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DRIVING AVOIDANCE AND FUNCTIONAL IMPAIRMENT IN OLDER DRIVERS[1]

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Abstract—The purpose of this study was to examine the association between visual and cognitive impairment in older drivers and their avoidance of potentially challenging driving situations. A group of 257 older drivers participated in assessments of visual sensory function, eye health and cognitive function including the useful field of view test, and completed a structured questionnaire on driving exposure and how frequently they avoided challenging driving situations. Results replicated earlier studies showing that many older drivers limit their exposure to driving situations which are generally believed to be more difficult (e.g. rain, night, heavy traffic, rush hour). Furthermore, older drivers with objectively determined visual and/or attentional impairments reported more avoidance than those free of impairments; those with the most impairment reported avoiding more types of situations than other less impaired or non-impaired drivers. Older drivers with a history of at-fault crashes in the prior five years reported more avoidance than those who had crash-free records. Future research should evaluate the potentially beneficial role of self-regulation in enhancing older driver safety, particularly in those older drivers with visual and attentional processing impairments who have elevated crash risk.

Keywords—Cognitive impairment, Crash risk, Driving avoidance, Older drivers, Self-regulation, Vision impairment

INTRODUCTION

People are more active and living longer, healthier lives than they were 50 years ago. This has led to an increase in both the number of older drivers as well as the miles they annually drive. It is estimated that by the year 2024, one out of four drivers in the U.S.A. will be over the age of 65 (National Highway Traffic Safety Administration, 1988). Older adults rely heavily on the automobile for independence, mobility and an active lifestyle. One survey has suggested that individuals aged 65 years and older use the automobile for 80% of their errands and trips (Kosnick et al., 1988).

While research has shown that older drivers as a group have more crashes and incur more fatalities per mile driven than most other age groups (Transportation Research Board, 1988), most older drivers have crash free records (Evans, 1991). This is presumably because the subset of older drivers having functional impairments increase the average risk for the entire age group. In particular, older drivers with visual, cognitive, and/or attentional impairments are at a greater risk for crash involvement than individuals without such difficulties (Johnson and Keltner, 1983; Owsley et al., 1991; Ball et al., 1993). It may be the case that these risks could be minimized if older adults avoided driving situations which were the most visually and/or cognitively challenging, a question that deserves further investigation.

There is evidence that at least some older drivers modify or self-regulate their driving habits in certain driving situations. For example, older drivers are less likely as a group to drive at night or in heavy traffic (Planek et al., 1968), to make left turns, drive in the rain and fog, drive at sunrise and sunset, drive in heavy traffic and drive alone (Hennessy, 1995). There are several potential reasons why older adults modify their driving habits in later life, such as they may have more flexible daily schedules and thus have greater freedom to choose when and where they drive, they may have less need to drive on a daily basis, or

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they may recognize that they have functional impairments which prompt safety concerns. There may be individual differences as to the underlying rationale for changes in driving habits, but several studies imply that as a group, the elderly tend to limit their driving to those times and places where they feel the safety risk is lower (Planek et al., 1968; Janke, 1994; Hennessy, 1995).

The deterioration of eye health and visual function in many older adults has long been thought to be a primary cause of increased driving difficulty. There is evidence that older drivers compensate for visual impairments by modifying their driving behavior. For example, Hennessy (1995) reported that visual field impairments are significantly related to specific areas of driving avoidance (e.g. driving at night, in the rain or fog, at sunrise or sunset and making left turns). Planek et al. (1968) and Schlag (1993) found that vision problems generally motivated the older driver to modify their driving behavior. For instance, they found that individuals with reduced contrast sensitivity, increased sensitivity to glare and slow glare recovery minimized driving at night and under conditions of reduced visibility. Owsley et al. (1991) found that older drivers who had been told by an eye care specialist that they had an eye disease or condition tended to avoid difficult driving situations.

A number of studies have shown that dementing disease in the elderly, specifically Alzheimer's disease (AD), is associated with driving difficulty (Hunt et al., 1993). The extent to which AD affects one's driving ability obviously depends on the stage of the disease. However, even in its mild stages, dementia can affect driving performance by impairing one's perception, attention, and decision making processes, all of which are important functions for safe driving performance (Messinger, 1993). There is evidence that older drivers with AD avoid challenging driving situations, however, they under-report difficulties with driving maneuvers, implying they may lack insight into their performance capabilities (Dubinsky et al., 1993).

Despite suggestions from the literature that older drivers modify their driving habits in response to visual and cognitive impairments, there is also evidence that some older drivers are resistant to the idea of self-regulation. Jette and Branch (1992) found that older drivers continue to drive as long as possible and that, although they may cut down on their frequency of travel, they resist any change in the preferred mode of travel. These researchers concluded that self-regulation may not be a realistic strategy for promoting safety in the older adult population.

As discussed above, avoidance behavior or driving modifications among older drivers can take many forms. Most of the studies reviewed above imply that many older drivers are aware of their impairments and appear to modify their driving behavior accordingly. However, the avoidance behaviors that have been demonstrated may not be sufficient to substantially reduce crash risk. Owsley et al. (1991) and Ball et al. (1993) found that older drivers with visual and cognitive processing impairments were as a group at a greater risk for crash involvement than those without these problems, despite self-reports that many of these functionally impaired drivers avoided difficult driving situations.

The purpose of the present study was to examine self-reported driving avoidance in a sample of older drivers with objectively established visual and cognitive functional capabilities. First, we sought to replicate findings from previous research related to the types of driving situations which older drivers report avoiding. Second, we examined relationships between visual and cognitive impairment and avoidance of challenging driving situations. Finally, we examined the interrelationships among functional impairment, avoidance, and crash risk.

METHODS

Study participants were recruited from licensed drivers aged 55 years or older residing within Jefferson County, Alabama ($N = 118{,}553$). A detailed description of the recruitment and study population is provided elsewhere (Ball et al., 1993). The objective was to obtain a stratified sample with respect to both crash frequency (from the previous 5 years) and age. The sampling strategy was designed to have an equal number of drivers within three categories of crash frequency (0, 1–3, 4+) and seven categories of age (55–59, 60–64, 65–69, 70–74, 75–79, 80–84 and 85+). Therefore, the sample over-represented individuals with numerous crashes and includes a wide range of ages.

A total of 306 individuals were initially recruited for participation in the study. Twelve participants were excluded from the sample due to driving cessation prior to the assessment date even though they maintained active drivers licenses, and an additional 37 were omitted from analysis due to failure to complete the entire protocol. The final sample consisted of 257 community dwelling active drivers for whom complete data were available. The mean age of the sample was 70 years (range 56–90 years) and included 137 males and 120 females. The mean age for males was 70 ($SD = 9$), and for females, 71 years ($SD = 9$). Prior to participation, subjects gave written informed consent and were given detailed descriptions of all study procedures.

With respect to visual function, visual acuity was measured with the ETDRS (Early Treatment of Diabetic Retinopathy Study) chart (Ferris et al., 1982), and expressed as log minimum angle resolvable (logMAR). Contrast sensitivity was measured with the Pelli-Robson Contrast Sensitivity Chart (Pelli et al., 1988), and expressed as log contrast sensitivity. Visual field sensitivity was measured with the Humphrey Field Analyzer screening program for the central 60° (Haley, 1987) and was expressed as the average depth of defect (in terms of dB) in the better eye for both the central 30° and the peripheral 30-60°. The standard protocols according to manufacturers' guidelines were followed for all of these tests, all of which were measured binocularly except the Humphrey visual field test in which both eyes are monocularly evaluated.

All subjects received an eye health examination by an ophthalmologist. A three-point rating scale (see Owsley et al., 1991) was used to determine to what extent clinical defects would likely result in functional problems in each of three areas, central vision, peripheral vision, and ocular media; these three scores were then averaged to generate a single estimate of eye health. Each subject was also assigned to a primary diagnostic category [e.g. normal, cataract, age-related macular degeneration (AMD)].

Cognitive function was assessed with the Mattis Organic Mental Status Syndrome Examination (MOMSSE), which was specifically designed to assess cognitive status in the elderly (Mattis, 1976). The MOMSSE provides a composite score of cognitive function covering several domains including abstraction, digit span, verbal and visual memory and block design.

The size of the useful field of view (UFOV®) was assessed with the Visual Attention Analyzer, Model 2000 (Visual Resources, Inc. is located in Chicago, Illinois, U.S.A.). The UFOV® task was comprised of three subtests designed to assess processing speed, divided attention and selective attention (Ball et al., 1990). In order to summarize UFOV® performance, scores from each of these subtests are summed to yield a composite reduction score. Subtest scores range from 0, indicating no problem, to 30, indicating great difficulty. Thus overall UFOV® scores can range from 0 (no difficulty in any subtest) to 90 (great difficulty in all subtests).

A driving habits questionnaire (DHQ) asked about driving exposure and the avoidance of potentially challenging driving situations. The question on driving exposure asked how many days/week the subject typically drove. The DHQ items on avoidance were as follows:

(1) "do you avoid driving at night";
(2) "do you avoid high-traffic roads";
(3) "do you avoid rush-hour traffic";
(4) "do you avoid high speed interstates expressways";
(5) "do you avoid driving alone";
(6) "do you avoid left-hand turns across oncoming traffic";
(7) "do you avoid driving in the rain".

The response options covered a range of 1-5 (1 = never, 2 = rarely, 3 = sometimes, 4 = often and 5 = always).

In addition to this self report information on driving habits, at-fault crash involvement during the prior 5 years was determined from state records compiled by the Alabama Department of Public Safety (DPS). DPS provided accident reports for all crashes incurred by our study subjects during the previous five year period. An 'at-fault' crash was defined as one in which the study subject was deemed at least partially at-fault, as determined by three independent raters who studied the accident scenario provided in each accident report. Two of the three raters did not know which of the drivers mentioned in the report was our research participant. For all at-fault crash determinations, the three raters agreed 100% of the time that our driver was at least partially at fault.

STATISTICAL ANALYSIS

Figure 1 illustrates the percentage of subjects who reported various levels of avoidance for each of the seven DHQ avoidance items. Most older drivers in the cohort reported frequent avoidance of driving at night and in rush hour traffic. With respect to the other avoidance items, there was wide variability in the frequency with which subjects reported avoiding each situation. With respect to driving exposure, about 55% of the sample reported driving seven days/week.

Table 1 lists the Spearman correlation coefficients among visual and cognitive function, eye health, driving exposure (days/week), and the seven DHQ avoidance items. Scores on the avoidance items were expressed in their original form in this analysis, that is, as scores ranging from 1 to 5. As shown in Table 1, subjects reporting more avoidance were more likely to have visual and/or cognitive impairments and eye health problems. Frequent avoidance of driving in heavy traffic, high speed and rain were significantly associated with all types of functional assessments. In addition, reduced driving exposure (days/week) was significantly associated with all types of func-

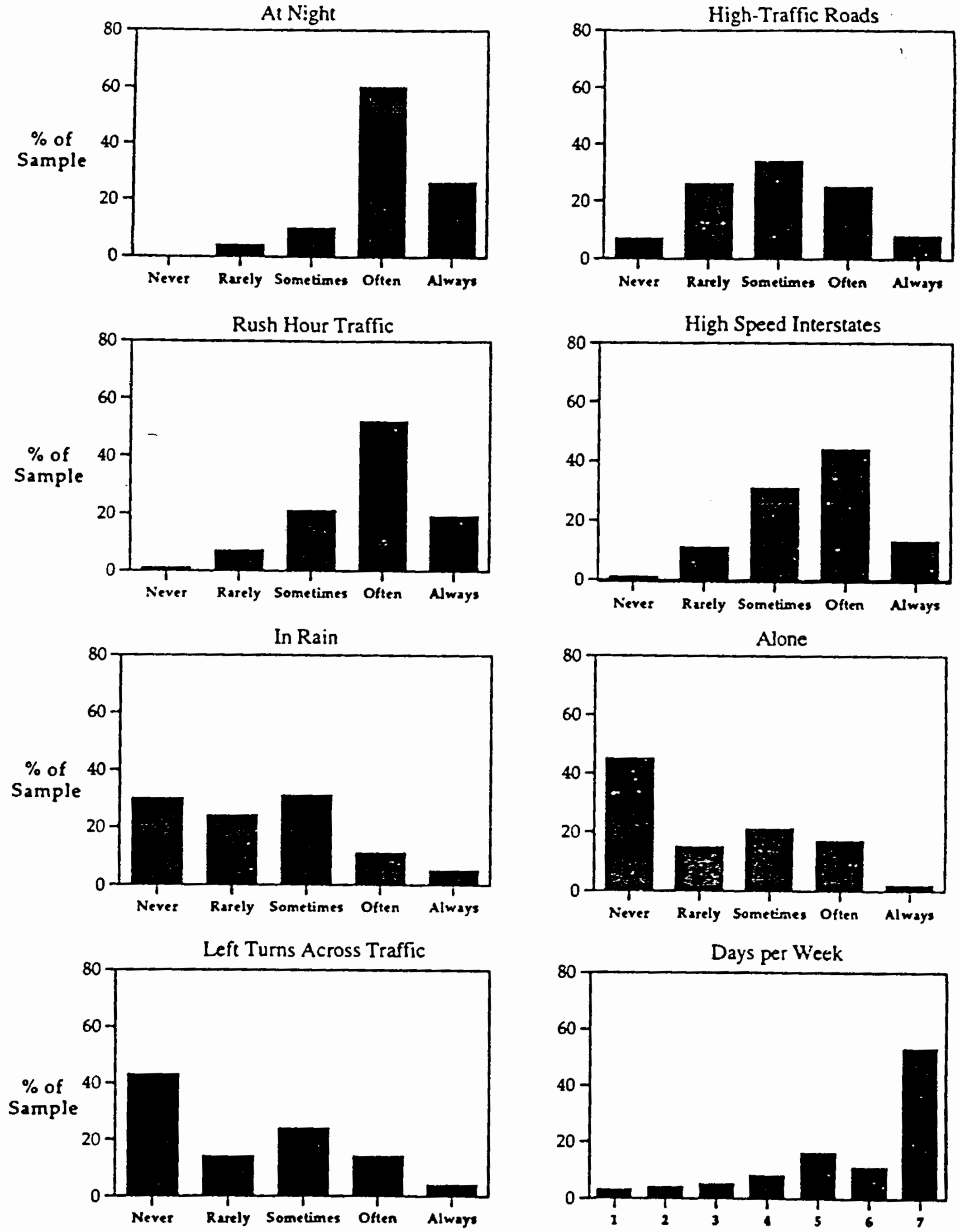

Fig. 1. Percentage of subjects reporting various levels of avoidance for each of the seven avoidance items and the driving exposure item from the DHQ.

tional impairments. In summary, older drivers who were more visually and/or cognitively impaired tended to report more avoidance and also reported less exposure, that is, driving fewer days per week.

In general, associations between the reported avoidance of night driving and the functional measures were weak, which may reflect the relatively high level of night driving avoidance displayed by almost all subjects in the cohort (see Fig. 1). Relationships between mental status and the avoidance items were generally weaker than those between visual function and avoidance. One exception is the relationship between mental status and driving alone, in which case mental status showed the strongest relationship with driving alone, compared to all other functional measures.

Table 1. Correlations among visual and cognitive measures, eye health and items on DHQ

	Contrast sensitivity	Central	Peripheral	Eye health	Mental status	UFOV®	Exposure	Night	Traffic	Rush hour	High speed	Alone	Left turns	Rain
Acuity	−0.66	0.44	0.37	0.62	0.14	0.36	−0.27	0.17	0.33	0.25	0.24	0.11	0.11	0.24
Contrast sensitivity		−0.5	−0.46	−0.7	−0.2	−0.45	0.3	−0.23	−0.34	−0.26	−0.28	−0.13	−0.1	−0.33
Central			0.83	0.49	0.3	0.47	−0.22	0.13	0.34	0.33	0.33	0.2	0.17	0.36
Peripheral				0.39	0.36	0.46	−0.2	0.08	0.31	0.24	0.29	0.16	0.11	0.29
Eye health					0.2	0.38	−0.28	0.18	0.32	0.2	0.26	0.19	0.06	0.3
Mental status						0.44	−0.19	−0.1	0.22	0.02	0.14	0.26	0.1	0.2
UFOV®							−0.27	0.14	0.28	0.25	0.21	0.18	0.15	0.37
Exposure								−0.26	−0.23	−0.24	−0.22	−0.2	−0.03	−0.23
Night									0.04	0.07	0.2	−0.01	0.04	0.21
Traffic										0.53	0.58	0.12	0.14	0.22
Rush hour											0.5	0.07	0.03	0.18
High speed												0.18	0.05	0.25
Alone													0.37	0.39
Left turns														0.24
Rain														

Two-tailed significance; critical $r = 0.12$; $p \leq 0.05$.

In the next stage of data analysis cutpoints for impairment were established for each visual and cognitive variable. These cutpoints are listed in Table 2. With respect to the visual cutpoints (acuity, contrast sensitivity, central visual field, peripheral visual field, eye health), boundaries were chosen based on the minimum level of vision required to adequately perform a suprathreshold visual discrimination task, as determined in our prior work (see Owsley et al., 1995). For mental status, the cutpoint for the MOMSSE test was based on clinical convention and our prior work on crash-involved older drivers (Ball et al., 1993). For the UFOV®, the cutpoint was based on that used in our prior work on older drivers. Thus, individuals were classified as either 'unimpaired' or 'impaired' on each of the functional measures listed in Table 2. Before pursuing further analyses on impaired versus unimpaired drivers, we noticed that according to our definition of acuity impairment (worse than 20/40, the legal limit for driving in many states in the U.S.A.), there were scarcely any subjects with impaired acuity (only 5%). Thus, acuity impairment was dropped as a criteria for functional impairment. Furthermore, because 90% of subjects with impaired mental status also had impaired UFOV®, mental status was not considered as a separate variable in order to eliminate redundancy in later analyses. UFOV® was retained as a variable in later analyses, rather than mental status, because there were a significant number of older persons who show reduced UFOV® who did not have reduced mental status. As our earlier work has demonstrated (Ball et al., 1993), UFOV® is a sensitive indicator of poor mental status, and the two share a reliance on some cognitive domains (e.g. processing speed, attention, decision-making).

Subjects were placed in one of six groups based on whether or not they had certain combinations of impairments listed in Table 2. Membership in each group was defined in terms of the number of vision impairments types (0–4) and poor (impaired) versus good (unimpaired) UFOV®. These six groups were defined as listed in Table 3. Since Group 3 (3–4 vision problems and good UFOV®) contained only three subjects, it was dropped from any further analysis. Low membership in this group was not surprising because individuals with extremely poor vision typically fail (≥40% reduction) the UFOV® test (Owsley et al., 1995).

Mean responses on the remaining five functionally-defined groups across the seven DHQ avoidance items are plotted in Fig. 2. Note that the overall level of reported avoidance differs across the various driving situations evaluated. Specifically, some activities, such as avoiding night driving or rush hour traffic

Table 2. Criteria used to determine cutpoints for visual and cognitive abilities

Functional variable	Unimpaired (% of sample)	Impaired (% of sample)
Contrast sensitivity	> 1.35 dB (90%)	≤ 1.35 dB (10%)
Humphrey peripheral 30	< 15 dB (73%)	≥ 15 dB (27%)
Humphrey central 30	< 10 dB (86%)	≥ 10 dB (14%)
Eye health	0 (46%)	> 0 (54%)
Acuity	< 0.48 logMAR (95%)	≥ 0.48 logMAR (5%)
Mental status	< 9 (82%)	≥ 9 (18%)
UFOV®	< 40% reduction (45%)	≥ 40% reduction (55%)

Table 3. Criteria used to determine the six functional groups based on number of vision problems and UFOV® score

Group 1	N = 59	0 Vision problems and unimpaired UFOV® (< 40)
Group 2	N = 55	1–2 Vision problems and unimpaired UFOV® (< 40)
Group 3	N = 3	3–4 Vision problems and unimpaired UFOV® (< 40)
Group 4	N = 40	0 Vision problems and impaired UFOV® (≥ 40)
Group 5	N = 67	1–2 Vision problems and impaired UFOV® (≥ 40)
Group 6	N = 33	3–4 Vision problems and impaired UFOV® (≥ 40)

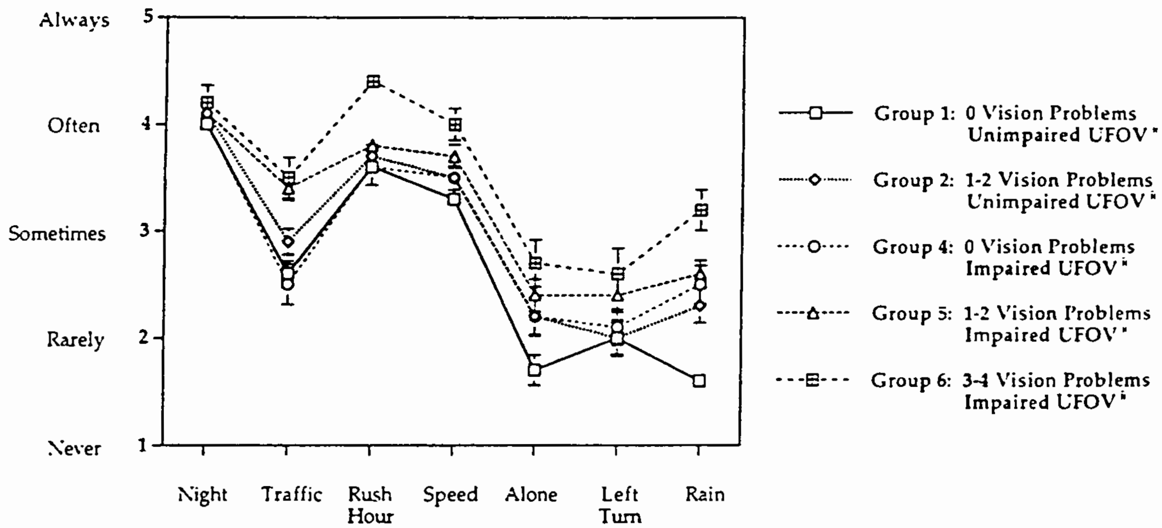

Fig. 2. Mean avoidance score as a function of DHQ avoidance item, plotted separately for each impairment group. Standard error bars represent one standard error above and below the mean. (Continuous lines connecting points do not denote a continuous x-axis scale, but serve only as an illustration of differences in avoidance profiles for various impairment groups.)

are at least sometimes avoided by most of the respondents, regardless of functional status, while avoidance of driving alone or making left turns are reportedly avoided much less frequently.

A multivariate analysis of variance was conducted on the five groups to determine whether the pattern of reported avoidance (responses on each of the seven DHQ avoidance items) was significantly different across functional groups. Although the avoidance measure uses an ordinal response scale, these items were analyzed as a continuous variable since assumption of normality was reasonable given the distributional characteristics of the raw data (Kleinbaum et al., 1988). This analysis confirmed significant differences across the five groups [$F(24, 988) = 2.37$, $p < 0.0005$], as well as a significant interaction between group and avoidance items [$F(28, 984) = 3.34$, $p < 0.0005$], indicating that the pattern of responses to the avoidance items differed across functional impairment group. Subsequently, a separate univariate analysis of variance was conducted on each item to determine differential responses across groups.

The results of these analyses and their associated *post-hoc* comparisons (Tukey *HSD* tests, $p < 0.05$) are listed in Table 4. Responses on all avoidance items across functional groups differed significantly, except for avoiding night driving in which all groups reported a similar level of avoidance. For the remaining items, there were differing patterns of responses

Table 4. Results of univariate analysis on each avoidance item as a function of group

Item	F-ratio	df	p	Significant *post-hoc* comparisons
Night	0.71	4,249	0.59	None
Traffic	9.47	2,249	<0.0001	1 versus 5, 6 versus 5, 6
Rush hour	5.22	4,249	<0.0005	1 versus 6, 4 versus 6, 2 versus 6, 5 versus 6
High speed highways	4.28	4,249	0.0023	1 versus 5, 1 versus 6
Alone	4.84	2,249	0.0009	1 versus 5, 1 versus 6
Left turns	2.67	4,249	0.0327	None
Rain	14.39	4,249	<0.0001	1 versus 2, 4, 5, 6; 2 versus 6, 4 versus 6

depending on the driving activity addressed. With respect to the avoidance of heavy traffic, Group 1 (the group with good functional ability) reported significantly less avoidance of heavy traffic than did Groups 5 or 6 (the two groups with the most severe visual cognitive impairment). In addition Group 4, which had a moderate level of impairment, reported significantly less avoidance of heavy traffic than Groups 5 or 6. With respect to avoiding rush hour traffic, Group 6 (the most impaired group) reported significantly more avoidance than each of the other four groups. Avoidance of high speed highways was reported significantly more often in the two most impaired groups, Groups 5 and 6, than in Group 1 (the group with good visual/cognitive function), as was avoidance of driving alone. Avoidance of making left turns across traffic differed significantly among the five groups, however, *post-hoc* analysis did not demonstrate significant differences between any two groups in particular. Finally, avoidance of driving in the rain differed significantly between Group 1 and each of the other four impaired groups, as well as between Groups 2 and 6, and between Groups 4 and 6. In summary, results indicated that self-reported driving avoidance varies with functional impairment, with more severely impaired drivers reporting more avoidance. In addition, the level of avoidance differs depending on the type of driving situation evaluated.

As mentioned earlier, all subjects were assigned to a primary diagnostic category with respect to eye health on the basis of an examination by the ophthalmologist. The two most prevalent conditions in this sample were cataract ($N=83$) and AMD ($N=19$). To determine whether reported avoidance was associated with the presence of either of these conditions, the no-disease group ($N=126$) was used as the reference group for comparisons. Other eye conditions were relatively infrequent so were not compared against the no-disease group.

Comparing those with cataract to the no-disease group, there was a significant main effect for group [$F(6, 202)=121.9$; $p<0.0005$], with the cataract group reporting higher overall avoidance, as well as a significant group × avoidance item interaction [$F(6, 202)=2.97$, $p<0.008$]. *Post-hoc* t-tests examined which individual avoidance items were statistically different between the cataract and normal groups. Compared to drivers with no eye health problems, those drivers with cataract reported more avoidance of driving on high traffic roads, rush hour traffic, high speed highways, alone, and in the rain (all $p<0.035$). However, drivers with cataract did not report higher levels of avoidance of driving at night and making left turns.

In a parallel analysis, those with AMD were compared against the no-disease group. There was a significant main effect for group [$F(6, 138)=42.41$, $p<0.0005$], with the AMD group reporting higher overall avoidance. The group × avoidance item interaction was non-significant [$F(6, 138)=1.01$, $p=0.423$], indicating that the extent of avoidance reported by drivers with AMD was approximately the same across all situations addressed in the seven items.

Finally, correlations were computed to examine relationships between responses on the avoidance items and a history of crashing. It was found that the number of crashes incurred in the previous 5 years was significantly related to reports in 1990 of avoidance of driving in the rain ($r=0.20$ $p=0.002$), making left turns ($r=0.18$, $p=0.004$) and driving in rush-hour ($r=0.15$, $p=0.018$). That is, subjects who had a higher number of crashes in the prior 5 years tended to report more avoidance of driving in the rain, during rush hour and making left turns.

Reported avoidance in 1990 was also evaluated in terms of its relationship with incurring an at-fault crash in the subsequent 3 years. Spearman correlation coefficients were computed between avoidance scores averaged across all seven items and the number of crashes in the 3 years subsequent to the evaluation date in 1990. It is important to note that a significant number of older drivers (52) in the analyses above stopped driving or died during the subsequent 3 years and were removed from any risk of incurring a crash, and thus were eliminated from the sample. Approximately 79% of these individuals were from the groups with functional impairment, which were of primary interest in this analysis. This reduced sample thus hampers our ability to evaluate the relationship between avoidance and future crashing. Thus, it was not surprising that the average avoidance score was unrelated to the number of future crashes ($r = 0.03$, $p = 0.616$).

DISCUSSION

This study is consistent with a growing body of work (e.g. Planek et al., 1968; Hennessy, 1995) implying that many older drivers self-regulate their driving in that they avoid driving in situations which are more challenging. It appears that most older drivers minimize their driving at night, during rush hour traffic and on high traffic roads, situations where rapid and unexpected events occur in a visually cluttered environment, often under conditions of reduced visibility. Since our results indicate that most drivers, impaired and unimpaired alike, avoid these situations at least sometimes, this modification of driving habits may reflect a safety strategy typical of the older driver population in general. Because many older adults have increased flexibility in the scheduling of car trips, minimizing their exposure to these more challenging driving scenarios is a simple option they can exercise to enhance safety. Avoidance of night driving by most older adults may stem from the fact that vision under low illumination is impaired even in older adults in good eye health, relative to younger adults (Sloane et al., 1988).

This study establishes a firm link between visual and attentional impairments and avoidance of challenging driving situations. A strength of the design is that the presence of visual and attentional impairments in this older driver sample was not determined by self-report, but by objective and reliable evaluation methods. Those older drivers with objectively determined visual and/or attentional impairments reported more frequent avoidance of difficult driving situations compared to those with no or minimal impairments. In particular they reported heightened avoidance of driving on high traffic highways, in rush hour, in the rain and alone. Older drivers with multiple impairments, that is having both visual and attentional processing difficulties, restricted their driving to a larger extent and in more situations than those with visual impairments alone or those who were functionally normal; the multiply impaired reported that they avoided at least 'sometimes' or 'often' all seven driving situations asked about on the questionnaire.

This pattern of extensive avoidance in the multiply impaired drivers underscores the importance of both visual and attentional skills for controlling a vehicle (Ball et al., 1993; Johnson and Keltner, 1983). Our data also indicate that visual and attentional processing impairments are associated with fewer days of driving/week, suggesting that self-regulation is not only expressed as avoidance of certain driving situations, but also reduction in other aspects of driving exposure.

Older drivers who have diagnoses of cataract or AMD also tend to report more avoidance than those free of ocular disease. This is not surprising since these conditions engender vision impairment, and thus, analyzing the data by diagnosis rather than degree of functional impairment is simply another way to arrive at the same conclusion, that poor vision is associated with self-regulation of driving. These findings are in agreement with prior work which has linked these eye conditions to driving cessation, which can be viewed as an extreme form of avoidance (Campbell et al., 1993; Marottoli et al., 1993).

An interesting finding with respect to the relationship between functional impairment and driving avoidance involves older drivers with poor mental status. Poor mental status has been associated in the past with under-reporting of driving difficulties, presumably because they fail to recognize they are having driving problems related to their functional impairments (Dubinsky et al., 1993). Although this is a problematic issue to address in research, the present results provide some additional support for the notion that cognitively impaired older adults under-report driving problems. Recall that 90% of the individuals with poor mental status also demonstrated impaired visual attention (e.g. UFOV®). However, there were a substantial number of individuals with impaired UFOV® who did not have impaired mental status. In comparing the magnitude of correlations between mental status and the DHQ avoidance items with that between UFOV® and the DHQ items, the relationships were generally stronger with UFOV® than mental status (aside from the one DHQ item addressing driving alone). Examination of the avoidance responses of the individuals with poor mental status indicates that these weaker relationships are attributable to generally lower avoidance responses in the impaired mental status group relative to the impaired UFOV® group. Apparently older drivers in our sample who have impaired mental status do not avoid challenging driving situations, presumably because they fail to recognize that they have impairments which make such behavior prudent.

This study implies that some older drivers are aware that their functional declines in visual and cognitive processing capabilities can make driving more difficult, even posing a safety threat and as a result, they modify when and where they drive. Of course the present cross-sectional study does not prove that avoidance is the result of insight into one's visual/attentional impairments and thus signifies self-regulation. However, such an interpretation has a great deal of face validity and garners support from anecdotal reports and focus groups of older adults (Persson, 1993). While this study and others present evidence that older drivers self-regulate through avoidance, the present results do not indicate if avoidance is effective in reducing risk for future crashes. It could be that self-regulation as a safety measure may have its strongest impact within certain types of older drivers. For older drivers with no functional impairments, driving avoidance may simply reflect a common sense approach to avoid aversive driving situations such as heavy traffic or rush hour driving, especially since one's schedule permits it. For these drivers, avoidance would likely be unrelated to crash risk due to the fact that most older drivers free of visual and cognitive impairments have low crash risk; so in essence there is a floor effect. On the other hand, for those drivers with moderate impairment, self-regulation may provide some advantage, keeping them away from those on-road situations which are exceedingly difficult for them. The result could be a reduction in crash risk. The present study did not permit an adequate evaluation of this issue since many of the impaired drivers in the cohort stopped driving or died during the three year follow-up of crash data. Driving cessation is the most extreme level of driving avoidance, and is interesting as an outcome from this standpoint, however, one cannot utilize safety records as an outcome if the cohort is not on the road.

The promotion of self-regulation as a method for improving safety among older drivers with visual/cognitive impairments is intriguing and deserves further examination. There are many key issues to be addressed as alluded to earlier, such as whether it improves safety, which subpopulations would benefit the most from such an intervention, and how would such an intervention program be implemented, even if shown to be successful. For those drivers with the most severe functional impairments, self-regulation may not sufficiently reduce crash risk, and driving cessation may be the only safe option. One advantage of self-regulation as a mechanism for reducing crash risk is that it may be cheaper than governmental intervention programs, and perhaps could be based on existing health care delivery systems involving eye care. An intervention evaluation study on this topic could go far in examining the feasibility of this approach.

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