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What Factors Influence the Relationship between Feedback on Cognitive Performance and Subsequent Driving Self-Regulation?

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Abstract

Recent research indicates that providing feedback about cognitive abilities (i.e., UFOV[®] test performance) may change driving self-regulation; however, 42% of participants who received negative feedback failed to increase driving self-regulation (Ackerman, Ball, Crowe, Owsley, Vance, & Wadley, 2011). The current study extends those findings, using the same sample ($N = 129$) to investigate factors that may influence the relationship between feedback regarding cognitive abilities and driving self-regulation. Feedback by age and feedback by number of eye conditions showed significant interactions, and feedback by baseline driving exposure interaction approached significance. Older participants (80–94; $n = 38$) who received negative feedback significantly increased subsequent avoidance of challenging driving conditions relative to baseline. Participants with no reported eye conditions ($n = 36$) who received negative feedback significantly increased subsequent driving avoidance, and participants with below median baseline driving exposure ($n = 66$) tended to increase subsequent driving avoidance. These results identify individual level factors that may influence the relationship between feedback regarding cognitive abilities and self-regulation and have implications for encouraging older adults to make informed decisions about appropriate driving behavior.

Keywords

Older drivers; Self-regulation; Driving exposure; Driving avoidance

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It has been proposed that driving safety is produced by the ability to self-evaluate enabling factors such as cognition, vision, and physical functioning and adjust driving behavior accordingly (referred to as self-monitoring; Anstey, Wood, Lord, & Walker, 2005). However, research suggests that older adults may not be aware of deficits in physical or cognitive abilities (Eby, Molnar, Shope, Vivoda, & Fordyce, 2003; Freund, Colgrove, Burke, & McLeod, 2005). Accordingly, if older adults are unaware of deficits in physical or cognitive abilities, they may be unable to adjust their driving behaviors to ensure safety.

Preliminary evidence suggests that providing feedback about functional abilities relevant to driving may promote better informed decisions about driving self-regulation (Ball, Owsley, Stalvey, Roenker, Sloane, & Graves, 1998; Holland & Rabbitt, 1992; Owsley, Stalvey, & Phillips, 2003). One recent study (Ackerman et al., 2011) indicates that providing feedback regarding cognitive abilities (based on UFOV[®] test score) may lead to changes in driving self-regulation. Older drivers aged 75–93 ($N = 129$) took part in the Senior Driver Research Project. Participants who surpassed a cut-off score on the UFOV[®] test were informed that they qualified for a discount on their auto insurance; those with scores below the cut-off were informed that they did not qualify. Subsequent change in driving self-regulation across three months was measured with difference scores on a composite of self-reported avoidance of six challenging driving situations (e.g., driving at night) at baseline and follow-up assessments. Participants were informed about the significance of the UFOV[®] test in predicting crash risk but were not given recommendations for driving behavior. Receiving negative feedback about cognitive abilities (not qualifying for the discount) was a significant predictor of increased avoidance of challenging driving situations across three months ($p = .02$). However, 42% of the participants who received negative feedback in this study did not report any subsequent increase in driving self-regulation.

Research has identified many factors associated with greater levels of driving self-regulation in older adults, including older age (particularly as health status declines), female gender, fewer years of education, not being the principal driver in the household, crash involvement in the previous two years, vision problems, poor health status, declines in reaction time, low annual mileage, having fewer activities and thus fewer driving destinations, and poorer cognitive functioning (Charlton et al., 2006; Donorfio, D'Ambrosio, Coughlin, & Mohyde, 2008; Meng & Siren, 2013; Naumann, Dellinger, & Kreshnow, 2011; Vance et al., 2006; West et al., 2003). It is not known whether individual level factors may moderate the relationship between feedback regarding cognitive abilities and self-regulation. The current study sought to extend the findings of Ackerman et al. (2011), using the same sample to investigate such potential moderators.

Method

Overview and Procedure

This study was part of a larger ongoing project known as the Senior Driver Research Project, which began data collection in July 2004 at eleven sites across the state of Alabama. The study was conducted in a collaboration between State Farm Insurance Company, Visual Awareness, Inc. and the University of Alabama at Birmingham Edward R. Roybal Center for Translational Research on Aging and Mobility. Further details of this study have been

published elsewhere (Okonkwo, Wadley, Crowe, Roenker, & Ball, 2007). Between July, 2006 and May, 2008, State Farm-insured drivers aged 75 and older from the Birmingham area were administered an expanded questionnaire at their initial visit (IRB protocol number X031203004). These 165 participants were eligible for telephone follow-up interviews after two to four months. The telephone questionnaire included questions from the baseline visit as well as additional questions on mobility outcomes and driving perceptions.

Participants

Participants included 129 community-dwelling older adults who completed the questionnaire and successfully completed a follow-up telephone interview approximately three months after their baseline visit. Thirty-six participants eligible for follow-up were not included in these analyses (13% refused participation, 4% missing data, 5% reported not knowing their qualification status). Descriptive characteristics are displayed in Table 1. Sixty-seven percent ($n = 86$) of participants qualified for the insurance discount.

Measures

Demographics—Age in years and gender (*females = 0, males = 1*) were transcribed from participants' driver's licenses. Years of education was self-reported (*1st grade = 1, through doctoral degree = 20*).

Medical Conditions Questionnaire—Participants reported if they had ever been diagnosed by a physician with any of the following eye conditions (cataracts, diabetic retinopathy, dry eye syndrome, glaucoma, macular degeneration, optic neuritis, retinal detachment) or medical conditions (asthma/breathing problems, chronic skin problems, diabetes, heart disease, heart problems, high cholesterol, hypertension/high blood pressure, multiple sclerosis, osteoporosis, Parkinson's, stroke/mini stroke/transient ischemic attack). Total number of eye conditions endorsed and medical conditions endorsed were separately summed for analyses.

Modified Telephone Interview of Cognitive Status (TICS-M; Brandt et al., 1993)—This measure of global cognitive status includes 13 items, and was administered in-person. Possible scores range from 0 to 39, with higher scores indicating better cognitive function; scores below 21 have been found equivalent to a score below 25 on the Mini Mental Status Examination (De Jager, Budge, & Clark, 2003).

Crash History—Automobile crash involvement information for five years prior to the baseline visit was obtained from the Alabama Department of Public Safety, which compiles records on all drivers licensed in Alabama. Number of at-fault crashes was ascertained individually by three separate assessors. Eleven percent ($n = 15$) of participants had experienced at least one at-fault crash, while 21% ($n = 28$) had experienced at least one crash (regardless of fault).

Qualification Status—Qualification for the automobile insurance discount in this study was dependent on surpassing a cut-off score on the UFOV® test (Edwards et al., 2006), which measures processing speed by determining the minimum display duration at which a

participant can process visual information for three subtests of increasing difficulty. Based on these minimum duration scores, participant performance was designated into one of five possible risk categories (Ackerman et al., 2011), where category 1 or 2 (low risk) qualified for the discount, while those in categories 3, 4, or 5 (moderate to high risk) did not qualify. Qualification regarding the insurance discount was reported to participants at the end of their baseline visit (*non-qualified* = 0, *qualified* = 1).

Driving Habits Questionnaire (DHQ; Owsley, Stalvey, Wells, & Sloane, 1999)

This measure assesses avoidance of specific driving situations and exposure in terms of the amount one drives. Using a likert scale, six driving avoidance items (referring to the prior three-month period) ascertain how often participants avoid driving in various situations such as at night, during bad weather, in rush-hour traffic, on high traffic roads, in unfamiliar areas, or making left turns across on-coming traffic (*never* = 1 to *always* = 5). Responses on these items were summed to form a driving avoidance composite score at baseline and three-month follow-up. A change score was calculated by subtracting avoidance composite scores at baseline from those at follow-up. Positive change scores denote increased avoidance over three months, while negative change scores denote decreased avoidance.

Driving exposure was measured by two self-report items – number of days per week driven and miles driven per week. Responses were converted to *z* scores and summed to form a baseline driving exposure composite.

Data Analysis

All analyses were calculated using SPSS 14.0 for Windows. On the basis of the literature reviewed, variables potentially impacting the relationship between feedback regarding cognitive performance and driving avoidance were selected: age, education, gender, vision, health, cognitive status, crash involvement, and driving exposure. Eight separate linear multiple regression models (Table 2) were conducted to assess the associations of interaction terms (cross-product of feedback by respective variable) for each variable of interest (age, gender, education, TICS-M, number of eye conditions, number of medical conditions, crash history and baseline driving exposure) with change in driving avoidance across three months. Step 1 of each model included the interaction term, feedback, and variable of interest, while Step 2 controlled for age, gender, and baseline driving avoidance. In each model, baseline avoidance scores were significantly associated with change in avoidance across three months scores ($p < .001$). Only significant and near significant interactions were evaluated further using separate regression analyses, controlling for age, gender and baseline driving avoidance (Table 3).

Results

Significant interactions were found for age by feedback ($p = .031$), number of eye conditions by feedback ($p = .043$), and an interaction approaching significance was found for baseline driving exposure by feedback ($p = .057$).

For models with significant or near significant interaction terms, separate multiple linear regression analyses have been completed for stratified data sets (Table 3) for the three

factors identified as having possible interactions, again controlling for age, gender, and baseline avoidance. For the interaction of feedback and age, separate regressions were conducted to examine feedback as a predictor of three month change in avoidance among participants 75–79, and those 80+. This cut-off was chosen based on previous research on driver perceptions and self-reported and actual driving exposure and patterns which examined sex and age differences between adults below 80 years and those 80 years and older (Myers, Trang, & Crizzle, 2011). Feedback was a significant predictor among participants 80+ ($n = 38$; $p = .045$), but not for those 75–79 ($n = 91$; $p = .136$). For the interaction of feedback and number of eye conditions, separate regressions were conducted; feedback was a significant predictor among participants with no eye conditions ($n = 36$; $p = .007$), but not for those with one or more eye conditions ($n = 93$; $p = .124$). For the interaction of feedback and driving exposure, separate regressions were conducted, and feedback was found to be a significant predictor among participants with low (below median) exposure ($n = 66$; $p < .01$), but not for those with high (above median) exposure ($n = 63$; $p = .76$).

Discussion

The purpose of the current study was to examine potential moderators of the relationship between feedback regarding cognitive abilities and subsequent self-reported driving behavior. Potential moderators included age, gender, education, global cognitive status (TICS-M), number of medical conditions, number of eye conditions, crash history and baseline driving exposure. Analysis revealed that three factors influenced the relationship between feedback on cognitive performance and subsequent driving self-regulation: age, number of eye conditions, and baseline driving exposure. Further investigation revealed that older participants (80–94), those with no reported eye conditions, and those with low (below median) baseline driving exposure who did not qualify for a discount subsequently avoided more challenging driving situations.

None of the other potential moderators showed significant interactions. This study is not a cross-sectional examination of driving self-regulation, but investigates change in self-regulation over three months, while controlling for baseline avoidance. Previous research indicates that at least some older adults with driving-related functional and cognitive deficits were most likely engaged in compensatory self-regulation at baseline (Baldock, Mathias, McLean, & Berndt, 2006; Charlton et al., 2006; Owsley et al., 1999; Vance et al., 2006; West et al., 2003). This may explain why participants with no eye conditions were more likely to self-regulate after receiving negative feedback; if they had no functional deficits they may not have been engaging in previous self-regulation, leading to a statistically significant change. Additionally, this study focused on factors that moderate an older driver's decision to self-regulate their driving after receiving feedback regarding their driving-related cognitive abilities (and qualification for an insurance discount). Research suggests that self-regulation of driving increases with age (Donorfio et al., 2008), with poor vision (West et al., 2003), and lower driving exposure (Naumann, Dellinger, & Kresnow, 2011). As these factors have been related to voluntary changes in driving behavior, it is perhaps not surprising that these same factors would relate to willingness to change driving behavior after receiving negative feedback regarding cognitive abilities.

This study's limitations mirror those of the original study (see Ackerman et al., 2011), including a majority of self-report measures and a largely cognitively and physically healthy sample. Participants in this study were those who were insured by State Farm and who were motivated to receive an insurance discount, which may indicate subject selection effects and may also account for the relatively high rates of at-fault crashes reported (Table 1).

Summary

These results suggest that some older drivers are more amenable to making changes in their driving self-regulation after receiving feedback about functional abilities relevant to driving. Older adults with minimal driving exposure, those with no reported eye conditions, and those over 80 years old were more likely to modify their driving habits after receiving negative feedback regarding cognitive skills related to driving safety. While these findings may have implications for encouraging older adults to make informed decisions about appropriate driving behavior based on driving-related functional and cognitive abilities, the challenges of changing driving behavior requires further research.

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Table 1

Sample Description and Potential Moderators

Baseline Variables	M	SD	Range
Demographics			
Age	78.7	4.0	75 – 93
Education	14.2	2.6	9 – 20
Gender (% female)	46		
Health/Physical Functioning			
Number of Eye Conditions	1.1	0.9	0 – 4
Number Medical Conditions	3.5	1.9	0 – 9
Cognition			
TICS-M ^a	24.9	3.1	18 – 34
Crash History	0.3	0.5	0–2
Feedback			
Qualification Status (% qualified for discount)	66.7		
Driving Measures			
Baseline Avoidance Composite	11.1	4.9	6 – 25
Baseline Exposure Composite	0.0	1.6	–3.2 – 10.1
Three Month Change in Avoidance ^b	11.4	5.2	6 – 30

Note. *N* = 129;

^aHigher scores indicate better performance;

^bhigher scores indicate increased avoidance;

TICS-M = Modified Telephone Interview of Cognitive Status.

Table 2

Multiple Linear Regression Models Examining the Interactive Impact of UFOV[®] Feedback and Various Socio-demographic Data on Three Month Driving Avoidance

Interactive Terms	<i>b</i>	<i>SE</i>	β	<i>p</i>
1. Feedback by Age*	-.321	.147	-3.39	.031
2. Feedback by Education	.371	.246	.755	.134
3. Feedback by Gender	1.53	1.20	.211	.206
4. Feedback by Eye Conditions*	1.369	.669	.304	.043
5. Feedback by Medical Conditions	.045	.312	.026	.886
6. Feedback by TICS-M	.154	.182	.545	.389
7. Feedback by Crash	-.499	1.23	-.063	.686
8. Feedback by Baseline Driving Exposure	.824	.429	.316	.057

Note. $p^* < .05$, $p^{**} < .01$;

all models control for baseline self-rated driving avoidance, gender, and age (except for models 1 and 2 when age and gender were used as interaction terms); TICS-M = Modified Telephone Interview of Cognitive Status.

Table 3

Multiple Linear Regression Models Examining UFOV[®] Feedback and Stratified Variables on Three Month Driving Avoidance

Model	<i>b</i>	<i>SE</i>	β	<i>p</i>
Age by Feedback				
1. 80+ (<i>n</i> = 38)*	-2.70	1.30	-.344	.045
2. 75-79 (<i>n</i> = 91)	-1.05	.698	-.141	.136
Driving Exposure by Feedback				
3. Lower than median baseline driving exposure (<i>n</i> = 66)**	-2.45	.902	-.311	.009
4. Higher than median baseline driving exposure (<i>n</i> = 63)	-.287	.936	-.041	.760
Driving Exposure by Eye Conditions				
5. No eye conditions (<i>n</i> = 36)**	-3.92	1.36	-.496	.007
6. One+ eye conditions (<i>n</i> = 93)	-2.12	.722	-.153	.124

Note. $p^* < .05$, $p^{**} < .01$;

All models control for baseline self-rated driving avoidance, gender, and age.