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Centre for Research on Ageing, Health and Wellbeing

Predictors of driving outcomes and driving cessation in older drivers.

A 5 year validation study.

A Report from Research Funded by the NRMA ACT Road Safety Trust, Prepared by the Centre for Research in Ageing, Health and Wellbeing (CRAHW)

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By

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1. Executive Summary

We followed-up up a sample of older driver's five years after they were initially assessed to evaluate the long-term predictive validity of screening tools and other cognitive and visual measures allowing for the identification older adults at risk of road crashes. A second aim was to examine the readiness of participants still driving to cease driving and factors which might be related to an increased readiness. An examination of ceased drivers was also planned however only a small number of the sample reported ceasing driving in the five year follow-up period.

Some findings include:

- A generally healthier sample of drivers' were followed up who performed better on measures of driving capacity in the original study
- Age and reported traffic crashes both influenced readiness to cease driving
- In general participants showed poor insight into their own driving with ratings of driving ability collected in 2006 not differing based on reported crashes in 2012
- The only measure of capacity to drive safely which remained sensitive to crash likelihood over the five year follow-up period was the UFOV. The Hazard Perception Test, Change Blindness Test and other cognitive measures did not remain predictive of crashes at follow-up. Similarly health, vision and mental health measures were not predictive of crashes at follow-up. The only other predictor found (other than the UFOV) was reported crashes in 2006.

Recommendations for future research include a closer examination of the time course of the sensitivity of the measures, to determine how long they remain predictive of driving outcomes. This could be achieved through an annual follow up rather than after five years. Additionally future research could benefit from other sampling techniques to access different sub populations, such as those drivers who have been referred for testing due to health issues or concerns over driving.

2. Introduction

Older drivers represent an increasing population with estimates suggesting that the proportion of licensed drivers older than 65 will rise from 13% in 2000 to 22% by 2030 (OECD Group, 2001). Given this increase as well as the increased risk of injury and fatality when an older driver is involved in a crash (Li, Braver, & Chen, 2003) research into older drivers is a growing area. The current study had two objectives: first, the examination of long term predictors of crash likelihood in older drivers over a 5 year period, and secondly, predictors of driving cessation over the same period of time. This study includes the incidence of, and factors related to, ceasing driving, as well as the development of a scale designed to measure older driver's readiness to cease driving.

2.1. Older drivers

The declines in cognitive and perceptual abilities due to aging are in general well documented (e.g. Janke, 2001; Lyman, McGwin, & Sims, 2001; McGwin & Brown, 1999) and such age related changes are particularly important to changes in driving ability. Such normal changes related to ageing may result in a reduced capacity to drive safely in some individuals but not necessarily all (Gilhotra, Mitchell, Ivers, & Cumming, 2001).

While it is not the case that older drivers overall have more crashes than younger drivers there is some suggestion that once corrected for kilometers driven then older drivers are over-represented in crash rates. Using Australian data Meuleners, Harding, Lee, and Legge (2006) found that male drivers over the age of 85 years had the greatest crash involvement per kilometer driven, even greater than young male drivers. Regardless of crash likelihood in older drivers the worrying statistic is that if involved in a crash, older drivers are more likely to sustain serious injury or die, due to increased frailty (Li, et al., 2003; Meuleners, et al., 2006) However, the effects of aging on driving ability are not straight forward and many older drivers manage to maintain a high standard of performance for many years (Dobbs, Heller, & Schopflocher, 1998; Hakamies-Blomqvist, 1998). Hence it is important to determine what factors are related to an increase in crash likelihood for older drivers as well as understanding protective factors.

A range of factors have been identified as important for the continued driving abilities of older drivers. Often used to assess driving ability in a practical setting is driver knowledge of road rules and safe driving practices. While Alosco and colleagues (2011) demonstrated that tests of knowledge of driving laws did predict driving outcomes in an on road test (ORT) little other research exists verifying such tests. One particularly important factor to driving is visual functioning and as such the Useful Field of View (UFOV) test is a common inclusion in a large body of research. The UFOV test measures the area over which individual can extract information in single glance, without moving their head or eyes. Older drivers with poorer performance on the UFOV are at higher risk of crashes relative to other older drivers who perform well and the UFOV has been found to relate to ORT outcomes and crash statistics (Gentzler & Smither, 2012).

Generally, age related declines in cognitive ability are associated with a decline in driving ability, for example difficulty in attending to driving tasks and slowing in information processing increases with age, particularly processes involving complex decision making (Gentzler & Smither, 2012). Hence many batteries for assessment of older driving capabilities include measures of cognitive functioning such as selective and divided attention abilities, processing speed, memory, intelligence, accuracy and reaction time. Such batteries have been found to predict road test failure in older drivers (McKenna, Jefferies, Dobson, & Frude, 2004). Testing that focuses on shifting and updating functions as part of executive functioning (Adrian, Postal, Moessinger, Rascle, & Charles, 2011), and trail marking and attention (Mullen, Chattha, Weaver, & Bedard, 2008) have been found to be related to components of driving. However, the relationship between off-road cognitive tests and driving ability is often inconclusive (e.g. Marottoli et al., 1998; Selander, Lee, Johansson, & Falkmer, 2011; Stutts, Stewart, & Martell, 1998).

Other factors which may be important in determining safe driving in older adults include the number of kilometers driven (Meuleners, et al., 2006) and the driver's self reported driving ability. In general older drivers ratings of the driving abilities are not related to driving abilities as measured by on road test performance (Marottoli & Richardson, 1998). However interestingly, in the original, 2006, study older drivers ratings of their driving ability were not found to be related to their performance on the hazard perception test or crash rates (Horswill, Anstey, Hatherley, Wood, & Pachana, 2011). So insight does not appear to be strong. For a full discussion of the factors related to older driver's driving ability please see Anstey, Wood (2005).

2.2. Aims of the present study

2.2.1. Aim 1: A 5 year follow-up

The primary aim of the current study is to reassess after 5 years a sample of older adult drivers who were originally measured in 2006. This follow-up study allows for an evaluation of the long-term predictive validity of screening tools and other cognitive and visual measures allowing for the identification older adults at risk of road crashes. Furthermore, the longitudinal study allows for an examination of predictors of readiness to give up driving, and how driving behavior and perceptions of driving ability change over time.

The original 2006 study examined a sample of 298 ACT drivers aged over 65 years who consented to take part in a study examining driving and healthy aging. This study included a range of measures examining the health, cognitive abilities and driving behavior of the participants. In particular three measures of capacity to drive safely were included namely the UFOV, a hazard perception test and a hazard change detection task. For a full description of the previous methodology please see Horswill and colleagues (2011)**.**

2.2.2. Aim 2: Examine readiness to cease driving using the Readiness to Ease Driving Inventory (REDI)

The second aim is to examine the readiness of participants still driving to cease driving and factors which might be related to an increased readiness. This includes determining if the participants previous driving experience, age or gender have resulted in a greater planning and thinking about ceasing driving. This may provide a source of information about this important transition for older adults. Furthermore, it may result in a scale which can be used to standardize assessment of driver's preparedness to cease driving which may help in practical settings to make the process less stressful.

2.3. Relevant literature

2.3.1. Longitudinal studies of older drivers

While a range of factors have been identified as important for predicting driving ability it is also of interest to determine factors related to changes in driving ability. However, the number of studies examining older drivers in a longitudinal design is small. One study by Aksan and colleagues (1999) examined driving in ORT over a period of three years and found that while age and previous driving ability accounted for 28% and 30% of the variance in overall errors, cognitive functioning also emerged as a predictor. Cognitive functioning included memory, visuomotor speed, spatial abilities and executive functioning. Further while visual sensory, motor functioning and UFOV performance had significant bivariate correlations, none remained a significant predictor in multivariate models. Hence there appears to be a range of predictors over this period but none emerged as particularly important when considered together, rather explaining similar variance

UFOV has also been found to predict crash occurrence at a 3 year follow-up in a study of 294 drivers aged 55 to 87 after adjusting for age, sex, race, chronic medical conditions, mental status, and days driven per week (Owsley et al., 1998). Similarly in examining 174 drivers over a

5 year period Sims, McGwin, Allman, Ball and Owsley (2000) found that after adjusting for age, race, days driven per week, and gender, reported difficulty with yard-work or light housework, or difficulty opening a jar, using hypnotic medication, self-reported stroke or transient ischemic attack, depression and UFOV were all related to involvement in police-reported vehicle crashes. Ball and colleagues (2006) examined participants in the setting of a Department of Motor Vehicles and found that vision, age, sex, history of falls, and poorer cognitive performance (on the Trail Making test, motor free visual perception test and UFOV), were predictive of at-fault motor vehicle collision involvement 4 to 5 years after the initial assessment. Hence a range of factors have been found to be predictive of future driving ability, as well as current driving ability in older adults.

Longitudinal driving abilities have also been assessed by a series of studies such by Brown et al (2005) which include retrospective measures of driving, in this case reports of driving violations from the previous three years. Finally driving simulator performance has been found to predict crashes 5 years later where the driver was at least partially at fault (Hoffman & McDowd, 2010).

2.4. Older driver’s self regulated changes in driving

One way in which older drivers compensate for their age-related declines in relation to driving is by modifying their driving behaviours. This can take many forms from avoiding driving situations, driving less or changing the way in which they drive and many older drivers successfully manage and self regulate their driving to maintain a high level of driving performance. Baldock, Mathias, McLean and Berndt (2006) found in a sample of older drivers from South Australia that they generally avoided driving situations where they lacked confidence such as parallel parking and driving at night in the rain. However, in general avoidance was low and it was not related to driving ability, as measured by errors in an on road test (Baldock, et al., 2006). Additionally Freeman, Munoz, Turano and West (2005) indicated that older drivers with poor health, particularly eye health, did regulate their driving, however the level and effectiveness of self-regulation is at least partly determined by available knowledge.

Hence it is not clear whether driving modification is actually effective and results in a decrease in unsafe driving and hence crashes. In a study of ACT older drivers those with a medical condition did not show a greater knowledge of the effects of their condition on driving safety compared to those older adults without the condition; nevertheless, those who reported a condition also reported significant driving behaviour change as a result of their condition (Sargent-Cox, Windsor, Walker & Anstey, 2010). In addition, age itself was a stronger predictor of change in driving behaviour than medical conditions or knowledge of the impact of medical conditions on driving safety. Further, reported driving behavior modification was not related to performance on a hazard perception test or confidence on the test (Horswill, et al., 2011).

2.4.1. Impact of and readiness for driving cessation

One way that driving behavior can be modified is through the cessation of driving, however, for older drivers driving cessation is often associated with poor mental health outcomes such as increased depressive symptoms (Fonda, Wallace, & Herzog, 2001; Marottoli et al., 2000; Marottoli, et al., 1998). Not only is ceasing driving stressful but also the prospect of having to cease driving and the associated repercussions may be an additional cause of psychological distress. Edwards, Lunsman, Rebok and Roth (2009) found a significant decline in physical and social functioning, physical performance and physical role which accompanied the transition to ceasing driving.

Reasons why older adults may cease driving are varied and include such things as health problems, loss of enjoyment or comfort in driving, concern about crash involvement or safety, license cancellation, influence of family and doctors or a dislike of driving (Oxley & Charlton, 2009). Even with this variety of reasons for ceasing driving in older drivers there appear to be a few factors which may make the transition easier with the main being control over the decision. Windsor, Anstey, Butterworth, Luszcz and Andrews (2007) found that cessation of driving was associated with an increase in depressive symptoms but the difference between continuing and ceased drivers was partly explained by perceived control. Further there is some suggestion that those who voluntarily cease driving are less likely to experience depression to the same extent as those who lost their license (Oxley & Fildes, 2004) and those who made the decision themselves report greater satisfaction with their current mobility than those for whom the decision was made for them (Oxley & Charlton, 2009). As such it is important to understand not only older driver's understanding of their driving ability but also the stage that they are at towards giving up driving.

3. Method

3.1. Participants / Recruitment

Of the 298 participants in the 2006 study, consent to follow-up and current address details were available for 226. This was because ethical approval to invite participants for follow-up studies was obtained only mid-way through the 2006 study. Invitation letters and consent forms were mailed to these 226 individuals, who were asked to sign and return the consent form in a reply paid envelope. Participants were asked to indicate on the consent form suitable times for an interviewer to contact them in order to conduct the telephone interview. Reminder letters were sent to those who had not returned the consent form within approximately six weeks. Overall, 177 people responded by returning a signed consent form.

3.2. Procedure

A copy of the questionnaire was mailed to all those who consented to participate, together with a reply paid envelope for the return of the questionnaire to the researchers. Reminder calls were made to participants who had not returned their questionnaires after several weeks. Of the 177 participants who consented to participate, 176 returned their completed questionnaires. Of these 176 participants, 173 also completed a brief cognitive assessment; the TELE interview (Gatz et al., 2002). The TELE provides an assessment of dementia which is administered over the phone which is important for the current study not only as an outcome but also as cognitively impairment may affect the participant’s capacity to complete the questionnaire. This was conducted by telephone for all but two of the 173 participants; these two participants elected to come in to the Centre for Research on Ageing, Health and Wellbeing (CRAHW) at ANU to conduct the interview, due to hearing difficulties which precluded conducting the interview by telephone. The interview was also used to collect any missing data and clarify responses where required. The interview also provided participants with the opportunity to ask any questions they might have regarding the research.

3.3. Measures

3.3.1. Demographics

Items related to socio-demographic characteristics included age, living arrangements, employment status, and distance to local facilities such as shops, healthcare, and public transport, in addition to current driving status and age at which their driver's license was first obtained. If driving had ceased since the initial study then an approximate date of cessation was requested.

3.3.2. General self-rated health

To assess the participants perceived level of health in a range of domains the SF-36 was administered (Ware & Sherbourne, 1992).

3.3.3. Medical conditions and vision problems

A checklist of medical conditions was included in the questionnaire and participants indicated which conditions they had. Participants also indicated what eye related problems/procedures/conditions they had ever experienced and whether they were in both eyes, the right eye or left eye.

3.3.4. Falls

Participants were asked whether they had experienced any falls in the past year "including those falls that did not result in injury as well as those that did" and if they indicated that they had experienced a fall then the number of such falls. Participants also indicated the number of falls in the last year which "required medical attention or limited you in doing your usual activities for more than 2 days".

3.3.5. Driving Experience

Participants were asked about characteristics of their driving including weekly frequency, distance driven each week, common destinations, presence of long distance driving and likelihood driving on unfamiliar roads. Participants were asked if they had been involved in a crash in the past five years using items previously included in our research. If they indicated that they were then the number was asked as well as the characteristics of the crash/es (whether it involved a single vehicle, multiple vehicles, injury, or if it occurred at an intersection or when parking). Participants further rated their difficulty with a series of driving conditions on a 5 point Likert scale from 1 representing very difficult, to 5 representing very easy.

3.3.6. Readiness to Ease Driving Inventory

Twenty items, designed specifically for this study, measured participant's readiness to cease driving. This included intentions to cease driving, altering driving and transport behaviours and views about the impact of ceasing driving. Statements were rated on a 4 point Likert scale from strongly agree to strongly disagree or as not applicable.

3.3.7. Comparison measures obtained five years ago

The measures contained in the initial study five years previously have be reported elsewhere (e.g. Horswill, et al., 2011). The risk assessment tools included in the original project are the focus of the present report. These included the UFOV, the ACT Hazard Perception Test and a Change Detection Task.

3.3.7.1. UFOV.

For the original study, subtest two of the UFOV® was adapted for use in this study, as it has demonstrated high reliability and validity (Ball, et al., 2006; Owsley, et al., 1998), and has been used without subtests one or three in other large studies on driver screening (Ball, et al., 2006). Participants attend to dual targets presented simultaneously on screen: a white, two-dimensional block figure of a car or truck at the centre of the screen with a second car figure presented 10cm (radially) from the central fixation point at 0º, 45º, 90º, 135º, 180º, 225º, 270º, or 315º from the vertical. Following presentation, a random noise mask was shown and participants were instructed to indicate: (a) which vehicle was presented in the centre of the screen by pressing a picture of a car or truck; and (b) where the second car was located by pressing one of the eight possible locations onscreen.

3.3.7.2. Hazard Perception Test

This test required participants to anticipate potential traffic conflicts in video clips of traffic scenes filmed from the driver's point-of-view (Wetton et al., 2009) by pressing the relevant area of the touchscreen whenever they identified a potential incident. Twenty-two traffic conflicts (across 20 traffic clips of between 15-40 seconds duration) were selected on the basis that (1) there were anticipatory cues available, and (2) the conflict became unambiguous such that nearly all participants would be expected to respond eventually. The software recorded a response time for each potential conflict (starting from the first moment that the potential conflict was detectable) and these were averaged to obtain an overall hazard perception response latency. Performance on this test has been validated against self-reported crashes using the sample on which the current study is based (Horswill, Anstey, Hatherley, & Wood, 2010).

3.3.7.3. Hazard Change Detection Task

The Hazard Change Detection Task (Marrington, Horswill, & Wood, 2008) was used to measure participants' ability to detect the presence of hazards independent of other factors (e.g., speed). The task used pairs of still images of traffic scenes, which were displayed on a computer screen using the flicker paradigm(Wetton, et al., 2009). Each pair of scenes (59 trials in total) contained an original and an altered image which were displayed for 250ms, and this was alternated with a gray mask (which was displayed for 80 ms). Participants were asked to identify the difference between the two pictures by pressing on the screen as soon as they noticed the difference and the outcome measure was the mean reaction time for correct trials.

4. Results

4.1. Participants in follow-up

Of the original 298 participants included the original study 175 participants were followed up in the current survey. Note one participant who was excluded from the original dataset due to being below the cut off for the MMSE (score of 23) was included in the follow-up.

Of participants contacted only five did not consent to be included in the study. Using the National Death Index it was determined that a further 11 participants had passed away in the time between the initial study and the follow-up. This leaves 49 participants unaccounted for. Figure 1 demonstrates the flow of participant numbers

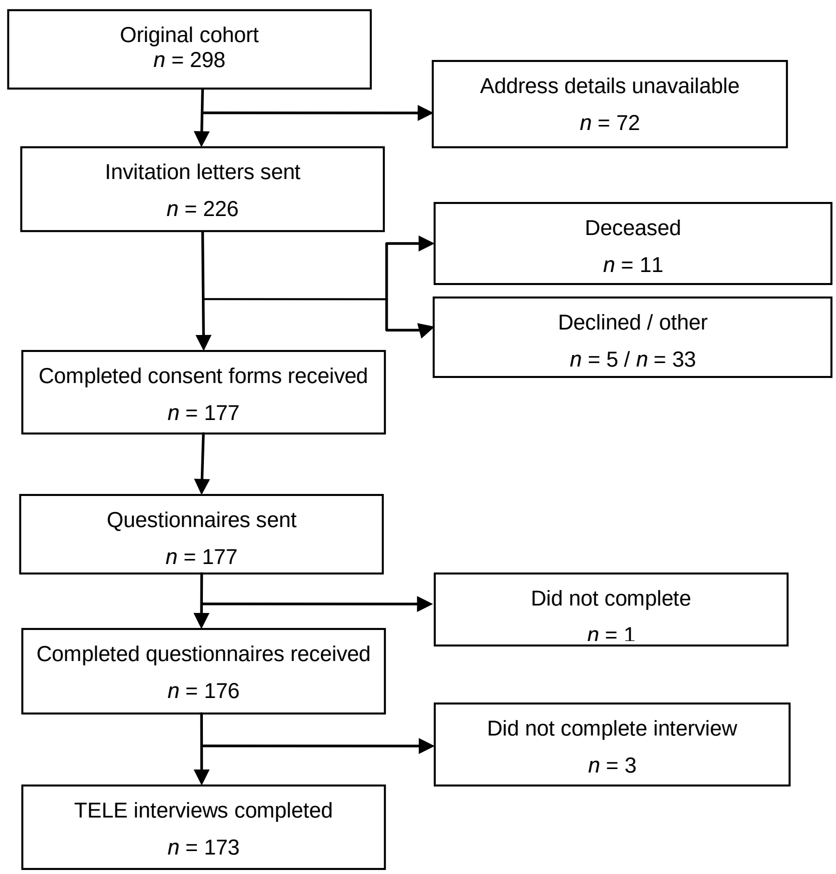

Figure 1. Flowchart illustrating participant recruitment and participation.

Using Australian Bureau of Statistics data to provide an estimate of the percentage of individuals aged 65 to 92 years who are predicted to pass away over a 5 year period the expected rate would be around 9.8%. Hence the mortality rate in this sample was quite low at 3.69%. In examining the differences between the followed up group with those who were not followed up as a whole Table 1 shows the comparisons on numerous variables from the 2006 study. As can be seen there was a significantly smaller proportion of females in the follow-up than not and the age of those followed up is slightly younger. Participants followed up have significantly more accurate hazard perception test scores, quicker change detection reaction times (RT) and quicker thresholds on the UFOV. No other significant group differences were found.

Table 1.

Comparison of participants followed up with those not.

Measure in 2006	Followed up	Not Followed up	Significance
N	175	123	
Female (%)	29.1 %	40.7 %	χ^2 (1) = 7.19, *p* = .007
Age - *Range, M (SD)*	65 – 92 years, 78.2 yrs (6.5)	65 – 96 years, 76.2 yrs (7.6)	*t*(294) = -2.27, *p* = .024
MMSE Total - *M (SD)*	27.41 (1.0)	27.38 (1.2)	*t*(296) = -.227, *p* = .82
HPT – *M RT (SD)*	5.39 (.89)	5.86 (.96)	*t*(296) = 4.41, *p* < .001
UFOV Threshold – *M ms (SD)*	112.42 (87.7)	168.9 (113.8)	*t*(296) = 4.83, *p* <.001
Change detection – *M RT (SD)*	7.41 (2.19)	9.12 (2.79)	*t*(296) = 5.87, *p* < .001
Years driving – *M (SD)*	52.93 (8.37)	53.33 (8.78)	*t*(294) = .398, *p* = .69
Kilometres driven – *M (SD)*	193.4 (147.6)	185.7 (169.8)	*t*(288) = -.411, *p* = .68
SF36 General Health subscale – *M (SD)*	74.38 (15.95)	71.87 (18.92)	*t*(291) = -1.23, *p* = .22

Note: All significances remained, except for age, when excluding those who are known to have passed away.

4.2. Screening of follow-up data

No missing or incorrect data points were found other than the two respondents who did not complete the phone interview. On the TELE two participants scored below the 15/16 cut-off criteria for cognitive functioning as recommended by Gatz and colleagues (2002). As this is a follow-up these participants were not excluded but their scores were taken into account.

4.3. Descriptors of the follow-up sample

4.3.1. Demographics

At follow- up 123 participants were married, five in de-facto relationships, 10 divorced, thirty six widowed and two never married. The majority lived in a house (n = 137), followed by a unit (n = 21), retirement village (n = 14), nursing home (n = 2) and townhouse (n = 2). Most lived with one other (n =119), but 41 lived alone and 15 with two or more others. Only two were still in full time employment, ten part time and three occasional/casual with the majority being retired (n = 161).

4.3.2. Driving behaviour

Of the 175 followed-up participants only eight had ceased driving in the five years since the original study. Those who were no longer driving were older (M = 84.13, SD = 6.77) than those still driving (M = 77.90, SD = 6.35), $t(173) = 2.70$, $p = .008$. Two ceased driving in 2006, three in 2010, two in 2011 and one did not provide details. Reasons for ceasing were; health reasons (n = 6), doctor's orders or concerns (n = 3), no longer confident (n = 2), fear of collapse (n = 1) and physical impairment (n = 1).

Of the 167 still driving 51 (30.5%) reported being the only driver in the house. The average age of license acquisition was 20.14 years (SD = 5.0) for continuing drivers and 26.50 years (SD = 7.0) for ceased drivers. The average distances to amenities were; shops (M = 1.85 km, SD = 1.61), public transport (M = 0.63 km, SD = 0.92) and healthcare (M = 3.35 km, *SD* = 3.05) for continuing drivers and shops (*M* = 1.14 km, *SD* = 1.68), public transport (*M* = 0.32 km, *SD* = 0.20) and healthcare (*M* = 2.38 km, *SD* = 2.49) for ceased drivers.

Most respondents still driving drove their car everyday (55%), followed by four to five times a week (30%), two to three times a week (11%) and once a week (2%). The average distance driven a week was 161.47 km (range 5 – 700 km; *SD* = 119.62). Destinations when driving were work (*n* = 17), shopping centre (*n* = 94), friends/relatives (*n* = 72) and anywhere (*n* = 127). One hundred and thirty reported still driving long distances (> 100kms). When asked whether they drove in unfamiliar areas 90% indicated that they did so occasionally with less doing so half of the time (6%), most of the time (.6%) and always (1.8%), and only two never drove in unfamiliar areas.

Most respondents had not had an crash in the last five years (*n* = 136). However, 23 experienced one crash, six had two, and one participant was involved in three. Table 2 presents the characteristics of those crashes and indicates that most crashes involved multiple vehicles and intersections.

Table 2.

Crash characteristics of those still driving participants who were involved in an crash in the last five years, by gender.

Crash characteristics	*Females*	*Males*
Single vehicle	2	7
Multiple vehicle	3	15
Injury to self or other	0	1
At an intersection	4	13
When parking	2	5

4.3.3. Prevalence of Physical Illness, disability or disorders

Table 3 presents the prevalence in the follow-up sample of different illness, disorders, disabilities, and so on, including eye problems and procedures. Additionally 6.3% of participants reported some eye related issues and 6.8% that they wore glasses. Most respondents rated their eye sight outside without glasses as good (39.2%) followed by very good (25%), fair (22.7%), poor (9.1%) and very poor (4.0%). Of the sample 30.1% respondents reported a fall in the past year and the maximum number of falls reported was five with an average of 1.74 (*SD* = .83). Of these falls the maximum number requiring medical attention or limited activities for more than two days was two with an average of .33 (*SD* = .55).

Table 3.

Physical health of the follow-up sample.

Illness, disorder, disability	%	Eye problem / procedure	% Right eye	% left eye	% Both eyes
Hearing impairment	47.2	Cataracts	6.2	3.4	35.2
Parkinson's Disease	.6	Cataract surgery	5.1	1.7	27.8
Diabetes	5.7	Glaucoma	1.1	5.7	6.8
Peripheral Vascular Disease/Leg Ulcers	7.4	Macular degeneration	2.8	2.3	4.0
Stroke/TIA	14.8	Short-sightedness	0	0	31.2
Heart Disease/Heart Attack	20.4	Long sightedness	0	0	17.6
High Blood Pressure	50.6	Visual field loss	.6	0	5.7
Incontinence - Urinary	18.2	Astigmatism	0	0	16.5
Arthritis	52.8	Congenital/acquired blindness	1.1	.6	1.7
Broken Hip	4.0				

4.4. Readiness to Cease Driving Inventory

4.4.1. Descriptive analyses

Table 4 presents all of the items, for the Readiness to Ease Driving Inventory (REDI) and Table 5 presents descriptive for each item. Means presented in Table 5 represent average agreement with each item not including those individuals who indicated that the item was not applicable. Items which elicited the greatest level of agreement were REDI1 and REDI2 relating the prospect of ceasing at some point in the future while the items least agreed with were items REDI5, REDI7,REDI11, REDI14 and REDI19 relating to ceasing soon and more concrete altering behaviors, such as arranging community transport.

Table 4.

Items on the Readiness of Ease Driving (REDI) scale and abbreviations.

Item	Abbreviation
1. I currently drive, and I do not intend to cease driving in the foreseeable future.	REDI1. Cease in future
2. I currently drive and do not intend to cease driving in the next few years.	REDI2. Cease in few years
3. When my vehicle is adapted I will be able to keep driving for the foreseeable future	REDI3. Adapted vehicle
4. I currently drive and intend to cease driving within the next 12 months.	REDI4. Cease in 12 mths
5. I currently drive but am thinking about ceasing driving in the next 6-12 months.	REDI5. Cease in 6 to 12 mths
6. I have recently started to think about ceasing driving but have no immediate plans to do so.	REDI6. No plans to cease

7. I have been thinking about ceasing driving for some time, and am ready to make some plans to do this over the next few months.	REDI7. Cease in few mths
8. I have altered my driving habits to drive locally and avoid certain conditions, but have no intention of giving up driving.	REDI8. Altered habits, no inten.
9. I have altered my driving habits and realise that one day I will have to give up driving.	REDI9. Altered habits, realised
10. I have altered my driving habits and have plans to cease driving in the next few years.	REDI10. Altered habits, few yrs
11. I have altered my driving habits and have plans to cease driving within 12 months.	REDI11. Altered habits, 12 mths
12. I have sought information on alternative forms of transport for when I give up driving	REDI12. Alt. transport info
13. I have trialled alternate transport so I am prepared when I give up driving	REDI13. Alt. transport trial
14. I have arranged for community transport so that I can stop driving when I'm ready	REDI14. Alt. transport arranged
15. I have worked out what I will do with my car when I stop driving	REDI15. Car plans
16. I am anxious about how I will cope when I give up driving	REDI16. Anxious about coping
17. I am concerned about the impact of giving up driving on my family	REDI17. Concerned -family
18. I feel confident that I will cope well once I give up driving	REDI18. Confident - coping
19. My life will improve once I no longer drive	REDI19. Life improve
20. People sometimes become unsafe drivers as they age	REDI20. Unsafe driving as ageing

Table 5.

Overall agreement with items on the REDI. Abbreviations are strongly agree (SA), agree a little (AAL), disagree a little (DAL), strongly disagree (SD) and not applicable (NA) and average represents the average agreement level after not applicable responses are removed

Item	Percentage agreement					average
	SA (1)	AAL (2)	DAL (3)	SD (4)	NA	(SD)
REDI1. Cease in future	83.9	7.7	5.4	3.0	-	1.27 (0.70)
REDI2. Cease in few years	77.8	11.4	4.2	3.6	3.0	1.31 (0.73)
REDI3. Adapted vehicle	7.2	3.0	3.0	3.6	83.2	2.18 (1.2)
REDI4. Cease in 12 mths	1.8	1.2	5.4	64.7	26.9	**3.82 (0.58)**
REDI5. Cease in 6 to 12 mths	1.2	1.2	1.8	68.3	27.5	**3.89 (0.48)**
REDI6. No plans to cease	9.6	10.2	5.4	44.9	29.5	3.22 (1.1)
REDI7. Cease in few mths	1.8	1.8	1.8	64.7	29.9	**3.85 (0.58)**
REDI8. Altered habits, no inten.	19.8	11.4	4.2	32.9	31.7	2.74 (1.3)
REDI9. Altered habits, realised	18.6	24.0	6.0	24.0	27.5	2.49 (1.2)
REDI10. Altered habits, few yrs	6.0	3.0	7.8	52.1	31.1	3.54 (0.93)
REDI11. Altered habits, 12 mths		1.2	1.8	67.1	29.9	**3.94 (0.30)**
REDI12. Alt. transport info	8.4	13.2	2.4	37.1	38.9	3.12 (1.2)
REDI13. Alt. transport trial	11.4	15.0	3.6	34.7	35.3	2.95 (1.2)
REDI14. Alt. transport arranged	1.8	1.8	3.0	45.5	47.9	**3.77 (0.68)**
REDI15. Car plans	13.8	5.4	3.0	39.5	37.7	3.11 (1.3)
REDI16. Anxious about coping	12.0	15.6	8.4	34.7	29.3	2.93 (1.2)
REDI17. Concerned - family	9.0	12.6	7.8	35.9	34.7	3.08 (1.1)
REDI18. Confident - coping	39.5	21.6	9.0	9.6	20.3	1.86 (1.0)
REDI19. Life improve	.6	1.8	10.8	62.9	24.1	**3.79 (0.51)**
REDI20. Unsafe driving as ageing	56.9	35.9	3.0	3.6	.6	1.53 (0.73)

4.4.2. Predicting readiness to ease driving

There are many factors which may predict an individual's readiness to ease driving. Cessation rates are known to be influenced by both gender and age (see Oxley & Charlton, 2009 for a review) but also incidence of crashes may result in an individual reconsidering their ability to continue driving. Hence the responses to the items on the REDI were analysed in relation to gender, crashes in 2006, crashes at follow-up and age. Any relationship which did not reach a significance level of 0.1 or greater is not reported here. A decreased alpha level than normal was used due to the number of analyses conducted.

As is shown in Table 6 males were more likely to strongly agree that they are not intending on ceasing in a few years while women are more likely to agree a little or strongly disagree that this is the case. Females were more likely to have altered their driving in preparation of ceasing diving in the next few years while men were more likely to strongly disagree with this statement. Females are also more likely to agree a little that they have sought information about alternative forms of transport while men are more likely to strongly disagree. Finally women are more likely to strongly agree that some people become unsafe drivers as they age.

Table 6.

Effect of gender on reported readiness to ease driving

Item	gender	SA	AAL	DAL	SD	NA	
REDI2	female	71.4	18.4	2.0	8.2	0	$\chi^2(4) = 10.22$,
	male	80.5	8.5	5.1	1.7	4.2	$p = .03$
REDI10	female	12.2	2.0	12.2	38.8	34.7	$\chi^2(4) = 9.16$,
	male	3.4	3.4	5.9	57.6	29.6	$p = .06$
REDI12	female	8.2	28.6	0	26.5	36.7	$\chi^2(4) = 16.33$,
	male	8.4	6.8	3.4	41.5	39.8	$p = .003$
REDI20	female	75.5	22.4	2.0	0	0	$\chi^2(4) = 10.85$,
	male	49.1	41.5	3.3	5.1	0.8	$p = .028$

Note SA = strongly agree, AAL = agree a little, DAL = disagree a little, SD = strongly disagree and NA = not applicable

As shown in Table 7 crash incidence had an effect on participants' agreement with different items on the REDI. So some type of readiness to cease driving could potentially be outcomes of experiencing a crash. In particular items scores were related to crash incidence in the original 2006 study. Importantly the incidence of a crash did not always result in increased readiness, for example those who reported a crash had more conservative views (or less strong) of item 6 relating to thinking about driving but not having any immediate plans to do so.

Table 7.

Effect of crash incidence on ratings of items on the REDI

Item	crash incidence	study	SA	AAL	DAL	SD	NA	
REDI3	No	2006	3.8	2.3	3.8	3.8	86.3	$\chi^2(4) = 13.22$,
	Yes	2006	20	5.7	0	2.9	71.4	$p = .01$
REDI4	No	2006	1.5	1.5	3.8	69.5	23.7	$\chi^2(4) = 8.89$,
	Yes	2006	2.8	0	11.4	45.7	40	$p = .064$
REDI6	No	2006	6.9	12.2	6.9	48.1	26.0	$\chi^2(4) = 15.01$,
	Yes	2006	20	2.9	0	31.4	45.7	$p = .005$
REDI6	No	2011/2012	11.1	5.9	3.7	47.4	31.8	$\chi^2(4) = 26.60$,
	Yes	2011/2012	3.3	26.7	13.3	36.7	20	$p = .009$
REDI7	No	2006	2.3	0.8	2.3	68.5	26.2	$\chi^2(4) = 8.91$,
	Yes	2006	0	5.7	0	51.4	42.9	$p = .063$
REDI7	No	2011/2012	0.7	1.5	0.7	65.9	31.1	$\chi^2(4) = 21.50$,
	Yes	2011/2012	6.7	3.3	6.7	60	23.3	$p = .043$
REDI19	No	2006	0.8	1.5	6.9	65.4	25.4	$\chi^2(4) = 8.20$,
	Yes	2006	0	2.9	22.8	54.2	20	$p = .085$
REDI20	No	2006	52.7	42.0	1.5	3.1	0.7	$\chi^2(4) = 12.94$,
	Yes	2006	71.4	14.2	8.5	5.7	0	$p = .012$

We examined whether there were differences in agreement to the REDI items related to age. Age was collapsed into the main age categories of the study so those in their 70s (*M* = 73.2 years, *SD* = 2.8), 80s (*M* = 82.1 years, *SD* = 2.6) and 90+ (*M* = 91.1 years, *SD* = 2.1) at follow-up. Table 8 shows the ANOVA output examining the mean level of agreement between the three categories. Figure 2 then presents the mean agreement for the age groups when a significant difference was found. Older participants had a greater disagreement to ceasing in a few years however the 90s group agreed more on ceasing in 12 months and 6 to 12 months. So older drivers appear to have more immediate plans. Additionally older participants were more likely to have agreed with statements about altering their habits to continue driving, or cease soon. Finally older drivers were also found to be more likely to have made plans for their car when they cease driving. Hence overall with older age increased readiness is found particularly for more immediate plans rather than distant plans.

Table 8.

ANOVA output examining the differing levels of agreement to REDI items for the different age categories.

Item	Significant difference between age categories
REDI1. Cease in future	$F(2, 165) = 1.15, p = .32$
REDI2. Cease in few years	$F(2, 162) = 2.83, p = .004$
REDI3. Adapted vehicle	$F(2, 25) = 2.04, p = .15$
REDI4. Cease in 12 mths	$F(2, 119) = 3.49, p = .03$
REDI5. Cease in 6 to 12 mths	$F(2,118) = 8.292, p < .001$
REDI6. No plans to cease	$F(2, 114) = 2.40, p = .09$
REDI7. Cease in few mths	$F(2, 114) = 2.40, p = .09$
REDI8. Altered habits, no inten.	$F(2, 111) = 8.41, p < .001$
REDI9. Altered habits, realised	$F(2, 118) = 5.10, p = .008$
REDI10. Altered habits, few yrs	$F(2, 114) = 7.07, p = .001$
REDI11. Altered habits, 12 mths	$F(2, 114) = 0.11, p = .31$
REDI12. Alt. transport info	$F(2, 102) = 2.48, p = .09$
REDI13. Alt. transport trial	$F(2, 108) = 2.30, p = .10$
REDI14. Alt. transport arranged	$F(2, 84) = 3.09, p = .05$
REDI15. Car plans	$F(2, 103) = 7.89, p = .001$
REDI16. Anxious about coping	$F(2, 115) = 1.94, p = .15$
REDI17. Concerned -family	$F(2, 109) = 0.07, p = .93$
REDI18. Confident - coping	$F(2, 130) = 0.47, p = .62$
REDI19. Life improve	$F(2, 124) = .81, p = .45$
REDI20. Unsafe driving as ageing	$F(2, 163) = .52, p = .59$

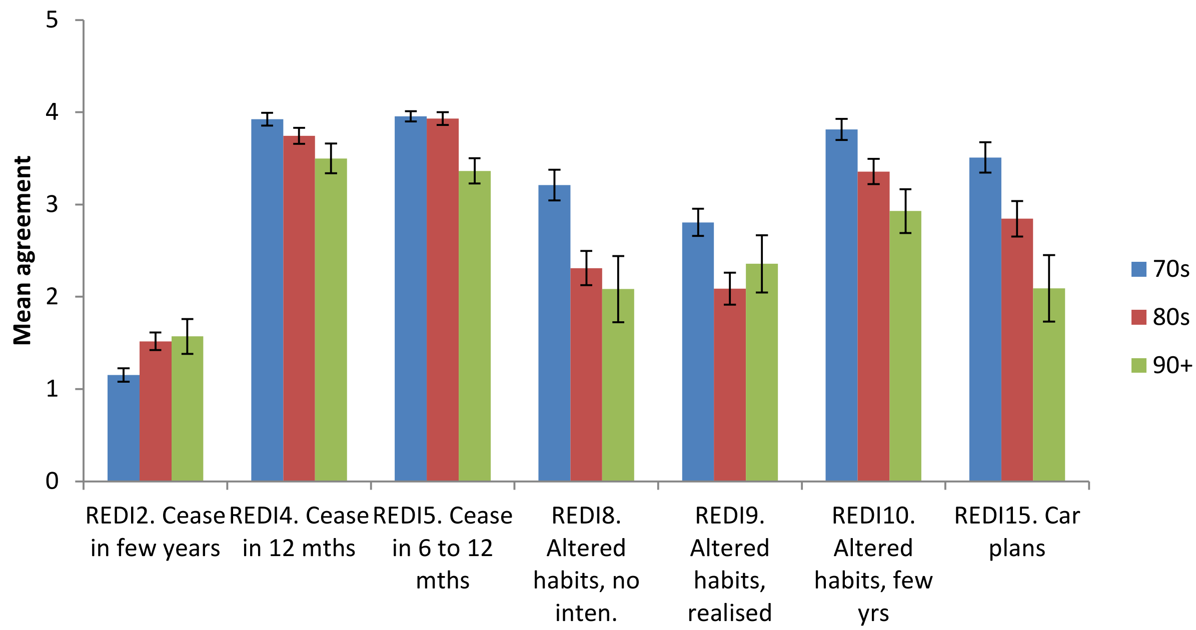

Figure 2. Mean level of agreement for each age group for REDI items where the age groups significantly differed. Error bars represent standard error. Higher numbers represent greater disagreement.

4.5. How the sample changed over the five years

4.5.1. Changes in physical health

Table 9 presents the incidence of health problems including eye issues in both the original study as well as the follow-up. Participant's ratings of their distance-vision while walking outside without glasses did not significantly change from 2006 (M = 3.70, SD = .08) to 2012 (M = 3.71, SD = .08), $t(172) = -.159$, p = .874.

Table 9.

Changes in prevalence of physical health indicators for only participants who completed the follow-up.

disease, problem, procedure	% initial study			% follow- up		
Hearing impairment		39.5			46.9	
Parkinsons		2.3			.6	
Peripheral vascular disease / leg ulcers		7.4			7.4	
Diabetes		5.3			5.7	
Stroke/TIA		9.8			14.3	
Heart disease/heart attack		16.6			20.0	
High blood pressure		52.6			50.3	
Incontinence		13.1			17.7	
Arthritis		56.1			52.6	
Broken hip		3.4			4.0	
	Right Eye	Left eye	Both	Right Eye	Left eye	Both
Cataracts	6.3	2.3	20.6	6.3	3.4	34.9
Cataract surgery	1.1	3.4	18.3	5.1	1.7	27.4
Glaucoma	.6	1.7	4.0	-	1.1	5.7
Macular Degeneration	1.7	2.3	2.9	2.9	2.3	4.0
Short-sightedness	-	-	31.4	-	-	31.4
Long-sightedness	-	-	22.1	-	-	17.7
Visual Field loss	-	-	5.1	.6	-	5.7
Astigmatism	.6		16.7	-	-	16.0
Blindness	-	-	1.7	1.1	.6	-

In the initial study 44 participants reported having falls in the past year regardless of injury which increased to 53 in the follow-up study. The average number of falls decreased from 2.07 (*SD* = 2.24) in the initial study to 1.75 (*SD* = .837) in the follow-up.

4.5.2. Changes in Driving Behaviour

For driving behavior there were only eight individuals who had ceased driving in the follow-up hence their results may not be highly representative. However, the results from the initial study are presented for both the participants who ceased driving and those who continued driving at follow-up as a comparison. Table 10 presents the general demographics of the driving behavior for the two groups in the initial study and the follow-up change.

Table 10.

Driving behaviour as a function of study and driving at follow-up.

		Initial study - 2006		Follow-up – 2011/12
		N= 8 ceased driving	N = 158 still driving	N= 158
How often do you drive		3 – 5 times	2 – 5 times	0 – 4 times
		M = 4.43, *SD* = .79	*M* = 4.64, *SD* = .61	*M* = 1.60, *SD* = .79
			$t(167) = 31.80$, $p < .001$	
Average number of kms		50 – 275 km	20 – 1000 km	5 – 700 km
		M = 142.9 km,	*M* = 195.5 km,	*M* = 161.5 km,
		SD = 71.8	*SD* = 149.7	*SD* = 119.6
			$t(164) = 3.34$, $p = .001$	
Proportion who drive				
to work		0	0.17	0.10
to shopping centre		0.43	0.55	0.56
to friends /relatives		0.43	0.53	0.43
anywhere		0.86	0.83	0.76
long distances		0.71	0.87	0.77
on unfamiliar roads	Never	-	0.02	0.02
	Occas.	0.86	0.85	0.90
	Half	-	0.11	0.06
	Most	-	0.02	0.006
	Always	-	0.006	0.02

Examining crashes, 43% of those who ceased driving after the 2006 study reported being involved in a crash in 2006, compared to 21% who were still driving in the follow-up survey.

Driving crash incidence decreased in the follow-up to 18%. In the 2006 the mean number of incidences was 1.33 (*SD* = .058) for those who subsequently ceased driving and 1.20 (*SD* = .058) for those who continued. In the follow-up, the mean incidence rate was 1.27 (*SD* = 0.52).

Respondents also reported difficulty with a series of driving situations on a 5 point scale from 1 being “very difficult” to 5 “very easy”. Table 11 presents mean difficulty ratings for different driving situations as a function of driving status at follow-up. As can be observed the respondents reported the least amount of difficulty for making turns (right and left hand), overtaking and reversing when parking. On the other hand the situations which caused the most problems were related to conditions (in the wet, into the sun and at peak hour) and at intersections without lights. We also examined how reported difficulties changed over the follow-up period and while difficulty did not significantly change for any situation there was a non significant increase in the difficulty of reversing when parking and freeway driving.

Table 11.

Mean rating of driving difficulties (and standard deviation) as a function of study and driving at follow-up across a range of driving situations. Lowest and highest ratings are bolded for interpretation.

	Initial study - 2006		Follow-up – 2011/12	2006 to 2011 comparison
	ceased driving (*n* = 8)	still driving (*n* = 158)	(*n* = 158)	
Into the sun	**2.29 (.95)**	**2.83 (.97)**	**2.89 (1.02)**	*t*(166) = -.93, *p* = .35
At night	**2.71 (.95)**	3.40 (.84)	3.29 (.98)	*t*(162) = 1.72, *p* = .09
Peak hour	3.14 (1.07)	3.39 (.89)	3.37 (.92)	*t*(166) = .40, *p* = .69
In the wet	**2.57 (.95)**	3.32 (.81)	3.37 (.89)	*t*(165) = -.87, *p* = .38
Reversing when parking	3.14 (1.21)	3.62 (.88)	3.49 (.86)	*t*(166) = 1.89, *p* = .06
Parallel parking	**2.71 (.95)**	3.54 (.96)	3.48 (.94)	*t*(165) = 1.01, *p* = .31
Intersections w/o lights	3.17 (1.17)	3.57 (.81)	3.62 (.88)	*t*(165) = -.92, *p* = .36
Estimating car speed	3.43 (.53)	3.65 (.78)	3.72 (.83)	*t*(164) = -1.10, *p* = .27
Reading road signs	**2.86 (1.21)**	3.81 (.85)	3.78 (.89)	*t*(166) = .39, *p* = .70
Merging with traffic	3.00 (1.15)	3.81 (.92)	3.85 (.84)	*t*(166) = -.70, *p* = .48
Overtaking a vehicle	3.43 (.98)	3.87 (.89)	3.87 (.84)	*t*(166) < .001
Changing lanes	3.42 (.98)	3.85 (.90)	3.90 (.87)	*t*(164) = -.79, *p* = .43
Roundabouts	3.42 (.79)	3.91 (.89)	3.99 (.86)	*t*(166) = -1.30, *p* = .20
Freeway driving	**4.00 (1.00)**	4.25 (.80)	4.15 (.83)	*t*(164) = 1.87, *p* = .06
Making a right turn	3.57 (.98)	4.17 (.80)	4.22 (.79)	*t*(166) = -.88, *p* = .38
Making a left turn	3.57 (.98)	**4.36 (.74)**	**4.38 (.75)**	*t*(166) = -.19, *p* = .85
At traffic lights	3.86 (1.07)	**4.36 (.76)**	**4.39 (.73)**	*t*(166) = -.50, *p* = .62

4.6. How good were participants at predicting their driving ability? Meta-cognitive ability

In the original 2006 study participants were asked questions about their perceptions of their driving ability to be. These scores were found not to be related to scores on the hazard perception test suggesting that participants had relatively little insight into their driving ability (Horswill, et al., 2011). However, the driving ability ratings may be related to longer term driving outcomes. Hence mean ratings of driving ability in the initial study were examined in terms of driving status at follow-up; ceased driving (n = 8), still driving and have had no crashes (n = 128) and still driving but had a crash (n = 30).

Ceased drivers were included as a comparison but not analysed any further due to the small number. As can be seen in Figure 3 there is no significant difference in reported driving for those who were and were not involved in a crash, $t(160) = -.071$, $p = .94$ for likelihood of an crash, $t(161) = 1.29$, $p = .20$ for driving ability and $t(163) = .58$, $p = .56$ for control.

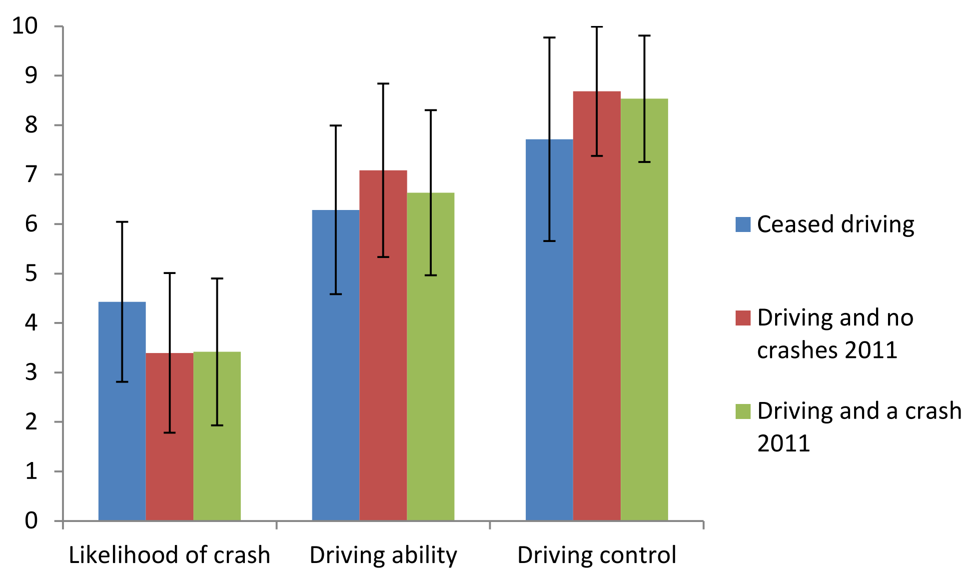

Figure 3. Average rated driving components in terms of what occurred at follow-up. Error bars represent standard deviations.

Participant's reported driving modification in 2006 was also examined in relation to driving status at follow-up. Driving modification was calculated as a score from 0 to 18 as outlined by Horswill and colleagues (2011) with higher scores representing greater driving modification. As shown in Figure 4, no significant differences in mean driving behavior modification was found between groups, $t(157) = .966$, $p = .34$.

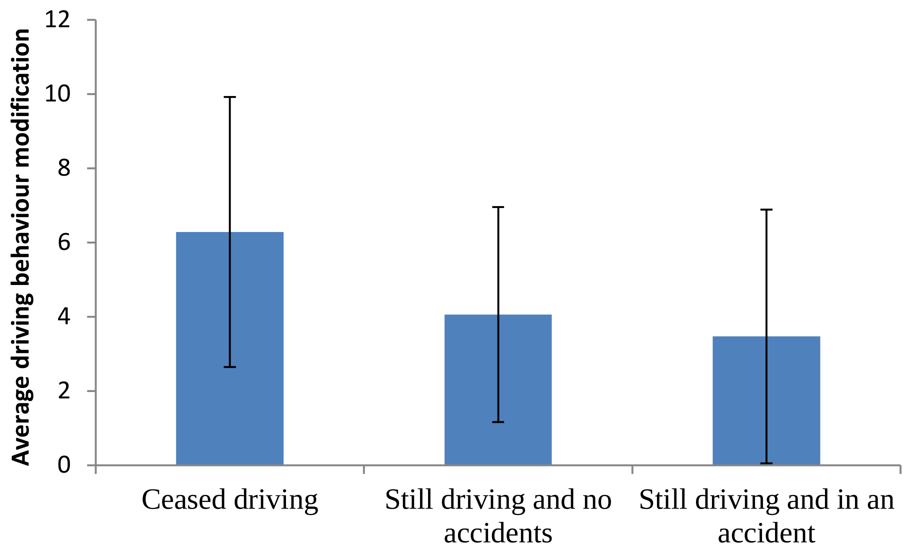

Figure 4. Average driving behaviour modification reported in the original study by driving status in the follow-up. The error bars represent standard deviations.

4.7. Measures in 2006 which are related to crash incidence in at follow-up

There are a range of measures in the initial 2006 study which may predict reported driving status at follow-up so each will be worked through separately. Of particular interest is whether the participant ceased driving by the follow-up, however, only eight respondents reported that this was the case so while this group is included for a comparison statistics are not actually conducted. The driving status at follow-up of most interest is whether the participant reported being involved in a car crash in the previous 5 years therefore most statistics report the comparison between those who did report a crash in the previous five years and those who report no crashes.

4.7.1. Measures of capacity to drive safely

Four measures of driving ability in the original study may potentially predict driving ability in the follow-up study, in particular the incidence of crashes. The first is the incidence of reported crashes in the original study as unsafe drivers may continue to be so. The other three have all been identified previously as important predictors of driving capacity (Anstey, Horswill, Wood, & Hatherley, 2012). As mentioned in the method these are the Hazard Perception Test (HPT), the UFOV and Hazard Change Detection Test (HCDT).

Table 12 shows all four measures in terms of driving status at follow-up. Again due to the small number of ceased drivers comparisons were only conducted comparing those who reported a crash to those who did not. For the number of crashes in 2006 a significant difference was found based on crash status, $\chi^2(1) = 5.34$, $p = .021$ potentially suggesting that poor driving continues over time.

For the HPT there are three different measures which can be examined: response time, accuracy and confidence. Respondents who reported a car crash at follow-up did not differ from those who did not report a crash on any of the measures of the HPT; $t(164) = -.17$, $p = .87$ for response time, $t(159) = -.92$, $p = .36$ for accuracy and $t(159) = .35$, $p = .73$ for confidence. These results indicate that HPT scores in 2006 were not a strong predictor of crash status at follow-up.

UFOV threshold scores in milliseconds were found to differ on crash status with those who reported being involved in a crash at follow-up having a significantly higher threshold score on the UFOV than those who reported that they had not been involved in a crash, $t(164) = -2.24$, $p = .027$. Note that on this test lower thresholds are better hence UFOV in 2006 appears to be an effective way of identifying those who reported a crash in the 2011/12 follow-up.

The outcome for the HCDT is reaction time in milliseconds. Due to problems with the normality of the distribution of the data, the HCDT scores were transformed to the log of reaction time. The difference in HCDT for those who did and did not report an crash was non-significant, $t(164) = -.37$, $p = .71$, suggesting that HCDT scores in 2006 may not be a sensitive measure of incidence over a five-year time span.

Table 12.

Relationship between measures of driving ability in the original study (2006) and driving status at follow-up (2011/12)

	Ceased driving *n* = 8	No crash reported 2011/12 *n* = 30	Reported Crash 2011/12 *n* = 128
Reported crash/es in 2006 (%)	43%	18%	37%
HPT – Resp. time (seconds??)	6.17 (1.09)	5.35 (.89)	5.38 (.77)
HPT - Prop. Correct	.85 (.09)	.93 (.10)	.94 (.08)
HPT – Confidence	.74 (.17)	.82 (.12)	.82 (.13)
UFOV Threshold (ms)	152.4 (59.2)	104.5 (87.8)	144 (86.4)
HCDT – log of RT	2.41 (.22)	1.94 (.28)	1.96 (.22)

4.7.2. Physical health

To examine whether the general health of participants was different between those who did or did not report a crash at follow-up mean scores on the general health, physical functioning and instrumental activity limitations due to physical health sub-scales of the SF-36 were investigated. Means by driving status at follow-up are presented in Figure 5. Note that higher scores here represent better health. While there were small decreases in self reported health for those who reported a crash at follow-up this was not significant, $t(164) = .86$, $p = .39$ for initial study health and $t(164) = 1.403$, $p = .16$ for follow-up health. Similarly for physical functioning no difference was found for those who reported a crash and those who did not, $t(172) = -.627$, $p = .45$ and $t(172) = 1.04$, $p = .3$ for follow-up. For instrumental activity limitations the 2006 score differed between those who did and did not report a crash $t(172) = 2.09$, $p = .038$ but differences were not found at follow-up, $t(172) = 1.28$, $p = .20$. These results suggest that self-reported health status and falls did not differentiate between those who reported incidents at follow-up and those who did not.

Further there was no relationship between reporting a fall in the initial study and reporting an traffic incident at follow-up, $\chi^2(1) = 0.09$, $p = .77$, with 24% of those who reporting no driving crashes in 2011/12 reporting that they experienced a fall and 27% of those who reported being involved in a car crash also reporting a fall. However, 43% of those who ceased driving at the follow-up had also experienced a fall. This was similar to reported falls in the follow-up which was also not related to reported crashes at follow-up $\chi^2(1) = .014$, $p = .90$. These results suggest that self-reported health status and falls did not differentiate between those who reported incidents at follow-up and those who did not. This may be indicative of a selection effect – where less healthy drivers ceased driving.

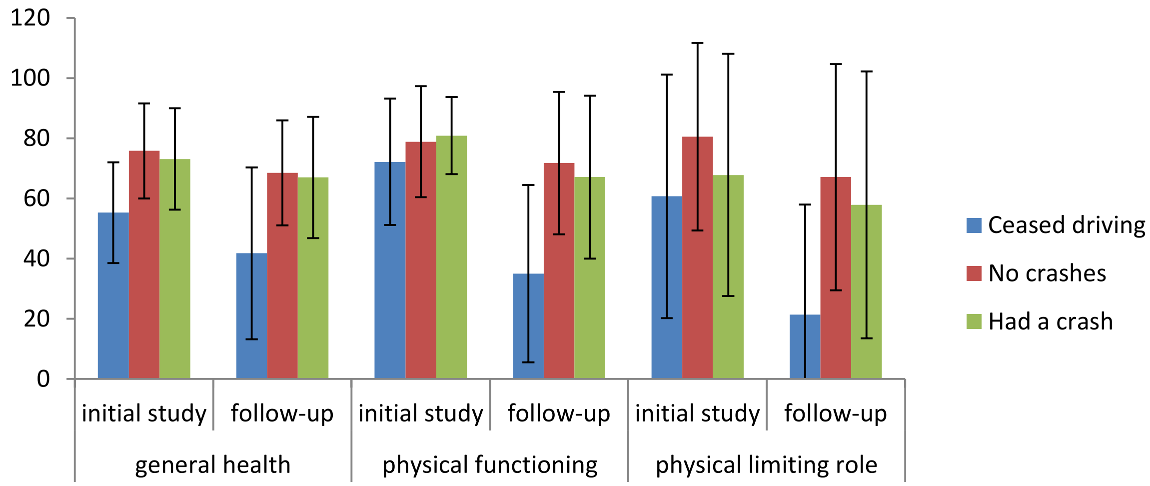

Figure 5. Reported health differences in terms of driving status at follow-up (2011/12). Error bars represent standard deviations.

4.7.3. Vision

The included vision test from the initial study that may differ with crash incidence is the high and low contrast Bailey-Lovie (logMAR) scale, which measures visual acuity (Bailey & Lovie, 1976). As shown in Figure 6 regardless of the contrast level scores the logMAR did not differentiate those who had an crash from those who did not, $t(165) = -0.60$, $p = 0.55$ for high contrast or $t(165) = 0.19$, $p = 0.85$ for low contrast.

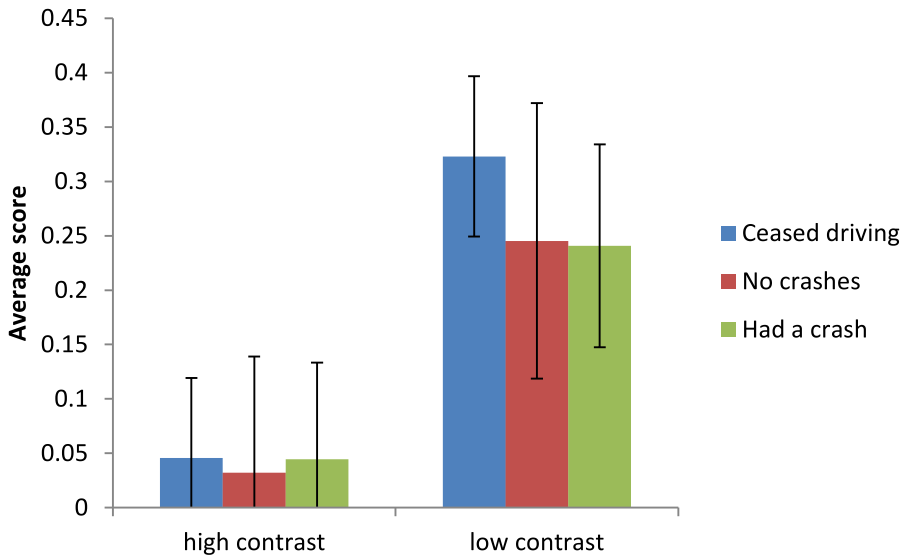

Figure 6. Average score on the high and low contrast logMAR. Error bars represent standard deviations.

4.7.4. Cognitive test scores

Table 13 presents the mean score across a range of cognitive tasks in terms of driving status at follow-up and a comparison between those who reported crashes at follow-up and those who did not. Tests include the mini-mental state exam (MMSE), Gestalt Completion test, digit span, the Card Rotation test, visual search, Trail Making task (TA and TB) and the Colour Choice Reaction Time test (CRTC). Descriptions of many of the tasks can be found in (Anstey, et al., 2012). As can be seen in Table 13 no significant differences in cognitive functions were found between those who did and did not report being involved in a crash at follow-up.

Table 13.

Differences in Cognitive tests in the initial student for driving status at follow-up and a comparison between those who did and did not a crash at follow-up. Reported t-test compare participants on measured based on their crash incidence report.

	Ceased driving *N* = 8	No crashes in 2011/12 *N* = 128	Had a crash 2011/12 *N* = 30	Crash Incidence Comparison
MMSE	27.86 (.69)	27.37 (.96)	27.50 (1.25)	$t(165) = -.62, p = .54$
Gestalt Score	6.56 (4.99)	5.68 (3.15)	5.91 (3.47)	$t(165) = -0.36, p = .72$
Digit Span	5.43 (2.22)	7.31 (2.38)	6.87 (1.98)	$t(165) = 0.96, p = .342$
Card Rotations	27.29 (9.10)	34.77 (11.18)	32.73 (10.04)	$t(165) = .92, p = .36$
Visual Search	89.57 (12.19)	93.13 (17.98)	89.50 (14.96)	$t(165) = 1.03, p = .30$
TA time	46.73 (13.71)	35.10 (10.74)	34.51 (9.49)	$t(165) = 0.28, p = .78$
TB time	107.43 (51.27)	69.10 (27.11)	73.56 (23.96)	$t(165) = -0.83, p = .41$
CRTC-Total Correct	54.57 (4.03)	57.18 (2.33)	57.33 (2.12)	$t(164) = -0.34, p = .74$
-Total Incorr.	5.43 (4.03)	2.82 (2.33)	2.67 (2.12)	$t(164) = 0.34, p = .74$
- Correct RT	1.15 (.14)	0.93 (.14)	0.97 (.14)	$t(164) = -1.31, p = .19$

4.7.5. Mental health

Measures of mental health were the Anxiety and Depression scales in the Depression Anxiety and Stress Scale 21 (DASS21), however means scores on these scales also did not differ with crash status at follow-up, $t(165) = -.69$, $p = .49$ for anxiety or $t(164) = .18$, $p = .85$ for depression. The means for these are presented in Figure 7.

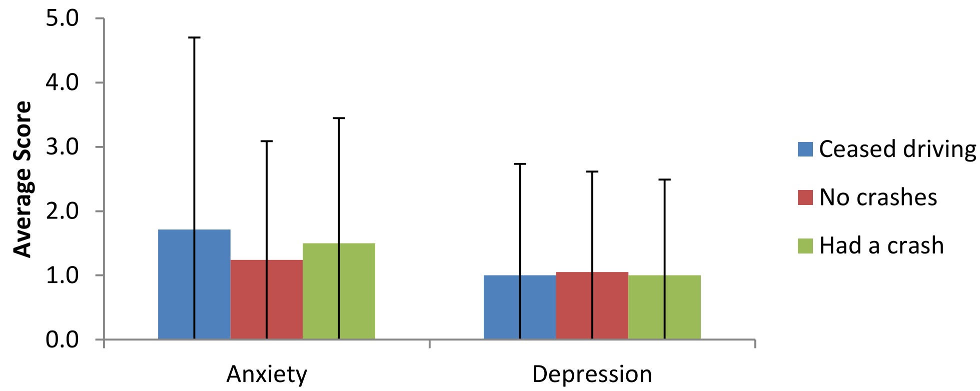

Figure 7. Average scores on the DQ Anxiety and Depression scales in the initial study in terms of the driving status at follow-up. Error bars represent standard deviations.

This pattern is supported by data from the SF-36 emotional wellbeing and social functioning subscales where no difference was found between those who did and did not report a crash in 2011/2012 regardless of whether the SF-36 was conducted in 2006 or 2011/2012, $p > .1$ for all. Means are presented in Figure 8.

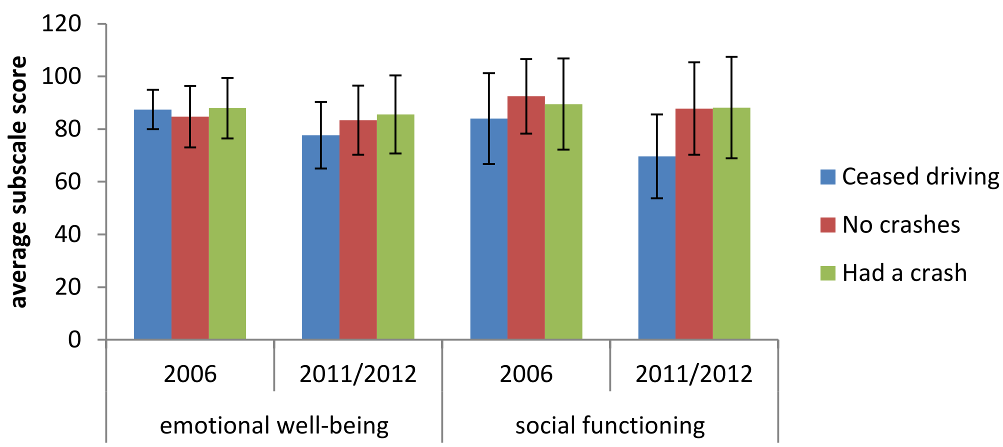

Figure 8. Average emotional well-being and social functioning as measured by the SF-36 in 2006 and 2011/2012 as a function of the driving status in 2011/2012. Error bars represent standard deviations.

4.7.6. Kilometres driven

As kilometres driven is often linked to better driving or decreased crash incidence (e.g. Meuleners, et al., 2006) the kilometres reported driven both at the initial and follow-up studies and the reported crash incidence at both times were examined. The mean kilometres driven across all these are presented in Figure 9. Kilometres driven at either time did not differentiate those who were involved in a crash from those who did not. One possible reason may be the quite large variation in reported kilometres.

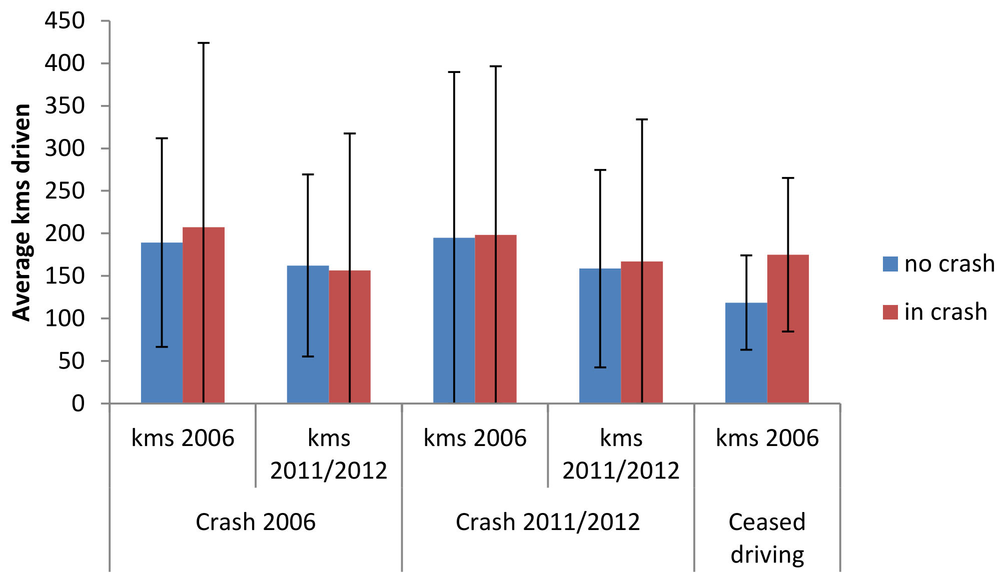

Figure 9. *Relationship between kilometres driven and crash incidence. Error bars represent standard deviations.*

5. Summary and recommendations

This report outlines a follow-up study of 175 older drivers over a five year period. The first aim of this study was to examine changes in older drivers' physical, cognitive and neurological health over those five years and to determine what factors predicted safe driving at follow-up. The second aim was to examine the readiness to cease driving and what factors are important to understanding older driver's readiness to transition to a non-driver.

Participants from the original study who were not followed-up either had declined, could not be contacted or had passed away in the follow-up period. In general those who were followed up were better drivers in that they performed better on the HPT, UFOV and change detection tasks. However, those who were followed-up were not involved in a greater number of crashes or had a different number of years driving or kilometres driven. The lower scores on tests of driving capacity of those individuals not followed-up may be due to a large number of those individuals potentially being ceased drivers, and hence not responding to a driving study. Of the whole sample only 4.6% had ceased driving in the 5 years between the initial study and the follow-up. However, this proportion is in line with previous research; for example in a sample of older drivers 65 years and older Edwards and colleagues (2009) found that 5.9% ceased driving after a 5 year follow-up while in a sample of drivers aged 70 and over Windsor and colleagues (2007) found that 8.2 % ceased driving after a 2 year follow-up.

5.1. Factors predicting driving ability/changes in driving ability

One of the key aims of this study was to reassess the utility of the predictors of driving ability after five years, in particular allowing for the identification of those older adults who are at greater risk of car crashes or incidents. A number of factors were examined, however the key variables of interest were tests which have specifically been linked to driving ability in the past, the UFOV, the ACT Hazard Perception Test and a Hazard Change Detection Task. The outcome measure of interest was whether the participant self reported being involved in any crashes in the previous five years (from the time of the original study). Considering each individually the only measure which predicted crash likelihood five years later was threshold scores on the UFOV while scores and confidence on the HPT and scores on the HCDT were not related to reported crash incidence. In addition, previous reported crashes were related to crashes reported at follow-up suggesting that those who had previously experienced a traffic incident may be at greater risk of experiencing a crash in the future.

Similar to the HPT and HCDT, scores on a range of cognitive tests conducted in 2006 were not found to distinguish between those who did and did not report crash in 2011/2012. However, the cognitive tests may have a role to play as a “battery” with all measures taken together. This involves complex statistics beyond the scope of this report but will be considered in the future. Of similar interest is the finding that self reported health, falls, depression and anxiety scores, and vision were not found to identify those older drivers at greater risk of a car incidence. These findings suggest that as separate items, these indicators are not useful predictors for incidence risk in older drivers over a five year period.

Interestingly kilometres driven did not differentiate between those who reported a crash and those who did not. Our measures included both the number of kilometres driven in 2006 as well as kilometres driven currently in the follow-up. Our findings are in direct contrast to the literature that indicates a low kilometre bias, where individuals who drive a fewer number of kilometres are at higher risk of a crash.

5.2. Changes in driving behaviour and the ability to predict driving ability

In the initial study and the follow-up participants reported changes in their driving, in particular whether they were driving less often and for fewer kilometres each week. Those who were still driving at follow-up were less likely to report a crash at baseline. Furthermore, the number of crashes reported fell from 2006 to 2011. Those still driving also rated a series of driving situations as similarly difficult in the follow-up as they did in 2006 suggesting that they were not having increased problems with any particular conditions or situations when driving.

Despite modifying their behaviour participants, this driving modification does not appear to be an outcome of insight into their own driving abilities. In particular increased ratings of driving behaviour modification in 2006 were not related to crash likelihood in 2011/2012. Further participants ratings of their driving abilities in 2006 were not found to be related to crash likelihood in 2011/2012. These findings suggest that distinguishing between older drivers who modify their behaviour and those who do not does not provide an identifying factor for older adults at greater incidence risk.

5.3. Driving cessation

One way driving behaviour can be modified is through the cessation of the activity all together. As mentioned previously, due to small numbers we have not analysed the ceased drivers in the same way as the continuing drivers. However, in examining the means of this group it can be seen that there are many potential reasons why these individuals chose or were forced to no longer drive. They appeared more likely to have modified their driving behaviour in 2006, drove less kilometres (though not necessarily less often) and had generally worse scores on the measures of safe driving. Importantly they appeared to have worse self reported physical health, and worse cognitive test score than continuing drivers. While they do not appear to have greater levels of depression and anxiety there does seem to be a decrease in social functioning from 2006 to 2011/2012 which is in line with the reports of some negative consequences associated with ceasing driving.

One of the main goals of the current study was not only to examine ceased drivers but also to examine the readiness of participants still driving to give it up. Particularly we were interested in the overall readiness of a population of older drivers to cease driving and also demographics which may influence an individual’s readiness. In general participants in the study were more likely to agree with statements reflecting vague intentions to cease driving rather than clear statements of short term plans to cease driving or alter driving behaviours. This is surprising given the mean age of the sample was 76 years at follow-up. Demographics of the participants did however play a role in an individual's readiness. Not only did age and gender influence cessation rates they also influence an individual's readiness to cease driving. Women generally indicate that they have prepared for driving cessation compared to men and are more likely to agree that age can make individuals unsafe on the road. In contrast men are less likely to have short term intentions to cease driving. This is consistent with findings in the literature that in general women have a higher likelihood of cessation, for less pressing reasons and in better health than men (Oxley & Charlton, 2009).

Accidence incidence similarly influence reported readiness to cease driving, particularly crash incidence reported in the initial study. It was not however always the case that crash incidence increased reported thoughts of driving cessation, even though this was the most common direction. Similarly increased age was shown to heighten an individual's reported readiness to cease driving.

5.4. Recommendations

5.4.1. Around Driving Cessation

There are many ways in which driving cessation outcomes for older drivers can be improved. This includes increasing the public education effort to help older drivers make evidence based decisions about when to cease driving. Part of this could be a simple tool which can be used to assess older drivers' thoughts on cessation, such as the REDI presented here. Such an inventory would allow increased help to those at risk of losing their license who are not thinking about this potential transition. For example it may be particularly useful to focus on males as they were found to have relatively low levels of intentions to cease driving. Particular focus may also be paid to those who are at risk (possibly those who have high thresholds on the UFOV) in preparing for driving cessation. As a lack of control is often linked to poor outcomes for driving cessation this provides an effective means for addressing such feelings of lack of control in older drivers'.

5.4.2. Around Future Research

One potential avenue for future research is to alter the follow-up period and look at the effects of time more closely. A five year gap may potentially be too long a period to effectively "catch" the questions of interest, for example the measures we used may lose sensitivity over time and be better short term. Hence it might be of interest to examine different time frames to examine when sensitivity is lost. Such research is also of interest as the effects may not be linear, hence two time measurements will not capture non-linear effects. In this case the recommendation would be to conduct a repeated measure study design that has much shorter time measures with greater than two measurement occasions.

However, a longer time frame with the same participants may also be of interest, in particular to examine driving cessation. A greater number of participants may have ceased driving after a longer period of time and as ceased drivers do appear to differ throughout this report on a number of factors this would be of interest. Additionally the relationship between opinions expressed on the REDI and driving outcomes could be examined in detail. In general, further reach to understand differences in driving cessation readiness and what may be helpful to prepare older drivers to transition (if transition is considered necessary).

Finally, this research is potentially limited by its relatively small sample size of mostly healthy older drivers. With only 11 or 3.7% of the original sample of over 65s passing away in the five year follow-up period and a low umber ceasing driving this suggests that the sample collected here was likely a relatively high functioning sub set. This is particularly true for the sample which was followed-up. As such this may not represent the utility of the measures of driving capacity in the populations. To address this issue along with the issue of the predictive length of the measures it would be appropriate to conduct an annual follow up study on a larger sample of older drivers recruited through naturalistic settings. Of particular interest would be those drivers who have been referred for testing due to health issues or concerns over driving as this may represent the population for which the measures may have the highest utility.

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