The Gerontologist
Vol. 51, No. 3, 367–378
doi:10.1093/geront/gnq082

© The Author 2010. Published by Oxford University Press on behalf of The Gerontological Society of America.
All rights reserved. For permissions, please e-mail: journals.permissions@oup.com.
Advance Access publication on November 11, 2010

The Impact of Feedback on Self-rated Driving Ability and Driving Self-regulation Among Older Adults

Michelle L. Ackerman, PhD,*[,1] Michael Crowe, PhD,[1] David E. Vance, PhD,[1,2] Virginia G. Wadley, PhD,[1,3] Cynthia Owsley, PhD,[4] and Karlene K. Ball, PhD[1]

[1]Department of Psychology, Edward R. Roybal Center for Translational Research on Aging and Mobility, University of Alabama at Birmingham.
[2]Department of Family/Child Health and Caregiving, School of Nursing, University of Alabama at Birmingham.
[3]Department of Medicine, University of Alabama at Birmingham.
[4]Department of Ophthalmology, University of Alabama at Birmingham.

*Address correspondence to Michelle L. Ackerman, Department of Psychology, Edward R. Roybal Center for Translational Research on Aging and Mobility, University of Alabama at Birmingham, 1530 3rd Avenue South, HM 100, Birmingham, AL 35294. E-mail: mlynnack@uab.edu

Received March 24, 2010; Accepted September 10, 2010

In 129 community-dwelling older adults, feedback regarding qualification for an insurance discount (based on a visual speed of processing test; Useful Field of View) was examined as a prospective predictor of change in self-reported driving ability, driving avoidance, and driving exposure over 3 months, along with physical, visual, health, and cognitive variables. Multiple regression models indicated that after controlling for baseline scores on the outcome measures, failure to qualify was a significant predictor of increased avoidance over 3 months (p = .02) but not change in self-rated driving ability or exposure. Female gender (p = .03) was a significant predictor of subsequent lower self-rated driving ability. Overall, the findings of this study provide support for the role of feedback in the self-monitoring of older adults' driving behavior through avoidance of challenging driving situations but not through driving exposure or self-rated driving ability.

Key Words: Older drivers, Driving ability, Self-regulation, Self-rated driving, Driving exposure, Driving avoidance

Research suggests that many drivers adjust their driving behavior as they age due to a variety of factors, including health indicators, and cognitive and sensory declines (Ball et al., 1998 ; Holland & Rabbitt, 1992; Tuokko, McGee, Gabriel, & Rhodes, 2007). Several interrelated components of driving behavior have been examined in this literature, including driving avoidance, perceived driving difficulty, days driven per week, and total miles driven over a given time period. For example, older adults may limit their driving to times and places where they feel safe or competent, and may avoid specific driving situations in which they do not feel confident (i.e., driving at night), or which require little effort to avoid (i.e., driving during peak traffic hours; Baldock, Mathias, McLean, & Berndt, 2006a; Ball et al., 1998). Characteristics associated with greater levels of driving self-regulation include being female, of older age, not being the principal driver in the household, crash involvement in the previous 2 years, fewer years of education, vision problems, poor health status, and low driving confidence ratings (Charlton et al., 2006; Owsley, Stalvey, Wells, & Sloane, 1999; West et al., 2003). Additionally, although self-regulation tends to increase with age, this trend becomes much more pronounced as health status declines (Donorfio, D'Ambrosio, Coughlin, & Mohyde, 2008).

Older drivers' lower self-rated driving ability has been associated with several components of driving behavior, including fewer days per week driven (Lyman, McGwin, & Sims, 2001), greater avoidance of difficult driving situations (Baldock, Mathias, McLean, & Berndt, 2006b), and restrictions in driving behavior among cognitively unimpaired older adults—and to a lesser degree for those with poor cognitive functioning (Dobbs, 1999). Regardless, the preponderance of evidence indicates that some older adults tend to overrate their own driving abilities and driving safety (Cooper, 1990; Freund, Colgrove, Burke, & McLeod, 2005).

Poor cognitive functioning has also been associated with decreased driving exposure and increased avoidance of difficult driving situations (Baldock et al., 2006a; Stutts, 1998; Vance et al., 2006). Reduced performance on one measure of visual attention and speed of information processing, Useful Field of View as measured by the Useful Field of View (UFOV) test, has been associated with driving avoidance (Ball et al., 1998). Drivers at higher risk for crashes, as indicated by poorer UFOV performance, have been found to report greater avoidance of challenging driving situations than lower risk drivers (Okonkwo, Crowe, Wadley, & Ball, 2008).

Some question remains as to whether older drivers self-regulate their behavior in a manner consistent with driving skill and safety. As noted by Man-Son-Hing, Marshall, Molnar, and Wilson (2007), the relationship between self-regulation and prospective crash risk is unclear. Baldock and colleagues (2006b) reported that poorer performance on an on-road driving test was related to self-reported avoidance of specific driving situations but not to global avoidance across all situations examined, whereas another study (Holland & Rabbitt, 1992) found that older adults who reported compensatory restrictions in driving behavior also reported fewer recent crashes than those who did not report such restrictions. A recent 5-year longitudinal study (Ross et al. 2009) indicated that older drivers at higher risk of crash (determined by the UFOV test) reported reduced driving distance and frequency, and increased driving avoidance over time compared with their lower risk counterparts. However, taken in combination with prior research from the same study sample that found that drivers with poor UFOV scores were twice as likely to incur an at-fault crash over 5 years (Ball et al., 2006), there are questions of whether such increased self-regulation is sufficient to compensate for speed of processing impairment.

Although the previous studies examined only self-reported driving behavior, one recent study examined objective measures of driving behaviors in relation to self-reported driving behaviors. Blanchard and Myers (2010) examined driving behaviors using in-vehicle devices among 61 drivers aged 65–84 years. They then compared participants' recorded driving behavior over the course of 1 week with participants' self-reported usual driving practices. Results suggested that poorer perceived driving abilities and driving comfort (particularly for night driving) were significantly related to recorded driving behavior, including reduced driving exposure (in general and at night), average and maximum distance traveled from home, and driving in challenging situations. Age and gender were not associated with any of the driving indicators.

Impact of Feedback

Anstey, Wood, Lord, and Walker's (2005) multi factorial model for enabling driving safety proposes that factors such as cognition, vision, and physical functioning determine capacity for safe driving, and the ability to self-evaluate these enabling factors and adjust driving behavior accordingly (referred to as self-monitoring) produces safe driving. Accordingly, if older adults are unaware of deficits in physical or cognitive abilities due to lack of feedback or metacognitive issues, as some evidence suggests (Eby, Molnar, Shope, Vivoda, & Fordyce, 2003; Freund et al., 2005), they may be unable to adjust their driving behaviors to ensure safety. Providing feedback regarding such abilities may facilitate appropriate self-monitoring, perhaps leading to modification of driving self-regulation.

Some research appears to support the concept that providing feedback regarding a variety of driving-related abilities may lead older adults to modify their driving behaviors (Holland & Rabbitt, 1992; McKenna & Myers, 1997; Owsley, Stalvey, & Phillips, 2003; Tuokko et al., 2007). In a sample of older adults that included some participants with visual and auditory impairment, 1 month after receiving feedback about sensory abilities, two thirds of participants reported making compensatory changes in their driving habits (Holland & Rabbitt, 1992). Owsley and colleagues found that visually impaired drivers who received an educational intervention regarding visual abilities also reported more frequent self-regulatory practices.

Another study (Eby et al., 2003) reported that among older adults who completed a workbook that addressed domains such as health, vision, cognition, and driving behaviors, 14% reported discovering a previously unnoticed change in their abilities and 25% reported an intention to change their driving behaviors.

Although self-ratings of driving ability have been found to be relatively stable over time and across driving tasks (Groeger & Grande, 1996), some research suggests that they are modifiable. For example, accountability may help correct over estimation of drivers' skill and safety. McKenna and Myers (1997) found that among drivers aged 18–40 years, participants whose self-ratings were confidential had significantly higher ratings of their general and specific driving skills than participants who were told they would later be tested by a government examiner on the skills they were asked to rate. Groeger and Grande (1996) reported that feedback given by instructors during an on-road driving task influenced subsequent self-assessments of driving ability, but only when the errors were regarded as "serious."

Tentative evidence suggests that providing feedback about functional abilities (such as visual speed of processing) relevant to driving may promote better informed decisions about driving self-regulation (Holland & Rabbitt, 1992; McKenna & Myers, 1997; Owsley et al., 2003). More accurate self-rating of driving ability may also result in more appropriate driving behavior, which may in turn lead to lower risk of adverse driving events among older adults. Unfortunately, self-monitoring by individuals with cognitive impairment at levels consistent with mild to severe dementia may be hampered by lack of awareness of cognitive and functional deficits (Clément, Belleville, & Gauthier, 2008; Kalbe et al., 2005). Such individuals may lack the ability to appropriately self-monitor their driving based on such feedback. In such cases, providing feedback regarding driving-related abilities would likely not lead to changes in driving behavior or crash risk.

Purpose

Unlike previous research investigating indicators of driving self-regulation and self-rated driving ability, this study aimed to examine predictors of change in these outcomes over a relatively short time period, while controlling for specific demographic, physical, health, and cognitive indicators that may also account for changes in driving behavior across a 3-month interval. The current study examined feedback regarding qualification for an insurance discount (based on UFOV test performance) as a prospective predictor of change in self-reported driving ability, driving avoidance, and driving exposure over 3 months, along with physical, visual, health, and cognitive variables.

Methods

Overview and Procedure

This study was an extension of a larger ongoing project titled "Development and Evaluation of a Brief UFOV® Measure." Known as the Senior Driver Research Project, this study is being conducted in collaboration with the State Farm Insurance Company, Visual Awareness Research Group, Inc., and University of Alabama at Birmingham Edward R. Roybal Center. All drivers older than 75 years in Alabama who are insured by State Farm and are designated as the primary driver on their policy are invited to participate. Study participants can qualify for a 10% discount on their automobile insurance rates for the subsequent 2 years if they exceed a predetermined cutoff score on the UFOV test.

Before being administered the UFOV test, participants were informed that the test administered would measure how well participants could divide their attention and notice things to the side, which is necessary for getting around safely in their environment, and is related to their risk of having an automobile crash. Criteria for crash risk cutoff scores were based on previous studies validating the UFOV relative to state-recorded crashes (Ball et al., 2006; Owsley et al., 1998). At the end of their baseline visit, participants were informed whether they had or had not qualified for the discount based on their UFOV test performance. If qualified, participants received a discount certificate to present to their insurance agent. If the participant did not qualify, or until qualifying participants present their certificate, State Farm had no knowledge of their participation in the study. Participants were also administered questionnaires regarding demographics, driver's license number, self-report of falls, general rating of health, and mobility. Further details of this study have been published elsewhere (Okonkwo, Wadley, Crowe, Roenker, & Ball, 2007; Okonkwo et al., 2008).

More than 2,800 participants have been enrolled since the project began in 2004. From

July 2006 until May 2008, participants from the Birmingham site (N = 165) were administered an expanded baseline questionnaire, which included the Modified Telephone Interview for Cognitive Status (TICS-M), additional Driving Habits questions, 12-Item Short-Form Health Survey (SF-12), and a medical conditions questionnaire. These participants were then contacted by telephone between 2 and 4 months after baseline for follow-up interviews. Questions from the original study questionnaire were repeated at follow-up and additional questions on mobility outcomes and self-rated driving ability were administered. The approximate 3-month interval between baseline and follow-up was largely determined by the Driving Habits Questionnaire, which inquires about driving avoidance over the previous 3 months.

Participants

Participants in the current analyses included 129 older adults who completed the expanded baseline questionnaire and were successfully contacted for interviews approximately 3 months after baseline. Of 36 participants eligible for follow-up but not included in analyses, 22 (13%) refused participation, 3 (2%) had extensive missing data at baseline, 3 (2%) had extensive missing data at follow-up, and 8 (5%) had missing data or reported not knowing their qualification status. Descriptive characteristics are displayed in Table 1. Eighty-six of these participants qualified for the insurance discount (67%).

Measures

Demographics.—Age in years and gender (female = 0, male = 1) were transcribed from participants' drivers' licenses. Years of education completed was reported (first grade = 1, through doctoral degree = 20).

Medical Conditions Questionnaire.—Participants reported if they had been diagnosed by a physician as having cataracts, diabetic retinopathy, dry eye syndrome, glaucoma, macular degeneration, optic neuritis, retinal detachment, arthritis, asthma/breathing problems, chronic skin problems, diabetes, heart disease/problems, high cholesterol, hypertension/high blood pressure, multiple sclerosis, osteoporosis, Parkinson's disease, muscular dystrophy, cerebral palsy, epilepsy, or stroke/mini-stroke/transient ischemic attack. Two composites were used in analyses: total number of eye conditions endorsed and total number of health conditions endorsed.

12-Item Short-Form Health Survey.—This instrument measures general health, vitality, bodily pain, physical functioning, role functioning (physical and emotional), social functioning, and mental health. Two summary scores were calculated using standard methods (Ware, Kosinski, & Keller, 1996): a mental component summary (MCS) and physical component summary (PCS). Each of 12 items is used in the calculation of each summary score but weighted differently and standardized using z-score transformation. Summary scores range from 0 to 100, where higher scores indicate better functioning.

Modified Telephone Interview for Cognitive Status.—This 13-item instrument (Brandt et al., 1993) measures general cognitive status, and includes four domains: (a) orientation; (b) registration, recent memory, and delayed recall; (c) attention/calculation; and (d) semantic memory, comprehension, and language repetition. The TICS-M can be administered face-to-face or by telephone, and during this study was administered in-person at baseline, and by telephone at follow-up. Scores on the TICS-M range from 0 to 39, with higher scores indicating better cognitive function. A TICS-M score below 21 has been found equivalent to a score below 25 on the Mini-Mental Status Examination based on comparative test score percentiles (De Jager, Budge, & Clark, 2003).

Crash History.—Information on automobile crash involvement for 5 years prior to baseline was obtained from the Alabama Department of Public Safety. Two scores were used in analyses: number of at-fault crashes and a dichotomous variable reporting whether any crashes (at-fault or otherwise) had been experienced (no = 0, yes = 1). Eleven percent of participants had experienced at least one at-fault crash in the previous 5 years, whereas 21% had experienced at least one crash (regardless of fault).

Qualification Status.—Qualification for the insurance discount was dependent on surpassing a cutoff score on the UFOV test at baseline (Edwards et al., 2006). The personal computer, touch-screen

Table 1. Sample Description and Indicators of 3-Month Driving Measures

Baseline variables	*M*	*SD*	Range
Demographics			
Age (years)	78.73	4.04	75–93
Men (*n* = 70)	78.62	3.97	75–93
Women (*n* = 59)	78.87	4.14	75–91
Education	14.26	2.56	9–20
Gender (% female)	46		
Health/physical functioning			
SF-12 physical component[a]	48.56	8.56	23.15–67.84
Number of medical conditions	3.52	1.93	0–9
Number of eye conditions	1.07	0.88	0–4
Cognition			
SF-12 mental component[a]	56.57	5.44	28–65.27
TICS-M[a]	24.94	3.10	18–34
UFOV (composite of 3 subtests)	393.09	291.23	51–1367
Feedback			
Qualification status (% qualified for discount)	66.6		
Driving measures (baseline and follow-up)			
Number of at-fault crashes	0.12	0.35	0–2
Any crashes (% with)	21.71		
Self-rated driving ability	4.40	0.63	3–5
Avoidance composite	11.01	4.91	6–25
Exposure composite	0.00	1.56	−3.16–10.01
3-month self-rated driving ability	4.19	0.662	1–5
3-month avoidance composite	11.40	5.15	6–30
3-month exposure composite	0.00	1.65	−2.94–7.81

Notes: *N* = 129. SF-12 = 12-Item Short-Form Health Survey; TICS-M = Modified Telephone Interview for Cognitive Status; UFOV = Useful Field of View.

[a]Higher scores indicate better performance.

three-subtest version of the UFOV measured visual speed of processing by determining the minimum display duration (ranging from 17 to 500 ms) at which a participant could process visual information for three subtests of increasing difficulty. The first subtest (identification) requires the identification of a target object (silhouette of a car or truck) presented in a central fixation box. The second sub test (divided attention) involves simultaneous identification of the central target and localization of a peripheral target (silhouette of a car). The third subtest (selective attention) involves the two tasks in subtest 2 but also includes visual distractors (triangles of the same size and luminance as the central and peripheral targets). The program increased and decreased speed of display duration until the participant could not correctly complete the task 75% of the time at a given speed. This duration speed becomes the score for a given subtest. Based on minimum duration scores for each of the three subtests, participant performance on this test was grouped into one of five possible crash risk categories (see Appendix A; Ball et al., 2006; Okonkwo et al., 2008). Participants in Risk Category 1 or 2 (low risk) were eligible for the discount, whereas those in Category 3, 4, or 5 (moderate to high risk) were not eligible. Participants were informed at their end of their visit that "your performance on the UFOV test qualifies you for a discount from State Farm if you are rated as the principal driver on a State Farm insured vehicle and are 75 or older," or that "unfortunately, your performance did not qualify you for a discount. Although you did not perform well enough to qualify for a discount today, you may be able to re-take the test in 6 months."

The Driving Habits Questionnaire—This assesses avoidance of specific driving situations and exposure in terms of the amount one drives, and was administered at baseline and 3-month follow-up (Owsley et al., 1999). The six avoidance items refer to the prior 3-month period and ascertain how often participants avoid driving in situations such as at night, during bad weather, in rush-hour traffic, in unfamiliar areas, or making left turns across on-coming traffic (*never* = 1, *always* = 5).

Responses on these items were converted to *z*-scores and summed to form an avoidance composite. Driving exposure was measured by two self-reported indicators—number of days per week driven and miles driven per week. Responses on these items were converted to *z*-scores and summed to form an exposure composite.

Self-rated Driving Ability.—Participants were asked, "How would you rate the quality of your driving?" (*poor* = 1, *fair* = 2, *average* = 3, *good* = 4, and *excellent* = 5) at baseline and follow-up. At baseline, 47% of this sample rated their driving as excellent, 45% as good, 8% as average, and 0% as fair or poor. At 3-month follow-up, 31% rated their driving as excellent, 59% as good, 9% as average, 0% as fair, and 1% as poor.

Statistical Analysis

All analyses were performed using SPSS 14.0 for Windows. Based on the literature reviewed, variables potentially impacting driving avoidance, exposure and self-rated ability were considered. Hierarchical multiple regression analyses were conducted to assess the longitudinal associations between baseline predictor variables and (a) 3-month self-rated driving ability, (b) 3-month driving avoidance, and (c) 3-month driving exposure.

Results

Attrition

A one-way analysis of variance was performed to examine baseline variables used in analyses (qualification, self-rated driving, driving avoidance, driving exposure, age, gender, education, TICS-M, SF-12 PCS and MCS, medical conditions, and eye conditions) by attrition group (follow-up participation and refused follow-up) to assess for selective attrition. Significant differences were found only for qualification status, $F(1,150) = 5.98$ ($p = .02$). Participants who refused at follow-up ($n = 22$; 13%) had poorer UFOV test performance and thus were less likely to have qualified for the discount compared with those who participated at follow-up.

Regression Models

To reduce the number of predictor variables in the regression models, Spearman correlations were conducted to examine associations among demographics, baseline measures, qualification status, and each of the outcome measures (3-month self-rated driving, driving avoidance, and driving exposure; Table 2). Only significant ($p < .05$) relationships were included in regression models. Gender, TICS-M, SF-12 PCS, and qualification status were associated with self-rated driving ability. Age, gender, TICS-M, SF-12 PCS, number of medical conditions, and qualification status were associated with driving avoidance. Gender, TICS-M, and qualification status were associated with driving exposure. Variables uncorrelated with outcome measures were not explored further.

Three hierarchical multiple regression models were conducted, each examining an outcome measure, and including only predictor variables significantly associated with the outcome of interest in each model. Potential multicollinearity of measures was examined using Spearman correlations. No coefficients between variables were greater

Table 2. Correlation Matrix

	3-month self-rated driving	3-month driving avoidance	3-month driving exposure
Age	−.119	.210*	−.130
Gender	.216*	−.317**	.282**
Education	.137	−.111	.124
SF-12 physical component	.186*	−.250**	.120
SF-12 mental component	.095	−.096	.062
Number of medical conditions	−.038	.216*	−.164
Number of eye conditions	.054	.122	−.163
TICS-M	.238**	−.227**	.182*
Qualification status	.181*	−.302**	.207*
Number of at-fault crashes	−.063	.109	.030
Any crashes	.039	.064	.042

Notes: SF-12 = 12-Item Short-Form Health Survey; TICS-M = Modified Telephone Interview for Cognitive Status.
*$p < .05$. **$p < .01$.

than an absolute value of .35. In Step 1, we adjusted each model for participants' baseline scores on the outcome variable of interest (e.g., baseline self-rated driving ability was included in Step 1 of examining 3-month self-rated driving ability). In each model, baseline scores were significantly associated with follow-up scores on the relevant measure (*p*s < .001). In Step 2, qualification status was included in each model. Finally, Step 3 included baseline variables that were significantly associated with each outcome variable.

Only baseline self-rated driving ability ($p < .001$) was significantly associated with subsequent self-rated driving in Step 2 of the first model (Table 3). After adding significant baseline predictors in Step 3, baseline self-rated driving ($p < .001$) and gender ($p = .027$) were found to be significant predictors. Female gender was predictive of lower self-rated driving after 3 months. SF-12 PCS, TICS-M, and qualification status were not significantly associated with follow-up self-rated driving ability. Of nonqualifying participants, 22% ($n = 10$) decreased their self-rating, 71% ($n = 32$) experienced no change, and 7% ($n = 3$) increased their self-rating. Of qualifying participants, 28% ($n = 24$) decreased their self-rating, 65% ($n = 56$) experienced no change, and 7% ($n = 6$) increased their rating.

Qualification status ($p = .002$) and baseline driving avoidance ($p < .001$) were significant predictors of subsequent driving avoidance in Step 2 of the second model (Table 4). After adding baseline predictors in Step 3, baseline driving avoidance ($p < .001$) and qualification status ($p = .032$) remained significant. Of nonqualifying participants, 58% ($n = 26$) increased their driving avoidance, 15% ($n = 7$) reported no change, and 26% ($n = 12$) decreased their avoidance. Of qualifying participants, 39% ($n = 34$) increased their driving avoidance, 28% ($n = 24$) experienced no change, and 33% ($n = 28$) decreased their avoidance.

Only baseline driving exposure was a significant predictor ($p < .001$) of subsequent driving exposure in Step 2 and in Step 3 of the third model (Table 5). Of nonqualifying participants, 15% ($n = 7$) increased their exposure, 58% ($n = 26$) reported no change, and 27% ($n = 12$) decreased their exposure. Of qualifying participants, 13% ($n = 14$) increased their driving exposure, 71% ($n = 61$) experienced no change, and 16% ($n = 6$) decreased their exposure.

Discussion

The purpose of the current study was to examine the association between feedback on qualification for an insurance discount (based on a test of visual speed of processing) and subsequent self-reported indicators of driving—avoidance, exposure, and ability. We found that feedback was differentially associated with the three outcome measures, with a significant association only for change in driving avoidance. We hypothesized that, congruent with Anstey's model for enabling driving safety, providing feedback regarding a cognitive ability important to driving safety (visual speed of processing) might be predictive of change in driving self-regulation and self-rated driving ability. This was in part supported by the significant finding in regards to driving avoidance. After controlling for baseline driving avoidance, qualification status emerged as a significant predictor of driving avoidance at follow-up ($p = .041$). This

Table 3. Regression Model Examining Indicators of Self-rated Driving Ability at 3-Month Follow-up

Model	*B*	*SE B*	β	*p*
Step 1				
Baseline self-rated driving ability	.651	.073	.620	.000
Step 2				
Baseline self-rated driving ability	.631	.076	.600	.000
Qualification Status	.106	.101	.075	.298
Step 3				
Baseline self-rated driving ability	.596	.079	.567	.000
Qualification status	.059	.105	.042	.574
Gender	.199	.093	.151	.034
SF-12 physical component	.002	.006	.024	.742
TICS-M	.014	.016	.066	.386

Note: Step 1, $R^2 = .384$ ($p < .001$); Step 2, $\Delta R^2 = .005$ ($p = .298$); Step 3, $\Delta R^2 = .027$ ($p = .134$). SF-12 = 12-Item Short-Form Health Survey; TICS-M = Modified Telephone Interview for Cognitive Status.

Table 4. Regression Model Examining Indicators of Driving Avoidance at 3-Month Follow-up

Model	*B*	*SE B*	β	*p*
Step 1				
Baseline driving avoidance	.794	.061	.757	.000
Step 2				
Baseline driving avoidance	.747	.061	.712	.000
Qualification status	−1.97	.630	−.181	.002
Step 3				
Baseline driving avoidance	.714	.065	.680	.000
Qualification status	−1.58	.679	−.145	.022
Age	.136	.078	.107	.082
Gender	−.751	.604	−.074	.216
SF-12 physical component	−.044	.037	−.074	.231
Number of medical conditions	.032	.162	.012	.844
TICS-M	.076	.104	.045	.468

Note: Step 1, $R^2 = .572$ ($p < .001$); Step 2, $\Delta R^2 = .031$ ($p = .002$); Step 3, $\Delta R^2 = .024$ ($p = .177$). SF-12 = 12-Item Short-Form Health Survey; TICS-M = Modified Telephone Interview for Cognitive Status.

finding is consistent with previous studies that reported changes in driving self-regulation after providing participants with feedback regarding abilities relevant to driving (Eby et al., 2003; Holland & Rabbitt, 1992; Owsley et al., 2003). That qualification for a discount was predictive of self-rated driving avoidance but not self-rated exposure or self-rated driving ability is interesting and has not been found before because this study is unique in using multiple measures of driving outcomes.

The lack of significant findings for self-rated driving exposure and self-rated driving ability in this study is perhaps not surprising. Although prior research has identified a variety of physical and cognitive factors associated with driving self-regulation, the purpose of this study was to examine whether feedback predicted change over 3 months, beyond the role of other possible contributing variables (health, cognitive, and physical). Variables previously found associated with self-regulation may not impact changes in self-regulation over a relatively short amount of time (3 months) in a significant way. Because the statistical models included baseline outcome measures, variance contributed by factors previously linked with self-regulation may already have been accounted.

Although Baldock et al, (2006a) found that older drivers restricted their driving due to general health status and medication use, none of the health/physical functioning variables were predictive of driving avoidance in this sample. This finding may be due in part to the use of a relatively healthy sample, as the average SF-12 score in this sample was higher ($M = 48.56$) than nationally

Table 5. Regression Model Examining Indicators of Driving Exposure at 3-Month Follow-up

Model	*B*	*SE B*	β	*p*
Step 1				
Baseline driving exposure	.745	.065	.712	.000
Step 2				
Baseline driving exposure	.737	.066	.705	.000
Qualification status	.161	.220	.046	.465
Step 3				
Baseline driving exposure	.7108	.070	.677	.000
Qualification status	.122	.230	.035	.599
Gender	.275	.218	.083	.210
TICS-M	.012	.035	.023	.724

Note: Step 1, $R^2 = .51$ ($p < .001$); Step 2, $\Delta R^2 = .002$ ($p = .465$); Step 3, $\Delta R^2 = .007$ ($p = .429$). TICS-M = Modified Telephone Interview for Cognitive Status.

representative values for noninstitutionalized adults of the same age (*M*s for men and women of ages 70–89 ranged from 36 to 41.1; Hanmer, Lawrence, Anderson, Kaplan, & Fryback, 2006). Also, health and physical functioning may be more relevant to gradual changes in driving regulation, rather than the relatively immediate changes examined in these analyses.

Although previous studies have found poorer cognitive abilities to be associated with decreased driving exposure (Stutts, 1998), qualification status based on UFOV performance was not associated with subsequent exposure. Previous research indicates that at least some older adults with lower cognitive functioning were probably engaged in compensatory self-regulation at baseline (Okonkwo et al., 2008; Stutts, 1998). It is also possible that when given feedback regarding their elevated crash risk, some older adults who already have minimal driving exposure may be unable to further reduce their exposure and may instead choose to regulate driving avoidance behaviors. Personal vehicles are the primary mode of transportation for most older adults, and access to health care, social opportunities, and other activities require a minimum amount of driving exposure to maintain independence. Illness or other changes in daily life might necessitate increased driving, independent of an individual's perceived abilities, or driving safety.

Lower baseline self-rated driving ability and female gender were predictive of lower subsequent self-rated driving ability, whereas feedback was not. Because the UFOV test upon which qualification was based has been found to predict crash risk over a 5-year period (Ball et al., 2006), this finding is concordant with research reporting unrealistically high self-ratings of driving ability among older adults (Freund et al., 2005; Marottoli & Richardson, 1998). If older adults are not basing their self-ratings on abilities that are important for driving safety, then these self-ratings may be inaccurate. Some researchers have suggested that older adults may refuse to admit awareness of deficits (Freund et al., 2005). Participants in this sample did not significantly change their self-ratings after receiving feedback about their qualification status, which may imply a refusal to admit awareness of changes in cognitive abilities. However, this finding may simply reflect the general stability of self-rated driving ability reported previously (Groeger & Grande, 1996). Whereas 33% of this sample reported a change in self-rated driving ability over 3 months (7% positive and 26% negative), the majority did not. If older adults are reluctant to alter their opinions of their driving ability, particularly if changes in ability can be compensated for by altering driving habits, this may contribute to stable ability ratings. There is also some question as to how long individuals must experience a decline in ability before altering their opinion, as reflected in self-ratings.

It is interesting that gender was significantly predictive of subsequent self-rated driving ability, even after controlling for baseline self-ratings. Men rated their driving ability higher at follow-up, regardless of qualification status. Many studies of self-rated driving ability have not examined gender (Freund et al., 2005; McKenna & Myers, 1997), examined only one gender (Anstey & Smith, 2003; Vardaki, 2008), or reported no gender differences in self-rated driving ability (Marottoli & Richardson, 1998; Parker, MacDonald, Sutcliffe, & Rabbitt., 2001). Consistent with our findings, Nasvadi (2007) found that, compared with women, older men reported more comfort with their driving ability and were more likely to report better driving skills after a driver education program. Perhaps overestimation of driving ability, as a strategy to maintain a positive self-image, is utilized more frequently by men when faced with negative feedback such as nonqualification for a discount.

Some participants did not alter their self-regulation or self-rating after receiving negative feedback, or altered them in an unexpected direction. De Raedt and Ponjaert-Kristoffersen (2006) have suggested that older adults may overestimate their driving abilities as a coping strategy to deal with age-related limitations. Nonqualifying participants may have increased their self-ratings or decreased avoidance behaviors to reinforce or boost positive self-appraisals as means of coping with feedback that may threaten participants' independence. Nonqualifiers who increased exposure might be employing self-protective coping, or increased exposure may signify a change in life circumstances.

It was also unexpected that some participants who received positive feedback reported increased self-regulation and lower self-rated driving, although there are several possible reasons for this finding. Anecdotally, the authors noted that most participants, even those who qualified, reported experiencing difficulty performing the test. This may have resulted from the format of the UFOV test itself. The display time of objects ranged from 17 to 500 ms, where the program increased and decreased speed of display duration until the participant could not correctly complete the task 75% of the time at a given speed. Therefore, even the best possible score (17 ms) on each of the three sub tests could have included many incorrect responses (as long as the incorrect responses accounted for less than 25% of responses at each display speed). Few of the participants in this sample attained a score of 17 ms on each subtest, meaning that many incorrect responses were possibly made during the course of the test. Even participants with the best possible scores often remarked to investigators that they did not do as well as they expected. As a consequence, even participants with qualifying scores may have felt a need to reevaluate their driving behaviors after completing the task. In fact, those who qualified may have been more likely to judge the test a valid measure, as doing so would not threaten their assessment of themselves as safe drivers.

Previous crash involvement (at-fault or general involvement) was not found to be related to any outcome measure, perhaps because it was infrequent in this sample. Fewer than 12% of participants had experienced an at-fault crash, and only 21% had been involved in any crash (regardless of fault) during the previous 5 years. Analyses in a sample with higher rates of crash experience may find a relationship between crash history and subsequent driving self-regulation. Also, it is possible that previous crash experience is related to baseline self-assessments but not to follow-up measures unless the collisions occurred during the interval between baseline and follow-up. Participants who had experienced crashes may have already been regulating their driving at the time of the initial interview.

Limitations

Participants in the current study were not excluded based on physical or cognitive measures but were largely intact in terms of health/physical (Hanmer et al., 2006) and cognitive functioning (De Jager et al., 2003). Similar analyses in a more impaired sample may yield differing results. Participants with severe cognitive impairment may lack self-monitoring ability, which might change the significant relationship between qualification status and subsequent driving avoidance. A sample composed of more physically impaired participants (particularly visual impairment) may have shown greater baseline self-regulation of driving and lower baseline self-rated driving ability. All health and physical measures included in these analyses relied upon self-report, and may be more informative as predictors of mobility outcomes when assessed directly or if measured in terms of functional limitation caused by such conditions. All outcome measures were also based upon self-report. No objective measures of visual ability were available for inclusion in these analyses, and the low rate of previous crashes in this sample may have limited our ability to investigate this variable. Another possible limitation of this study is the face validity of the UFOV test for older drivers. A road test would have the best face validity for assessing driving competency. As a test of visual processing speed, some older adults may not view UFOV feedback as final or decisive regarding their actual driving ability or safety. Also, feedback for this study was given in a relatively neutral manner, and more strongly worded scripts (for both positive and negative feedback) may have had a different impact on subsequent driving behavior.

Because the majority of participants in this study rated their driving as good or excellent, ceiling effects may have occurred. Of participants who reported no change in self-rating across 3 months, 7% (n = 6) rated their driving at baseline as average, 53% (n = 47) as good, and 40% (n = 35) as excellent. For participants with baseline ratings of excellent, improvement in self-rating could not be detected. A significant relationship was found between qualification status and attrition. Inclusion of participants lost due to refusal (n = 22) would have resulted in a qualification rate of 61%, rather than 67%, which may have limited our ability to detect effects of feedback.

Summary

Overall, the findings of this study provide modest support for the role of feedback in the self-monitoring of older adults' driving behavior through avoidance of challenging driving situations but not through driving exposure or self-rated driving ability. These findings suggest that feedback on cognitive performance may differentially affect various components of driving behaviors and beliefs, supporting the use of a multidimensional approach to measuring these constructs in older adults. Future research could examine the relationship between past crash incidents and change in self-regulation in a sample that includes a higher rate of crashes. Additionally, more research is needed to examine whether increased driving self-regulation due to feedback regarding cognitive abilities decreases subsequent crash risk. There are many different reasons that older drivers may regulate their driving behavior, and although this study examines just a few possible factors, it is unique in the literature. The results of this study need to be replicated and would benefit from augmentation with certain other measures and procedures, particularly measures of actual (rather than self-reported) driving behavior.

Funding

The State Farm study was supported through a Small Business Innovation Research grant from the National Institute on Aging (R44 AG022799) to Visual Awareness Research Group, Inc. The Center for Translational Research on Aging and Mobility is supported by an Edward R. Roybal Center grant (5 P30 AG022838).

Acknowledgments

The authors thank the entire State Farm team and Philip Ball and Matt Parsons, in particular, who were instrumental in collecting data. K. K. Ball owns stock in the Visual Awareness Research Group, Inc. (formerly Visual Awareness, Inc.) and Posit Science, Inc., the companies that market the Useful Field of View Test and speed of processing training software. Posit Science acquired Visual Awareness Research Group, Inc., and K. K. Ball continues to collaborate on the design and testing of these assessment and training programs as a member of the Posit Science Scientific Advisory Board. D. E. Vance and V. G. Wadley have also worked as consultants to Visual Awareness Research Group, Inc. No other authors have a financial disclosure or conflict of interest.

References

Anstey, K. J., & Smith, G. A. (2003). Associations of biomarkers, cognition and self-reports of sensory function with self-reported driving behavior and confidence. *Gerontology*, *49*, 196–202.

Anstey, K. J., Wood, J., Lord, S., & Walker, J. G. (2005). Cognitive, sensory and physical factors enabling driving safety in older adults. *Clinical Psychology Review*, *25*, 45–65.

Baldock, M. R., Mathias, J. L., McLean, J., & Berndt, A. (2006a). Self-regulation of driving and older drivers' functional abilities. *Clinical Gerontologist*, *30*(1), 53–70.

Baldock, M. R., Mathias, J. L., McLean, J., & Berndt, A. (2006b). Self-regulation of driving and its relationship to driving ability among older adults. *Accident Analysis and Prevention*, *38*, 1038–1045.

Ball, K., Owsley, C., Stalvey, B., Roenker, D. L., Sloane, M. E., & Graves, M. (1998). Driving avoidance and functional impairment in older drivers. *Accident Analysis and Prevention*, *30*, 313–322.

Ball, K., Roenker, D., Wadley, V., Edwards, J. D., Roth, D., & McGwin, G., et al. (2006). Can high risk older drivers be identified through performance-based measures in a department of motor vehicles setting? *Journal of the American Geriatrics Society*, *54*, 77–84.

Blanchard, R. A., & Myers, A. M. (2010). Examination of driving comfort and self-regulatory practices in older adults using in-vehicle devices to assess natural driving patterns. *Accident Analysis and Prevention*, *42*, 1213–1219.

Brandt, J., Welsh, K. A., Breitner, J. C., Folstein, M. F., Helms, M., & Christian, J. C. (1993). Hereditary influences on cognitive functioning in older men. A study of 4000 twin pairs. *Archives of Neurology*, *50*, 599–603.

Charlton, J. L., Oxley, J., Fildes, B., Oxley, P., Newsteadt, S., & Koppel, S. (2006). Characteristics of older drivers who adopt self-regulatory driving behaviours. *Transportation Research Part F*, *9*, 363–373.

Clément, F., Belleville, S., & Gauthier, S. (2008). Cognitive complaint in mild cognitive impairment and Alzheimer's disease. *Journal of the International Neuropsychological Society*, *214*, 222–232.

Cooper, P. J. (1990). Elderly drivers' views of self and driving in relation to the evidence of accident data. *Journal of Safety Research*, *21*, 103–113.

De Jager, C. A., Budge, M. M., & Clark, R. (2003). Utility of TICS-M for the assessment of cognitive function in older adults. *International Journal of Geriatric Psychiatry*, *18*, 318–324.

De Raedt, R., & Ponjaert-Kristoffersen, I. (2006). Self-serving appraisal as a cognitive coping strategy to deal with age-related limitations: An empirical study with elderly adults in a real-life stressful situation. *Aging and Mental Health*, *10*, 195–203.

Dobbs, B. (1999). *Self-perceptions of competence as determiners of driving*. Doctoral dissertation, University of Alberta, Edmonton, Canada.

Donorfio, L. K. M., D'Ambrosio, L. A., Coughlin, J. F., & Mohyde, M. (2008). Health, safety, self-regulation and the older driver: It's not just a matter of age. *Journal of Safety Research*, *39*, 555–561.

Eby, D. W., Molnar, L. J., Shope, J. T., Vivoda, J. M., & Fordyce, T. A. (2003). Improving older driver knowledge and self-awareness through self-assessment: The driving decisions workbook. *Journal of Safety Research*, *34*, 371–381.

Edwards, J. D., Ross, L., Clay, O., Wadley, V., Crowe, M., Roenker, D., et al. (2006). The Useful Field of View test: Normative data. *Archives of Clinical Neuropsychology*, *21*, 275–286.

Freund, B., Colgrove, L. A., Burke, B. L., & McLeod, R. (2005). Self-rated driving performance among elderly drivers referred for driving evaluation. *Accident Analysis and Prevention*, *37*, 613–618.

Groeger, J. A., & Grande, J. A. (1996). Self-preserving assessments of skill? *British Journal of Psychology*, *87*, 61–79.

Hanmer, J., Lawrence, W. F., Anderson, J. P., Kaplan, R. M., & Fryback, D. (2006). Report of nationally representative values for the noninstitutionalized US adult population for 7 health-related quality-of-life scores. *Medical Decision Making*, *26*, 391–400.

Holland, C. A., & Rabbitt, P. M. (1992). People's awareness of their age-related sensory and cognitive deficits and the implications for road safety. *Applied Cognitive Psychology*, *6*, 217–231.

Kalbe, E., Salmon, E., Perani, D., Holthoff, V., Sorbi, S., & Elsner, A., et al. (2005). Anosognosia in very mild Alzheimer's disease but not in mild cognitive impairment. *Dementia and Geriatric Cognitive Disorders*, *19*, 349–356.

Lyman, J. M., McGwin, G. J., & Sims, R. V. (2001). Factors related to driving difficulty and habits in older drivers. *Accident Analysis and Prevention*, *33*, 413–421.

Man-Son-Hing, M., Marshall, S. C., Molnar, F. J., & Wilson, K. G. (2007). Systematic review of driving risk and efficacy of compensatory strategies in persons with dementia. *Journal of the American Geriatrics Society*, *55*, 878–884.

Marottoli, R. A., & Richardson, E. D. (1998). Confidence in, and self-rating of, driving ability among older drivers. *Accident Analysis and Prevention*, *30*, 331–336.

McKenna, F. P., & Myers, L. B. (1997). Illusory self-assessments—Can they be reduced? *British Journal of Psychology*, *88*, 39–51.

Nasvadi, G. E. (2007). Changes in self-reported driving behaviour following attendance at a mature driver education program. *Transportation Research Part F*, *10*, 258–369.

Okonkwo, O., Crowe, M., Wadley, V., & Ball, K. (2008). Visual attention and self-regulation of driving among older adults. *International Psychogeriatrics*, *20*, 162–173.

Okonkwo, O., Wadley, V., Crowe, M., Roenker, D., & Ball, K. (2007). Self-regulation of driving in the context of impaired visual attention: Are there gender differences? *Rehabilitation Psychology*, *52*, 421–428.

Owsley, C., Ball, K., McGwin, G., Sloane, M. E., Roenker, D. L., & Whilte, M. F., et al. (1998). Visual processing impairment and risk of motor vehicle crash among older adults. *Journal of the American Medical Association*, *279*, 1083–1088.

Owsley, C., McGwin, G., Phillips, J. M., McNeal, S. F., & Stalvey, B. (2004). Impact of an educational program on the safety of high-risk, visually impaired, older drivers. *American Journal of Preventative Medicine*, *26*, 222–229.

Owsley, C., Stalvey, B. T., & Phillips, J. M. (2003). The efficacy of an educational intervention in promoting self-regulation among high-risk older drivers. *Accident Analysis and Prevention*, *35*, 393–400.

Owsley, C., Stalvey, B., Wells, J., & Sloane, M. (1999). Older drivers and cataract: Driving habits and crash risk. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *54A*, M203–M211.

Parker, D., MacDonald, L., Sutcliffe, P., & Rabbitt, P. (2001). Confidence and the older driver. *Ageing and Society*, *21*, 169–182.

Ross, L. A., Clay, O., Edwards, J. D., Ball, K., Wadley, V., & Vance, D., et al. (2009). Do older drivers at-risk for crashes modify their driving over time? *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *64B*, 163–170.

Stutts, J. C. (1998). Do older drivers with visual and cognitive impairments drive less? *Journal of the American Geriatrics Society*, *46*, 854–861.

Tuokko, H. A., McGee, P., Gabriel, G., & Rhodes, R. E. (2007). Perception, attitudes and beliefs, and openness to change: Implications for older driver education. *Accident Analysis and Prevention*, *39*, 812–817.

Vance, D., Roenker, D. L., Cissell, G. M., Edwards, J. D., Wadley, V., & Ball, K. (2006). Predictors of driving exposure and avoidance in a field study of older drivers from the state of Maryland. *Accident Analysis and Prevention*, *38*, 823–831.

Vardaki, S. (2008). Investigation of actual and perceived behavior of older drivers on freeways. *Transportation Research Record: Journal of the Transportation Research Board*, *2078*, 41–48.

Ware, J. E., Jr., Kosinski, M., & Keller, S. D. (1996). A 12-item short form health survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care*, *34*, 220–233.

West, C. G., Gildengorin, G., Haegerstrom-Portnoy, G., Lott, L., Schneck, M. E., & Brabyn, J. (2003). Vision and driving self-restriction in older adults. *Journal of the American Geriatrics Society*, *51*, 1348–1355.

Appendix A

UFOV Cut-off for Classifying Risk Category

Scores for subtests (in ms)	Risk category
Subtest 1 >0 but ≤30, and Subtest 2 >0 but ≤100, and Subtest 3 >0 but <350	Very low (1)
Subtest 1 >0 but ≤30, and Subtest 2 ≥100 but <350, and Subtest 3 ≥350 but ≤500	Low (2)
Subtest 1 >0 but ≤30, and Subtest 2 ≥100 but <350, and Subtest 3 >0 but <350	Low (2)
Subtest 1 >0 but ≤30, and Subtest 2 ≥100 but <350, and Subtest 3 ≥350 but ≤500	Low to moderate (3)
Subtest 1 >0 but ≤30, and Subtest 2 ≥350 but ≤500, and Subtest 3 ≥350 but ≤500	Moderate to high (4)
Subtest 1 >30 but ≤60, and Subtest 2 >0 but <100, and Subtest 3 >0 but <350	Low (2)
Subtest 1 >30 but ≤60, and Subtest 2 >0 but <100, and Subtest 3 ≥350 but ≤500	Low to moderate (3)
Subtest 1 >30 but ≤60, and Subtest 2 ≥100 but <350, and Subtest 3 >0 but <350	Low to moderate (3)
Subtest 1 >30 but ≤60, and Subtest 2 ≥100 but <350, and Subtest 3 ≥350 but ≤500	Moderate to high (4)
Subtest 1 >30 but ≤60, and Subtest 2 ≥350 but ≤500, and Subtest 3 ≥350 but ≤500	High (5)
Subtest 1 >60 but <350, and Subtest 2 ≥100 but <350, and Subtest 3 >0 but <350	Low to moderate (3)
Subtest 1 >60 but <350, and Subtest 2 ≥100 but <350, and Subtest 3 ≥350 but ≤500	Moderate to high (4)
Subtest 1 >60 but <350, and Subtest 2 ≥350 but ≤500, and Subtest 3 ≥350 but ≤500	High (5)
Subtest 1 ≥350 but ≤500, and Subtest 2 ≥350 but ≤500, and Subtest 3 ≥350 but ≤500	Very high (5)