The Development and Efficacy of a Theory-Based Educational Curriculum to Promote Self-Regulation Among High-Risk Older Drivers

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Knowledge Enhances Your Safety (KEYS) is a curriculum developed for older drivers who maintain driving privileges while coping with visual limitations that increase crash risk. KEYS' goal is to promote safe driving through self-awareness of vision impairment and adopting self-regulatory strategies. We discuss KEYS' theoretical framework based on the tenants of the Social Cognitive Theory, Health Belief and Transtheoretical Models, and Principles of Self-Regulation and Regulatory Self-Efficacy. Baseline and 6-month posttest evaluations tested its efficacy in terms of theoretical construct outcomes. KEYS' participants improved self-perceptions of vision impairment, perceived a greater number of benefits in the performance of self-regulatory behaviors, and moved closer to the preparation and action/maintenance stages of change. Results indicate that high-risk older drivers benefit from educational interventions that promote self-awareness and self-regulation of driving. Future work will evaluate KEYS' efficacy for high-risk older drivers in promoting driver behavior changes and its impact on crash involvement.

Keywords: *self-regulation; older drivers; driver education; driver safety; health behavior theory*

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 personal mobility. However, older adults as a group have a higher rate of crash involvement per mile driven compared to most other age groups and are also more likely to die or be injured as a result of a crash (Barancik, Chatterjee, Greene-Cadden, & Michenzi, 1986; McCoy, Johnson & Duthie, 1989; National Highway Traffic Safety Administration, 1995). Therefore, it has become increasingly important to develop interventions that provide older drivers with strategies to increase driver safety, while still allowing them to maintain mobility 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; Owsley et al., 1998; Owsley, Ball, Sloane, Roenker, & Bruni, 1991; Owsley & McGwin, 1999). 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 more than 90% of crashes (Evans, 1996), those who do experience impaired visual capabilities may compromise their driver 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, a priority driving population at high risk for crash involvement. The purpose of this article 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 the practice of self-regulation as a mechanism to reduce crash risk and enhance public safety without significantly restricting personal mobility.

The educational intervention described here builds on previous older driver education programs (AAA Foundation for Traffic Safety, 2003; Janke, 1994; McKnight, Simone, & Weidman, 1982; National Safety Council, 1997) by using a theoretical framework to motivate the program's structure. To date, only two older driver education programs have been formally evaluated and in both cases, the outcome measures focused on knowledge gained; in other words, 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 maneu-

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vers when behind the wheel. Both the American Association of Retired Person's 55-Alive Mature Driver program (McKnight, Simone, & Weidman, 1982) and the California Mature Driver Improvement program (Janke, 1994) were successful in improving participants' knowledge of driving maneuvers and rules of the road. Yet in the end, neither program was successful in demonstrating a reduction in the crash rate of program participants compared to those who did not participate in the program (Janke, 1994; McKnight, Simone, & Weidman, 1982). It may not be that these educational programs are ineffective, only that these programs failed to demonstrate an impact on the outcome of crash involvement, a distal outcome that theoretically 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 health behavior theory known to play a significant role in the adoption of preventive behaviors (Bandura, 1977, 1982; Mischel, Cantor, & Feldman, 1996; Prochaska & DiClemente, 1992; Rosenstock, 1974). Thus, the purpose of this intervention evaluation is to examine the efficacy of the educational program in promoting change with respect to theoretical components that lie at a more proximal level of the driving behavior continuum.

Intervention Goals and Objectives

Knowledge Enhances Your Safety (KEYS), developed for high-risk older drivers, is designed to not only orient with facts, but to also promote the use of 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, Ball, Sloane, Roenker, & Bruni, 1991; Schlag, 1993; Stutts, 1998). 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 as determined by national statistics; for example, 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, Ball, Sloane, Roenker, & Bruni, 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 ultimate 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 used 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.

METHOD

Participants

High-risk older drivers included in this sample were defined as those aged 60 and older who were legally licensed to drive in the state of Alabama and who had visual acuity and/or 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 legal limit for licensure in Alabama) (Ferris, Kassoff, Bresnick, & Bailey, 1982) and/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 and/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 (UAB) for further evaluation of eligibility (e.g., the presence of visual deficits, mental status). The study protocol was approved by the Institutional Review Board for Human Use at UAB. 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 that 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 that include an initial 2-hour visit, followed by a booster session 1 month later. The primary costs per participant included the comprehensive eye examination ($80) and participant reimbursement for the completion of all screening visits and intervention sessions ($50). A master's degree-level health education specialist was added to the project staff to deliver all educational intervention sessions.

Curriculum Development: Selection of Theoretical Framework

An intervention well-grounded in theory does not ensure intervention success; however, theoretical models furnish a conceptual foundation that serves to (a) provide insight into how program information should be communicated to participants, and (b) set the parameters for the evaluation of the relationship between constructs to demonstrate how program components may 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 article. However, the following descriptions are included to facilitate a discussion of the process by which theory is translated into practice and to describe the outcome measures used in this efficacy evaluation.

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, Simone, & Weidman, 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, Grimley, & Reynolds, 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 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; Kelly, Zyzanski, & Alemagno, 1991; Kirscht, 1974; Strain, 1991). The Health Belief Model (HBM) (Rosenstock, 1960, 1974, 1990) postulates that individuals will engage in preventive behaviors if they perceive a threat; in other words, 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) (Prochaska, DiClemente, & Norcross, 1992; 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 (Prochaska, DiClemente, &

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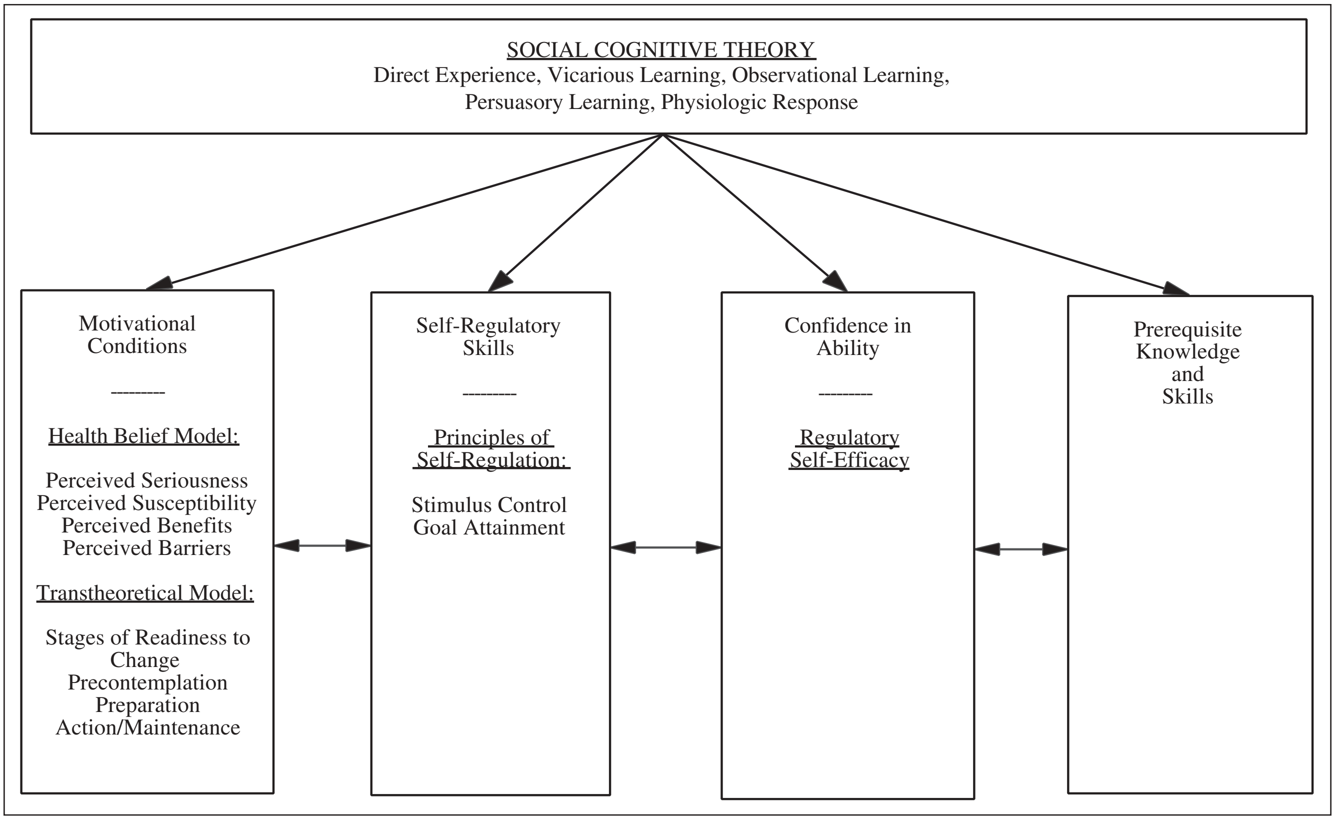

FIGURE 1 Theoretical Framework of Intervention

NOTE: According to the Social Cognitive Theory (Bandura, 1977), the adoption of new behaviors depends on motivational conditions, self-regulatory skills, confidence in ones' ability to exert the effort, and prerequisite knowledge and skills. The Health Belief Model (Rosenstock, 1960) and the Transtheoretical Model (Prochaska & DiClemente, 1992) aid in the motivation of health beliefs; the Principles of Self-Regulation (Bandura, 1977; Mischel, Cantor, & Feldman, 1996) guide the promotion of self-regulatory skills; and the Principles of Self-Efficacy (Bandura, 1982) promote confidence in the ability to self-regulate.

Norcross, 1992). This model has a great deal of use in the delivery of an individualized intervention. For example, researchers in one study found that self-help manuals that matched the individuals' current level 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 refer to the ability of the individual to refrain from a negative behavior and to engage in a new behavior (Bandura, 1977, 1986b) using the internal resources of the "self" (Kelly, 1955; Mischel, Cantor, & Feldman, 1996; Tobin, Reynolds, Holroyd, & Creer, 1986). The primary source of regulatory skills are the individual's own set of personal goals (Maes & Gebhardt, 2000; Mischel, Cantor, & Feldman, 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 refers to the individuals' perceived level of confidence in their ability to refrain from the practice of an unsafe behavior and to engage in the practice of a new safe behavior consistently over time (Bandura, 1982, 1986a, 1996; Mischel, Cantor, & Feldman, 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 & Smart, 1971; Schunk, 1989; Strecher, DeVillis, Becker, & Rosenstock, 1986). Therefore, a key goal of education is to promote the individuals' perceived level of confidence in their ability to achieve self-regulatory goals.

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 are strengthened by the ability to rely on the existing understanding and ability of the older individual to conduct the driving task 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 ability to perform 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 that occurred approximately one month apart. The education was delivered to each driver in a one-on-one session with a health educator (Beth T. Stalvey, one of the authors of this article).

Informational component. The first session began with a discussion of the participants' eye examination received prior to enrollment. This action falls under the SCT category of persuasory learning techniques, wherein 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 visual capabilities important to the driving task (Owsley et al., 1998; Owsley & McGwin, 1999; Owsley, McGwin, & Ball, 1998; Owsley & Sloane, 1990). Under the guidance of the Health Belief Model (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., a cataract) can hinder visual abilities (e.g., clouding of the lens, which blocks light and leads to blurred vision) and lead to crash involvement (e.g., 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 used strategies to deliver the message according to the motivational levels outlined by the Transtheoretical Model (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 and/or visual processing). Because all participants had some level of vision impairment as criteria for inclusion in the study, 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 promote the translation of 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, Cantor, & Feldman, 1996). 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). 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. 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 their own driving history (Bandura, 1986b). Slide photographs were used to facilitate skill-building through observational learning as the 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 individual's own personal driving goals (Mischel, Cantor, & Feldman, 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 that would minimize the obstacle (Rubenstein, 1994).

Confidence-building component. 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 his or her 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 are used throughout the sessions (see above). 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; worried about other drivers' mistakes when it was raining). The benefits they have experienced and how barriers were successfully reduced were also discussed.

Because goal-setting is a primary component of self-regulation (Mischel, Cantor, & Feldman, 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 his 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 driver's intention to adopt the self-regulatory behavior. 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 one and session two. If individuals can recognize progress, such as reducing the number of nights driven each week, they may be more likely to stay on course to achieve their goal of traffic safety (Maes & Gebhardt, 2000; Mischel, Cantor, & Feldman, 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 ability to continue to self-regulate (Bandura, 1996; Maes & Gebhardt, 2000; Mischel, Cantor, & Feldman, 1996).

Efficacy Evaluation

Measuring theoretical constructs. 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 six 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, susceptibility due to the general nature of the driving task); (c) barriers to the performance of self-regulatory practices in terms of external sources (e.g., lack of public transportation), personal desire (e.g., do not want to use public transportation even if available), and dependence on others (e.g., 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, 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 = Strongly Disagree). For some items, participants were asked to rate the extent to which they believed the statement is true or false (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 pre-test 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 such as 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 pre-test 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 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], increase in regulatory self-efficacy). Parametric statistical tests (independent sample *t* tests) were used ($p = 0.05$, two-tailed) to examine group differences because change variables were normally distributed.

TABLE 1
Pre-Test 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.

RESULTS

Participants

Participants in this study (N = 365) had an average age of 74 years (range = 60 to 91 years; SD = 6) with 23% African American and 77% White. The sample consisted of 69% male and 31% female. The higher percentage of males in this sample is consistent with the population of crash-involved drivers from which they were recruited, wherein males have higher rates of crash involvement than females (National Highway Traffic Safety Administration, 1995). A total of 18% of our participants had both visual acuity impairment (between 20/30 and 20/60) and useful field of view impairment (≥40% reduction in useful field of view). A total of 7% had visual acuity impairment and no useful field of view deficit. A total of 75% had useful field of view deficit with visual acuity better than 20/30. Drivers had a high amount of driving exposure (M = 6.4; range = 3–7; SD = 0.9 days each week; M = 256; range = 9–3179; SD = 325 miles each week) and had good mental status (M = 27.4; minimum/maximum = 23–30; SD = 1.8). Demographic variables and inclusion criteria were compared across each randomization group; the distributions of each of these variables in the two group were not different as reported in detail elsewhere (Owsley, Stalvey, & Phillips, 2003).

Theoretical Constructs

Theoretical constructs were also examined to confirm the level of pre-test 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 2 compares the mean change between pre-test and posttest assessments. At posttest, 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, at posttest, 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 moved closer to the preparation stage, $t(1, 352) = 5.01$, $p < 0.01$, and the action/maintenance stage, $t(1, 352) = 3.80$, $p < 0.01$, than those in the control group. As listed in Table 2, there were no intervention and control group differences in change scores with respect to the perceived threat of crash involvement (i.e., severity, susceptibility), perceived barriers to self-regulation (i.e., external, personal desire, dependency on others), perceived regulatory self-efficacy, and being in the precontemplation stage of change.

DISCUSSION

The purpose of this article was to describe the process of developing, implementing, and evaluating the efficacy of an educational intervention designed to increase awareness of vision impairment among high-risk older drivers and to promote the adoption of self-regulatory strategies to reduce harm. 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 priority population includes those who are

TABLE 2
Mean Change Scores for Theoretical Construct Measures from Pre-Test to 6-Month Posttest, Listed for Each Group Separately

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
Susceptibility/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.

at risk due to diminished functional ability, yet remain legally licensed to drive. Rather, the ultimate goal of the intervention is to provide older drivers with awareness of strategies to reduce harm and increase safety, while allowing them to maintain 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, Simone, & Weidman, 1982). The efficacy of the program in changing theoretical constructs among individuals provides valuable insight into the mechanisms of the driving behavior change process. For driving behavior, 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 affect health beliefs in a positive manner. Those who received education demonstrated a greater awareness of their vision impairment and the potential impact it has on driving. In this study, the education of older drivers was associated with increased readiness for change (i.e., preparation and action/maintenance stages) implying that interventions that 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, Grimley, & Reynolds, 1999; Nigg et al., 1999; Nigg, Courneya, & Estabrooks, 1997; Prochaska & DiClemente, 1992). The results presented here imply that the educational curriculum had no significant effect on regulatory self-efficacy. However, this null result may stem from ceiling effects in regulatory efficacy in this sample; in other words, many participants had high regulatory self-efficacy at pre-test. 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, no alternate roadways in extreme rural areas). Thus, intervention programs that aim to reduce barriers to self-regulation at the community and organizational level are deserving of future investigation.

There are also study limitations that dictate these data be interpreted with caution. The primary outcome data are self-report. Although there is no way of knowing for certain, it is possible that a participant in the intervention group may have responded based on what he or she believed the interviewer "wanted to hear," rather than what his or her true belief was. However, the posttest interviewer was a different individual than the educational counselor, which may have minimized this bias. In addition, previous work has established that older adults can report driving behavior in a reliable (Owsley, Stalvey, Wells, & Sloane, 1999) and valid (Murakami & Wagner, 1997) fashion.

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 in this sample was measured in terms of self-reported hazard avoidance, performance of self-regulatory practices, and driving exposure (days, miles, places, trips per week). Preliminary analyses indicate that after participating in the educational intervention, older drivers report 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 significantly fewer days, places, and trips made each week. The crash rates of the drivers in this sample will be collected at 24 months posttest to evaluate the efficacy of the KEYS intervention in promoting safety among these high risk older drivers in terms of reduced crash risk. A detailed description of the evaluation of the KEYS curriculum in terms of self-reported driving performance is discussed elsewhere. (Owsley, Stalvey, & Phillips, 2003).

CONCLUSION

Previous older-driver education programs were evaluated in older driver volunteers who were at low-risk for crash involvement in that the majority did not have serious functional impairments and had safe driving records (Janke, 1994; McKnight, Simone, & Weidman, 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; in other words, those who have a history of crash involvement and who cope with vision impairments that elevate crash risk, yet remain legally licensed to drive. 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 legally licensed, yet are deemed high-risk because of other types of functional deficits such as physical/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 licensed 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 that allowed the education to be tailored to the older adults' level of motivation and unique driving needs. The results described here demonstrate that education delivered one-on-one promoted changes in older drivers' perceptions of self-regulation. There are suggestions from further analysis that these changes in perceptions lead to changes in real-world driver behavior, at least as self-reported by the participants (Owsley, Stalvey, & Phillips, 2003). Because 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 that 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, American Academy of Ophthalmology) to counsel patients about visual impairment and the effect 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 have similar efficacy in delivering the message is unknown, but is worth investigation. 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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