Self-Awareness of Driving Impairment in Patients with Cataract or Glaucoma.

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ABSTRACT

This study compared the driving performance of individuals with the eye diseases cataracts or glaucoma with age-matched controls, as well as the individual's own perceptions of driving. Participants included drivers over the age of 50 years who had been diagnosed with glaucoma (n=29) or cataracts (n=33) and a control group with no ocular pathology (n=13). Driving performance was measured on a closed road circuit using a range of standardised measures of vehicle control and hazard recognition and avoidance, while visual performance was measured with a battery of tests including visual acuity, contrast sensitivity and visual fields. Perceptions of vision and driving were assessed using the Activities of Daily Vision Scale, Driver Behaviour Questionnaire and a driving exposure questionnaire. Driving performance was significantly poorer ($p<0.05$) for each of the ocular disease groups compared to the control group. Impaired contrast sensitivity and the higher disease severity scores (for the glaucoma group only) correlated most strongly with poorer driving performance. While participants with cataracts rated their vision significantly more poorly than those in the glaucoma and control groups, there were no significant differences between the participant groups rating of their own driving performance. These findings suggest that there is no direct relationship between self-rated driving ability and actual vision and driving performance. This has serious road safety implications.

INTRODUCTION

The purpose of this study was to examine the relationship between vision and driving capability among drivers with the eye diseases glaucoma and cataracts and compare their *actual* performance with their *perceived* ability.

Cataracts are one of the most commonly occuring eye diseases, appearing in over 40% of people over the age of 75. Cataracts result in impairments in a range of visual functions including distance and near visual acuity, visual fields and contrast sensitivity and increased glare sensitivity, with vision in bright sunlight or under conditions involving glare at night (such as oncoming headlights while driving) being reduced (Rubin, Adamsons, & Stark, 1993). Importantly the impairment in contrast sensitivity seen in individuals with cataracts that has been shown to impact on quality of life (Owsley, Stalvey, Wells, Sloane, & McGwin, 2001). Owsley, et al (2001a) found that contrast sensitivity deficits in drivers with cataracts were correlated with a history of crashes. Those drivers who had been involved in a crash were eight times more likely to have a severe contrast sensitivity deficit in at least one eye, compared to those who had not been in a crash. It was suggested that one of the reasons why acuity was not related to crash risk was the likelihood of people ceasing driving before cataracts reduce visual acuity too severely, this cessation either being related to self regulation or failure to meet driver licensing requirements. It may be possible that contrast sensitivity losses are less obvious to the patient and thus do not result in a similar pattern of self regulation, despite having a negative impact on driving vision.

The impact of cataracts on driving and the benefits of cataract surgery have been illustrated in several other studies. Monestam (1999) found that 82% of those cataract patients experienced difficulty whilst driving, and one quarter of them were driving with insufficient acuity to meet the legal standard.

This finding is supported by Pager, McCluskey, and Retsas (2004) who found that 23% of the cataract patients who were awaiting surgery and still driving were doing so with vision that did not meet the legal 6/12 standard for driving. Interestingly, preoperative visual acuity was not found to be related to improvement in visual quality of life (Monestam, 1999). In a later study, it was found that surgery reduced the number of people driving without meeting the legal requirements from 16% to 5% (Monestam, Lundquist, & Wachtmeister, 2005). In a longitudinal study, Owsley et al., (2002) found that patients who elected to have cataract surgery reported having difficulty with driving pre-operatively, whereas those who did not have surgery reported no such difficulty, despite the latter group having double the crash rate of the surgery group. The poor crash risk associated with the no-surgery group, combined with their failing to report experiencing any driving difficulty, suggests that awareness of defects may be a key factor both in seeking medical aid for visual problems and actually adjusting driving behaviour to compensate for visual deficits.

Unlike cataracts, glaucoma involves damage to the optic nerve head and retinal ganglion cells, so the loss of visual function is permanent and irreversible. Treatment of glaucoma involves management of the condition to prevent further loss rather than trying to restore vision. It may take the form of either surgery or eye drops with the primary goal of reducing intraocular pressure. The prevalence of primary open angle glaucoma increases with age, with reported prevalence rates of 4.5% in people aged 60-69 years rising to 11.8% in those aged 90 years and above (Wensor, McCarty, Stanislavsky, Livingston, & Taylor, 1998). Glaucomatous visual loss is manifested as sensitivity losses across the peripheral visual field while central visual acuity usually remains at normal levels until late in the disease, it is also associated with decreased contrast sensitivity and depth perception (Coleman, 1999).. Importantly, visual field loss in one eye can be masked by the other eye and the patient is unlikely to notice any loss in overall visual function until the later stages of the disease. Interestingly, half of the patients diagnosed with glaucoma are previously unaware of the condition (Tielsch et al., 1991).

The impact of glaucoma on driving has not been as well documented as that of cataracts. Owsley and McGwin (1999) reported in a review that studies concerned with glaucoma and driving usually found some correlation between glaucoma and increased crash risk and that further investigation is warranted. Glaucomatous male drivers have been found to restrict their night and freeway driving when compared to an age-matched control group (Adler, Bauer, Rottunda, & Kuskowski, 2005). The glaucomatous drivers in Adler et al's (2005) study also reported that, while family and friends may have concerns about their continued driving, the drivers did not and so they did not make plans for cessation of driving. The disparity between making changes to exposure but not planning for cessation suggests that the drivers in this study may have some level of awareness about the impact of their condition but are either unable to recognise or unwilling to admit to a defect that would prevent them from driving.

Compensatory behaviour was also found in a study by McGwin, Mays, Joiner, Decarlo, McNeal, and Owsley (2004). Drivers with glaucoma exhibited more driving avoidance behaviours and had a lower crash rate for both at fault and not at fault crashes than the controls. It is worth noting that while this study had confirmed diagnoses of glaucoma for the pathology group it did not rate the severity of the condition. It is therefore not possible to determine from this study if crash risk increases with severity of vision impairment.

This potential relationship between greater severity of an eye disease and increased driving impairment has some support. Szlyk, Taglia, Paliga, Edward, and Wilensky (2002) compared the driving performance of patients with mild to moderate glaucoma with that of age-matched control subjects. While there were no significant between-group differences in crash rate (simulator and official crash records), the glaucoma patients tended to have lower driving speeds, more lane crossings, and more cautious braking behaviour. The glaucomatous drivers also exhibited worse braking behaviour as their contrast sensitivity declined. In a later experiment with more severe glaucoma cases (Szlyk, Mahler, Seiple, Edward, & Wilensky, 2005) it was found that peripheral field loss correlated with crashes both in the simulator and in actual driving.

The purpose of this research was to examine the impact of glaucoma and cataracts on perceived driving skill and compare this with actual driving skill and visual ability. It has been suggested that older drivers compensate for driving defects (De Raedt & Ponjaert-Kristoffersen, 2000; Hakamies-Blomqvist, 1994). Assuming compensation is occurring then it is relevant, particularly in relation to drivers with eye disease, to identify which mechanisms facilitate this compensation.

METHODS

Participants:

Participants were drivers over the age of 50 years who had been diagnosed with glaucoma (*n*=29, mean age=69.96) or cataracts (*n*=33, mean age=73.93). A control group with no ocular pathology (*n*=13, mean age=70.77) was also recruited. Participants were recruited from local ophthalmologists, community groups, or the QUT Optometry clinic. Participants were excluded if they had a co-existing ocular pathology or had significant general health problems.

Design:

Data was collected relating to the participant's vision, driving performance, self-reported vision and driving exposure and behaviour.

Driving performance was assessed at the Mt Cotton Driver Training Centre on a closed road circuit (Wood & Troutbeck, 1994), which is representative of a rural road environment. A station wagon with automatic transmission and power steering was used. Each participant drove around a practice circuit in order to familiarise themselves with the car, the road environment and the experimental tasks. This was followed by the recorded circuit. Participants drove with the spectacle correction that they usually wore for driving but were not permitted to wear sunglasses. The driving assessment involved tasks of road sign recognition, road hazard recognition and avoidance, divided attention and reaction times, gap judgement and manouevring, lane keeping and speed of completion.

Visual function was assessed using a battery of tests, which were undertaken binocularly (with the exception of static visual fields). The refractive correction used habitually for driving (and worn for all of the driving assessments described here) was used in conjunction with the appropriate distance correction for each test. The tests were selected to better represent the driving environment than standard acuity tests and included measures of contrast sensitivity, peripheral vision and glare sensitivity.

Static Acuity. Static high contrast visual acuity was measured using Bailey Lovie Charts at a distance of 3.0 m.

Pelli-Robson Letter Contrast Sensitivity. Letter contrast sensitivity was determined using the Pelli-Robson chart (Pelli, 1988) at a distance of 1.0 m.

Visual Fields. Static visual fields were measured using the Humphrey Field Analyser. The static visual fields were used as a basis to grade the severity of glaucomatous loss against the Hodapp scale for glaucoma (Hodapp, Parrish, & Anderson, 1993).

Three questionnaires were administered to assess driving exposure and beliefs about driving skill and visual ability. Not all cataract participants were available to complete the exposure questionnaire. A subset of nine was tested. Driving, vision and ADVS results were compared for the cataract group and no significant differences were detected between the group who did the questionnaire and those who did not (Table 1).

Exposure Questionnaire. This was developed and piloted for the purposes of this research and was based on items used in previous studies (Wood & Mallon, 2001). It contains items on participant's beliefs about driving proficiency, self-rated visual capability, situational avoidance, family assistance and how participants became aware of their condition and changes in their driving patterns..

Driver Behaviour Questionnaire (DBQ). This measures self-reported driving habits focusing on inherently risky traffic behaviour such as speeding, failure to yield and driving errors related to lapses in concentration.

Activities of Daily Vision Scale (ADVS). This test measures subjective difficulty with a variety of tasks involving day vision, night vision, glare, distance vision and near vision. It features well-documented and well-established normal data (Mangione et al., 1992).

RESULTS

Data were analysed using a univariate analysis of variance with a post hoc analysis (Tukey's HSD) performed to explore differences between groups.

To gain an overall measure of driving skill, course time, bumps hit, correct gap judgements, signs seen and reaction lights seen were converted to Z-scores and a composite score was derived from the mean. Post hoc analyses found a significant difference in closed road driving ability between the control group and each of the pathology groups ($F(1,74) = 8.71$, $p<0.05$, $\eta^2=0.20$) (Figure 1). No difference was detected between the drivers with cataract and glaucoma ($F(1,61) = 2.16$, $p>0.05$, $\eta^2=0.04$). Impaired visual acuity ($r=0.380$, $p<0.05$) and contrast sensitivity ($r=-0.439$, $p<0.05$) were significantly associated with worse driving performance in all three groups as were left ($r=0.524$, $p<0.05$) and right ($r=0.488$, $p<0.05$) Hodapp scores for the glaucoma group.

No between group differences were found in self-rated driving performance ($F(1,50) = 1.37$, $p>0.05$, $\eta^2=0.05$) (Figure 2), self–reported crash rate ($F(1,50) = 0.34$, $p>0.05$, $\eta^2=0.01$), or how many days per week participants drove ($F(1,50) = 1.41$, $p>0.05$, $\eta^2=0.06$), how often they drove at night ($F(1,50) = 2.46$, $p>0.05$, $\eta^2=0.09$) or in heavy traffic ($F(1,50) = 1.29$, $p>0.05$, $\eta^2=0.05$).

When asked to rate their vision, participants with cataracts rated themselves more poorly than those in the glaucoma and control groups ($F(1,50) = 5.31$, $p<0.05$, $\eta^2=0.181$) (Figure 2) .The cataract group also had lower total scores on the activities of daily vision scale ($F(1,74) = 30.49$, $p<0.05$, $\eta^2=0.46$) as well as lower scores on the night ($F(1,74) = 12.99$, $p<0.05$, $\eta^2=0.27$), day ($F(1,74) = 16.46$, $p<0.05$, $\eta^2=0.31$), distance ($F(1,74) = 6.32$, $p<0.05$, $\eta^2=0.15$), glare ($F(1,74) = 23.12$, $p<0.05$, $\eta^2=0.39$) and near ($F(1,74) = 24.89$, $p<0.05$, $\eta^2=0.41$) subscales (Figure 3).

DISCUSSION

This study examined the relationship between actual and perceived vision and driving ability in drivers with glaucoma or cataracts and controls. We found that in accord with previous studies (Owsley et al., 2002; Owsley & McGwin, 1999; Owsley, Stalvey, Wells, Sloane, & McGwin, 2001b; Szlyk et al., 2002; Wood & Troutbeck, 1994), the visual impairment resulting from cataracts and glaucoma resulted in poorer driving performance compared to controls. However, despite the impairment in their driving performance, the drivers with cataracts or glaucoma reported similar levels of driving exposure and rated their driving capability as comparable to that of drivers with no eye disease. One possible explanation is that while drivers with eye disease have impaired driving performance, they lack insight into the effect of their disease on their performance. Consequently, they are unlikely to adopt appropriate compensatory behaviours, such as driving less or avoiding challenging situations.

The drivers with cataracts in this study were more likely to rate their vision poorly but rated their driving ability as similar to that of other drivers. This belief in their driving competency offers one explanation for the findings of Pager, McCluskey, and Retsas (2004) and Monestam (1999) that patients with cataracts continue to drive even though they did not meet legal visual requirements for driving. Alternatively it is also possible that their apparent self-belief in their own driving skills is derived more from their need to drive to allow their continued independence rather than a true rating of their own ability. A wider survey of drivers with eye disease would benefit from the inclusion of items that would test how perceived travel needs influence driving in those with early visual impairment. Conversely, the glaucomatous drivers rated themselves as having good vision, despite the fact that 86% (25/29) had impaired peripheral vision with several having severe field loss. All groups rated themselves as above average drivers even though driving performance was worse for those with greater levels of vision impairment. Although this mismatch between perceived and actual ability is typical for many aspects of performance (Kruger & Dunning, 1999) it is particularly worrying in the case of driving. Previous studies (Dalziel & Job, 1997) have indicated the phenomenon of optimism bias among drivers can lead to unrealistic beliefs about their ability to drive safely even when impaired. This lack of insight denies the driver the opportunity to adjust their behaviour to compensate for the effect of diminished visual abilities on driving by limiting their driving exposure or avoiding more hazardous driving environments (e.g. night, heavy traffic).

The results for the glaucoma subjects differ from those of Adler et al (2005) which suggest that male glaucomatous drivers have some awareness of their deficits, as they sought to compensate for their deficits by limiting their exposure. Even with this insight the drivers in that study did not fully appreciate the impact of their condition on their driving and were unwilling to consider cessation of driving as an option. McGwin et al (2004) also suggested that drivers with glaucoma compensate for their defects but no data were collected on the severity of glaucomatous loss of the study participants. It is therefore difficult to determine if those drivers who reported being involved in crashes were those with more severe visual symptoms. In the this study severity data was collected and field loss and contrast sensitivity loss was shown to correlate with decreased driving performance suggesting that late stage glaucomatous drivers may represent a greater crash risk than other drivers in their age group.

The observed decline in driving performance for glaucoma and cataract patients, together with their apparent lack of insight into the impact of their condition on driving is of great concern to road safety practitioners. Australian health professionals are required to ensure that drivers' visual acuity meets a minimum standard of 6/12 binocularly for an unconditional car or motorcycle licence and that there is no significant field loss that would impair driving (Austroads, 2003). However, there are problems with this approach. For example in many jurisdictions, including Queensland, there is no vision test at licence renewal and any visual problems must be self-reported by the applicant on the licence form. This approach assumes that the applicant is aware of visual problems, which may not always be the case, particularly with progressive conditions such as cataracts and glaucoma (Olofsson, Lundstrom, & Stenevi, 2001; Tielsch et al., 1991).

Importantly, drivers with glaucoma or cataracts are not subject to any special licensing requirements in Australia (Austroads, 2003). The guidelines recommend that cataract patients are monitored as the associated contrast sensitivity losses may impair driving more than might be suggested by visual acuity, but no such note exists for glaucoma (Austroads, 2003). New Zealand also lacks any special requirements for licensing drivers with glaucoma or cataracts although it does suggest that contrast sensitivity and visual fields must be monitored carefully (LTSA, 2002). In the United Kingdom there is a requirement to inform licensing authorities of glaucoma, but when surveyed, 77% of ophthalmologists said they did not ask glaucomatous patients if they drove unless they considered them unfit to drive (Potamitis et al., 1994). Patients in the UK were also not normally informed about their responsibilities to the licensing department until the doctor declared them unfit to drive (81%). This was despite 51% of ophthalmologists being aware of the law to declare glaucoma regardless of visual ability (Potamitis et al., 1994).

This paper, when considered along with previous research, highlights several issues. Older people with eye disease have poorer driving performance than age-matched controls, yet their self-rated ability and actual vision and driving performance were only weakly related. The participants may rate themselves as good drivers either because they are not aware of their deficits or because they believe that they have already appropriate compensatory strategies. Further research needs to be undertaken to fully understand how older drivers cope with eye disease and to establish how we can manage the mobility needs of an ageing population.

ACKNOWLEDGEMENTS

The authors would like to thank the following people for their ongoing contribution to this research: Associate Professor Peter Swann, Associate Professor Alex Chaparro, Tabitha Carberry, the staff of the Mt Cotton Driver Training Centre, Queensland Transport, and the QUT driving research team.

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FIGURES AND TABLES

Table 1: Comparison of drivers with cataract

	t	Sig. (2-tailed)
age	1.30	0.20
mean driving z score	0.53	0.60
Bailey Lovie binocular	-1.31	0.20
Pelli Robson binocular	0.09	0.93
Berkeley glare score	-1.63	0.12
ADVS - night score	-1.13	0.27
ADVS - day score	1.01	0.32
ADVS - distance score	0.53	0.60
ADVS - glare score	1.50	0.14
ADVS - near score	0.49	0.63
ADVS - total score	-0.18	0.86

Figure 1: Mean Driving Score.

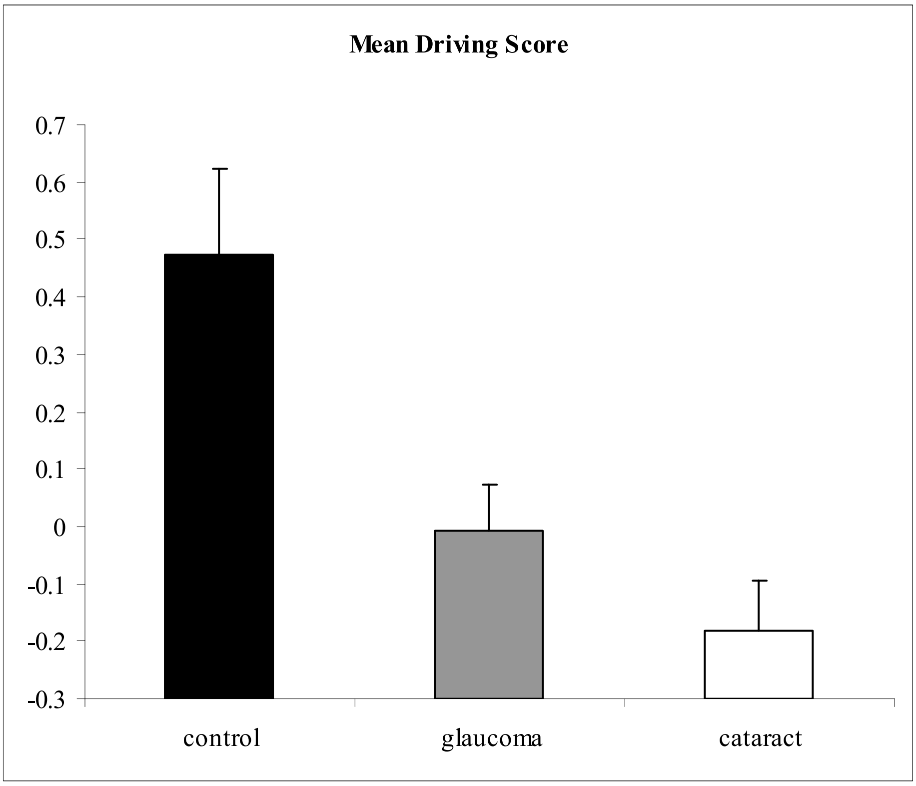

Figure 2: Self Rating of Driving and Vision.

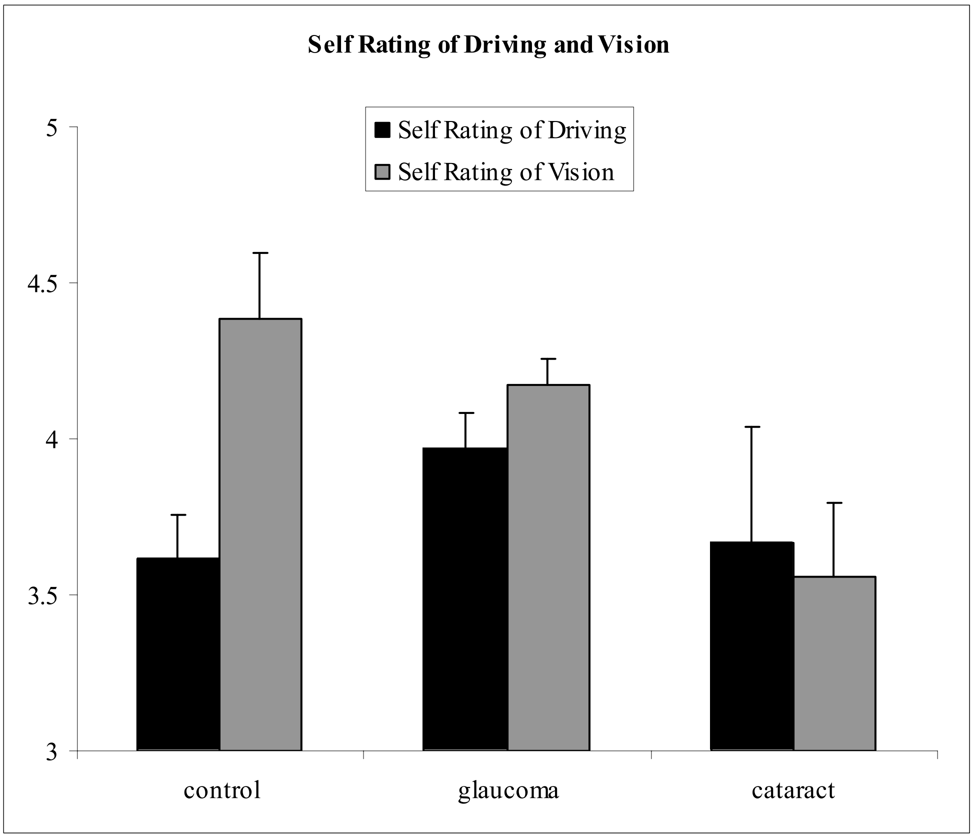

Figure 3: Activities of Daily Vision Scale.