mechanisms by which the driver in the picture is avoiding a hazard (driving during daytime, waiting until rain stops, finding left-turn arrow or making three right turns around next block, driving on an alternate route instead of interstate, scheduling trips at times other than rush hour, using alternate routes to avoid heavily traveled routes, having others ride with them) (Bandura, 1986b). Identifying self-regulatory strategies is highly individualized according to the individuals' own personal driving goals (Mischel et al., 1996). Therefore, it was possible for a driver to identify strategies not presented in the collection of slide photographs. For each self-regulatory scenario, the driver was asked to identify perceived benefits and barriers to performing the compensatory driving strategy, and, when barriers were perceived, the driver was encouraged to entertain methods which would minimize the obstacle (Rubenstein, 1994).

<u>Confidence-building component.</u> The driver participating in this intervention may have acknowledged a vision impairment and may have been well-skilled in evaluating hazardous situations and determining self-regulatory strategies. However, if the driver did not have confidence in the ability to actually perform the self-regulatory practices outside the confines of the educational session, the adoption of a new behavior was not likely (Bandura, 1996). Efficacy can be built through verbal persuasion, direct experience, and vicarious experience (Bandura, 1977, 1982). Verbal persuasion from the educator and direct experience of the driver were utilized throughout the sessions. Vicarious experience also builds confidence as individuals learn through the experiences of others. This curriculum incorporated a peer testimony component to promote vicarious experience through a slide/tape program. Slide photographs of driving scenarios were presented simultaneously with an audio recording of older drivers (not actors) describing, in their own words, the process by which the decision was made to adopt self-regulatory practices (i.e., could not see the lines on the road at night and worried about other drivers' mistakes when it was raining). The benefits they have experienced and how barriers were successfully reduced were also discussed.

Since goal setting is a primary component of self-regulation (Mischel et al., 1996), each driver was asked at the end of the first session whether there were any compensatory strategies they felt a need to adopt. If so, the individual was asked to state the goal in hsi or her own words and to cite the personal benefits and potential barriers to achieving that goal. These goals were used to create a behavioral contract drawn up to formalize the drivers' intentions to adopt self-regulatory behaviors. The contract was signed by the individual as well as the educator which served to hold the individual accountable for completing their goals (Haber, 1993). Goal attainment is difficult to recognize if the individual fails to develop methods for self-evaluation (Maes & Gebhardt, 2000). Therefore, drivers were sent home with a travel diary to facilitate the process of self-monitoring. The diary allowed the driver to record the hazardous situations encountered and the self-regulatory practices performed each day, for a total of 7 days between Session 1 and Session 2. If the individual can recognize progress, such as reducing the number of nights driven each week, they may be more likely to stay on course to achieve the goals of traffic safety (Maes & Gebhardt, 2000; Mischel et al., 1996).

The second educational session served as a booster where behavioral goals were reviewed and drivers were assisted in ascertaining whether progress had been made toward those goals. Verbal reinforcement from the educator served as a mechanism to build confidence in their abilities to continue to self-regulate (Bandura, 1996; Maes & Gebhardt, 2000; Mischel et al., 1996).

Efficacy Evaluation

Questionnaire assessments were administered at baseline and again by telephone to both groups at 6 months following randomization. The Driver Perceptions and Practices Questionnaire (DPPQ) was developed as part of this study and contains items related to perceptions of vision and driving based on prior research and theoretical models of health behavior change established in the literature (Stalvey & Owsley, in press). The following seven theoretical domains were assessed: (a) self-perceptions of vision impairment and its impact on driving, (b) perceived threat of crash involvement (i.e., severity, susceptibility due to vision impairment and susceptibility due to the general nature of the driving task), (c) barriers to the performance of self-regulatory practices in terms of external sources (i.e., lack of public transportation), personal desire (i.e., do not want to use public transportation even if available), and dependence on others (i.e., do not have anyone else to drive), (d) benefits to the performance of self-regulatory practices, (e) level of readiness to adopt new behavior (i.e., Precontemplation, Preparation, and Action/Maintenance stages of change) and (f) regulatory self-efficacy. For the majority of items, respondents were asked to rate the extent to which they would agree or disagree with each statement based on a 4-point scale: 1 (strongly agree), 2 (mostly agree), 3 (mostly disagree), 4 (mostly disagree). For some items, participants were asked to rate the extent to which they believe the statement is true or false by choosing 1 (definitely true), 2 (mostly true), 3 (mostly false), 4 (definitely false). Subscales for all six domains were calculated by summing the response values across items in each scale with higher numbers indicating the desired response.

Data Analysis

Those who were assigned to the intervention group but did not elect to participate in the educational program (n = 20) were excluded from analysis. T tests and chi-square tests were used to examine pretest group equalization on continuous and categorical variables, respectively. For each of the educational outcome measures (self-perceptions of vision impairment, perceived threat of crash involvement [i.e., severity and susceptibility], barriers and benefits to the performance of self-regulatory practices, level of readiness to adopt new behavior, and regulatory self-efficacy), a change score was obtained by calculating the difference between subscale scores at pretest and at 6-month posttest. Differences were calculated so that positive change values indicated change in the desired direction (i.e., increase in perceived severity of vision impairment, increase in perceived threat of crash involvement, decrease in perceived barriers to self-regulation, increase in perceived benefits of self-regulation, increase in level of readiness (move closer to Action/Maintenance stage of change), and increase in regulatory self-efficacy. Parametric statistical tests (independent sample t tests) were utilized ($\alpha = 0.05$, two-tailed) to examine group differences because change variables were normally distributed.

RESULTS

Participants

Participants in this study ($N = 365$) had an average of 74 years of age ($SD = 6$) and were 23% African American and 77% White. The sample consisted of 69% male and 31% female subjects. The higher percentage of males in this sample is consistent with the population of crash-involved drivers from which they were recruited where males have higher rates of crash involvement than females (National Highway Traffic Safety Administration, 1995). Eighteen percent of our participants had both visual acuity impairment (between 20/30 and 20/60) and useful field of view impairment ($\geq$ 40% reduction in useful field of view). Seven percent had visual acuity impairment and no useful field of view deficit. Seventy-five percent had useful field of view deficit with visual acuity better than 20/30. Drivers had a high amount of driving exposure (M= 6.4; SD =0.9 days each week; M= 256; SD = 325 miles each week) and had good mental status (M=27.4; SD = 1.8). Demographic variables and inclusion criteria were compared across each randomization group; the distributions of each of these variables in the two groups were not different (Owsley, Stalvey, & Phillips, 2000).

Theoretical Constructs

Theoretical constructs were also examined to confirm the level of pretest equalization in the intervention and control groups. Table 1 shows that the intervention and control groups have similar distributions at baseline across all theoretical domains.

Table 1

Pretest Scores on Theoretical Construct Measures for Intervention and Control Groups

Theoretical construct measure	Intervention group N = 194 Mean (SD)	Control group N = 171 Mean (SD)	t statistic[a]	Probability level
Self-perception of vision impairment	7.2 (1.06)	7.2 (1.2)	-0.54	0.95
Perceived threat				
Severity	5.7 (0.6)	5.7 (0.5)	-0.104	0.91
Susceptibility/vision	3.3 (1.2)	3.3 (1.2)	0.113	0.91
Susceptibility/general	3.8 (1.0)	3.8 (1.0)	0.101	0.92
Perceived barriers				
External sources	6.9 (2.3)	6.7 (2.1)	0.525	0.60
Personal desire	4.5 (1.6)	4.6 (1.5)	-0.136	0.89
Dependency on others	5.1 (1.4)	5.2 (1.4)	-0.703	0.48
Perceived benefits	6.4 (1.8)	6.1 (1.9)	0.981	0.33
Regulatory self-efficacy	20.4 (3.8)	20.9 (3.8)	-1.550	0.12
Stage of change				
Precontemplation	10.6 (2.0)	10.6 (2.3)	0.195	0.84
Preparation	7.0 (1.5)	6.8 (1.7)	1.040	0.29
Action/Maintenance	8.5 (1.9)	8.6 (2.1)	-0.540	0.59

[a]Independent sample t test comparing intervention and control groups.

Table 2 compares the mean change between pretest and posttest assessments. Those who participated in the educational intervention sessions reported a significantly greater level of perceived vision impairment and understanding about its impact on driving when compared to controls, t (1, 362) = 4.42, $p < 0.01$. In addition, those who participated in the educational intervention reported a significantly higher number of perceived benefits to self-regulation, t (1, 352) = 3.53, $p < 0.01$, when compared to controls. With respect to level of readiness, those who participated in the educational intervention were more likely than controls to fall into the Preparation stage, t (1, 352) = 5.01, $p < 0.01$, and the Action/Maintenance stage, t (1, 352) = 3.80, $p < 0.01$. As listed in Table 1, there were no intervention and control group differences in change scores with respect to the perceived threat of crash involvement (i.e., severity and susceptibility), perceived barriers to self-regulation (i.e., external, personal desire and dependency on others), perceived regulatory self-efficacy, and being in the Precontemplation stage of change.

DISCUSSION

The purpose of this paper was to describe an educational intervention designed to provide high-risk older drivers with strategies to reduce harm and increase safety, while allowing them to maintain driving mobility in order to continue to perform activities necessary for daily living. A strength of this intervention is that the curriculum's development and evaluation was based on established theoretical models, a component not included in previous older driver program evaluations (Janke, 1994; McKnight et al., 1982). The evaluation of theoretical constructs provides valuable insight into the mecha-

Table 2

Mean Change Scores for Theoretical Construct Measures

Theoretical construct measure	Intervention group N = 194 Mean (SD)	Control group N = 171 Mean (SD)	t statistic[a]	Probability level
Self-Perception of Vision impairment	-0.01 (1.3)	-0.66 (1.5)	4.42	<.001
Perceived threat				
Severity	-0.06 (0.7)	-0.09 (0.7)	0.40	0.686
Susceptibility/vision	-0.01 (1.3)	-0.14 (1.2)	1.00	0.314
Susceptability/general	-0.07 (1.1)	-0.25 (1.2)	1.47	0.141
Perceived barriers				
External sources	0.33 (2.9)	0.80 (2.7)	-1.51	0.124
Personal desire	0.38 (2.1)	0.47 (2.2)	-0.38	0.698
Dependency on others	0.33 (2.1)	0.53 (2.0)	-0.94	0.347
Perceived benefits	0.58 (2.5)	-0.33 (2.4)	3.53	<.001
Regulatory self-efficacy	-0.08 (3.1)	0.34 (3.1)	-0.79	0.430
Stage of change				
Precontemplation	-0.83 (2.9)	-0.29 (2.6)	-1.80	0.072
Preparation	0.80 (2.1)	-0.29 (2.0)	5.01	<.001
Action/Maintenance	0.50 (2.7)	-0.53 (2.4)	3.80	<.001

[a]Independent sample t test comparing intervention and control groups.

nisms of the driving behavior change process and further enhances the ability to determine program efficacy. For driving, this is a particular strength because there are few published studies that provide a comprehensive evaluation of the motivational domains of individual driving behavior. Results presented here demonstrate that education can impact health beliefs in a positive manner. In this study, those who participated in education exhibited more characteristics of Preparation and Action/ Maintenance stages of readiness than controls, implying that interventions which account for the individual level of motivation may serve to boost the adoption of new driving behaviors. This finding is consistent with previous applications of the TTM model in advancing the adoption of healthy habits, such as smoking cessation, increased exercise, and healthy diet (Kohler et al., 1999; Nigg, Courneya, & Estabrooks, 1997; Nigg et al., 1999; J. O. Prochaska et al., 1992). The results presented here imply that the educational curriculum had no significant impact on regulatory self-efficacy. However, this null result may stem from ceiling effects in regulatory efficacy because many participants had high regulatory self-efficacy at pretest. As a result of the intervention, there were also no changes in perceived barriers; however, many barriers that exist with respect to driving are not "perceived" but are, in fact, very real physical obstacles to the adoption of self-regulatory practices (i.e., no available public transportation and no alternate roadways in extreme rural areas). Thus, intervention programs that aim to reduce barriers to self-regulation at the community and organizational levels are deserving of future investigation.

Health beliefs, regulatory self-efficacy, and stage of readiness are not the ends but rather the means to an end. Therefore, the ensuing question is whether this educational curriculum can facilitate changes in real-world driver performance. Daily driving behavior was evaluated in terms of self-reported hazard avoidance, performance of self-regulatory practices, and driving exposure (days, miles, places and trips per week). A detailed description of the evaluation of the efficacy of the KEYS curriculum on driver performance is provided elsewhere (Owsley, Stalvey, & Phillips, 2000). The results of this evaluation showed that after participating in the educational intervention, older drivers reported a significantly higher frequency of situation avoidance (e.g., left-turns), a higher frequency of performing self-regulatory practices (e.g., making three right turns) and reported significantly fewer days, places and trips made each week suggesting that visually impaired older drivers can learn to translate education into the adoption of self-regulatory behaviors. Future evaluation will determine the efficacy of the KEYS intervention in promoting safety among these high risk older drivers in terms of reduced crash risk.

CONCLUSIONS

Previous older driver education programs were evaluated in older driver volunteers who were at low risk for crash involvement in that they did not have serious functional impairments and had safe driving records (Janke, 1994; McKnight et al., 1982). Therefore, it is not surprising that previous program evaluations did not demonstrate that these programs reduced crash involvement. The evaluation presented here is unique in that it focuses on those older drivers who are at high risk and thus stand to reap a benefit from an educational intervention, namely, those who have a history of crash involvement and who cope with vision impairments that elevate crash risk. However, those with visual processing impairments are only one subpopulation of high-risk older drivers. It would be interesting to determine whether a derivation of this educational curriculum would be helpful to populations of drivers who are high-risk because of other types of functional deficits, such as physical and motor impairments or mild cognitive problems, that could hamper safe driving performance. Thus, one potential application of this intervention is to extend the educational program described here so that it is applicable to other types of functional problems experienced by older drivers, not only visual impairment.

Both older driver and novice driver education programs to date have been delivered in a classroom setting where drivers are addressed as a group, a method typically considered more practical from a economic standpoint. In contrast, the KEYS curriculum was delivered in a one-on-one, highly interactive format, which allowed the education to be tailored to the older adults' levels of motivation and unique driving needs. The results described here demonstrate that education delivered one-on-one promoted changes in older driver perceptions of self-regulation, and there is further evidence that these changes in perceptions lead to changes in real-world driver behavior, at least as self-reported by the participants (Owsley, Stalvey, & Phillips, 2000). Although the individualized format appears to have utility in promoting behavior change among older drivers, an additional question arises as to whether a one-on-one driver education program would produce similar results among high-risk novice driver populations, an area worthy of further study.

The KEYS educational intervention was designed to be delivered in a clinic setting, namely eye care clinics. Many older adults with visual impairment already seek advice and treatment from eye care professionals, and, in this sense, they are already tapped into a system which could potentially assist in promoting safe driving. Eye care specialists are in an already established position to identify individuals who have vision impairments that could elevate crash risk. Furthermore, eye care specialists are urged by their practice organizations (e.g., American Optometric Association and American Academy of Ophthalmology) to counsel patients about visual impairment and the impact such impairment can have on daily activities such as driving. Thus, the KEYS curriculum may provide eye clinics with a valuable resource to aid in the communication of information regarding visual deficits and driver safety to their patients.

To reduce the cost of administering this type of educational curriculum, it may be fruitful to develop a computerized version of the curriculum which could preserve tailoring of the program for each individual user while minimizing the need for one-on-one interaction with a health educator. Whether a software version of the curriculum would be effective in delivering the message is unknown but worth investigating. This automatic format may also enhance the feasibility of its use at state licensing administrations who are legally charged with enhancing the road safety of licensed drivers.

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THE EFFICACY OF AN EDUCATIONAL INTERVENTION IN PROMOTING SELF-REGULATION AMONG HIGH-RISK OLDER DRIVERS

by

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ABSTRACT

Visual processing impairment is associated with increased crash risk among older drivers. Many older drivers meet the legal requirements for licensing despite having vision impairments that elevate crash risk. Three hundred and sixty-five older drivers who were licensed, visually impaired, and crash involved in the prior year were randomized to an intervention group or usual-eye-care control group to evaluate the efficacy of an educational intervention promoting driver behavior change through the performance of self-regulatory practices. The educational curriculum was designed to change self-perceptions about vision impairment and how it impacts driver safety and to promote the avoidance of challenging driving situations through self-regulation. This curriculum also promoted methods to reduce driving exposure as a mechanism to improve safety. Analyses compared the intervention and control groups at pretest and 6-month posttest with respect to self-reported perceptions about vision impairment and driving practices. Drivers receiving the educational intervention were more likely to acknowledge they had vision impairment, report a significantly higher frequency of avoiding challenging driving situations (e.g., left turns), and report performing more self-regulatory practices (e.g., three right turns) than controls. Additionally, drivers receiving the educational intervention reported driving significantly fewer days, fewer places, and fewer trips made per week compared to those not receiving education. These findings suggest that high-risk older drivers can benefit from educational interventions that promote driving self-regulation in that they increased their avoidance of challenging driving situations and reduced their driving exposure. Further work will examine whether this educational intervention has an impact on safety among high risk older drivers by reducing crash risk.

INTRODUCTION

Mobility through the use of the automobile is essential to the lifestyles of many individuals in developed countries. However, adverse outcomes associated with driving, such as crashes, injury, and death, have become a significant public health concern, particularly among older drivers who have higher crash rates per mile driven than most other age groups (National Highway Traffic Safety Administration, 1995). Like adults of other age groups, almost 90% of older adults rely on the private automobile for the majority of their transportation needs (Martinez, 1995; Transportation Research Board, 1988). Thus, it is not surprising that driving cessation severely reduces the personal mobility of this population. As a result, there is a pressing need to develop interventions that enhance driver safety without substantively restricting mobility.

The increased crash risk among older drivers is largely attributable to functional impairments, which are more prevalent among the elderly compared to other age groups (National Highway Traffic Safety Administration, 1993). Declines in visual and cognitive function have been linked to crash involvement (Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Johnson & Keltner, 1983; Kline et al., 1992; Owsley, Ball, Sloane, Roenker, & Bruni, 1991; Owsley, Ball, McGwin et al., 1998). Yet, it is important to remember that not all older adults experience visual and cognitive impairment. However, with driver error as the predominant factor in the majority of crashes (Evans, 1996), those who do experience diminished capabilities that hinder the safe operation of a motor vehicle pose a substantial threat to public safety. License revocation may be the only option for those older drivers with severe, irreversible functional impairments. However, many older drivers with visual sensory deficits and visual processing problems meet the legal requirements for licensing despite having impairments that elevate crash risk. Therefore, it is important to develop interventions for those older drivers who maintain driving privileges while coping with functional limitations that increase risk.

Driver safety in terms of crash prevention has traditionally occurred at three levels which can be conceptualized as before, during, and after the adverse event. Primary prevention centers on the specific human behaviors performed by the driver that contribute to crash events before they happen. Secondary prevention focuses on enhancing the design of roadways and maximizing vehicle design to protect the occupants from injury during a crash (Evans, 1991; Transportation Research Board, 1988). Tertiary prevention targets the medical treatment of the driver following a crash in order to prevent death in the worst case scenario and also to minimize the risk for chronic disability (Mandavia & Newton, 1998; Schwab & Kauder, 1992). Safety promotion at the primary level has gained attention from traffic safety professionals over the years as individual driver behavior consistently emerges as a significant factor leading to crash occurrence (Evans, 1991). Based on these findings (Evans, 1990), efforts to intervene at the primary level of older individual driver behavior are worth serious attention. Studies show that most older drivers intend to drive as long as possible and resist any change in their preferred mode of travel, suggesting that driver behavior change without formal intervention is not likely (Branch & Jette, 1984). Furthermore, there is evidence that changes in driver behavior can be beneficial. For example, older adults' avoidance of challenging driving situations has been associated with reduced driving exposure (Hakamies-Blomqvist, 1993; Lefrancois & D'Amours, 1997) which may serve to ultimately improve driver safety by reducing crash rates.

Several educational programs have been developed over the years to address the unique driving issues faced by older drivers (Beno, 1981). Program curricula have addressed topics that relate to common age-related functional changes that impact driving such as vision and hearing problems, slowed reaction time, the effects of alcohol and medication, and the proper maintenance of a vehicle (AAA, 1998; American Association of Retired Persons [AARP], 1997; Janke, 1994; National Safety Council, 1997). These programs have typically been administered to groups of older adults in a classroom setting or in a standard booklet or video rather than on an individualized basis where a health educator or driver safety specialist offers counseling and advice tailored to the unique functional problems and mobility needs of the individual driver. Furthermore, the majority of program participants have been volunteers from the community who were typically at very low risk for crash involvement (e.g., having no functional impairment and no history of crash involvement).

With respect to the formal evaluation of these programs, the two outcome evaluations that have been carried out to date focused on knowledge gained, specifically, what facts the driver learned from participation in the educational program. An evaluation of the AARP's 55-Alive Mature Driving program demonstrated success in improving participants' knowledge of driving maneuvers and rules of the road (McKnight, Simone, & Weidman, 1982). Similarly, the Mature Driver Improvement program in California demonstrated success in communicating traffic safety information to program participants (Janke, 1994). While this prior work demonstrates a positive impact of education on older drivers in terms of gains in knowledge of safety facts, it remains to be determined whether changes in driver attitudes and self-perceptions actually occur as a result of the knowledge gained from the educational curriculum. The field of health education provides clear evidence indicating that changes in attitudes and self-perceptions play a critical role in generating intentions to change behavior and are thus prerequisites to changing behavior itself (Ajzen & Madden, 1986; Pender & Pender, 1986; Strain, 1991). Thus, it is interesting to consider whether drivers provided with information to increase self-awareness about their risks for adverse driving outcomes would be more likely to exhibit safety-oriented behaviors, as compared to those who are not provided with such information. Older drivers may be particularly good candidates for this type of educational intervention because drivers over 50 years of age have the most misconceptions regarding the risk of having a collision (Evans, 1991). Furthermore, prior research has demonstrated that those who are unaware of their own limitations tend not to take preventive action, which places them at higher risk of crash involvement (Martinez, 1995), whereas those who are aware of their deficits tend to compensate for their impairments by modifying their driving behavior (Ball et al., 1998; Owsley et al., 1991; Owsley, Stalvey, Wells, & Sloane, 1999; Schlag, 1993; Stutts, 1998).

These prior findings serve as a rationale for evaluating whether an educational intervention to increase self-awareness and promote safe driving leads to driving behavior changes in high risk older adults. Promoting driving behavior change in older drivers appears to be a worthy strategy given evidence that many older adults are successful in making positive behavior changes that protect their health status (Best & Cameron, 1986; Orlandi, 1987). Even in the presence of chronic illness, research has indicated that individuals can learn to utilize self-management techniques that reduce risk and improve health (Lorig et al., 1999; Rowe & Kahn, 1998). For example, older adults with heart disease who participated in educational classes learned to better react to physical symptoms in order to protect against the adverse event of a heart attack (Clark, Janz, Dodge, & Sharpe, 1992). Similarly, older adults who were educated on techniques to prevent falls reported fewer falls over a 1-year period compared to those who did not receive any education (Wagner et al., 1994). Thus, previous studies demonstrate that older persons have the ability to learn health protective behaviors as well as the motivation to implement behavior changes that enhance health status and well-being.

The purpose of this study was to evaluate the efficacy of an educational curriculum designed to increase self-awareness and promote self-regulatory behaviors among older drivers who are high risk for crash involvement. The focus in this paper is on three questions. Does an individualized curriculum presented to high-risk older drivers in one-on-one educational sessions (a) change self-perceptions about the quality of vision, (b) change general attitudes toward driver safety, and (c) promote the avoidance of challenging driving situations through self-regulation and promote reduced driving exposure? "High-risk" in this study is defined as older drivers with visual-processing impairment, high driving exposure, and a crash on the state record in the year prior to enrollment. The study utilized an experimental design with random assignment to either an intervention group (those who receive the educational curriculum) or a non-intervention group.

METHODS

Subjects

The source population consisted of older, crash-involved drivers in the Birmingham, Alabama, area as identified by records of the Alabama Department of Public Safety.

Potential participants were contacted by a letter describing the study, which was followed by a telephone call to determine if they met the inclusion criteria for age, driving status, and driving exposure. If so, they were invited to visit the Clinical Research Unit in the Department of Ophthalmology at the University of Alabama at Birmingham for further determination of eligibility. Inclusion criteria were as follows: (a) age 60 years old or over; (b) legally licensed to drive in the State of Alabama; (c) involved in a state recorded crash in the year prior to enrollment; (d) drove at least 5 days per week or at least 100 miles per week by self-report; (e) no or only minimal cognitive impairment, defined as a Mini-Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) of 23 or higher; and (f) visual impairment. Visual impairment was defined in either of two ways: visual acuity impairment (habitual, binocular), defined as acuity between 20/30 and 20/60 (legal limit in Alabama) as measured by the ETDRS chart (Ferris, Kassoff, Bresnick, & Bailey, 1982), or a restriction in the useful field of view, defined as scores of 40% or greater as measured by the UFOV test (Ball, Roenker, & Bruni, 1990; Ball et al., 1993). The study protocol was approved by the Institutional Review Board for Human Use at the University of Alabama at Birmingham. After the purpose of the study was explained, each subject who met the inclusion criteria was asked to sign a document of informed consent before being enrolled in the study.

Design

The study had an experimental design with participants randomly assigned to one of two groups: (a) a usual care control group or (b) a usual care plus educational intervention group. All participants received usual care that consisted of a comprehensive examination by an optometrist. Because our screening process had the potential for identifying vision impairment, it was ethically important to offer all study participants an eye exam to determine if any vision problem identified was treatable and correctable. Participants were not randomized until after the eye examination to allow the exclusion of individuals who received treatment that eliminated their vision impairment, thus making them ineligible for the study. As part of usual care, the eye care specialist discussed the impact of any diagnosed visual impairment on the activities of daily living, such as driving, as would normally occur during any eye examination. After the comprehensive eye examination, eligible participants were randomized to either the usual care control group or the intervention group (usual care plus educational intervention). Because the primary research question addressed the efficacy of the educational intervention, unequal randomization (55% for intervention and 45% for control) was selected to allow a greater number of participants to be assigned to the intervention group.

After usual care, those randomized to the intervention group participated in two educational sessions which included an initial visit within 2 weeks following screening, followed by a "booster" session 1 month later. Posttest assessments were administered by telephone to both groups 6 months after randomization.

Intervention Curriculum

The educational curriculum, described in detail elsewhere (Stalvey & Owsley, 2000), was guided by several well-established models of behavior change and is summarized below. The curriculum consisted of the following components, and an example is presented in Table 1.

During Session 1 which lasted 2 hr, each participant randomized to the intervention group met one-on-one with a health educator (BTS) who led a discussion with the driver based on the results of the participant's eye exam. The purpose of the discussion was to provide information designed to increase self-awareness of vision impairment and the impact on safe driving. This information was derived from evidence found in the research literature. Also in Session 1, slide photographs of eight specific hazardous driving scenes were shown to participants, which facilitated a detailed discussion of the dangers present in hazardous driving situations (i.e., oncoming traffic at a left turn). Hazardous driving situations were chosen based on the level of visual difficulty and the statistically high rates of crash occurrence at these locations (National Highway Traffic Safety Administration, 1995). All hazardous driving situations discussed in the intervention are shown in Table 1.

After the dangers in each situation were identified, participants were encouraged to consider eight specific strategies that can be used to avoid each hazard (i.e., looking for left-turn arrow and driving to next block and making three right-hand turns). All self-regulatory practices suggested in the intervention are listed in Table 1.

Drivers were encouraged to identify additional strategies that would be consistent with their daily driving needs and that could be easily incorporated into their routine driving habits. Each participant was asked to set specific goals for driver behavior change. Participants were encouraged to work toward achieving these goals prior to the second session.

Table 1

Intervention Curriculum Case Study Example

Self-Perception of vision impairment

A sixty-nine year old male notices difficulty finding the golf ball after he hits it. His eye examination report reveals that he has a cataract (VA 20/40) yet he has not yet elected to have surgery . The following information is provided to the driver:

"When a cataract develops, the normally transparent lens of the eye becomes cloudy, like a frosted window. This condition is most common in adults over age 55. The cataract is the most likely cause of your 20/40 acuity. Acuity is your eye's ability to see details and shapes from a distance. 20/20 is considered normal. Therefore, 20/40 means that you will have more difficulty seeing objects clearly from a distance which may be why you have difficulty seeing the golf ball from a distance."

Impact of vision impairment on driver performance

The implications of a cataract and 20/40 vision on driving are discussed:

"The cloudy lens of a cataract makes it difficult to see clearly. Vision is usually blurred or hazy which makes it more difficult to see traffic signs and other objects clearly. Cataracts also make your eye more sensitive to light which makes it difficult to drive at night. The glare from oncoming vehicles can be most challenging to accommodate. Having acuity of 20/40 makes it difficult to see details from a distance. Therefore, the lettering on street signs becomes harder to see in time to make a turn onto the street you want. If you have difficulty on the golf course, you may also have difficulty on the highway."

Hazardous driving situations and self-regulatory practice

Hazardous Situation	Self-Regulatory Practice
Rain	Wait until rain shower stops
Driving Alone	Have a friend or family member ride with you
Parallel Parking	Look for commercial parking lot
Left-turns across oncoming traffic	Make 3 right turns around next block: left turn arrow
Interstates	Find alternate routes
Heavy Traffic	Find less traveled routes
Rush-Hour	Schedule trips at times other than rush hour
Night	Schedule trips during the day

Note. Curriculum described in Stalvey, B., & Owsley, C. (2000). The development of an educational intervention curriculum to promote self-regulation among high risk older drivers: Translating theory into practice. Submitted for publication.

Session 2, administered 1 month later, was a 1-hr discussion designed to serve as a booster session, reiterating the topics previously discussed in the first session. Progress toward behavioral goals and strategies to continue safe driving behaviors in the future were the focus of the second discussion.

Measuring the Primary Outcomes

The primary outcomes measures were based on responses to questionnaires administered to all participants by an interviewer (JMP) who was masked with respect to the group membership of the participant. These questionnaires were administered to all participants before the intervention (pretest) and at 6 months following enrollment (posttest).

Self-perceptions of vision and driving. Self-rated eyesight was assessed by an item from the National Eye Institute-Visual Function Questionnaire-25 which asks "At the present time, would you say your eyesight (with glasses or contact lenses if you wear them) is 1 (excellent), 2 (good), 3 (fair), 4 (poor) or 5 (very poor)" (Mangione et al., 1998). Self-perception of driving difficulty evaluates perceptions regarding the impact of vision impairment on driving and was measured by a subscale of the Driving Habits Questionnaire (DHQ) as described in detail elsewhere (Owsley et al., 1999). Respondents were asked to rate the degree of visual difficulty perceived with respect to eight specific driving situations (rain, alone, parallel parking, left-hand turns, interstate, heavy traffic, rush hour, and night). Ratings were made on a 5-point scale: 5 (no difficulty), 4 (a little difficulty), 3 (moderate difficulty), 2 (extreme difficulty), 1 (so difficult I no longer drive in that situation). A composite score of driving difficulty was computed based on the responses to all eight items and scaled on a 100-point scale [(mean score - 1) x 25]. Lower composite scores indicate a greater degree of perceived difficulty.

Attitudes toward driver safety. General attitudes toward driving safety were measured by a subscale of the Driver Perceptions and Practices Questionnaire (DPPQ) described in detail elsewhere (Stalvey & Owsley, in press). Participants were asked to rate the extent to which they believe the driving statement is true or false: 1 (definitely true), 2 (mostly true), 3 (mostly false), 4 (definitely false). The attitude subscale is comprised of nine items. The attitudes toward driver safety subscale is calculated by summing the response values across all nine items, creating a total score ranging from 9 (negative attitudes toward safety) to 36 (positive attitudes toward safety; e.g., some should be denied the right to drive, taking chances does not make a better driver and crashes cannot always be prevented).

Driver behavior. Self-regulatory practices were assessed by a subscale of the DPPQ (Stalvey & Owsley, in press) which asked participants to report how often they perform one of eight specific self-regulatory strategies (wait until rain stops before driving, ask someone to ride with you to avoid driving alone, look for parking lot to avoid parallel parking, make right turns around next block to avoid turning left across traffic, find alternate routes to avoid interstate, choose locations with least amount of traffic, drive at times other than rush hour and reschedule activities to avoid driving at night).

Participants indicated the frequency of performance using a 4-point scale: 1 (never), 2 (rarely), 3 (sometimes), 4 (often). The self-regulatory practices subscale is calculated by summing the response values across all eight driving situations, creating a total score ranging from 8 (never perform any of these strategies) to 24 (often performs all eight regulatory strategies). Driving avoidance was estimated by asking participants to report the extent to which during the past 3 months they purposely avoided the same eight driving situations queried by the DHQ (Owsley et al., 1999) that place a high demand on visual processing abilities. If they did report avoidance, they were asked how often they avoided these situations on a 5-point scale: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always). The driving avoidance subscale is calculated by summing the response values across all eight driving situations, creating a total score ranging from 8 (never avoid any of these driving situations) to 40 (always avoid all eight driving situations). Driver dependency was assessed using a subscale of the DHQ (Owsley et al., 1999). Respondents were asked to name persons he or she travels with in a car on a regular basis and who usually drives when with that person. From this interview, an estimate of "dependency" on other drivers was generated, which ranged from 1 to 3 with higher scores meaning greater levels of dependency on others to drive. Driving exposure was determined by a subscale of the DHQ (Owsley et al., 1999), which asks participants to report the average number of days driven per week, where they drove in a typical week, and the approximate distance of these trips. From this interview, the following summary measures were obtained: number of places traveled to, number of trips made, number of miles driven, and the number of days driven, all within a typical week.

Information on general health and the presence of depressive symptoms was also collected because they impact the performance of tasks such as driving (National Highway Traffic Safety Administration, 1989), and thus we wanted to ensure that our intervention and control groups were similar with respect to the distribution of these variables. General health was assessed using a questionnaire described previously (Owsley et al., 1999), which asked participants if they have problems in 17 areas (e.g., heart, cancer, diabetes, and stroke) and, if so, to what extent they are bothered by the condition on a three-point scale: 1 (not bothered at all), 2 (bothered a little), 3 (bothered a great deal). To generate a comorbidity index, each medical condition present was weighted by the "bothersome score," and all were summed. Lower numbers indicate less bothersome comorbid conditions. The presence of depressive symptoms was assessed by the Center for Epidemiological Studies-Depression Scale (CES-D; Radloff & Teri, 1986). Patients were asked to rate 20 items based on how often they felt that way in the last week. Responses included "rarely or none of the time, some of the time, much of the time, or most or all of the time," which were scored from 0 to 3, respectively. Total scores ranged from 0 to 60, with a higher number indicating more depressive symptoms.

Data Analysis

Those who were assigned to the intervention group but did not elect to participate in the educational program ($n = 20$) were excluded from analysis. T tests and chi-square tests were used to examine pretest equalization on continuous and categorical variables, respectively. For each of the primary outcome measures (self-perceptions of vision impairment, self-perceived driving difficulty, attitudes toward driver safety, self-regulatory practices, driving avoidance, driving dependency, and driving exposure), a change score was obtained by calculating the difference between scores at pretest and at 6-month posttest. Differences were calculated so that positive change values indicate change in the desired direction (i.e., increase in perceived severity of vision impairment, increase in perceived driving difficulty, increase in positive attitudes toward driving, increase in frequency of self-regulatory practices, increase in frequency of situation avoidance, increased driving dependency, decreased driving exposure). Parametric statistical tests (t tests) were utilized to examine group differences because change variables were normally distributed. For all analyses, $\alpha = 0.05$ (two-tailed).

RESULTS

Sample Characteristics

Participants in this study ($N = 365$) were an average of 74 years of age ($SD = 6$) were 69% male and were 31% female, and were 23% African American and 77% White non-Hispanic origin. The high percentage of males in this sample is consistent with the population of crash-involved drivers from which they were recruited, as males are more likely to have a history of crash involvement than females (National Highway Traffic Safety Administration, 1995). Eighteen percent of participants had both visual acuity impairment and useful field of view deficit, 7% had visual acuity impairment and no useful field of view deficit, and 75% percent had useful field of view deficit with no visual acuity impairment. Drivers had a relatively high amount of driving exposure, averaging 256 miles each week, but there was wide variability in the sample (SD=325). In terms of days driven per week, the mean was 6.4 (SD = 0.9). The sample had good mental status (M=27.4, SD = 1.8). Overall, participants were in good health as indicated by their comorbidity scores (M=6.5, SD=4.5) and reported few depressive symptoms (M=6.7, SD=5.8). As indicated in Tables 2 and 3, the two groups were not significantly different from each other at pretest with respect to all key variables, including demographic variables, inclusion criteria, comorbidity score, depressive symptoms, and all dependent measures. There were 194 subjects randomized to the intervention group, and 171 were randomized to the control group.

Outcomes

Driver perceptions of eyesight. Those who participated in the intervention were more likely to acknowledge they had less than excellent vision as compared to the control group, t (1, 349) = 2.26, p = 0.02, as illustrated in Figure 1. Compared to controls, those in the intervention group reported more difficulty with visually challenging driving situations than did the control group, t (1, 352) = 4.4, p < 0.01, as illustrated in Figure 2.

Attitudes toward driver safety. Although the intervention group reported on average a more positive attitude toward driver safety than the control group (Figure 3), the group differences were not statistically significant, t (1, 356) = 1.0, p = 0.31.

Driver behavior. Those in the intervention group reported more frequent performance of self-regulatory practices, t (1, 350) = 8.24, p < 0.01, as illustrated in Figure 4. Similarly, those in the intervention group reported more frequent avoidance of hazardous driving than the control group, t (1, 360) = 6.21, p < 0.01, as seen in Figure 5.

Table 2

Pretest Measures of Demographic Variables

Theoretical construct measure	Total sample n = 365 Mean (SD)	Intervention group n = 194 Mean (SD)	Control group n = 171 Mean (SD)	p-value[a]
Age	73.5(6.0)	73.7(5.8)	73.3(6.0)	0.55
Education level	12.8(3.0)	12.9(3.1)	12.7(3.0)	0.69
Visual acuity	20/20(0.13)	20/20(0.14)	20/20(0.14)	0.95
Mental status	27.4(1.7)	27.5(1.7)	27.3(1.7)	0.39
Comorbidity	6.5 (4.5)	6.5 (4.5)	6.4 (4.5)	0.73
Depression	6.7 (5.8)	6.7 (6.1)	6.6 (5.5)	0.89
	% of Group	% of Group	% of Group	
Gender	69% Male 31% Female	67% Male 33% Female	72% Male 28% Female	0.36
Race	77% White 23% African American	77% White 23% African American	77% White 23% African American	0.55
Visual processing speed	39% = 0-39% 61% = 40-90% reduction	39% = 0-39% 61% = 40-90% reduction	41% = 0-39% 59% = 40-90% reduction	0.68

[a]Independent sample t test comparing intervention and control groups.

Table 3

Pretest Measures of Dependent Variables

Theoretical construct measure	Total sample n = 365 Mean (SD)	Intervention group n = 194 Mean (SD)	Control group n = 171 Mean (SD)	p-value[a]
Self-rated eyesight	73.5(6.0)	73.7(5.8)	73.3(6.0)	0.63
Perceived driving difficulty	12.8(3.0)	12.9(3.1)	12.7(3.0)	0.49
Driver safety attitudes	20/20(0.13)	20/20(0.14)	20/20(0.14)	0.29
Self-regulatory practices	27.4(1.7)	27.5(1.7)	27.3(1.7)	0.54
Frequency of avoidance	6.5 (4.5)	6.5 (4.5)	6.4 (4.5)	0.45
Dependency on others	6.7 (5.8)	6.7 (6.1)	6.6 (5.5)	0.54
Trips made each week	15.4(8.3)	15.4(7.9)	15.4(8.8)	0.95
Places driven each week	6.1(1.8)	6.4(1.0)	6.1(1.9)	0.75
Days driven each week	6.5(0.9)	6.5(0.78)	6.4(1.0)	0.12
Miles driven each week	255.7(324.8)	247.5(316.8)	266.2(335.8)	0.56

[a]Independent sample t test comparing intervention and control groups.

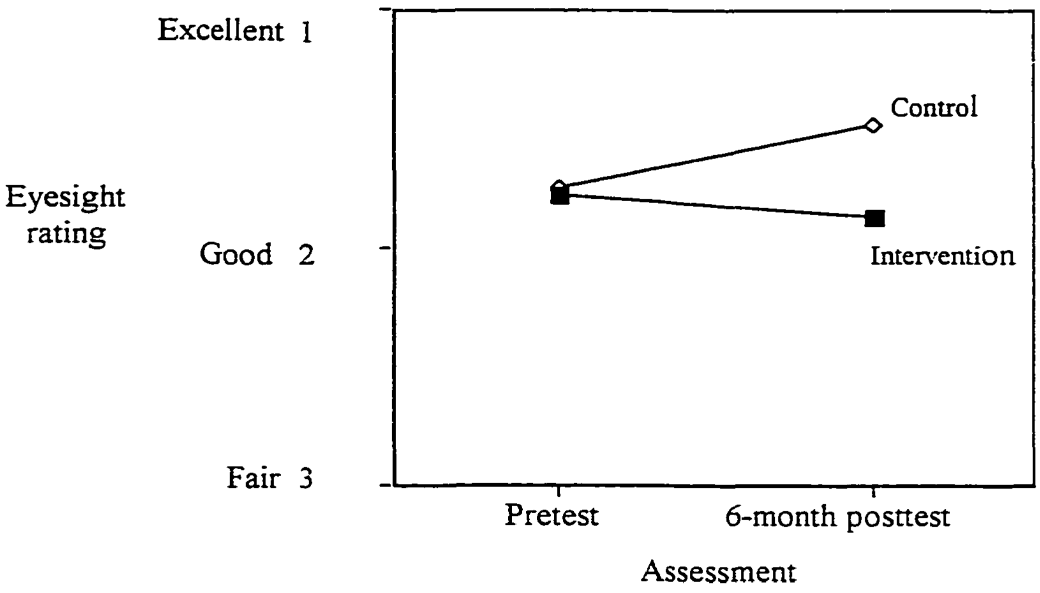

Figure 1. Self-rated eyesight.

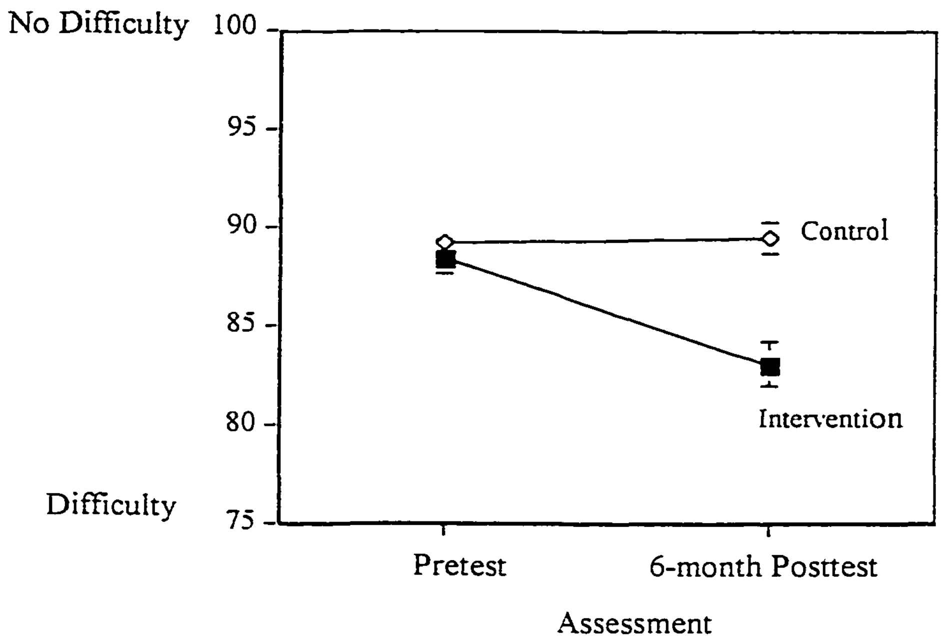

Figure 2. Perceived driving difficulty.

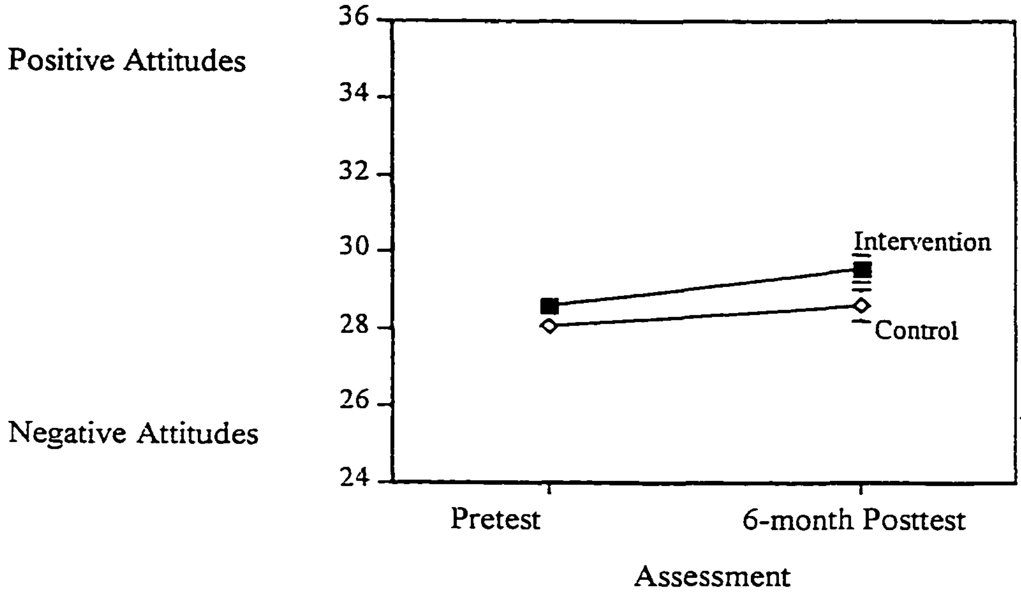

Figure 3. Attitudes toward driver safety.

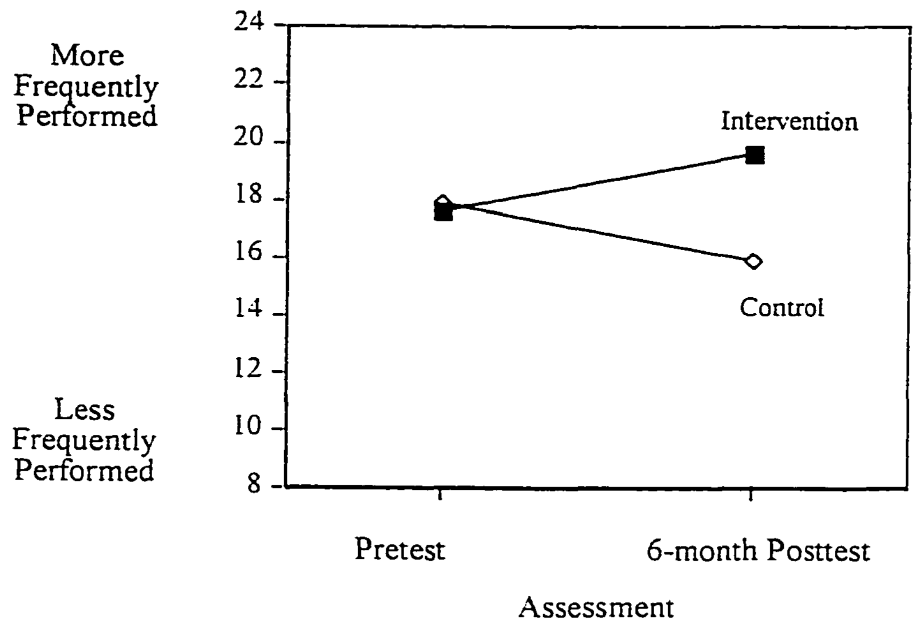

Figure 4. Frequency of performing self-regulatory practices.

With respect to dependence on others to drive, after receiving education, those in the intervention group were not more likely to increase their dependence on others to drive than were those in the control group, t (1, 361) = 1.44, $p = 0.14$, as illustrated in Figure 6. However, those in the intervention group reported a significantly greater reduction in driving exposure (i.e., places, trips and days driven per week), as compared to the control group (Figures 7-10).

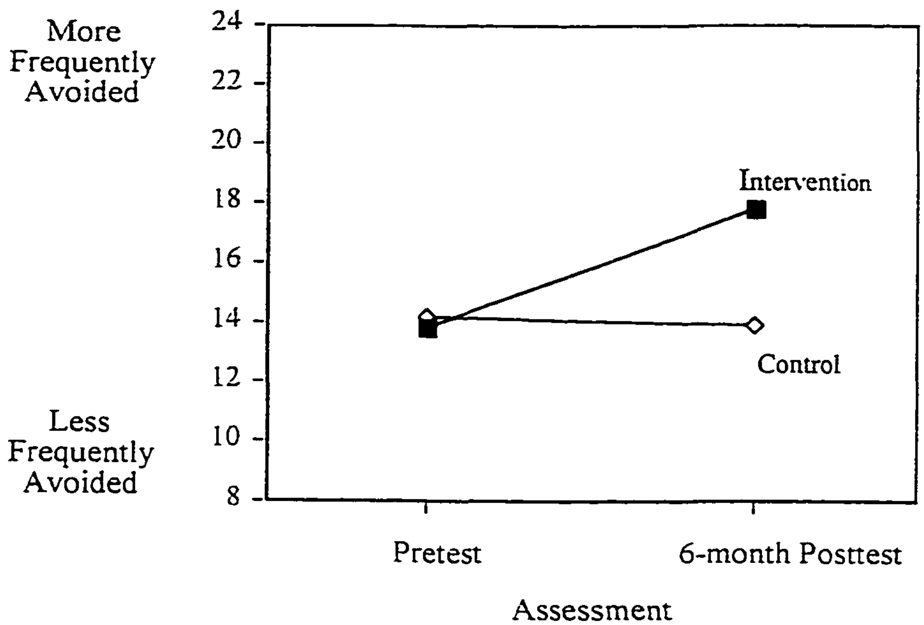

Figure 5. Frequency of avoiding hazardous driving situations.

Specifically, 6 months after the intervention, the intervention group reported fewer places traveled to, t (1, 361) = 2.01, $p < 0.05$; fewer trips per week, t (1, 361) = 2.26, $p < 0.02$, and fewer days driven per week; t (1, 361) = 2.01, $p < 0.05$, compared to the control group. There was a similar trend with respect to reported miles driven per week in that the intervention group reported a lower mean miles driven each week than did the control group; however, this group difference did not reach statistical significance, $t\ (1, 361) = 1.52$, $p = 0.13$.

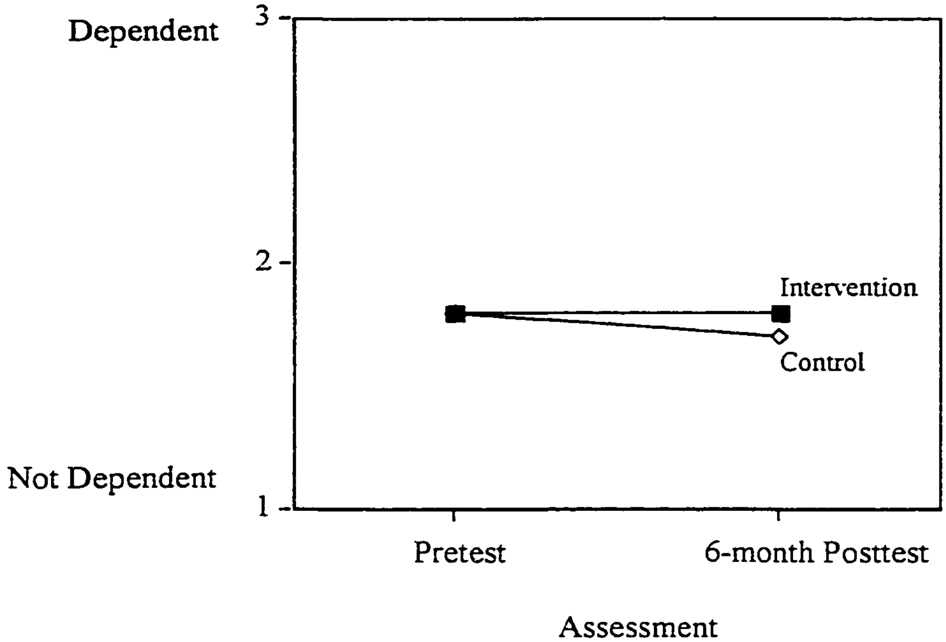

Figure 6. Driver dependency on others.

DISCUSSION

The purpose of this paper was to evaluate the efficacy of an educational curriculum designed to increase self-awareness about driving and vision and to promote self-regulatory behaviors among older drivers at high risk for crash involvement because of vision impairment, prior crash involvement, and high driving exposure. The first question addressed was whether an education curriculum could make older drivers better aware of the quality of their eyesight and how vision impairments threaten driver safety.

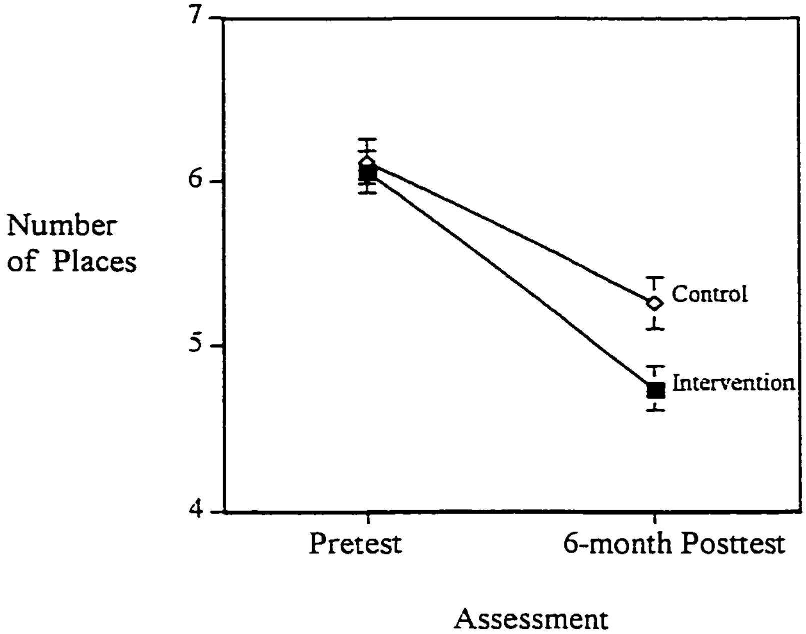

Figure 7. Places driven to each week.

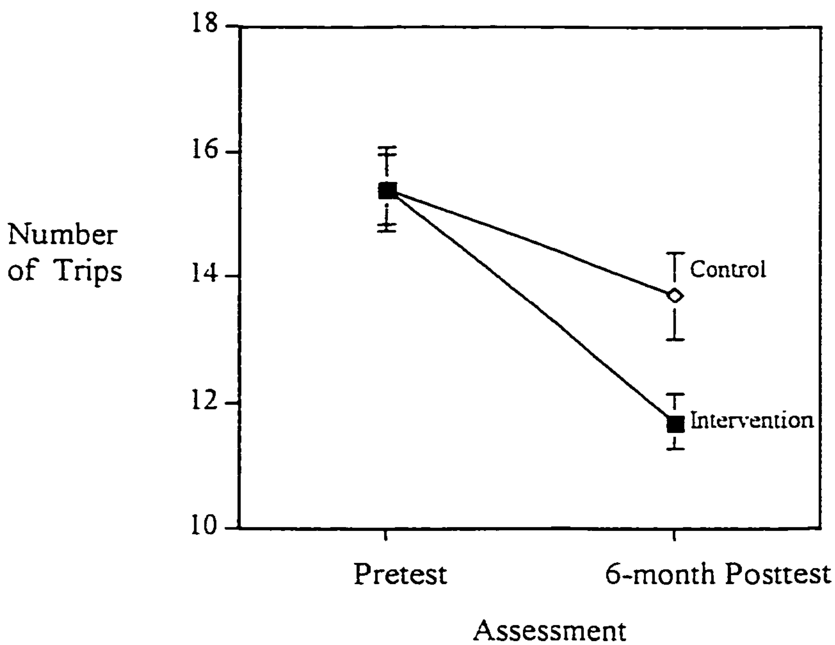

Figure 8. Trips made each week.

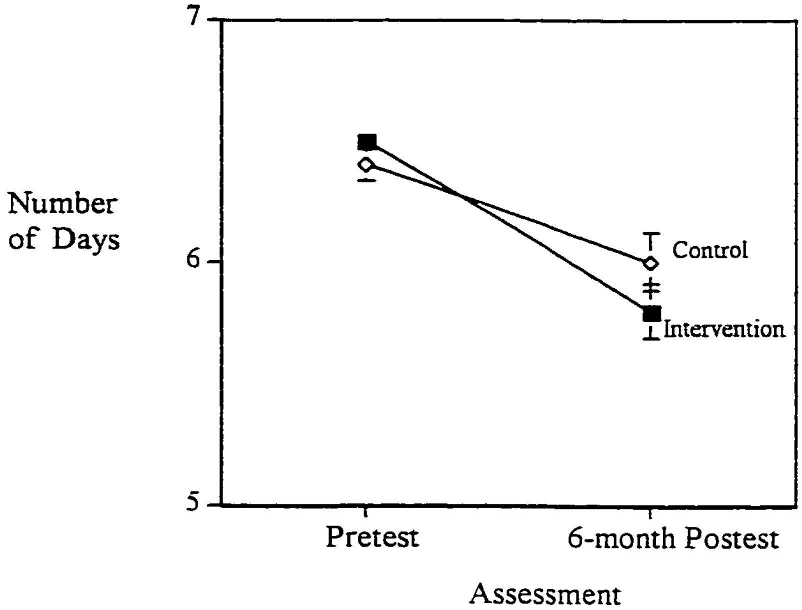

Figure 9. Number of days driven each week.

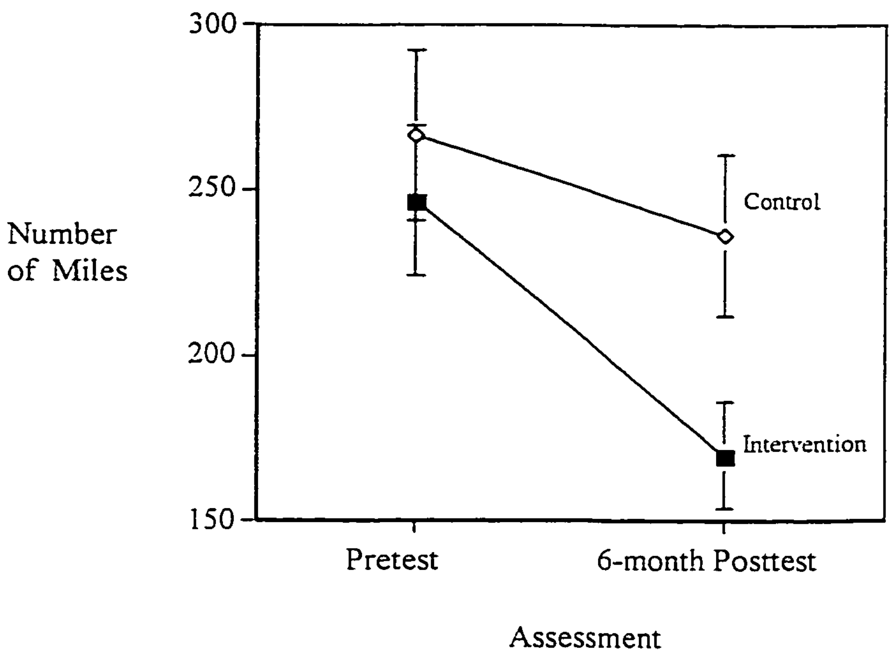

Figure 10. Miles driven per week

The results suggest that educating older drivers does lead to their having attitudinal changes about vision and driving. After the educational intervention, older drivers were more likely to acknowledge less than perfect vision and to report difficulty with challenging driving situations with high visual demands, as compared to those who were also visually impaired but who did not participate in the educational program.

The second question investigated was whether a one-on-one educational curriculum could change general attitudes toward driver safety (e.g., driving is a matter of personal freedom, the occurrence of a crash is a matter of chance and each driver is the best judge of his or her own driving capabilities). Results presented here imply that the educational curriculum had no significant impact on changing attitudes about general driving safety issues. This null result may stem from ceiling effects in general attitudes about driver safety because many participants had positive attitudes about general driver safety from the start, at pretest. Another reason for no change on this measure may be that the curriculum was tailored specifically for the needs of each individual driver, focusing on each drivers' own type of visual impairment and its ramifications for driving behavior and safety. Although general driver safety and crash prevention information were present throughout the curriculum, the discussions were not focused on abstract concepts or governmental policies but rather on specific driving strategies to enhance safety.

The third question pertained to whether a one-on-one educational curriculum for visually impaired older drivers could promote the self-regulation of driving behaviors, namely hazard avoidance and limiting exposure on the road. It appears that it can. Those who received the education reported more frequent performance of self-regulatory practices (i.e., scheduling driving trips during the day instead of at night and making right turns around the next block instead of turning left across traffic) and more frequent avoidance of hazardous driving situations (i.e., rush hour traffic and in the rain), as compared to those not participating in the educational program. Furthermore, the educational intervention led to a reduction in driving exposure. Drivers cut back not only on the days they drove but also on the number of trips and places they visited when they were the driver of the vehicle. Prior research on driver safety clearly indicates that higher driving exposure is associated with increased crash risk (Hakamies-Blomqvist, 1993; Lefrancois & D'Amours, 1997). Thus, our findings suggest that the reduced driving exposure implemented by our drivers after the intervention may be an effective strategy for reducing their crash risk, a question worthy of further investigation.

Previous studies evaluating educational programs for older drivers have utilized increased knowledge as the primary outcome, finding that older drivers can learn new facts about safe driving strategies and aging-related changes in functional capabilities (Janke, 1994; McKnight et al., 1982). Our results are consistent with these prior studies. However, our study goes beyond prior work by demonstrating that not only can an older driver's knowledge base change but also his or her self-perceptions about vision and driving can change, as well as self-reported driving behaviors. Specifically, drivers reported that they reduced their exposure and avoided difficult driving situations. It is interesting to point out that, despite making changes in their driving habits that reduced their time on the road, these drivers did not become more dependent on other drivers for their transportation needs, implying that it is possible to compensate for impairment by reducing exposure, while still maintaining an adequate level of mobility.

Prior research has demonstrated that those who are not aware of their own vision impairments are more likely to continue poor driving habits, whereas those who do acknowledge their own deficits tend to modify and adjust their driving (Ball et al., 1998). Older drivers who participated in this educational program illustrate this phenomenon. Furthermore, by nature of its experimental design, this study implies that the link is causal and that education leads to behavior change. It remains to be determined as to whether these behavior changes are sustained beyond 6 months after the intervention. Prospective follow-up of the participants in this project will eventually address this issue.

A limitation of this study may be the use of self-reported driver exposure as an outcome variable. However, previous work has indicated that older adults can report driving exposure in a reliable fashion (Murakami & Wagner, 1997). Nevertheless, it would be interesting to look at the impact of educational interventions on actual on-road behaviors by older drivers through the use of Global Positioning Systems or other tracking technologies. Another limitation is that we have focused on only one subpopulation of high-risk older drivers, namely those who have visual processing impairments. It would be interesting to determine whether educational interventions would be helpful to older drivers who are high risk because of other types of functional deficits, such as physical and motor impairments. Another type of functional impairment that elevates crash risk among older drivers is cognitive problems. It would seem that a priori an educational intervention would be ineffective for those drivers with dementia; however, for those with minor cognitive problems, an educational intervention or training program may be worthy of consideration.

The anticipated increase in the older driver population over the next few decades creates a pressing need for crash prevention interventions at all levels (Evans, 1990; Klein & Bloom, 1997). Primary prevention programs that promote self-regulation encourage drivers to engage in behaviors that will prevent crashes before they happen. Our results indicate that an educational program tailored for the needs of a specific high-risk, older driver population may be a promising primary prevention initiative. In the present study, this program was introduced on an individual level, and thus it remains to be determined whether a group setting would also be effective, which is an issue deserving of further study because it may be more practical from an economic standpoint to administer the program in a group than individually. The educational goals of our program were to transfer at least part of the responsibility for traffic safety from external sources (e.g., vehicle design engineering and trauma care) into the hands of the individual, older driver. In our setting, responsibility for safety translates into self-awareness of vision impairment and self-regulation of driving in response to an understanding of how visual deficits threaten road safety. Our data imply that some older drivers are capable of taking this responsibility.

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CONCLUSIONS

The three papers included in this dissertation provide insight regarding the mechanisms by which education can promote self-regulation among high-risk older drivers. According to theoretical models of behavior (Bandura, 1986b; I. M. Rosenstock, 1990; Schwarzer, 1992), high-risk older drivers possessed characteristics at baseline which indicated they were poised and ready for an intervention that promoted driving behavior changes. They perceived that crashes could be prevented and perceived the seriousness of crash involvement, yet they did not engage in self-regulatory actions to protect against the adverse outcomes of crash involvement, despite having high self-efficacy about their ability to do so. These findings suggested that, at baseline, older drivers had the intention to self-regulate yet lacked the motivation and perhaps the self-regulatory skills needed to adopt safe driving strategies.

The KEYS curriculum demonstrated to be instrumental in increasing motivation to take action, evident in the fact that, after receiving the education, older drivers moved through stages of readiness closer to Preparation and Action/Maintenance compared to those who were not educated. This result may be attributed to the one-on-one delivery format which allowed the message to be tailored to the unique needs of each individual driver, a tactic proven effective in previous individualized interventions (Nigg et al., 1999; Pallonen et al., 1994; J. O. Prochaska et al., 1992).

A majority of the KEYS curriculum focused on the promotion of self-regulatory skills where the dangers of the driving situation (i.e., oncoming traffic at a left turn) are evaluated and alternative safe driving practices (i.e., making three right turns instead of a left turn) are identified. This skill-building component appears to have been instrumental in that, after receiving education, older drivers reported more frequent avoidance of hazardous situations and more frequent performance of self-regulatory practices. Self-regulation was further evident in the finding that educated older drivers reported reduced driving exposure. These findings suggest that high-risk older drivers can benefit from educational interventions that promote awareness of vision impairment and the adoption of self-regulatory practices. Prospective follow-up and evaluation will determine the extent to which these behavior changes can be sustained in this population over time.

This intervention is unique in that it relies heavily on the principles of self-regulation and other theoretical models of human behavior in the development and evaluation of program efficacy. The measurement of theoretical constructs in this evaluation improves upon previous older driver education evaluations by providing a more sensitive examination of the often subtle links between education and the behavioral antecedents known to be instrumental in the organization of personal goals regarding driving safety (i.e., perceptions, motivation levels and attitudes; Ajzen & Madden, 1986; Bandura, 1986b; Mischel et al., 1996; I. M. Rosenstock, 1990). Thus, when compared to previous older driver program evaluations, the results of this project provide greater insight into the mechanisms by which education serves to facilitate driver behavior change. In addition, by nature of its experimental design, these results of this study imply that the links detected are causal, whereby education leads to driver behavior change.

It would be interesting to evaluate the extent to which future derivations of this educational framework could be utilized to educate other driving populations. Older drivers in this study represent a population with unique driving needs. For example, the majority of program participants had a great deal of flexibility with respect to their driving schedule, primarily due to retirement status. Self-regulation to times other than rush hour may be more difficult for full-time participants of the workforce who face the barrier of not being able to adjust work schedule to avoid the dangers of heavy traffic. Many barriers such as this are not just perceived but are, in fact, very real obstacles to the adoption of self-regulatory practices (i.e., no available public transportation, no alternate roadways in extreme rural areas). It is important to remember that this intervention was designed for the driver at the individual level. Thus, intervention programs developed under the auspices of the Social Ecology Model (Kohler et al., 1999), for example, which aim to reduce barriers to self-regulation at the community and organizational levels may also be deserving of further investigation.

It would also be interesting to evaluate the extent to which this curriculum would demonstrate efficacy in promoting behavior change among high-risk novice drivers. Previous attempts to educate novice drivers have failed to demonstrate an impact on crash outcomes. However, we do not yet understand the specific aspects of these curricula that may be enhanced or modified (i.e., information regarding rules of the road vs. risk taking behaviors; delivery in the classroom vs. one-on-one; skill-building through observational learning vs. on-road performance). Thus, it may be beneficial to test the efficacy of a theory-based curriculum developed specifically for high-risk novice driver populations.

A limitation of this study is the focus on only one subpopulation of high-risk older drivers, namely those who have visual processing impairments. It would be interesting to determine whether educational interventions would be helpful to older drivers who are high-risk due to other functional deficits, namely physical or motor impairments or mild cognitive impairment. Another limitation may be the use of self-reported perceptions and behaviors as an outcome variable. Thus, it is uncertain the extent to which participants actually perform the behaviors they report. Previous work has indicated that older adults can report driving exposure in a reliable fashion (Murakami & Wagner, 1997). Therefore, in terms of driving behavior, future evaluations may examine the impact of educational interventions on actual on-road behaviors of older drivers through the use of Global Positioning Systems or other tracking technologies.

From an economic standpoint, it may be more cost-effective to develop a computer version of this curriculum integrating assessment and tailored message generation designed to reduce the time intensive administrative burden. If automated, this curriculum would be in a format to more efficiently serve eye care specialists and other health care professionals or state licensing examiners who are all charged with the responsibility of identifying drivers with diminished capabilities and protecting public safety.

The changes in longevity and the improved health status of the aging population over the past few decades have created more opportunities for prevention interventions at primary, secondary, and tertiary levels in the older adult population. This effort falls under the auspices of primary prevention which is concerned with preventing predictable outcomes of crashing in order to protect existing states of health and functioning. The research on behavior theories that define components of protective action has evolved over time to create the body of knowledge that makes primary prevention in older adults achievable (Bloom, 1996; Klein & Bloom, 1997; Price et al., 1988). This program promotes health protective behavior in terms of preventing crashes before they happen, not just the treatment after an adverse crash event has occurred. The theoretical constructs described here provide a framework for achieving our health education goals which are to transfer the responsibility for driver safety from external sources (e.g., trauma care, vehicle design engineers) to the hands of the individual driver. In this case, responsibility translates into self-awareness of impairment and self-regulation of driving on the part of the high-risk older driver.

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APPENDIX

INSTITUTIONAL REVIEW BOARD APPROVAL FORM

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

Form 4: IRB Approval Form
Identification and Certification of Research
Projects Involving Human Subjects

The Institutional Review Board for Human Use (IRB) has an approved Multiple Project Assurance with the Department of Health and Human Services and is in compliance with 21 CFR Parts 50 and 56 and ICH GCP Guidelines. The Assurance became effective on January 1, 1999 and the approval period is for five years. The Assurance number is M-1149, identification number 01.

Principal Investigator: CYNTHIA OWSLEY

Protocol Number: X970305003

Protocol Title: Self-Regulation as a Mechanism for Improving the Safety of Older Drivers

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The IRB reviewed and approved the above named project on 3/3/00. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received **EXPEDITED** review.

IRB Approval Date: 3/3/00

Date IRB Approval Issued: 3/3/00

Marilyn Doss

Marilyn Doss, M.A.
Vice Chair of the Institutional Review Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

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DISSERTATION APPROVAL FORM
DOCTOR OF PHILOSOPHY

Name of Candidate Beth T. Stalvey

Graduate Program Health Education and Health Promotions

Title of Dissertation Developing and Evaluating the Efficacy of an Educational Intervention to Promote Self-Regulatory Behavior Among High-Risk Older Drivers: A Primary Prevention Approach

I certify that I have read this document and examined the student regarding its content. In my opinion, this dissertation conforms to acceptable standards of scholarly presentation and is adequate in scope and quality, and the attainments of this student are such that she may be recommended for the degree of Doctor of Philosophy.

Dissertation Committee:

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LeaVonne Pulley, **Chair**	LeaVonne Pulley
Cynthia Owsley	
Connie L. Kohler	Connie L. Kohler
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Date 1/4/01