

## SELF-REGULATORY BEHAVIOUR OF OLDER DRIVERS

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### ABSTRACT

The task of driving is complex and places high demands on cognitive, attention, decision-making, perceptual and motor processes. Age-related changes in these capacities present a compounding factor and place older drivers at a significant risk. It is frequently claimed that drivers *self-regulate* their driving behaviour as they age to minimise their risk of having a crash. Examples of such behavioural changes include using low-traffic roads, planning trips to avoid busy locations, and not driving at night. While there is evidence that older drivers do travel shorter distances on average than their younger counterparts (LTSA, 2000), the evidence of older drivers adopting more safe driving practices is less definitive. There is a suggestion, too, that the practice of self-regulation may not be consistent among all older drivers (eg. those with dementia). An important factor in determining self-regulatory driving behaviour is insight into one's own functional abilities, as well as an appreciation of the specific environment and situational context related to driving. This paper reviews existing research addressing issues of self-regulation. In addition, a preliminary investigation of self-regulatory behaviours in a small sample of Australasian drivers is reported. Older drivers participating in the study completed self-reports about their driving and underwent a series of functional assessments and an on-road driving test. Results describe the relationships among functional abilities, self-regulatory driving behaviours and on-road driving performance. Implications for safety and mobility are discussed.

### INTRODUCTION

One of the widely held assumptions about older drivers is that there is a high level of self-regulation. That is, older drivers are thought to make adjustments in their driving behaviour that adequately match their changing cognitive, sensory and motor capacities. Examples of such behaviours include travelling fewer kilometres and avoiding peak traffic times, night-driving and freeways. The abilities of older drivers to regulate their driving according to their own abilities and to cease driving when they judge they are no longer safe, are thought to be important strategies in reducing the incidence and severity of crashes.

Current crash statistics for Australia show that older drivers are involved in significantly more serious and fatal crashes than their younger counterparts when numbers are adjusted for differences in exposure (ABS, 1995; FORS, 1996). Moreover, without appropriate interventions, the older driver problem is expected to increase up to threefold over the following decades, given the predicted increase in the proportion of older persons in the population and associated changes in their mobility patterns (Fildes, Fitzharris, Charlton & Pronk, 2001; Hu, Jones, Reuscher, Schmoeyer & Truett, 2000). The factors contributing to the over-representation of older drivers in fatal and serious crashes are complex. While frailty and susceptibility to injury can explain these rates in part, the capacity of older drivers to adopt safe driving practice is also likely to impact on crash risk.

Driving a car is arguably a complex activity, drawing simultaneously upon many cognitive, attention, perceptual and physical capacities. Ageing results in a range of changes in these areas that may affect driving skill and susceptibility to injury. Researchers in the US argue that most older drivers are able to regulate their driving adequately and compensate for age-related declines by reducing their annual driving as well as regulating when and where they drive (Evans, 1988; Eberhard, 1996; Smiley, 1999). While it is likely that many older drivers adjust their driving behaviour adequately to accommodate these changes, it is also possible that there is a sub-set of older drivers who fail to self-regulate their driving adequately and as a consequence, may have a higher risk of crash involvement. Little, however, is known about the incidence and process of self-regulation in this country. In one of the few Australian studies on this issue, Peel, Steinberg and Westmoreland (2000) conducted a survey of 95 participants aged 75 years and older. In-depth interviews were also conducted with a smaller subset (n=30) of Queensland drivers, former drivers and non-drivers examining participants' experiences, perceptions and transportation needs. They reported that all of the drivers (n=10) interviewed had modified their driving patterns through self-regulation rather than through restrictions imposed upon them. Most reported that they were unhappy to drive at night and on unfamiliar roads. More research is needed to gain a better understanding of how widespread these practices are, what kinds of adaptive strategies they adopt, the reasons why they self-regulate and the impact of self-regulation on their mobility in terms of changes in lifestyle and activity patterns. More importantly, we need to know more about the characteristics of those who do/do not self-regulate and the effectiveness of self-regulation in reducing crashes among a larger sample of older drivers.

The urgent need to examine in detail the travel patterns and driving behaviour of older drivers was a key issue highlighted in the recent strategic approach to improve older driver safety developed at the Monash University Accident Research Centre (Fildes, 1997). This paper provides an overview of the literature on adaptation of driving practices among older drivers. It is important to note that to date, studies reporting self-regulatory practices of older drivers have been predominantly based in Europe and North America. In the second part of this paper we report a study of self-regulatory practice in a small sample of Australian drivers. This preliminary work is part of our on going research designed to examine the nature and extent of self-regulatory driving practices in Australasia.

### **Factors influencing the adoption of self-regulatory driving behaviours**

The processes involved in self-regulation and the factors that influence the adoption or avoidance of self-regulatory behaviours are complicated and not well understood (see Craik & Salthouse, 2000 for a review of self-evaluation theory). For the most part, the literature refers to these behavioural changes as compensatory, implying that older drivers change their behaviour in response to a loss of function or as a counteracting measure for difficulties experienced. However, other explanations are possible. For instance, the ageing individual's mature judgement, lifestyle choices, and personal preferences brought about by changes in circumstances may influence driving practices. While it is recognised that there are many factors that lead to changes in patterns of driving behaviour (see summary, tabled below), the focus of the following discussion is on compensatory strategies associated with functional changes.

FACILITATORY FACTORS	INHIBITORY FACTORS
?? Insight/awareness of the impact of declining functional performance and health issues on driving skill	?? Lack of insight into one's own physical status and functional ability
?? Influence from others (family, friends, general practitioner, other health professionals)	?? Lack of awareness of the impact of ageing on driving performance (e.g., presence of dementia)
?? Lifestyle choice and comfort	?? Inappropriate risk assessment
?? Good access to alternative transport	?? Perceptions of loss of independence
	?? Lack of available alternative transport and reluctance to become dependent on others

### **Adapting to age-related functional changes**

The view that older adults are able to adapt and compensate successfully for functional changes is supported by the fact that age-related changes in perceptual, cognitive and motor performance occur gradually over the life -span. Thus, it is argued that appropriate adjustments can be made in order to maintain a similar level of performance (Verillo & Verillo, 1985; Lawton, 1990). Lawton added that older adults adopt the process of 'selective optimisation with compensation' which he describes as follows: "Compensations are made, ...and most important, an economy of acceptable gains and losses is maintained whereby some goals are relinquished gracefully in favour of others that are both highly valued and still within the realms of the person's expertise" (p.532). Indeed, a large proportion of the evidence points to caution and conservativeness on behalf of older road users (Rumar, 1986; Winter, 1988; Eberhard, 1996). This would imply that at least some older adults are able to (and do) compensate well for limitations.

In contrast, Rothman, Klein and Weinstein (1996) argued that people of all ages are poor at recognising the relationship between their own actions and potential risks and that they perceive themselves as less likely than their peers to suffer harm. They further suggested that this optimism about one's invulnerability could hinder the adoption and maintenance of preventive behaviours. Other reports suggest that older drivers i) under-estimate the risk of being involved in a crash, ii) fail to admit to driving errors, iii) over-estimate their ability to handle the driving task and feel they have total control to avoid crashes, and iv) believe that a crash would be much more likely to occur through some other cause than their own error (Brainin, 1980; Matthews, 1986).

Although a detailed review of all areas of age-related functional decline is beyond the scope of this paper, vision impairment and cognitive decline merit some discussion. Perhaps the most recognised age-related decline is vision and it is the relationship between visual capability and driving that has attracted the most research attention. Researchers typically consider vision to be responsible for the greatest proportion of sensory input for drivers, however, it is difficult to determine what specific visual skills are essential for safe driving. Nevertheless, age-related declines in dynamic and static visual acuity, visual field, resistance to glare, contrast sensitivity, visual processing speed, visual search, low light sensitivity, perception of angular movement and movement in depth have all been associated to varying degrees with crash risk (Shinar & Scheiber, 1991; Kline, Kline, Fozard, Scheiber & Sekuler, 1992; Ball & Owsley, 1991; Ball, Owsley, Sloane, Roenker & Bruni, 1993). In their study of risk factors of injury crashes among older drivers, Owsley, McGwin and Ball (1998) found that drivers with a reduction of *useful field of view* of more than 40 percent were at least twenty times more likely to be involved in a crash involving injury than were those with minor visual limitations. In her analysis of the effect of visual and cognitive impairments on amount of driving, Stutts (1998) found a clear pattern of reduced driving exposure associated with lower levels of cognitive and visual function in the population of drivers studied. Similarly, others have reported that most older drivers themselves recognise that good vision is one of the most important elements for safe driving and often cite poor vision as a major determinant for reducing driving, particularly driving in poor vision conditions such as night driving or driving in poor weather (Persson, 1993; Marottoli et al., 1993; Kostyniuk, & Shope, 1998). However, what remains to be established is whether such self-regulatory practices are related to driving performance and crash risk.

In addition to normal age-related decline in vision described above, a leading cause of vision impairment in adults over 60 years is cataract. Almost half of those aged 75 to 85 years are affected by this condition, many of whom cope with associated vision impairment for an extended period until corrected surgically. Owsley, Stalvey, Wells and Sloane (1999) found that older adults with cataracts were more likely to experience reductions in driving exposure and restrictions in driving habits than those without cataract. Compared with drivers without cataract, those with cataracts preferred to have someone else drive, drove slower than the general traffic flow, drove less, experienced more difficulty when driving in the rain, turning across traffic, in unfamiliar areas, in peak hour and at night, and received advice that they should limit or stop their driving.

Cognitive and attentional abilities are also critical for safe driving. Many older driver crashes have been attributed to deficiencies or decline in attentional processes and information processing (Planek & Fowler, 1991; Transportation Research Board, 1988). Of interest here, is the adequacy of older drivers to self-assess their cognitive capacities and to adapt their driving behaviours appropriately. One of the most well established research findings in all behavioural domains is the slowing of performance with age. There is strong evidence to suggest that ageing results in slower and inadequate detection and registration of sensory information, slower cognitive processing of that information, slowed integration of the relevant information, and slowed initiation of movement and execution of responses (Welford, 1977; Ball et al., 1993). This slowness, however, is not necessarily observed in events that are simple and predictable. Generally, the more complex the stimulus and the decisions to be made, the slower the response speed of older persons (Welford, 1977; Inui, 1997). There is also a substantial body of literature showing that older adults are disproportionately penalised compared to younger adults when performing multiple-task situations (see Craik & Salthouse, 2000). The slowing of response is thought to be the result of slowing of information processing capacity along with a reduced ability to process information sources in parallel. Complex traffic, therefore, presents a real challenge and this is reflected in the crash involvement of older drivers in complex traffic situations (Stamatiadis et al., 1991; Fildes et al., 2000).

There is some evidence to suggest that older drivers tend to avoid complex traffic manoeuvres that require high cognitive demands (Hakamies-Blomqvist & Wahlström, 1998; Ball et al., 1998). In contrast, others have demonstrated that older drivers, or at least some older drivers, do not self-regulate adequately to compensate for age-related changes in cognitive abilities. This may be due to a difficulty, particularly for older adults, in making judgements about their own competency to perform everyday tasks. Support for this comes from the work of Stutts (1998) who examined functional abilities and driving habits in a group of drivers aged 65 years and over in North Carolina who were applying for renewal of their drivers licence. Results showed that around half of the drivers in the lowest quartile of cognitive performance still drove more than 3,000 miles a year. In fact, nearly 20 percent of participants reported driving more than 10,000 miles a year (a figure well above the average for this age group). Similarly, Peel et al (2000) in her in-depth interviews with older drivers in Queensland, found that cognitively normal drivers (n=5) were more likely to report avoiding busy traffic, roadworks, parking in main streets,

roundabouts and wet conditions than those who were cognitively impaired (n=5) (criterion for cognitive impairment, MMSE score < 26). The study also found that drivers with higher cognitive scores were more likely to undertake longer trips and travel longer average distances in the previous year than those with lower cognitive scores. In addition, Dobbs (1996) found that of 90 older drivers referred by physicians to the Northern Alberta Regional Geriatric Program, 70 percent were recommended to stop driving altogether and a further 15 percent to restrict their driving. Dobbs noted, that many of the drivers in this study were diagnosed with clinically significant memory and cognitive dysfunction and may not have been representative of all older drivers. Nevertheless, this finding shows that there were some older people still driving that possibly should not have been driving, or, at least, should be restricting their driving.

Holland and Rabbitt (1992) examined age-related sensory and cognitive deficits and highlighted a lack of awareness of changes in functional ability amongst adults aged 50 years and older in the UK (n=68). They found that older people were unaware of the extent of their declining vision and capacity to respond quickly. In particular, drivers aged 70 years and older did not perceive complex intersections as posing any particular problem to them, considered their reaction time as good as when aged 50 years, and felt that their ability to cope with intersections and roundabouts was much the same as it had been at younger ages. They argued that older drivers who are unaware of their deteriorating capabilities could not make appropriate adjustments to their behaviour on the road. However, when people were made aware of their declining abilities (following feedback on assessments) two-thirds reported making appropriate changes to their driving behaviour. In another study, Kiernan, Cox, Kovatchev, Kiernan and Giuliano (1999) found that driving performance of older drivers can be improved through self-monitoring with a driving diary. The diary was designed to heighten awareness of driving behaviour which can lead to improved driving performance and safety. These findings suggest that insight into ones own functional abilities as well as the ability to accurately self-assess driving performance are important components in the process of self-regulation.

#### **Evidence of self-regulatory behaviour from analyses of older driver crashes**

In the above review of self-regulatory behaviour, the major source of evidence, albeit indirect, is by self-report by older drivers. Another source of evidence comes from analyses of older driver crash. Crash rates in the US support the notion that older drivers limit their driving to times and situations they feel capable of handling. Stutts and Martell (1992) have argued that while older drivers show elevated crash rates when these figures are adjusted for estimated annual miles travelled, these figures do not account for, and can vary with, specific driving conditions. Specifically, they reported decreases in the overall proportion of weekend and night-time crashes with increasing age. They suggest that older persons drive less during weekends and at night and that when they do drive at these times, their likelihood of crashing is not elevated compared to that of the overall driving population. Eberhard (1996) also noted that when figures are adjusted for these types of exposure variables, most crashes involving older drivers occur during the day, in clear weather, and during off-peak traffic periods and argued that the crash patterns of older drivers reflect their self-restrictive behaviours. Crash data for the State of Victoria also provide some evidence of self-regulation. For example, Diamantopoulou, Skalova, Dyte and Cameron (1996) reported a steep decline in night time crashes with increasing age after 60 years.

World-wide crash data suggests that complex intersections are particularly troublesome for older drivers (Stamatiadis, Taylor & McKelvey, 1991; Benekohal, Michaels, Shim & Resende, 1994) and that rear-end collisions and crashes at signalised intersections represent the most common form of crash involvement for older drivers (Transportation Research Board, 1992). A more recent study of older drivers 'blackspot' crash sites in Australasia found that the principal problem for older drivers was selecting safe gaps in conflicting traffic (Fildes, Corben, Morris, Oxley, Pronk, Brown & Fitzharris, 2000). This basic problem manifests itself mainly at intersections controlled by stop or give-way signs, or at intersections controlled by traffic signals.

More information is needed from both real-world crashes and studies of driving practices of older drivers. Currently we are conducting a broad-based study of self-regulatory behaviour to examine the relationships between self-regulation, functional ability, and driving performance in a large cohort of drivers aged 55 years and older. The study described here is a preliminary attempt to explore some of these issues in a small sample of older drivers in Tasmania.

## **METHOD**

### **Participants**

Fifty-six older drivers, aged 85 years or older (range 85-96 years, median = 86 years), participated in the study (N=37 male and N=19 female). Participants were volunteers from the Hobart area, recruited using records provided by the licensing authority (DIER). As part of the requirements for licence re-assessment in Tasmania, all participants were required to undertake a medical examination and an on-road-driving test. All drivers had been deemed fit to drive by a medical practitioner. Participants' confidentiality was maintained and no data that would reflect on their licensing status were provided to the Tasmanian authorities. At the time of presenting for their licence re-assessment most drivers (83.9%) already held some form of restricted driving licence (eg: 95.7% were required to wear glasses when driving).

### **Experimental Design and Procedures**

All participants underwent a test of functional ability (GRIMPS), an on-road driving test and a survey of driving patterns. The study was undertaken in Tasmania, where age-based (older driver) re-assessments are a requirement.

#### *Functional Abilities Test*

The **Gross Impairments Screening Battery of General Physical and Mental Abilities (GRIMPS)** test (Scientex, Washington) was used to measure functional abilities of participants. This is a paper and pencil test, measuring a number of cognitive, perceptual, attention and motor functions that are believed to be important for driving. The test comprises 11 items, including a rapid pace walk, foot tapping, arm reach and head/neck rotation, vision acuity and perception, visual scanning, Trails A and B, and cued recall. On each subtest, participants were rated: "average or above" or below average". A total score was also derived from the number of subtests for which participants scored "average or above" (maximum = 11). Currently, two large studies validating this test are in progress; one in Maryland, USA and the other in New Zealand, by our group.

#### *On-Road Driving Skills*

The standard Tasmanian on-road driving test was re-structured to include an on-road test procedure for older drivers recently designed and introduced in New Zealand. Driving performance was scored simultaneously but independently, by two assessors (a driving assessor and research case officer), using both the Tasmanian and New Zealand scoring criteria. Only the NZ driving test results were used in this study. This test assessed drivers over a pre-planned route and included a number of specific driving manoeuvres including hazard detection. A pass/fail rating was applied.

#### *Survey*

A questionnaire was administered to explore self-reported functional status, mobility, travel patterns and driving practices. The survey included six questions on self-regulation as described below. Response categories for these questions were Always, Usually, Sometimes, Rarely, and Never.

Do you avoid driving at night?

Do you avoid making right turns against oncoming traffic?

Do you avoid driving in bad weather (e.g. rain, snow, fog etc)?

Do you avoid driving on high-traffic roads?

Do you avoid driving in unfamiliar areas?

Do you pass up opportunities to go shopping, visit friends, etc., because of concerns about driving?

## **RESULTS**

### *Functional Abilities*

Overall, of the 55 participants who completed GRIMPS, three had a score of 10 or 11 "average or above" (max. 11 subtests). The majority of participants (n=46) scored 'average or above' in 6-9 subtests, while six participants were rated 'average or above' on 5 subtests or fewer. Results for the GRIMPS subtests are presented in Table 1.

**Table 1 Number (and percentage) of drivers scoring “average or above” and “below average” on GRIMPS subtests.**

GRIMPS Subtest	GRIMPS Score “Average or above”		GRIMPS Score “Below Average”	
	N	(%)	N	(%)
Rapid Pace Walk	9	16	46	84
Foot-Tap	22	41	32	59
Cued recall	55	100	0	0
Arm reach	52	96	2	4
Head/Neck Rotation	11	20	44	80
Motor Free Visual Perception test	31	57	24	44
Delayed recall	29	53	26	47
Scan test	52	95	3	5
Trails A	49	89	6	11
Trails B	37	67	18	33
Visual Acuity (low/ high contrast)	15	29	36	71

#### *On-Road Driving Performance*

On-road driving performance was measured by outcomes on the standardised NZ licence test. Test outcomes were available for 46 of the 56 participants. Approximately 65% of those tested passed the on-road test. Errors incurred by those who failed the on-road test included running a red light (n=3), failing to give way (n=13), driving straight ahead from a right turn lane (n=5) and “other” errors (n=14, including situations where the driving assessor had to take control of the vehicle to avoid collision).

#### *Driving and Travel Patterns*

In response to questions relating to general patterns of driving, 13% of participants reported that they only drive in their local area and 41% indicated that they do not drive on long road trips. Approximately 54% drove up to 4 days per week while 46% drove on five days or more. In addition, the median distance travelled by drivers each week was 80 kilometres (range = 10-250 km).

#### *Self-Regulation*

Analyses of responses on self-regulation questions showed that avoidance of night driving was the most commonly adopted strategy of older drivers. Fewer drivers (20-34%) indicated that they avoided right hand turns, driving in bad weather, high traffic roads and in unfamiliar areas. Only 8% indicated that they passed up opportunities to drive to shops and visit friends because of driving concerns, sometimes, usually or often.

**Table 2. Percentage of drivers’ responses to questions about self-regulatory driving practices.**

QUESTION	Always	Usually	Sometimes	Rarely	Never
Avoid night driving? (n=51)	33.3	15.7	5.9	21.6	23.5
Avoid RH turns? (n=54)	5.6	11.1	3.7	20.4	59.3
Avoid bad weather? (n=53)	7.5	13.2	9.4	17.0	52.8
Avoid high traffic roads? (n=53)	5.7	3.8	11.3	24.5	54.7
Avoid unfamiliar areas? (n=53)	5.7	22.6	5.7	18.9	47.2
Pass up opportunities because of driving concerns? (n=53)	1.9	0	5.7	22.6	69.8

#### *Relationship Between Functional Abilities and Self-Regulatory Behaviours*

A number of t-tests were conducted to examine differences between two groups of drivers (i.e., those who adopted self-regulatory behaviours always/usually and those who rarely/never self-regulated) with respect to functional performance (GRIMPS scores; max. = 11). The validity of assumption of equal variances of groups was checked and where equality could not be reasonably assumed, the more conservative analyses are reported accordingly. Results showed that those who usually or always avoided right hand turns, had significantly lower (worse) scores on GRIMPS than those who rarely or never avoided right hand turns (means are 5.8 and 7.7, respectively),  $t(14.75)=4.3$ ,

$p = .001$ . Those who avoided driving in bad weather had significantly poorer GRIMPS scores than those who did not (means are 6.1 and 7.6 respectively),  $t(45) = 3.1$ ,  $p = .003$ . A similar trend was observed for avoidance of unfamiliar areas (means are 6.7 for avoid always/usually and 7.7 for avoid rarely/never), but this failed to reach significance ( $p = .09$ ). No significant differences in functional performance were observed for those who avoided night driving, high traffic roads and passed up on shopping and visiting friends because of driving concerns.

#### *Relationship Between On-Road Driving Performance and Self-Regulatory Behaviours*

Statistical tests applied to examine the relationship between driving performance and each of the self-regulatory behaviours revealed no significant differences. However, when drivers were grouped for their overall responses (across 6 areas) for self-regulation and exposure (drive 4 days per week or less vs. 5 days or more) two interesting trends emerged. (Note, a full data set was available for only 45 participants.) Firstly, over 80% of those who rarely or never adopted self-regulatory strategies, regardless of driving frequency, passed the on-road driving test, while 20% failed the driving test. Almost as many, just over 70%, of those who did adopt at least one self-regulatory measure sometimes, also passed the on-road test. Interestingly, these were the drivers who tended to drive more often (5 days per week or more). In contrast, of those who adopted at least one self-regulatory behaviour sometimes, but who drove less frequently (four days a week or less), only about 50% passed the on-road driving test (and by deduction, approximately 50% failed).

#### *Case Study*

The profile of one individual case is presented here to highlight the complexity of relationships between self-regulation, driving performance and functional ability. Driver, Mrs B., failed the on-road driving test, failing to give way at a roundabout, running a red light and frequently requiring assessor's intervention of vehicle control. She also scored below average on 6 of the 11 GRIMPS subtests, placing her below the 10<sup>th</sup> percentile on this measure. With respect to her driving behaviour, Mrs B. reported driving only 3 days and 50 kilometres per week. She reported at least one near-miss crash in the past three years. She rated her vision as *good* for safe driving during the day and *fair* for night driving. Speed for decision-making was self-rated as *good* for safe driving, as were strength and flexibility. Interestingly, although Mrs B. reported always or usually avoiding night driving, right turns, bad weather and unfamiliar routes, she rarely avoided using high traffic roads.

## **DISCUSSION AND CONCLUSIONS**

Several interesting findings emerged from the preliminary analyses of older drivers' self-regulatory behaviour. First, while self-regulation was evident, there were differences in the nature of practices adopted and in the frequency of their use. For example, 'avoiding night driving' was adopted by more participants than other practices. On the whole, self-regulation tended to be associated with poorer levels of functional ability. This suggests that at least some of those drivers with compromised cognitive, physical and vision capacities do indeed self-regulate. More work is needed to examine whether this pattern is reflective of good insight. Self-regulation was not associated reliably with driving performance as measured by outcomes on the on-road licence test. However, when figures were adjusted for driving frequency, there was a trend suggesting that self-regulators who drove less frequently were less likely to pass the driving test than those who drove more often. It should be noted, however, that these findings represent trends for a small sample of oldest drivers (85 years and older) and cannot be generalised necessarily to the wider population of older drivers. Moreover, older drivers who have voluntarily ceased driving are not included in this sample. Hence, it could be argued that the majority of this age group of 85+ year olds, have already taken themselves off the roads, many of them voluntarily, and as such could be said to have self-regulated appropriately. A larger study is currently in progress, addressing these limitations. Nevertheless, what seems clear from the preliminary work is that there are at least some older drivers who rarely or never adopt self-regulatory strategies and who also have poor driving skills (failed the driving test). This is the group of concern who may be at greater risk of crash than those who do adequately self-regulate.

For older people, driving continues to be a symbol and means of freedom and independence, just as with the rest of the driving population. It is not unreasonable to expect that the generation known as the 'baby-boomers' is likely to be an even more mobile older driver population, thus increasing their exposure to crash risk. Therefore a major challenge for the licensing policy makers will be to balance the need for maintaining high levels of mobility while maximising safety of road users. Self-regulation is central to current international thinking about licence re-assessment practices for older drivers (Fildes, Pronk, Langford, Hull, Frith, Anderson, 2000). It is claimed, for

instance, that if older people are able to adopt safer driving practices, then there is less need for them to have to submit to periodic re-licence testing. While this would represent a substantial community saving, there is a need to demonstrate that the practice is widespread and optimal for safety.

## REFERENCES

- Australian Bureau of Statistics (ABS) (1995) *Survey of Motor Vehicle Use 1995* Cat. No. 9208.0 Canberra: ABS
- Ball, K., & Owsley, C. (1991). Identifying correlates of accident involvement for the older drivers. *Human Factors*, 33(50), 583-595.
- Ball, K., Owsley, C., Sloane, M., Roeneker, D., & Bruni, J. (1993). Visual attention problems as a predictor of vehicle crashes in older drivers. *Investigative Ophthalmology and Visual Science*, 34, 3110-3123.
- Ball, K., Owsley, C., Stalvey, Roeneker, D., Sloane, M., & Graves, M. (1998). Driving avoidance and functional impairment in older drivers. *Accident Analysis and Prevention*, 30(3), 313-322.
- Benekohal, R., Michaels, R., Shim, E., & Resende, P. (1994). Effects of aging on older drivers' travel characteristics. *Transportation Research Record*, 1438, 91-98.
- Brainin, P. (1980). Safety and mobility issues in licensing and education of older drivers. Report DOT HS-805 492. NHTSA. US Department of Transport, Washington DC. Connecticut: Dunlap & Associates.
- Craik, F.I.M & Salthouse, T.A. (2000). *The handbook of aging and cognition*. (2<sup>nd</sup> edn). N.J., Lawrence Erlbaum Assoc.
- Diamantopoulou, K., Skalova, M., Dyte, D. and Cameron, M. (1996). Crash risk of road user groups in Victoria. (Report No. 88). Monash University Accident Research Centre, Melbourne.
- Dobbs, B. (1996). Consequences of licence cancellation: psychological, social and economic. Paper presented at the TRB mid-year meeting on the Safe Mobility of Older Persons, Washington DC.
- Eberhard, J. (1996). Safe mobility of senior citizens. *Journal of International Association of Traffic and Safety Sciences*, 20(1), 29-37.
- Evans, L. (1988). Older driver involvement in fatal and severe traffic crashes. *Journal of Gerontology: Social Sciences*, 43, S186-S193.
- Federal Office of Road Safety (FORS) (1996). *Serious Casualty Rates Among Drivers* Canberra: Federal Office of Road Safety.
- Fildes, B., Corben, B., Morris, A., Oxley, J., Pronk, N., Brown, L., & Fitzharris, M. (2000). Road safety environment and design for older drivers. (Report No. AP-169/00). Austroads, Sydney.
- Fildes, B.F., Fitzharris, M., Charlton, J.L. & Pronk, N. (2001) *Older driver safety – A challenge for Sweden's 'Vision Zero'* Paper presented at the Australian Transport Research Forum, Hobart, April, 2001.
- Fildes, B., Pronk, N., Langford, J., Hull, M., Frith, B., & Anderson, R. (2000). *Model Licence Re-Assessment Procedure for Older and Disabled Drivers*. AP-R176, Austroads Inc, Australia.
- Fildes, B (1997). Safety of older drivers: Strategy for future research and management initiatives. (Report No. 118). Monash University Accident Research Centre, Melbourne.
- Hakamies-Blomqvist, L., & Wahlström, B. (1998). Why do older drivers given up driving? *Accident Analysis and Prevention*, 30(3), 305-312.
- Holland, C., & Rabbitt, P. (1992). People's awareness of their age-related sensory and cognitive deficits and the implications for road safety. *Applied Cognitive Psychology*, 6, 217-231.
- Hu, P., Jones, D., Reuser, T., Schmoyer, R., & Truett, L. (2000). Projecting fatalities in crashes involving older drivers, 2000-2025. (Report ORNL-6963). Oak Ridge National Laboratory, Tennessee.
- Inui, N. (1997). Simple reaction times and timing of serial reactions of middle-aged and old men. *Perceptual and Motor Skills*, 84, 219-225.
- Kiernan, B., Cox, D., Kovatchev, B., Kiernan, B., & Giuliano, A. (1999). Improving driving performance of senior drivers through self-monitoring with a driving diary. *Physical and Occupational Therapy in Geriatrics*, 16(1/2), 55-64.
- Kline, D., Kline, T., Fozard, J., Kosnik, W., Scheiber, R., & Sekuler, R. (1992). Vision, aging and driving: The problems of older drivers. *Journal of Gerontology: Psychological Sciences*, 47(1), P27-P34.
- Kostyniuk, L., & Shope, J. (1998). Reduction and cessation of driving among older drivers: Focus Groups. (Report UMTRI-98-26). The University of Michigan Transportation Research Institute.
- Land Transport Safety Authority (2000). Travel survey report: Increasing our understanding of New Zealanders' travel behaviour – 1997/1998. Land Transport Safety Authority, Wellington, NZ.
- Lawton, M. (1990). Aging and performance of home tasks. *Human Factors*, 32, 527-536.

- Marottoli, R., Ostfield, A., Merrill, S., Perlman, G., Foley, D., & Cooney, L. (1993). Driving Cessation and changes in mileage driven among elderly individuals. *Journal of Gerontology, Social Sciences*, 48, 8255-8260.
- Matthews, M. (1986). Aging and the perception of driving risk and ability. *Proceedings of the Human Factors Society, 30<sup>th</sup> Annual Meeting*, (pp. 1159-1163).
- Owsley, C., McGwin, G., & Ball, K. (1998). Vision impairment, eye disease, and injurious motor vehicle crashes in the elderly. *Ophthalmic Epidemiology*, 5(2), 101-113.
- Owsley, C., Stalvey, B., Wells, J., & Sloane, M. (1999). Older drivers and cataract: Driving habits and crash risk. *Journal of Gerontology: Medical Sciences*, 54A(4), M203-M211.
- Peel, N., Steinberg, M., & Westmoreland, J. (2000). Transport safety for older drivers: A study of their experiences, perceptions and management needs. *Proceedings of the Road Safety, Research, Policing and Education Conference, Brisbane, November*, (pp. 223-228).
- Persson, D. (1993). The elderly driver: deciding when to stop. *Gerontologist*, 33, 88-91.
- Planek, T., & Fowler, R. (1991). Traffic accident problems and exposure characteristics of the aging driver. *Journal of Gerontology*, 26(2), 224-230.
- Rothman, A., Klein, W., & Weinstein, N. (1996). Absolute and relative biases in estimations of personal risk. *Journal of Applied Social Psychology*, 26, 1213-1236.
- Rumar, K. (1986). Elderly drivers in Europe. Swedish Road and Traffic Research Institute. Lidköping.
- Shinar, D., & Scheiber, F. (1991). Visual requirements for safety and mobility of older drivers. *Human Factors*, 33(5), 507-519.
- Smiley, A. (1999). Adaptive strategies of older drivers. Paper presented at the Conference on Transportation in an Aging Society: A decade of Experience, Transportation Research Board, Maryland, USA.
- Stamatiadis, N., Taylor, W., & McKelvey, F. (1991). Elderly drivers and intersection accidents. *Transportation Quarterly*, 45(3), 377-390.
- Stutts, J. (1998). Do older drivers with visual and cognitive impairments drive less? *Journal of the American Geriatrics Society*, 46(7), 854-861.
- Stutts, J., & Martell, C. (1992). Older driver population and crash involvement trends, 1974-1988. *Accident Analysis and Prevention*, 24(4), 317-327.
- Transportation Research Board (1988). Transportation in an Aging Society. Special Report No. 218, Volume 1. Washington DC, National Research Council.
- Transportation Research Board (1992). Research and Development Needs for Maintaining for Safety and Mobility of Older Drivers. (Circular No. 398). Washington DC.
- Verillo, R., & Verillo, V. (1985). Sensory and perceptual performance. In Charness, N. (Ed.). *Aging and Human Performance*, (pp. 1-45). Chichester. Wiley.
- Welford, A.T. (1977). *Fundamentals of skill*. London: Methuen & Co. Ltd.
- Winter, D. (1988). Older drivers – their perception of risk. SAE. Effects of aging on driver performance SP762. Passenger Car Meeting and Exposition. Michigan.