THE OLDER DRIVER
STUDIES OF ASSESSMENT AND PERFORMANCE

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Anita M. Ciesionik
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The current dissertation presents findings from three studies of older drivers, encompassing issues of medical assessment of fitness to drive and the decrements in driving performance associated with both primary and secondary aging. This research was conducted in the year 2000, under the supervision of Dr. Nancy Pachana and Professor Nigel Long in the School of Psychology at Massey University.

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TABLE OF CONTENTS

Acknowledgements ii

List of Tables and Figures v

I. Older drivers: A review of the issues

The natural decrements associated with age 1

Visual changes 1

Cognitive demands 3

Motor capacity 6

Dementia and driving 8

Decrement and driving performance 9

The importance of a drivers licence 11

Driving cessation in older drivers 12

Rationale for the present study 14

II. Models of driving behaviour 18

Taxonomic models of driving behaviour 19

Functional models of driving 21

Error theories of driving behaviour 23

Michon's three level hierarchy model 25

III. Deciding when to stop: Assessing medical fitness to drive in the elderly

Abstract 28

Introduction 28

Method 30

Results 31

Discussion 36

IV. A comparison of major and minor urban areas and their assessment of older drivers

Abstract 40

Introduction 40

Method 42

Results 43
Discussion 47

V. Increasing age and dementia: The effect on perception and reaction time in older drivers

Abstract 51
Introduction 51
Method 54
Results 59
Discussion 63

VI. Where to from here?

The focus of the thesis 69
Older driver assessment
An overview of the principle findings 70
The basis of assessment in driver behaviour models 71
Study limitations and directions for future research 72
Age related declines in perception and reaction time
An overview of the principle findings 76
Perception-reaction time and driver behaviour models 77
Study limitations and directions for future research 79

VII. References 84

VIII. Appendices

Appendix A. Ethical Approval for Study I and II 93
Appendix B. Older Driver Assessment Questionnaire 95
Appendix C. Facts on Aging Quizz 99
Appendix D. Information Sheet for Study I and II 100
Appendix E. Ethical Approval for Study III 102
Appendix F. Information Sheet for Study III 104
Appendix G. Demographic Sheet 106
Appendix H. Mini Mental State Examination 107
Appendix I. Common Traffic Signs Driving Assessment Tool 111

LIST OF TABLES AND FIGURES

FIGURE	TITLE	PAGE
Figure 1	New Zealand driver casualties in reported crashes, 1991, per 100,000 people, per 100 million kilometres driven (LTSA, 1996)	19
Figure 2	The hierarchical structure of the road user task (Michon, 1985)	26
Figure 3	General Practitioners views on the suitability of the LTSA common traffic signs driving assessment tool for older drivers	32
Figure 4	General Practitioners views on the association between referral and breeching patient/doctor confidentiality	35
Figure 5	General Practitioners views on the impact of an aging population on driver safety.	35
Figure 6	Main and minor urban comparison of commonly used methods for assessing fitness to drive in the elderly	44
Figure 7	Main and minor urban comparison as to who GP's regard as the most appropriate to assess driving skills in the elderly.	46
Figure 8	Main and minor urban comparison of the association between referral and breeching patient/doctor confidentiality.	46
Figure 9	The 6 road signs used in both the LTSA common traffic signs driving assessment tool and the perceptual experiment.	57
Figure 10	Photographs depicting the position of the video camera (i and ii) and the placement of the sign on the side of the road.	58
Figure 11	Average distance from the sign for each of the 6 signs across all 3 groups of participants.	60
Figure 12	Average distance from the sign for each of the 3 vehicle speeds across all 3 groups of participants.	61

TABLE	TITLE	PAGE
Table 1	Reasons given by older participants (*N*=56) for stopping driving.	13
Table 2	Most common methods used by General Practitioners in assessing fitness to drive in older persons.	32
Table 3	Circumstances under which General Practitioners most often refer.	33

Table 4	General Practitioners views on the most appropriate person(s) for the evaluation of driving skills in older adults.	34
Table 5	Respondent demographics with regard the location of their medical practice.	43
Table 6	Differences in stopping distance from the sign for each of the 6 signs and 3 speeds.	62
Table 7	The influence of vehicle speed on the ability to accurately perceive sign information.	63
Table 8	The influence of road signs on the ability to accurately perceive sign information.	63

OLDER DRIVERS: A REVIEW OF THE ISSUES

Internationally, people aged 65 and over are forming a rapidly increasing proportion of society (Heenan, 1993). New Zealand is no exception. By 2001, it is estimated that older people (people over the age of 65) will account for 11% of the New Zealand population (Statistics New Zealand, 1998). As the baby boom generation advances through their later years, and as life expectancy continues to improve, it has been predicted by Statistics New Zealand that by the year 2031, this figure will literally double, swelling to 22% (Statistics New Zealand, 1998).

Tomorrow's aged population will be accustomed to the high levels of motorisation that have developed in the latter part of last century. With demographers predicting the number of older persons increasing both in total and as a proportion of the whole population (Land Transport Safety Authority, 1994), people aged over 65 will form a rapidly increasing proportion of New Zealand's road users. As such, it is important that as people age they can continue to travel and enjoy their mobility as freely and safely as other road users (Transportation Research Board, 1988).

THE NATURAL DECREMENTS ASSOCIATED WITH AGE

According to McCloskey, Koepsell, Wolf & Buchner (1994), the complex task of driving is one that relies on three factors:

1. Sensory acuity (needed to process environmental cues).
2. Cognitive capacity (which interprets incoming information and formulates an appropriate response).
3. Motor capacity (which helps operate and control the vehicle).

However, aging is a continuous process of change, which occurs over the life span, and can result in impairments within these faculties, especially within an individuals health, visual, physical, and cognitive capabilities (Land Transport Safety Authority, 1994).

VISUAL CHANGES

The sensory system undergoes a number of changes with age, with perhaps none so important to driving as those changes occurring in the visual system (Pachana

& Long, 2000). It is thought that of all the sensory information available to a driver, over 90% of it is visual (Reuben, Silliman & Traines, 1988). Therefore, it is possible that any changes occurring in the visual system may have a deleterious effect on driver safety.

The aging process affects nearly every part of the visual system, resulting in the loss or decline of certain functions. Primarily, as we age, the lens of the eye grows without shedding (which results in a gradual thickening), limiting the amount of light able to reach the retina (Fox, 1988; Medina, 1996), as well as becoming discoloured, taking on an opaque hue (Medina, 1996). This results in decreased visual acuity, or the ability to see clearly – a skill necessary for interpretation of displays, controls, signs, and other environmental cues that may present themselves while driving (Fox, 1988).

Not only is the clarity of visual imagery compromised by a decrease in general visual acuity, it is also influenced by changes in sensitivity to glare, contrast, and levels of illumination, which can affect an older persons ability to drive at night or at times of reduced visibility (Fox, 1988). Since the lens discolours as it ages, as rays of light hit the lens, they scatter over the retina. This means that as we grow older, we develop a decreased resistance to glare (Reuben Silliman & Traines, 1988). In addition, the period of time necessary to recover from exposure to a glare source increases as we age, which can affect driver performance during the periods of dusk and hours of darkness (Shinar & Schieber, 1991).

In general, older people have more difficulty in seeing objects of low contrast, especially in the presence of a bright background (Fox, 1988). The decrease in contrast sensitivity is most notable at the higher spatial frequencies, and lower levels of luminance (Ball & Rebok, 1994; Shinar & Schieber, 1991; Sivak, 1995). Decreased light levels while driving pose a problem for older drivers as the fibres of the iris atrophy as we age. This allows less light to reach the retina, and results in an increased demand for greater levels of illumination (Medina, 1996). An older persons ability to drive at night or in periods of dusk is once again affected due to declines in light transmission. When this is combined with a lack of background contrast, driving can become quite a challenge (Fox, 1988).

General visual acuity is not the unitary component of visual decline associated with increasing age. Peripheral vision, or visual field, (the ability to detect motion, form or colour on either side of the head while looking straight ahead) also decreases with age (Fox, 1988; Pachana & Long, 2000). With age, an opaque ring, called the arcus senilis surrounds the iris (Fox, 1988), the lens becomes increasingly opaque, and pupil diameter decreases (Fox 1988; Medina, 1996). As a result of these changes, peripheral vision – a skill necessary to safely pass approaching vehicles, or to notice pedestrians approaching from the sides – is diminished by a reduction of light reaching the retina (Fox, 1988).

Driver safety can also be impeded by age related decreases in eye movements, depth perception and colour sensitivity. Important for environmental perception, eye movements, or the number of saccades, have been noted as slower and delayed in older drivers (Maltz & Shinar, 1999; Sivak, 1995). Depth perception, or a driver's ability to judge distances, is also impaired with age, especially at times where light levels are low (Sivak, 1995). Colour sensitivity is necessary to extract cues and discriminate between objects while driving (Fox, 1988). However, because the lens thickens and discolours, the eye is less sensitive to colours with shorter wave lengths (such as blue and green), and more colour discrimination errors are made (Fox, 1988; Sivak, 1995).

COGNITIVE DEMANDS

Although it would appear that vision is essential for driver safety, the process of driving a motor vehicle is a much more complex task than simply seeing clearly. The act of driving also places a neurocognitive demand on faculties such as attention, visuospatial abilities, motor programming, judgment, memory, sequencing and information processing (Hunt et al, 1997). These neurocognitive demands are an important factor when discussing the impact of aging on driving skill. Although it would appear that cognitive declines are not as widespread as those found in the visual system, changes in certain areas of cognitive functioning have been noted with increasing age that could impact on driver safety.

Attention is the energy necessary to support information processing, and for drivers, it is important this function remains relatively intact with age (Rybash, Roodin & Hoyer, 1995). The importance of this ability in our everyday lives is most apparent when we hear or read a statement that refers to some aspect of attention: "Are you listening to me?" "On your mark, get set . . ." "or perhaps most importantly, "Probable cause of accident – inattention of the driver in vehicle A" (Kausler, 1991). A faculty that encompasses a variety of processes, the two aspects of attention that appears to be most affected by age are selective attention and divided attention.

Selective attention refers to an individual's ability to distinguish relevant from irrelevant information – such as trying to read a road sign while ignoring a chatting passenger (Plude & Hoyer, 1986). Many studies have found age-related declines in attending to relevant information while trying to ignore distracting information (Conelly & Hasher, 1993; Plude & Hoyer, 1986). Divided attention requires an individual to simultaneously process two or more sources of information, such as driving a car in heavy traffic while trying to listen to the conversation of your passengers. When the dual tasks are not cognitively demanding, age differences in divided attention are negligible. However, the age difference becomes much more pronounced when the concurrent tasks are more cognitively demanding (McDowd & Craik, 1988).

Of all cognitive abilities, it would seem that memory is of greatest concern to older persons, after all, it is not uncommon to hear the phrase "my memory is not what it used to be". The earliest version of human memory systems made a distinction only between short term and long-term memory. Armed with only a dichotomous view of memory, cognitive aging research concluded that age differences were found in long-term memory, but not short-term memory (Smith & Earles, 1996). However, conceptualising memory, with all its facets, into a simple dichotomy was insufficient an explanation, and memory has since been broken down into more complex systems.

Short-term memory is now viewed as consisting of two components – primary memory (simply holding recent information in the mind) and working memory (simultaneously holding <u>and</u> using recent information) (Rybash, Roodin & Hoyer, 1995). It was discovered that while age differences for primary memory were very small, or nonexistent, working memory tasks showed large age differences, indicating that it is the processing requirement in working memory, rather than information storage that produces age differences (Smith & Earles, 1996). Replication of the original study has since determined that processing efficiency was the most important determinant of age differences in working memory (Salthouse & Babcock, 1991).

Just as the unitary concept of short-term memory was inadequate, long-term memory was also broken down into smaller memory systems – episodic memory (recollection of details of specific events), semantic memory (acquired knowledge about the world) and procedural memory (skills) (Rybash, Roodin & Hoyer, 1995). Procedural memory and semantic memory show negligible age effects, and generally remain well preserved. However, episodic memory is greatly susceptible to decline in old age, resulting from problems with encoding or memory retrieval (Smith & Earles, 1996). This deficit is most exaggerated in more difficult episodic memory tasks involving deliberate processing (Smith & Earles, 1996).

It would also appear that visuospatial processing (commonly known as nonverbal memory) in short term memory might have a tendency to slow in older persons (Rybash, Roodin & Hoyer, 1995). This is a point of theoretical discussion, however, as visuospatial tests tended to be timed, and, as older adults tend to react more slowly, they will tend to perform worse on a timed test (Smith & Earles, 1996). When time was not a factor in tests, both young and older adults were equally able to use nonverbal, visuospatial processing (Smith & Earles, 1996). Therefore, the impact of memory (in all its facets) in normal aging on driving is negligible.

Perhaps the most universally replicated finding in the psychology of aging is the slowing of response to a given stimulus (Kausler, 1991). In fact, slowed reaction time is one of the most certain consequences of aging (Belsky, 1999). The age difference is most noticeable when older people are asked to perform complex, rather than simple tasks. The reason for this is quite simple. Reaction time is broken down into two distinct phases:

1. A 'thinking phase', which is the period of time when we process the incoming information and decide what action to take.
2. And 'acting time', the time in which we physically carry out the action.

It would appear that the more complex the task, the more thinking is required, and as it is thinking time, not acting time, that shows the most dramatic age changes, a complex task will show a more exaggerated effect than a simple task (Belsky, 1999). Delays in reaction time can obviously have grave repercussions within the context of driving, where speed of response is often necessary.

Perhaps the most important cognitive function with regards to driving is an individual's perceptual skills (Pachana & Long, 2000). While sensory processes such as vision are associated with information reception and transmission, perceptual ability refers to the organisation and interpretation of information (Rybash, Roodin & Hoyer, 1995). While research has appeared to establish that information processing declines with age, it has come to light that these deficits can be attributed to the speed of processing, and that the ability to process information remains relatively intact with increasing age (Rybash, Roodin & Hoyer, 1995).

So, while it would appear that with normal aging, perceptual ability remains unscathed, older adults are unable to process information as quickly as they could before (Salthouse, 1991). Due to adaptation, the exact consequences of slower processing are not always easy to predict, however, in general, when processing speed is fast, there is opportunity to comprehend a greater amount of information (Salthouse, 1996). This means that compromised speed results in a reduced amount of information being processed. According to Salthouse (1991), if we are unable to think quickly, then by definition we cannot think well, and if older drivers are unable to process as much information in a given time period as their more youthful counterparts, then there lies the possibility for more severe consequences on the road.

MOTOR CAPACITY

Although changes within an individual's sensory and cognitive capacity with age are important factors when looking at road safety, driving is a complex task, and deterioration within McCloskey, Koepsell, Wolf & Buchner's (1994) third factor, motor capacity, can also impact on the operation and control of a motor vehicle. An older persons motor capacity depends on the integrity of the musculoskeletal system – the network of bones, joints and muscles that carry out movement (Belsky, 1999). When driving, it is important that a person has the bone strength and muscle power to push down on pedals and the joint flexibility to grasp the steering wheel, but with age comes limitations and impairments in body movements.

All human movement depends on the contraction of muscles. Each muscle has one movement, contraction, and when this occurs, force is exerted on the adjoining bones and motion results (Kalat, 1995). With increasing age come muscular changes. Muscle strength tends to peak around age 20, plateaus through middle age, then, beginning gradually once a person reaches 50, muscle strength declines, and accelerates once the individual reaches age 70 (Belsky, 1999; Schneider & Spraque, 1995). Not surprisingly, a decline in muscle strength can, in turn, deleteriously affect an individual's capacity to move, decreasing an older drivers ability to operate a vehicle in a safe and effective manner. This is of most concern in circumstances that require actions of strength, such as emergency braking, or applying the parking brake (Schneider & Sprague, 1995).

Actions can also be limited by osteoarthritis, a common affliction associated with increasing age that wears away the joint insulation, causing stiffness and discomfort (Belsky, 1999). While not every older person suffers from this condition, it is common enough to warrant concern, and is the top-ranking chronic condition of old age (Belsky, 1999). Motor tasks that require joint flexibility or range of motion (such as turning the steering wheel quickly) may present a problem to those suffering from osteoarthritis, and when it is located in the finger joints, manual dexterity is affected. Manual dexterity can also be affected by natural changes in tactile thresholds, which tend to increase with age, becoming most apparent post age 75 (Schneider & Spraque, 1995). There are also natural decrements in joint flexibility, but it would appear that the degree of decrement is dependant on the region of the body affected (Schneider & Sprague, 1995).

In today's auto-centered environment, driving can be seen as a complex task, requiring skills and abilities such as scanning, tracking, information processing, judgment and decision making (van Zormeren, Brouwer & Minderhoud, 1987). Driver safety relies on these cognitive skills working in conjunction with physical ability. Therefore, dexterity is needed to quickly locate and manipulate accessories and controls, and ease of movement is necessary for quick and accurate response. Any changes within these functions may adversely affect driver safety and become factors in the driver's ability to execute simple driving tasks.

While muscular strength, joint flexibility and manual dexterity are all important factors in driver safety, it has been suggested that perhaps the most important biomedical change with age is the degradation of head movement range, which has a degree of impact comparable to visual decline (Schneider & Sprague, 1995). Isler, Parsonson & Hansson, (1997) investigated the age related effects of head rotation, and discovered that, when compared to a younger control group, older drivers display a loss of approximately one third of movement. This significant age related decline has been displayed in previous studies, with similar degrees of loss (Schneider & Sprague, 1995). Elderly drivers appear to be over represented in intersection collision statistics, with the major driving error being failure to yield right of way (Cooper, Tallman, Tuokko & Beattie, 1993; Frith & Jones, 1991; Isler, Parsonson & Hansson, 1997). When limitations in the degree of neck rotation are combined with declines in visual perception, an older drivers ability to extract information is minimised, especially within demanding traffic environments, such as intersections (Isler, Parsonson & Hansson, 1997; Schneider & Sprague, 1995). The result is an increased risk of traffic accident within these environments.

DEMENTIA AND DRIVING

Growing old is one of life's certainties, and it has been acknowledged that the aging process can be attributed to a variety of mechanisms and factors, ranging from cellular to genetic (Rybash, Roodin & Hoyer, 1995). There comes a point in the life cycle where degenerative processes begin to overtake those responsible for regeneration – a phase termed senescence (Rybash, Roodin & Hoyer, 1995). Although the rate of senescence varies between biological systems and individuals, ultimately it will have an effect on everyone (Belsky, 1999). Senescent changes can be hastened by extrinsic factors, such as environmental toxins, and as a result, the terms primary aging and secondary aging have been developed to distinguish between intrinsic and extrinsic senescent processes (Belsky, 1999; Rybash, Roodin & Hoyer, 1995).

Primary aging refers to the universal and inevitable physical changes that are intrinsic to our makeup as human beings (Hoyer, Rybash & Roodin, 1999). In contrast, secondary aging can be described as any process that serves to affect the rate of primary aging (Hoyer, Rybash & Roodin, 1999). Thus far the document has discussed the visual, cognitive and physical changes occurring with age, and by definition, they can be seen predominantly as a result of primary aging. However, changes resulting from secondary aging can also impact on older driver safety, with perhaps none so important to the current discussion as the cognitive changes occurring as a result of dementia (the most well known of which is Alzheimer's disease).

Within New Zealand, some form of dementia affects approximately 7.7% of the population over the age of 65, with the percentage doubling with every 5 years of age (Campbell, McCosh, Reinken & Allan, 1983). The number of affected individuals in New Zealand is projected to increase by almost 100% by the year 2016 – this is in comparison with an estimated increase in the general population of between 18 and 26% (Pachana & Long, 2000) during the same period of time.

Tomorrow's Alzheimer's sufferers will be used to the mobility and freedom driving can offer, and if they are to continue driving in safety, the true impact of this disease on their driving ability must be assessed. At this point in time, the research surrounding the impact of dementia on driving is somewhat controversial. Research has suggested that Alzheimer's patients who continue to drive pose a significant traffic safety risk (Dubinsky, Williamson, Gray & Glatt, 1992). Frightening statistics have been uncovered, and it would appear that of all Alzheimer's patients who continue to drive, one third will have had at least one incident of unsafe motor vehicle operation (accident, violation or 'near misses') in the previous 6 months (Gilley et al, 1991). They also display an annual accident rate that is two and a half times higher than non-dementing older drivers (Drachman & Swearer, 1993).

Despite this, there has also been evidence suggesting that a diagnosis of dementia does not necessitate driving cessation. It would appear that disease duration is not a good predictor of driving ability (Drachman, 1988; Drachman & Swearer, 1993). A progressive disorder, the degree of disability and rate of decline amongst Alzheimer's sufferers varies between individuals (Pachana & Long, 2000), and it has been suggested that tests of driving competence, rather than diagnosis are a better criterion for determining driving ability (Pachana & Long, 2000). More research is needed to determine the specific cognitive functions most affected by a dementing disorder – especially within a New Zealand context – in order to improve driver safety in the future.

DECREMENT AND DRIVING PERFORMANCE

The understanding of these natural decrements in the physiological processes associated with age is important, as they are all processes necessary for safe driving. While it is important to note that the extent of this deterioration varies greatly between individuals, and that not all older drivers are unsafe, it has been widely assumed that deteriorating ability is responsible for an associated change in older persons driving patterns (Schieber, 1994). Compensatory behaviour in older drivers has been widely accepted, encompassing such acts as driving fewer miles, avoiding driving at night, dusk, and rush hours, as well as treacherous weather such as rain and fog (Ball & Rebok, 1994; Cooper, Tallman, Tuokko & Beattie, 1993; Land Transport Safety Authority, 1994; Persson, 1993). Older drivers are also more likely to adopt safe driving practices such as wearing their safety belt, moderating their speed, and not driving drunk (Cooper, Tallman, Tuokko & Beattie, 1993; Schieber, 1994).

While most studies tend to suggest self-regulation, whether or not this modification of driving patterns and habits are conscious acts of compensation is not firmly established (Ball & Rebok, 1995; Cooper, Tallman, Tuokko & Beattie, 1993). However, despite the trend to avoid these high-risk situations, accident rates in older drivers still occur. Over the course of 1998, older drivers in New Zealand were involved in 8% of all injury accidents, and 17% of all fatal accidents (Land Transport Safety Authority, 1999a). In comparison, younger drivers between the ages of 15 and 24 accounted for 31% of all injury accidents, and 25% of all fatal accidents in 1998 (Land Transport Safety Authority, 1999a).

While this may indicate that, as a group, older drivers are considerably safer, research has shown that over the past 10 years, the number of road fatalities amongst those aged over 60 has barely changed, while statistics for those aged under 25 have fallen by 27.2% (Federal Office of Road Safety, 1996). In addition, when accident rates are adjusted for the number of miles driven, crash rates for older drivers are as high as, or higher than, younger drivers (Evans, 1988; Hakamies-Blomqvist, 1993). Research also indicates that accidents involving older drivers tend to occur in daylight with good weather conditions (McGwin & Brown, 1999). These phenomena are indicative of the compensatory behaviour shown by older drivers, and are patterns that have been replicated within New Zealand (Frith & Jones, 1991). So while older persons may adjust their driving patterns and habits, their rate of car accidents per mile driven is comparable to that of their more youthful counterparts.

Although crash severity does not differ substantially with increasing age, the consequences of a given motor vehicle accident are more serious for older drivers, with older people more likely to be injured or killed than younger people (Land Transport Safety Authority, 1994). Evans (1988), found that for every year after the age of 20, fatality risk of car occupants in the United States increased by 2%, a phenomenon also evident in New Zealand (Frith & Jones, 1991). Other researchers have also gathered evidence of this fragility effect, substantiating the fact that there are increases in both fatality rates and cases of severe injury for older drivers involved in a motor vehicle accident (McCloskey, Koepsell, Wolf & Buchner, 1994; Peek-Asa, Blander-Dean & Halbert, 1998).

This general pattern of increased fragility with age is visible on New Zealand roads, and can be confirmed by New Zealand traffic accident statistics. Over the course of 1998, drivers over the age of 65 accounted for 17% of the total deaths caused by traffic accident, even though they only held 10% of the car licences (Land Transport Safety Authority, 1999a). During the same time period, older drivers suffering from non-fatal injuries were hospitalized for an average of 11 days, in comparison to an average of 7 days for the 15 to 29 age group, and 8 days for those aged between 30 and 64 (Land Transport Safety Authority, 1999a).

THE IMPORTANCE OF A DRIVERS LICENCE

> "I can barely hear, barely see, and barely walk. Things could be worse though. At least I can still drive" (Persson, 1993).

Despite the increased risk of death or injury within a given car accident, an older driver's ability to obtain or maintain a drivers licence is an important aspect of maintaining their identification as a functioning and socially capable adult (Persson, 1993). It has been suggested that a marker to successful aging is a person's ability to maintain independence in the community (O'Neill, 1996). A driver's licence not only denotes independence, convenience and responsibility, but also signifies autonomy and competence (Pachana & Long, 2000, Persson, 1993).

With 77% of drivers over age 55 perceiving the act of driving as very important, being a licenced driver means that individuals can gain access to appointments, health care, and shopping, as well as allowing the maintenance of social contacts (O'Neill, 1996; Pachana & Long, 2000). Recent figures issued by the New Zealand Transport Minister show that between May 1999 and February 2001, 120 older drivers made 5 or more attempts at the older driver test before passing, at a cost of $41 per attempt (Land Transport Safety Authority, 1999b; "Testing times", 2001). It was also noted that one individual persevered through 10 attempts before passing (at a cost of $410), which serves to highlight just how important the maintenance of a licence is to drivers over the age of 65 ("Testing times", 2001).

> "Driving is a way of holding on to your life. I was 94 years old, and it was like losing my hand to give up driving." (Persson, 1993)

The act of driving plays such an important role in affirming an older persons place in society, that when it becomes necessary for an older driver to relinquish their licence, it can often be viewed by the individual as a final rite of passage (Persson, 1993). The loss of a licence is of particular importance to the one third of New Zealand's older persons living in either rural, or minor urban areas (Pachana & Long, 2000). Without a well established public transport system, those that lose their drivers licence may find it difficult to maintain their social contacts, as well as facing increasing difficulty in carrying out daily tasks and routines (Pachana & Long, 2000). With the modern car becoming an essential factor of independent living, for older adults, the loss of a licence can result in loneliness, decreased life satisfaction, and decreases in out of home activity levels (Marottoli et al, 2000; O'Neill, 1996).

The psychological benefits for those older drivers able to maintain their licence are undeniable. As stated, the personal independence and control it offers is an important marker for successful aging. However, the loss of a licence does not only impact on psychological well being, it can also have a physical impact (Owsley, 1997). After conducting a large epidemiological study, Marottoli, Mendes de Leon, Glass & Williams (1997) revealed that driving cessation was associated with an increase in depressive symptoms, even when controlling for socio-demographic and health related factors. In fact, driving cessation was amongst the strongest predictors of increased depressive symptoms. Links have been discovered between depression (and depressive symptoms) and the level of an individual's functional disability (Marottoli, Mendes de Leon, Glass & Williams, 1997). This means that the loss of driving ability or a drivers licence can lead to depression, which can, in turn, further decrease the functioning of older adults (Pachana & Long, 2000).

DRIVING CESSATION IN OLDER DRIVERS

There is a tendency to think of driving as an inherent right, when in fact documents within both the Land Transport Safety Authority, and New Zealand Government clearly refer to it as a privilege (Pachana & Long, 2000). Despite the significance of a licence for older drivers, it is undeniable that with age come natural decrements across individuals' sensory, cognitive and physical faculties, which can impact on driving ability. This will mean that many older drivers will be faced with the decision to continue, limit or stop their driving.

The decision to cease driving is not made lightly, and it would appear that a number of medical and socio-economic factors play a role. Several studies have shown that the factors associated with driving cessation include increasing age, "At my age, I thought it was time to stop", declining health, medical conditions and recent hospitalisations (Marotolli, Mendes de Leon, Glass & Williams, 1997). It is also thought that socio-economic factors such as lower income, unemployment, and the availability of alternative transport may play a role (Marottoli, Mendes de Leon, Glass & Williams, 1997). In a recent study Persson (1993) investigated the reasons for discontinued driving in older adults (see Table 1). While most gave multiple reasons for driving cessation, her results have echoed the previous findings of medical and socio-economic factors (Jette & Branch, 1992; Kington, Reuben, Rogowski & Lillard, 1994).

Table 1.
Reasons given by older participants (N=56) for stopping driving

Reason	n	%
Advice from doctor	15	27
Increased nervousness behind the wheel	11	20
Trouble seeing pedestrians and cars	11	20
Medical conditions	10	18
Advice from family/friends	9	16
Difficulty in coordinating hand/foot movement	5	9
Transportation provided by retirement center	5	9
Cost of upkeep/age of vehicle	4	7
Involvement in minor accidents	3	5
Licence revoked	2	4

Note: Participants could choose more than one response, so the percentage does not equal 100.

Studies have suggested that older drivers believe they should make the decision as to whether or not they continue driving (Persson, 1993). However, at some point, the older driver can no longer be relied upon to be an objective judge of their own ability, and it would appear that it is the General Practitioner's (GP) recommendation that is subsequently most valued in the decision to cease driving (Cooper, Tallman, Tuokko & Beattie 1993; Persson 1993). The GP has a central role within the health care system, and, according to Martinez (1995), is in a unique position to play a significant advisory role in the driving capability of older drivers.

Within New Zealand, under section 18 of the Land Transport Act, there is a legal requirement for medical practitioners to report all cases where either a physical or medical condition is such that, in the interests of public safety, an individual should have driving privileges revoked, or be permitted to drive only under strict conditions and limitations (Land Transport Safety Authority, 1999a). The importance of assessment by a physician can also been recognised by the recent changes to New Zealand licensing laws, which state that a standardised medical examination is required once the driver reaches age 70, 80, and 2 yearly thereafter (Land Transport Safety Authority, 1999a). The Land Transport Safety Authority (1999a) has also published guidelines for medical practitioners who are faced with making decisions regarding an individual's ability to drive.

However, international research has indicated that the decision of a GP is often subjective, due to a lack of firm standards and valid tests of driving competence (Oswley, 1997; Reuben, Silliman & Traines, 1988). Methods of driving assessment have also been under scrutiny, and the validity of testing driving performance with pen and paper tests, as opposed to on road examinations is a point of contention amongst many researchers (Hunt et al, 1997; O'Neill, 1997). Whether or not similar issues exist within New Zealand assessment procedures is unknown, due to the dearth of nationwide research in this field.

RATIONALE FOR THE PRESENT STUDY

The aging of the population is an international concern, and as such, has resulted in an upsurge of research focusing on issues concerning the world's older population. The subject of aging and driving is no exception to this fact. It would seem that even though almost all aspects of this topic have been investigated, there appears to be a specific focus on the detection of aging decrements, both a result of senescence and those associated with disease, and how they can potentially influence driver performance (O'Neill, 1997).

However, the abundance of international literature in this field can be seen in stark contrast to the apparent dearth of New Zealand literature concerning older adults and driving, and it is this dearth that is the impetus of the current research. Although the discussion thus far has identified a number of issues concerning the older driver, there are two areas of main concern, which warrant further investigation. These are:

1. The true impact of both senescence and dementia (specifically Alzheimer's disease) on driving skills, and,

2. The medical assessment of fitness to drive conducted by physicians.

It is proposed that specific aspects of these topics will be investigated further, in a three-part study. The rationale for each piece of research is presented below.

Study I

Deciding when to stop: assessing the medical fitness of older drivers.

In 1995, the Land Transport Safety Authority (LTSA) developed a driving assessment procedure in an attempt to both standardise the testing of older drivers, and create an assessment tool that would emulate a real life driving situation, namely, the recognition of road signs. This was then distributed to all General Practitioners in New Zealand.

Since this time, there has been no study conducted as to the level of success, or degree of implementation of this assessment tool, and to date, it would appear that there have been no studies to investigate whether the issues surrounding older driver assessment found internationally are of concern in New Zealand. It is hoped that a large, national survey of General Practitioners will help to ascertain:

1. The current rate of usage of the LTSA common traffic signs driving assessment tool.

2. Other techniques that are currently used to ascertain driver safety among their older patients, and;

3. Whether the concerns within New Zealand are congruent with those found internationally, or whether there are issues indigenous to New Zealand.

Study II

A comparison of major and minor urban areas in their assessment of older drivers.

A recent (1996) Australian study conducted by Fox, Withaar and Bashford suggested that there are discrepancies between urban and rural communities with respect to the assessment of older drivers, particularly with regard to referral procedures, use of secondary health professionals, and the assessment methods used.

Within New Zealand, nearly one third of our population aged over 65 resides in either rural, or minor urban areas, and this number is steadily increasing. With the ability to drive playing such an affirming in society, any potential discrepancy in assessment is of concern. It is hoped that additional questions added onto the aforementioned survey of General Practitioners will help to ascertain:

1. Whether any discrepancies exist between minor and main urban areas with regards to assessment, and if so;
2. Whether they are similar to those found in Australia (or whether they are indigenous to New Zealand) and;
3. The potential impact any discrepancy may have on the assessment of older drivers in New Zealand.

Study III

The effect of increasing age and dementia on perception and reaction time in older drivers

The effect of driving with dementia has been a somewhat controversial topic. While it would appear that older drivers suffering from dementia are at an increased risk of being involved in an automobile accident, strong arguments have been put forward that individual rates of decline and functioning in patients with dementia necessitate tests of driving competence rather than diagnosis.

Not only are there issues surrounding how to best assess driving abilities, it would also appear that no one in New Zealand has asked whether the signs used in the LTSA common traffic signs driving assessment tool can be perceived by accurately by persons of any age, and, in particular, by persons with dementia. Therefore, it is hoped that a simulated driving task will help to discover:

1. How reaction time and perception in drivers is affected by increasing age, as well as the presence or absence of dementia.

2. Whether there are differences between normal older adults and older adults suffering from dementia in terms of sign perception in a semi-realistic setting, as opposed to being shown a two dimensional image in the doctors office.

3. Whether the signs included in the LTSA driving assessment tool can accurately be perceived by persons of any age, and particularly by those persons suffering from dementia.

MODELS OF DRIVING BEHAVIOUR

While the relationship between aging, senescence and driving performance has been intensely investigated in recent years, theories of traffic psychology have not yet satisfied the demand for a comprehensive model of driver behaviour, particularly with regard to older drivers (Huguenin, 1988; Ranney, 1994). With a distinct tendency to focus research and investigations on specific questions and problems (namely particular diving behaviours resulting in accidents) as opposed to theoretical advancement and development, much of our understanding of driver behaviour has been based on empirical generalisations (Huguenin, 1988; Ranney, 1994). This theoretical preoccupation with individual differences in accident causation has created a developmental stalemate, and resulted in mediocre success with regards to the identification of safe driving predictors (Ranney, 1994).

The beginning of the Twentieth Century saw a rapid increase in the predominance of the automobile, and with it came an analogous increase in the number of road traffic accidents. As a course of natural progression, driving began to be considered a perceptual-motor skill, and motor vehicle accidents an inherent failure of this skill (Summala, 1985). These early skill models implied that driver safety was largely determined by their level of skills (such as reaction time and visual attributes) in relation to the situational demands on these skills (Hopewell & Van Zomeren, 1990; Summala, 1985). Initially supported by early accident theorists (after all, if we are clumsy at running, or climbing stairs, why not behind the wheel?) by the mid 1950's, skepticism began to emerge (Summala, 1985).

While there are undeniable differences between peoples driving skills (as in other activities) they do not show up in traffic as reliable and large enough to warrant screening amongst drivers, or to make it useful (Summala, 1985). Modern research indicates that not only do high skill drivers have above average crash rates, but also that the level of driver training and education has little influence in altering accident rates, and the demographic supposedly possessing optimal perceptual-motor skills (young males) actually have the highest accident rate (Evans, 1991). This can be exemplified by New Zealand traffic accident statistics, which clearly demonstrate that drivers aged between 15 and 24 (the majority of whom are male) are the group with the highest accident/traffic violation risk (Land Transport Safety Authority, 1999). Although this demographic accounts for only 16% of the licenced population, in 1998, they accounted for 31% of all injury accidents and 25% of all fatal accidents (Land Transport Safety Authority, 1999a). In fact, as shown by Figure 1, when adjusted for the number of kilometres driven, traffic accident statistics for New Zealand drivers aged between 15 and 24 are comparable to those aged 65 and above – the demographic with the least optimal perceptual-motor skills (Land Transport Safety Authority, 1996).

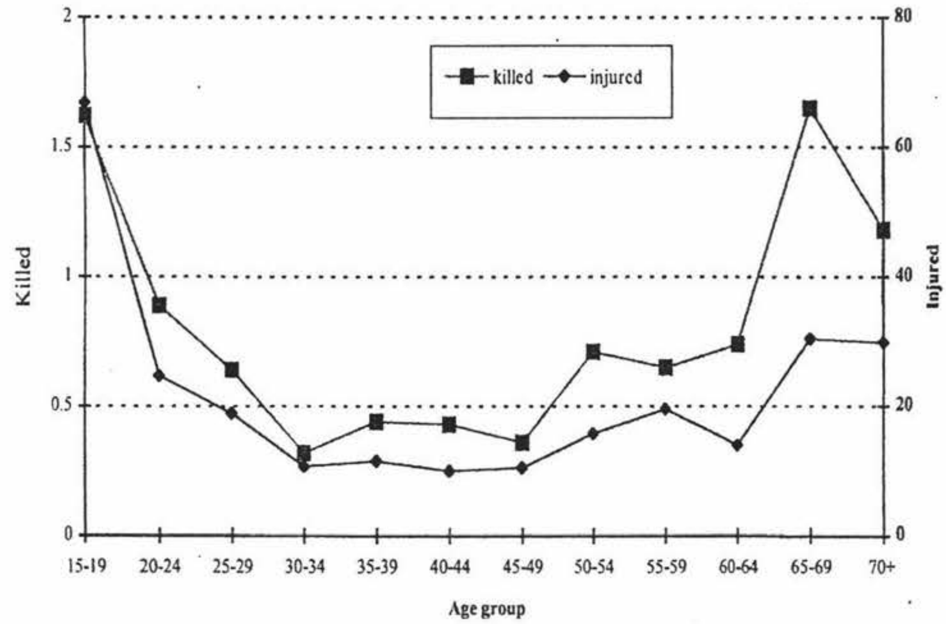


Figure 1. New Zealand driver casualties in reported crashes, 1991, per 100,000 people, per 100 million kilometres driven.

TAXONOMIC MODELS OF DRIVING BEHAVIOUR

As driver behaviour theory continued to evolve, the realisation that motor vehicle operation requires an interaction between information processing and motor response led to the development of more sophisticated models. When looking at the safety of motorists, it would seem that priority has been given to the identification of risk factors of accident causation, primarily through epidemiological studies. The emphasis appeared to be on trait or test based models, which are taxonomic in that no dynamic relations can be expressed amongst their components – at best the connections are correlative (they are essentially an inventory of facts) (Michon, 1985; Ranney, 1994).

Early efforts made use of visual attributes and reaction time as predictors, which resulted in unconvincing, negligible relationships with accident causation, presumably due to driver compensation for these deficiencies (Ranney, 1994). Studies into the role of selective attention perhaps provide the best exemplar of taxonomic models. Mihal and Barrett (1976) examined correlations between three information- processing measures (selective attention, perceptual motor reaction time and perceptual style) and accident involvement over a 5 year period. Through retrospective examination of accident statistics from 75 commercial drivers, it was found that both field dependence and selective attention were positively correlated with accidents, while reaction measures were not (Mihal & Barrett, 1976; Ranney, 1994). Subsequent studies have found significant relationships between selective attention measures and driving, and have involved both the auditory and visual modalities of the construct.

Auditory selective attention is most commonly investigated using a Dichotic Listening Task (DLT). This requires a participant response to two separate auditory inputs (such as strings of letters), which are presented simultaneously to each ear, and involves the recording of the number of omissions, intrusions and switching errors (Ranney, 1994; Weiten, 1995). With respect to driving safety, it has been found that stronger correlations exist between driving and switching errors than with either omissions or intrusions, which suggests that rapid switching of attention is of great significance to safe driving (Avolio, Kroeck & Panek, 1985).

Visual attention has come to the fore recently as an accident predictor for older drivers. Owsley and Ball's (1991) measure of attention, the useful field of view (UFOV), incorporates the visual field area over which information can be acquired through a brief glance. They found that drivers aged over 65 with poor visual fields had approximately twice as many intersection accidents as those with normal visual field sensitivity (Owsley & Ball, 1991). When the sample size was increased, correlations were observed between the UFOV and all types of accidents (Ranney, 1994). Latest research shows that the diminished efficiency of the UFOV in older drivers is exacerbated when driving conditions require division of attention between central and peripheral tasks (Sekuler, Bennett & Mamelak, 2000).

While taxonomic models of driver behaviour offer promising insights into driver safety, they are not without fault. The use of accidents as a basis for driver evaluation is of concern as accidents are relatively rare events. Evans (1991) and Ranney (1994) claim their infrequency affects statistical power, which decreases the probability of detecting statistically significant differences in rates. Furthermore, questions have also been raised as to the reliability of accident records, prompting concern as to the validity of retrospective studies as opposed to prospective data (Owsley & Ball, 1991; Ranney, 1994). There is also concern over the use of accident data as a criterion measure, as accidents tend to be multi-causal, and may not be related to human error (Ranney, 1994).

FUNCTIONAL MODELS OF DRIVING BEHAVIOUR

In contrast to the trait-based perspective of taxonomic models, functional models of driver behaviour involve the dynamic relationships amongst components, and offer a greater potential for helping to understand complex tasks (Michon, 1985). While individual difference models focus on predicting accident rates, functional models address driving as a whole, emphasising variability and replacing crashes with situational variables (Ranney, 1994). Emerging in the 1960's and 70's as an alternative to skill based models, functional models typically include two general categories: motivational models and information-processing models.

Traffic psychology is fundamentally concerned with traffic safety, and motivational models of road user behaviour are almost synonymous with models of risk taking (Michon, 1985). Assuming that driving is self-paced, and that drivers select the amount of risk they are willing to tolerate in any given situation, motivational models propose that the main influencing factor on driver behaviour is the risk associated with possible outcomes (Ranney, 1994). These models not only focus on driver behaviour over skill, but they also see the driver as an active participant, rather than a passive responder.

Fuller's (1988) discussion of driver behaviour in terms of a threat-avoidance model exemplifies the underlying principles of the motivational paradigm. He proposes that drivers are compelled by two principal incentives – getting to a pre-determined destination, and avoiding potential threats. Driver behaviour can be seen as threat-avoidance as, in order to reach our destination, we must continually either avoid aversive stimuli (for example, steering around obstructions) or avoid the possibility of aversive stimuli (for example, reducing speed). Through repeated exposure to these obstacles, the basis of risk identification is formed (Fuller, 1988). Compensatory behaviour in older drivers serves to exemplify this point. As revealed in Chapter 1, drivers aged over 65 are more likely to wear a safety belt, moderate speed, and not drive drunk (avoiding the possibility of aversive stimuli) and tend not to drive in heavy traffic or treacherous weather (avoiding aversive stimuli) (Ball & Reebok, 1994; Cooper, Tallman, Tuokko & Beattie, 1993; Persson, 1993; Schieber, 1994).

Despite their appeal, motivational models have failed to generate a significant body of research findings (Ranney, 1994). Primarily, it would appear that they lack specificity regarding internal mechanisms (such as goals and motivations), which in turn creates complexity in validation, due to the difficulty in creating testable hypothesis (Michon, 1985; van der Molen and Botticher, 1988). It would also appear that if driving is largely determined by goals and motivations, then the practice of studying driving in a laboratory, simulator or closed course may be immaterial, due to the fact that these situations lack a fundamental goal to the driving experience (Duncan, 1990)

Although not as popular as motivational models, information-processing models are still incorporated under the functional paradigm. In contrast to motivational models, information-processing models view the driver as a passive responder, rather than an active decision maker. Developed in response to air traffic controllers' limitations in handling simultaneous messages, these models are usually represented as a sequence of stages (such as perception, decision and response), each assumed to perform a degree of data transformation and take some time for it's completion (Ranney, 1994). The relationship between driving behaviour and information-processing models is best exemplified by studies into automaticity.

Characterised as effortless processing, which develops after consistent practice, the importance of automaticity is not a new idea (Shiffrin & Schneider, 1977). Normally contrasted with the notion of controlled processing, which is described as slow, serial and effortful processing, the notion of automaticity is relevant to driving as much routine driving is done automatically. Based on the theoretical advances of Shiffrin and Schneider (1977) in the field of memory and attention, the characteristics and conditions under which automaticity develop is beginning to influence driving theory.

It is believed that since automaticity is situation-specific, any response depends on the relationship between that specific situation and all previously encountered situations (Ranney, 1994). This means that a novel situation will disrupt automatic processing and the ensuing uncertainty will instigate controlled processing. One such theory suggests that when uncertainty exceeds a predetermined threshold (which varies between individuals and situations), there is a switch from passive regard of stimuli to active visual scanning (Ranney, 1994). Applied to driving in individuals aged over 65, this may mean that consistent practice following the same route to a destination (such as attending bowls) may lead to automaticity regarding weather variations or traffic conditions. However, if the driver comes across an unexpected obstacle en-route (such as a dog crossing in front of the car) controlled processing will take over.

Whereas motivational models lack detail with regards to the underlying mechanisms, Eysenck (1982) has claimed that information-processing models fail to incorporate motivational and emotional components. There appears to be a lack of specificity regarding the models ability to detail the control mechanisms responsible for changing the allocation of attention (for example, what is it about a novel situation that creates uncertainty and triggers controlled processing?) (Ranney, 1994). There is also a tendency for automatic processes to be defined solely in terms of a lack of attention, when in fact there is a need for greater differentiation amongst different kinds of automaticity (e.g. the identification of those automatic processes that have a direct effect on attention and responding, as opposed to those that have an indirect effect) (Eysenck, 1982).

ERROR THEORIES OF DRIVER BEHAVIOUR

In more recent years, theories of error have been applied to driving (Ranney, 1994). To date, much of the current evidence on road user errors has been derived from accident reports and data. However, due to the fact that not all errors committed on the road result in an accident, it has become clear that the use of accident data, which uses human error as a performance measure, is an inappropriate way to analyse the construct, mainly due to the fact that within this context, it is poorly understood and invalidly recorded (Brown, 1990; Brown & Groeger, 1990). This has led to the development of an alternative theoretical approach, which advocates the investigation of errors as part of normal behaviour and has led to an exploration of the construct within the context of all driving behaviour (Ranney, 1994).

In general, errors can be classified as either perceptual errors (mistakes in situation evaluation) or execution errors (inability to execute a planned response) (Brehmer, 1990). These two general categories can be dichotomised, with both perceptual and execution errors falling into either a systematic errors category (the systematic difference between a performance measure and a response), or variable errors category (within-subjects variability), both of which act independently of each other (Brehmer, 1990). Systematic errors can be best explained by the limitations of the human information-processing system, while variable errors typify the inherent variability of human nature (Ranney, 1994). According to Brehmer (1990), due to their inherent predictability, it is possible to compensate for systematic errors, and it would appear that humans are quite adept at doing so. This means that this form of error will only result in an accident to an inexperienced driver (Ranney, 1994). Variable errors, however, can be seen in stark contrast. We are generally unaware of variations in driving performance, and even if we were, we are generally unable to predict what state we will be in at any given moment (e.g. we are unable to predict the speed of our reactions, the efficiency of our attention, or our ability to predict the speed of an oncoming car) (Brehmer, 1990). The unpredictable nature of variable errors means that it acts as an obstacle to adaptation, and as such, is a major cause of accidents (Ranney, 1994).

One error model suggests that, as drivers are unable to predict the state they will be in, and as it is not sensible to expect their adaptation to variable error to take a behavioural form (such as driving slow on a 'bad judgment' day), a more general protective action is taken (Brehmer, 1990). Safety margins are adopted, which guards against any negative variation in the drivers perception, judgment and behaviour, protecting the individual against the consequences of their errors (Brehmer, 1990). The fact that accidents still occur (especially with relation to speed and accident rate) suggests that although drivers have considerable safety margins, they are not large enough (Brehmer, 1990). This bias towards inadequacy in the safety margins maintained by drivers occurs due to an overestimation of driving skill and an underestimation of road and traffic hazards (especially by drivers who are inexperienced, intoxicated or under stress) (Brown, 1990).

This model can result in prediction with regards to the certain types of errors that can be expected within certain situations (Ranney, 1994). Firstly, we can expect a high degree of attentional errors, especially in drivers with inadequate temporal safety margins (when speeding or following too closely), due to self-imposed time stress, and the allocation of insufficient time to visually sample the wide range of spatially distributed cues that are necessary for driving (Brown, 1990; Ranney, 1994). Secondly, a high frequency of perceptual errors would be expected, given the fact that when speeding or following too closely, drivers effectively limit the amount of time available to process motion cues and traffic information (Brown, 1990). Finally, judgment errors would be anticipated, especially in relation to the evaluation of potential danger presented by traffic hazards, although the nature of these errors are not well documented in accident studies (Brown, 1990).

MICHON'S THREE LEVEL HIERARCHY MODEL

Of all the proposed models concerning driver behaviour, the one that has perhaps made the most significant contribution to the conceptualisation of the driving task is Michon's three level hierarchy model. Hierarchical in the sense that decisions made at a higher level determine the 'cognitive load' at a lower level, Michon's model is based on the notion that there is a hierarchical cognitive control structure of human behaviour in the traffic environment (and also within a mobility and communication context) (Ranney, 1994; Michon, 1985). Conceptualising driving as a concurrent activity at three levels (strategic, tactical and operational), Michon's hierarchical model allows control to be switched between levels, according to driver experience and familiarity of the driving situation (a necessary criteria for a comprehensive model of driving behaviour) (Michon, 1985; Ranney, 1994).

At the strategic level (see Figure 2), there is minimal time pressure, and formation of plans is the most important feature (Michon, 1985). It is at this stage that general trip planning takes place, including choice of route, mode of transport, an evaluation of costs and risks, and the setting of trip goals (such as avoiding heavy traffic) (Michon 1989, Ranney, 1994). Risk acceptance predominates at this level, and the driver, although aware of the danger, nevertheless opts to involve him or herself in a potentially hazardous situation or activity (van der Molen & Botticher, 1988).

At the tactical (or maneuvering) level, it is driver behaviour and subsequent decisions in traffic that predominate (Michon, 1985). This involves the driver's ability to exercise maneuver control, allowing them to negotiate common driving situations, which may include actions such as turning, gap acceptance while overtaking or entering the stream of traffic, or avoiding obstacles on the road (Michon, 1989). The time pressure for tactical driving decisions is intermediate (usually measured in seconds), and the level of associated risk involves the fact that performing tactical maneuvers increases the probability that danger will not just be a risk, but actually occur (van der Molen & Botticher, 1988).

The final level in Michon's (1985) hierarchy is the operational (or control) level, which consists of immediate vehicle control inputs (the basic actions of driving which are largely automatic habits) such as shifting gears, braking or steering, as well as emergency reactions (van der Molen & Botticher, 1988; Ranney, 1994). Time pressure for operational driving decisions is high (usually measured in milliseconds), and the level of associated risk encompasses the driver's ability to manage the performance of appropriate maneuvers in order to avoid acute danger and threats (van der Molen & Botticher, 1988).

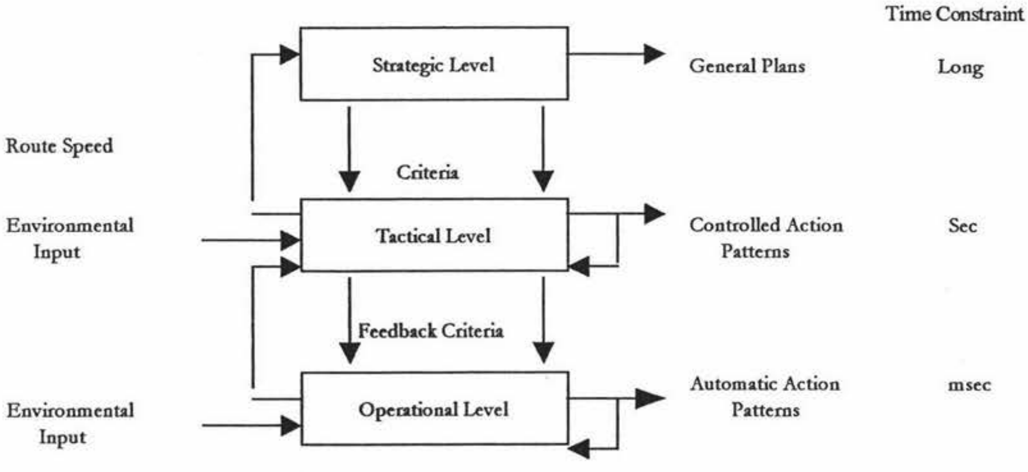


Figure 2. The hierarchical structure of the road user task (Michon, 1985).

According to Michon (1985), a comprehensive model of driver behaviour not only needs to take into account the various levels (in this instance the strategic, tactical and operational), but also needs to provide an information flow control structure that enables the control to be switched from one level to another, at appropriate times. By conceptualising driving as a concurrent activity that occurs over three levels Michon's model suggests that driver motivation also relates to the different levels of control. For example, while a driver may have selected a route and departure time in an attempt to ensure an uneventful journey (a strategic decision), unexpected situations en route may motivate the formulation of short term goals which require adjustment at the tactical level (such as the decision to pass slow traffic) (Ranney, 1994).

Compensatory behaviour may also operate at different levels of control. The rejection of a higher percentage of gaps during on-road merging by older drivers typifies tactical compensations, while their tendency to avoid rush hour or nighttime driving typifies strategic compensation (Planek & Fowler, 1971; van Wolffelaar, Rothengatter & Brouwer, 1987). It is believed that this compensatory behaviour is triggered by uncertainty (produced from an unexpected event or associated with conflict between motives at different levels of control), which in turn, leads to a reallocation of cognitive resources (Ranney, 1994).

Although as a conceptual model of driving, Michon's three level hierarchy model has not been rigorously tested through empirical measurement, this model has made a significant contribution to the conceptualisation of the driving task. In fact, it has been widely recognised as providing a new impetus for modeling efforts (Ranney, 1994). As such, in Chapter 6, the assessment of driver competence, and the impact of age on reaction and perception time in older adults will be discussed with particular emphasis on Michon's (1985) three level hierarchy model of driving.

DECIDING WHEN TO STOP: ASSESSING THE MEDICAL FITNESS OF OLDER DRIVERS

ABSTRACT

With the aging of New Zealand's population, there will be an increasing number of older drivers on the country's roads. Although issues regarding the management of older drivers have been raised internationally, whether or not the same issues exist within the New Zealand licencing system is unknown. In order to examine physicians' attitudes, awareness and practice of older driver assessment, a national survey using a randomly selected subset of 350 General Practitioners was conducted. Results indicate a general lack of consensus amongst respondents regarding appropriate assessment methods and management of older drivers. It would also appear that while General Practitioners display sound knowledge of the physical and psychological consequences of aging, the social impact is not so well understood. More research is needed in order to develop standardised assessment and referral methods, as well as investigation regarding ways to improve communication between health professionals and licenced Government agencies.

INTRODUCTION

In 1998, there were just over two million full licence holders in New Zealand. Of this number, approximately 16% were aged over 65 (Land Transport Safety Authority 1999a). With the baby boom generation advancing through their later years, and with continuing improvement in life expectancy, the proportion of licenced drivers within this age bracket will steadily increase. Given the high levels of motorisation that developed in the latter part of last century, it is important that as people age they can continue to enjoy their mobility as freely and safely as other road users (Transportation Research Board, 1988).

The continuing reliance on motor vehicles has important implications for the assessment of older drivers. Signifying independence, competence and responsibility, the ability to drive not only offers the older person a means of socialising and participating in community activities, but also acts as a primary mode of access to life's necessities, such as keeping medical appointments (Pachana and Long, 2000; Persson, 1993). For those older persons able to maintain their drivers licence, there are benefits of personal independence and control, but with the modern car becoming an essential factor of independent living, for those who relinquish or lose their licence there lies the possibility of depression and loneliness, as well as decreases in life satisfaction and out of home activity levels (Marottoli et al, 2000; Marottoli, Mendes de Leon, Glass & Williams, 1997; O'Neill, 1996). It is for these reasons that accurate assessment of an older person's driving ability is of utmost importance.

Within New Zealand, both health professionals and licenced government agencies (such as the Automobile Association) conduct the assessment of an older person's driving ability (Land Transport Safety Authority, 1999b). Each discipline contributes unique skills to the process, with the agencies responsible for the issuance of licences, and health professionals for the identification of medical conditions that may impair safe driving (Reuben, 1993). Changes to the driver licencing system in 1999 have led to new renewal requirements for older drivers aged over 75. Designed to remove unsafe older drivers from the road, during the month of their 75th birthday, drivers must renew their licence, at which time they must supply a current medical certificate stating their fitness to drive (Land Transport Safety Authority, 1999b). At the age of 80, and subsequently at two yearly intervals, drivers must renew their licence, produce a medical certificate, <u>and</u> pass an older driver practical test, which is a shortened, 20 minute version of the full licence practical test (Land Transport Safety Authority, 1999c). Failure to successfully complete any one of these provisions results in licence loss.

It is not just the act of licence renewal that can lead to the withdrawal of driving privileges – older drivers can also lose their licence if their mental or physical condition makes driving unsafe. Under the Land Transport Act, 1986, all registered medical practitioners have a legal requirement to advise of cases in which the cognitive or physical condition of a licence holder may impact on public safety (Land Transport Safety Authority, 1999d). However, while the conditions under which referral must be made are stated clearly in the guide book *Medical aspects of fitness to drive: A guide for medical practitioners*, the methods used to reach these conclusions are left to the discretion of the individual General Practitioner (with the exception of visual tests, which must measure acuity with a Snellen wall chart, and visual field with a fluorescent wand) (Land Transport Safety Authority, 1999d). Even so, the importance of the medical practitioner's role has been highlighted in recent months by the Land Transport Safety Authority (LTSA) sending a common road signs assessment tool to all General Practitioners with guidelines on evaluating the safety of the older driver in an attempt to both standardise the assessment procedure, and emulate a naturalistic driving setting (Land Transport Safety Authority, 1999e).

Despite the apparent benefits of a medical role in the assessment procedure, much of the current research into the area has tended to question the validity of screening for medical fitness, and has led to suggestions that the use of General Practitioners is not appropriate in driver safety assessment (Finlay & Jones, 1995; O'Neill, 1995). Clinical issues have also been raised, and it would appear that the practices concerning the management of older drivers varies widely, and a lot more help is needed to aid medical professionals in the assessment of older persons (Miller & Morley, 1993). Internationally, physicians have raised concerns regarding their legal obligations, the violation of patient/physician confidentiality, the lack of a reliable and valid assessment tool (which leads to subjectivity in the clinical decision) and the dilemma of balancing public safety with the older adult's need to be independently mobile (Owsley, 1997; Reuben, Silliman & Traines, 1988).

To date, there is a noticeable dearth of research conducted in New Zealand investigating the issues surrounding the assessment of aged drivers, and it is unknown whether the issues raised internationally are of concern here. Therefore, in order to define the attitudes, awareness and practice of physicians who are expected to deal with older driver assessment on a daily basis, a survey of New Zealand General Practitioners was conducted.

METHOD

PARTICIPANTS

A list of all registered medical practitioners in New Zealand (excluding specialists) was obtained from national telephone directory listings (N= 3426). Using systematic random sampling, of the total number of General Practitioners on the list, a smaller subset was selected (n = 350).

MATERIALS

After receiving ethical approval from the Massey University Human Ethics Committee (see Appendix A) This subset was subsequently posted a survey, which consisted of a questionnaire (see Appendix B), the New Zealand adaptation of the Facts on Aging Quiz (Pennington, Pachana & Coyle, in press) (see Appendix C), and a cover letter explaining the purpose of the study (see Appendix D). All questionnaires included freepost, self-addressed envelopes.

PROCEDURE

As the survey was anonymous, the act of sending back a completed questionnaire was taken as informed consent. The freepost envelopes were coded so that follow up surveys could be posted. Three weeks after the initial mail out, follow-up questionnaires, forms and freepost envelopes were posted to non-respondents (n = 274). Due to cost constraints, these reminder follow-up surveys were sent out to a subset of only 100 non-responders, once again selected through the use of systematic random sampling.

RESULTS

The response rates were 21% in the initial mail out (n = 74) and 26% after follow-up questionnaires were posted (n = 26) resulting in a total sample of 100 respondents. There were no differences between the two groups in terms of their responses. The majority of respondents worked in private practice (93%), and their number of years in practice ranged from 3 to 46 years ($\bar{x}$ = 19, SD=9.13). Only 15% of respondents had any specialist geriatric training. The percentage of patients aged over 65 in each practice ranged from 2% to 85% ($\bar{x}$ = 27, SD=16.25).

The participants were asked questions relating to older driver assessment methods – in particular their use of the common traffic signs driving assessment tool sent to all General Practitioners in New Zealand by the Land Transport Safety Authority. Despite the nationwide mail-out, very few respondents remember receiving the tool (13%), and even less can recall seeing it elsewhere (5%). Even so, as Figure 3 shows, many respondents felt that the tool was slightly, or very appropriate for use in a clinical setting (47%) – in fact, a number of respondents claim to use the tool in their medical assessments of older drivers (5%).

As shown in Table 2, when respondents were questioned about commonly used assessment tools, the use of general medical examinations appeared to be the predominant method of evaluation (42%). However, despite this, more than half of the respondents claimed to commonly use alternative methods of assessment in order to help them evaluate medical problems that could impact driving ability in the elderly (58%).

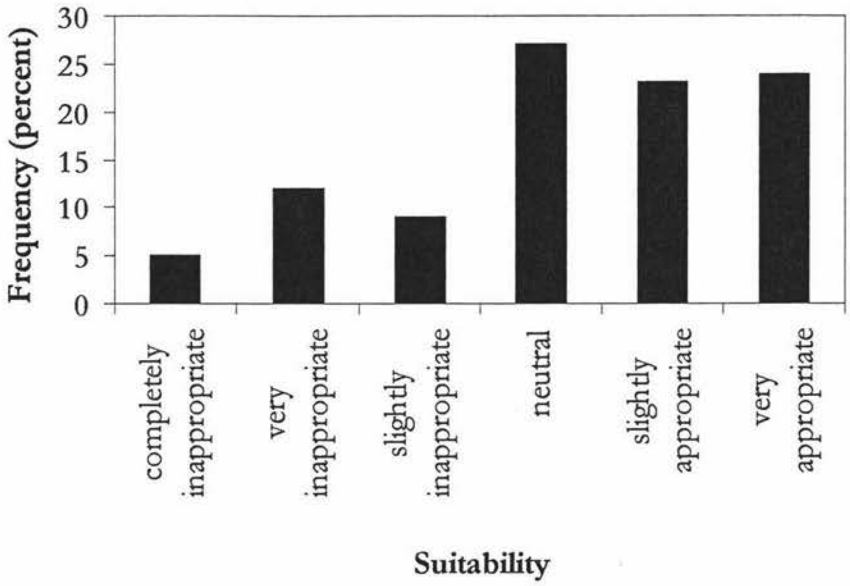


Figure 3. General Practitioners views on the suitability of the LTSA common traffic signs driving assessment tool for older drivers.

Table 2.
Most common methods used by General Practitioners in assessing fitness to drive in older persons

Assessment Method	*n*	%
Medical exam	35	42
Mini Mental State Examination	15	17
Knowledge of patient	9	11
Vision test	7	8
Cognitive ability questions	8	9
Hearing	4	5
Reaction time	2	2
Referral to OT for testing	2	2
LTSA practical test	1	1
Questioning of patient and family	1	1
Similar test to LTSA tool	1	1
Road code questions	1	1

When General Practitioners were asked how potential driving problems in older persons were first bought to their attention, the majority of respondents stated that concerns from the patient's family were usually the first indication of a problem (53%). A general medical examination, and the patient's own expression of concern were less common means of identifying potential difficulties (17% and 3% respectively), while a number of respondents couldn't identify one predominant means, citing a combination of the aforementioned channels (26%).

Once a potential problem was identified, the overwhelming majority of Practitioners initially discussed the issue with their patient (96%) with only a small number immediately referring the patient for further testing (4%). While most Practitioners used this discussion time as an opportunity to explain the problem before referral for further testing (74%), several used the discussion as an alternative to referral (making private arrangements) (14%), while others used both depending on individual circumstances (12%).

Once referral was deemed necessary, an Occupational Therapist was the preferred option (66%). Fellow General Practitioners and the Land Transport Safety Authority were the least prevalent (2% and 1% respectively), while the remainder commonly referred to other professionals, such as geriatric units, specialised older driver assessment teams, and appropriate specialists (31%). This variability in procedure continues through into referral circumstances. As shown by Table 3, the circumstances under which General Practitioners commonly refer are as variable as the people or organisations' that patients are referred to.

Table 3.
Circumstances under which General Practitioners most often refer

Circumstance	*n*	%
Visual impairment	10	11
Dementia/cognitive impairment	15	17
Physical impairment	12	13
Never had to	7	8
Patient doesn't accept recommendations	10	11
Poor physical condition	16	18
General concerns/doubts re driving ability	11	12
Other	9	10

When given the opportunity to offer their view as to the most appropriate person for the evaluation of driving skills, most of the respondents felt that it was a job best suited to an Occupational Therapist (OT) (37%). However, as shown by Table 4, the range of responses was wide, and encompassed many areas within both the health sector, and government agencies.

Table 4.
General Practitioners views on the most appropriate person(s) for the evaluation of driving skills in older adults

Most appropriate person	*n*	%
Occupational Therapist	37	37
LTSA/driving instructor	21	21
Driving assessment specialists	12	12
Both General Practitioner and Occupational Therapist	8	8
Both LTSA and Occupational Therapist	7	7
General Practitioner	7	7
Don't know	3	3
Geriatrician	1	1
Both Physiotherapist and Occupational Therapist	1	1
Patients' family	1	1
Both LTSA and General Practitioner	1	1
Appropriate specialist	1	1

When asked their views regarding whether or not referral poses an ethical dilemma (with respect to patient/doctor confidentiality), while the majority of opinion tended to cluster around the view that there was a small to moderate ethical dilemma, there was no predominant point of view (see Figure 4).

General Practitioners responses to the Facts on Aging Quiz revealed that while knowledge of age related physical and psychological changes were sound (94% and 82% accuracy rate respectively), in general, knowledge of the social consequences and impacts of aging were not so well understood (48% accuracy rate). For the 15% of respondents who had received some form of specialist geriatric training, knowledge of the physical, psychological and social aspects of aging was not drastically improved (93%, 73% and 55% accuracy rate respectively).

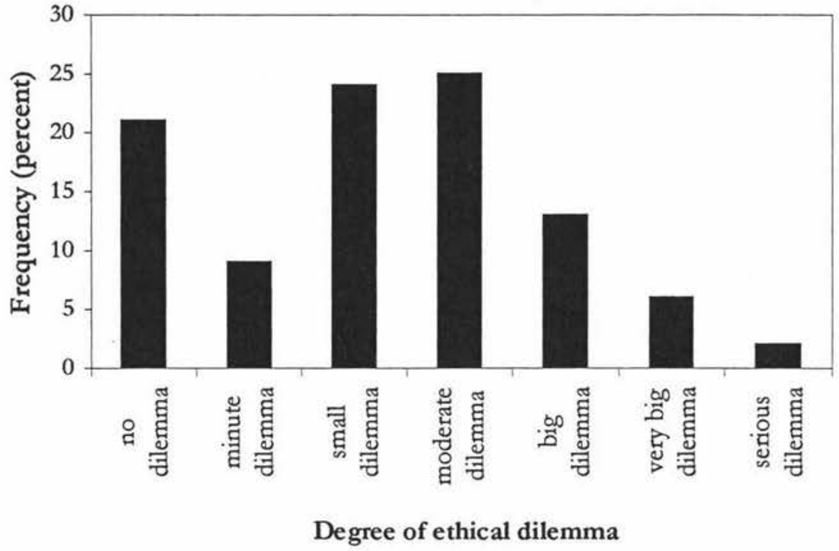


Figure 4. General Practitioners views on the association between referral and breeching patient/doctor confidentiality.

Only 55% of respondents were aware of the recent changes to the issuance of drivers' licences for over 65's. As shown by Figure 5, respondents also tended to underestimate the potential impact of the aging population on driver safety – a point reiterated when General Practitioners were asked to compare the issues surrounding younger and older drivers, with the overwhelming majority of responses indicating that there was more of an issue with younger rather than older drivers (78%).

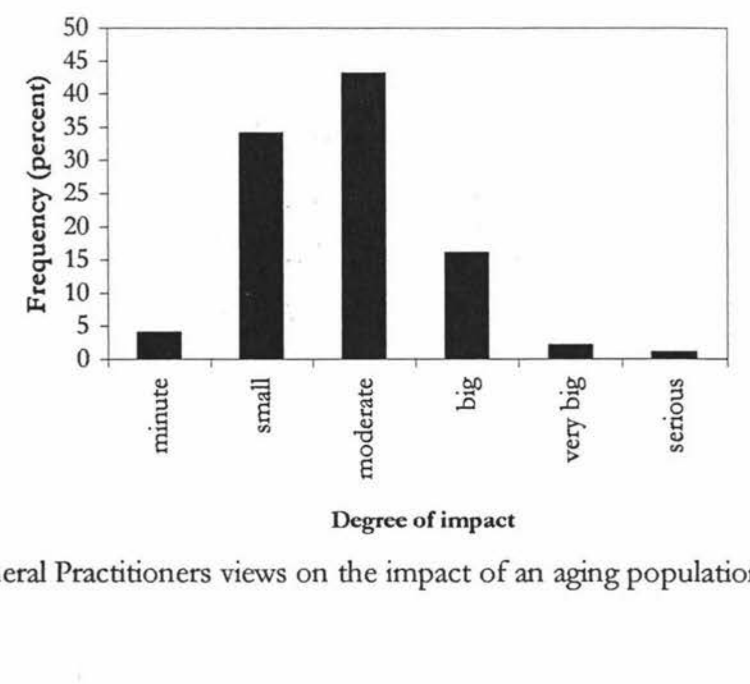


Figure 5. General Practitioners views on the impact of an aging population on driver safety.

DISCUSSION

> "Stopping an elderly patient from driving can have very significant mental consequences. I have had a patient who died (possible suicide from not taking his medication) within two weeks of me telling him he may not be able to drive much longer. To him the threat of loss of independence was greater than he could bear." – respondent in study

With society' increasing reliance on automobiles, for many older persons, the maintenance of driving ability is key to an independent and controlled lifestyle. The implications of licence loss can have profound and lasting psychological effects on an individual (Marottoli, Mendes de Leon, Glass & Williams, 1997), and as highlighted by the above account, this is not simply a foreign phenomenon – General Practitioners within New Zealand are also witness to the after effects of licence loss. Accurate assessment is the key to reducing this dilemma, and within New Zealand, as in most countries internationally, the responsibility for the assessment of older drivers is split between medical practitioners and licenced Government agencies. Internationally, this medical responsibility has raised concerns regarding the violation of patient/doctor confidentiality, and the lack of a reliable and valid assessment tool (Owsley, 1997; Reuben, Silliman & Traines, 1988). It would appear that these issues are also evident to a degree within New Zealand's medical practices.

Of primary concern, the results are indicative of a communication breakdown between the policy makers and General Practitioners. This point can be highlighted by the fact that 45% of respondents were unaware of the recent (1999) policy changes in the relicencing of older drivers, and that despite the LTSA'S attempt to standardise testing with the national mail-out of their common traffic signs assessment tool, it is not widely used, and not well remembered (only 18% can recall ever seeing the tool). With Government agencies and health professionals supposedly working as a team with regards to driver assessment, successful communication of information is of utmost importance.

The LTSA common traffic signs assessment tool is not only indicative of a communication breakdown, but also highlights the need for standardised assessment procedures. While the majority of respondents tended to view the tool quite positively, concerns were raised regarding the layout, its limited scope (as it only tests theory not driving skill), the 'commonality' of the signs used, time constraints and possible subjectivity of marking. As one doctor stated "I would probably fail it myself; I do these things automatically". This tool served to highlighted the confusion over the doctor's actual role in medical assessment, with a number of respondents questioning whether asking such 'non-medical' questions was their job.

Legally, when it comes to driver assessment, doctors are required to examine the cardiovascular, musculoskeletal, central nervous and respiratory systems, examine visual acuity and hearing, conduct a full neurological test, as well as investigate reaction time, and the locomotor system in older drivers. While these guidelines highlight the areas in need of examination, the methods doctors use to reach a medical decision, with the exception of vision, are left to their discretion. As this survey shows, similar to international findings, the range of assessment procedures are broad, with General Practitioners (GP's) commonly using a myriad of methods from standard medical exams, to knowledge of the patient, to road code questions, resulting in subjectivity of the clinical decision. This general lack of consistency also raises concerns as to whether tests of visual acuity are conducted according to LTSA specifications. While the LTSA requires acuity to be tested with a Snellen wall chart viewed at 6 metres, most surgeries have rooms that measure less than 6 metres, so they cannot be used.

With a lack of standardised assessment tools, and with only general guidelines as direction, given the extent of assessment required, and that the allotted consultation time of a GP is between 10 to 15 minutes, it is not realistic to expect medical assessment of driving ability to be conducted precisely and by the book. Patients requesting their normal medications during the same consultation (to save the cost of an additional trip and fee) only serve to exacerbate the constraints on time. Consequently, when poor communication is combined with a lack of standardised procedure, assessment results are less than optimum, and can lead to false positives (people who continue to drive who shouldn't) and false negatives (people whose licences are removed when they are capable of continuing driving), doing little to improve general road safety.

Given the degree of assessment expected during a medical examination for relicencing, and the constraints (both time wise and resource wise) on the GP to perform this role to the expected level, it is worthwhile considering another option. Perhaps medical assessment of drivers would be best conducted by specialised driver assessment teams in which there is a combination of Occupational Therapists, medical professionals and driving instructors who have the time and resources to conduct full, impartial and empathetic assessments of an individuals driving skills. Communication would consequently improve, as information would only need to be passed on to a small number of assessment units, as opposed to a large number of individuals, and if done in conjunction with the much needed development of standardised testing procedures (which will ensure all individuals are assessed to a similar standard), the possibility of false negatives and false positives will be reduced, resulting in more accurate results and efficient assessment.

Inconsistencies in assessment methods are not the only concern raised by this survey. Referral once a problem is noted also highlights discrepancies and differences of opinion within the assessment procedure. Unless the individual crashes in the surgery parking lot, potential driving problems are hard for the GP to recognise. As the survey shows, medical examinations are not a successful indicator of potential driving problems, and in the majority of cases, concerns from family were usually the first suggestion that something was wrong. Once a problem was noted, discussion of the problem usually pre-empted immediate referral. However, a number of GP's used discussion as an opportunity to make private arrangement with the patient, rather than refer them on.

If referral was deemed necessary, only 1% of respondents chose to refer to the LTSA, with a number of GP's raising concern over the treatment of elderly persons sitting their driving tests, and being failed for "silly, obvious reasons" – "Our problem in Wellington is inspectors penalising elderly for minor infringements". This is surprising given that driving instructors' were ranked second as the most appropriate person for evaluating driving skills, although this was commonly coupled with the proviso that they were trained to be more empathetic to older drivers. Not one respondent made mention of the use of psychology as helpful in the driver evaluation process.

The use of private arrangements, and the general lack of referral to the LTSA, indicates that there is uncertainty and a lack of faith in current relicencing methods. With referred patients facing one of two options (licence loss or retention), and given the importance of maintaining a licence in modern society, the use of an independent driver assessment unit becomes even more cogent. Knowing that the patient will receive a thorough examination by trained, empathetic staff may make referral a more amenable task.

Within this issue also lies the potential for the introduction of limited licences – for example, licences that restrict driving on highways or in the evening, or that allow the person to drive in their suburb or local area, so that they can still retain a degree of independence. More importantly, there is also a need to consider the utilisation of courses such as Age Concerns 'Safe with Age' program, (a three hour driving awareness program) and offer older drivers a refresher course in driver safety and skills (Age Concern, 1999). Although driving is a right, and not a privilege, removal of a licence should be a last resort, and all other options investigated before doing so.

Once again, as seen in international studies, while there was no predominant view point, it would appear that with New Zealand GP's, there <u>is</u> a general concern over referral posing an ethical dilemma with regards to the breech of patient/doctor confidentiality. However, unlike international studies, which are concerned with the act of referral itself, in New Zealand, it appears to be more of a concern with the GP's relationship with the patient, rather than guilt over breeching confidentiality – "It is not an ethical dilemma, the problem is more to do with letting patients down and hurting their feelings". If an independent body conducts older driver assessment, then the conflict between ethics and public safety can be resolved, or at best, minimised.

On a whole, it would appear from these results that, without standardisation of tests and referral procedures, and improved communication between Government agencies and health professionals, it is likely there will continue to be high levels of stress on the physicians time and (limited) resources, which, in turn, will impact negatively on the quality of assessment. Developed without any apparent thought for the realities of general practice, it is questionable whether current methods of relicencing will have any effect on improving road safety. With results indicating confusion and inconsistencies surrounding attitudes, awareness and practices of older driver assessment, if we are to successfully cope with the impending increase in the older population then more work needs to be done to facilitate the physicians role, and on enabling older people to retain their licences' for as long as is practicable.

A Comparison Of Major And Minor Urban Areas And Their Assessment Of Older Drivers

Abstract

A recent Australian study conducted by Fox, Withaar and Bashford (1996) suggests that there are discrepancies in older driver assessment between urban and rural communities. Within New Zealand, almost a third of the population aged over 65 live in minor or rural urban areas, and the number is steadily increasing. In order to ascertain whether similar discrepancies are evident within New Zealand, additional questions where added to the original survey of General Practitioners. Although not statistically significant, results indicate general tendencies for Practitioners within minor urban areas to apply their knowledge of the patient in assessment and refer to the LTSA more so than those in major urban areas. Conversely, General Practitioners in main urban areas tend to utilise uncommon methods of assessment, and were more likely to refer to a specialist. More in depth research is needed to analyse differences between the four population groups, as opposed to using a simple dichotomy, since the importance of the observed discrepancies may be overshadowed by the simplified classification system used in this study.

Introduction

It has been suggested that an important marker to successful aging is an individual's ability to maintain independence in the community (O'Neill, 1996). The final decades of the Twentieth Century saw an increase in the levels of motorisation, and as people became accustomed to the benefits of driving, the ability to obtain and uphold a drivers licence developed into an important aspect of maintaining an older person's identification as a functioning and socially capable adult (Persson, 1993). Exemplified by the fact that 77% of UK drivers' over age 55 perceives the act of driving as very important (AA Foundation for Road Safety Research, cited in Pachana & Long, 2000), a drivers licence signifies independence, responsibility, autonomy and competence, and when it becomes necessary for an older driver to relinquish their licence, it can often be viewed as a final rite of passage (Pachana & Long, 2000; Persson, 1993). The loss of a licence is of particular importance to the one third of New Zealand's elderly population living in either rural, or minor urban areas.

Within New Zealand, the population is divided into four groups according to the size of the population (Statistics New Zealand, 1988). They are known as:

1. Main urban areas: populations of 30,000 or more people.
2. Secondary urban areas: population between 10,000 and 29,999 people.
3. Minor urban areas: populations between 1,000 and 9,999 people.
4. Rural centres and areas: populations containing less than 1,000 people.

According to statistics gathered during the 1996 census, within New Zealand, 22% of the elderly population (those aged 65 and above) lives in either minor urban areas or rural areas (Statistics New Zealand, 1998). Although totaling not quite a third of those aged over 65, there are indications that the number of elderly living in these less populated areas are steadily increasing. As a percentage of the total population, the growth of elderly is highest in these areas. In fact, between 1986 and 1996, the percentage of elderly in these areas increased by an average of 34.5%, compared to an overall increase of just 6.1% in minor urban areas and 7.3% in rural areas during the same time period (Statistics New Zealand, 1998).

Perhaps the most conspicuous feature of minor urban and rural areas is their lack of widespread public transport systems (such as taxis and buses). For those individuals facing the loss of a licence, without well established public transport there will be ensuing difficulty in maintaining social contacts, as well as carrying out daily tasks and routines, such as shopping or meeting appointments (Pachana & Long, 2000). Moreover, according to Kington, Reuben, Rogowski and Lillard (1994), a number of elderly drivers are providing the majority of informal support to functionally impaired older people (both relatives and acquaintances). As a result, the possibility of driver disqualification can result in both personal and interpersonal losses (Pachana & Long, 2000). As noted in Chapter 3, with family and friends playing an important role in raising concerns regarding an individuals' driving skill, the support role played by many older drivers may generate reluctance in reporting their suspicions – especially if the individual represents the sole driver in the group (Pachana & Long, 2000). This concern is not without foundation, and can be corroborated by Adler, Rottunda, Rasmussen and Kuskowski's (2000) study into caregivers' dependant on drivers with dementia, in which it was discovered that dependant caregivers were less likely than independent caregivers to take an active approach in encouraging driving cessation, believing that if the patient with dementia were to cease driving, quality of life would be significantly affected.

It is for these reasons that accurate assessment of driving skill is of particular importance in the country's less populated areas. However, a recent Australian study conducted by Fox, Withaar and Bashford (1996) suggests that there are discrepancies in older driver assessment between urban and rural communities. They uncovered notable differences between the use of secondary health professionals, methods of assessment and the recommendations made. In general, rural assessors tended to utilise restricted licences more regularly, and made use of a Mini Mental State Exam (MMSE) cut off score. However, they also tended to use Road and Transport Authority's (RTA) guidelines less frequently, had less access to secondary health professionals (such as neuropsychologists), tended not to repeat assessment, and didn't always report assessment results to the RTA (Fox, Withaar and Bashford, 1996).

The dynamics of older drivers residing in minor or rural urban areas raises concerns regarding the need for accurate assessment of these individuals when relicencing. The potential interpersonal and personal losses in these communities as a result of licence loss, combined with the urban/rural discrepancies found within Australia not only highlight the importance of accurate assessment, but also underlines the dearth of information on this issue within New Zealand. As a result, in order to ascertain whether similar rural/urban discrepancies of assessment, secondary health professionals and recommendations exist here, additional questions were added onto the original survey of General Practitioners (see Chapter 3).

METHOD

RESPONDENTS

As stated in Chapter 3, a list of all registered medical practitioners in New Zealand (excluding specialists) was obtained from national telephone directory listings ($N = 3426$). Using systematic random sampling, of the total number of General Practitioners' on the list, a smaller subset was selected ($n = 350$).

MATERIALS

After gaining ethical approval from the Massey University Human Ethics Committee, the subset was subsequently posted a survey, which consisted of a cover letter, the New Zealand adaptation of the Facts on Aging Quiz (Pennington, Pachana & Coyle, in press), a free post envelope and a questionnaire (the contents of which are discussed in the previous Chapter). Additional questions were added to the questionnaire regarding the location of their medical practice, so that responses to all other questions could be analysed according to the size of the population in which they practice.

PROCEDURE

As only additional questions were added to the original questionnaire, the procedure outlined in Chapter 3 remains unchanged. To reiterate, as the survey was anonymous, the act of sending back a completed questionnaire was taken as informed consent. The freepost envelopes were coded so that follow up surveys could be posted. Three weeks after the initial mail out, follow-up questionnaires, forms and freepost envelopes were posted to non-respondents (*n*=274). Due to cost constraints, these reminder follow-up surveys were sent out to a subset of only 100 non-responders, once again selected through the use of systematic random sampling.

RESULTS

To recap, the response rates were 21% in the initial mail out (*n*=74) and 26% after follow-up questionnaires were posted (*n*=26) resulting in a total sample of 100 respondents. Half of the respondents came from main urban areas (50%), and half came from secondary, minor urban and rural areas (50%). The two groups were matched quite closely on other demographic points, as Table 5 shows.

Table 5
Respondent demographics with regard to the location of their medical practice

Demographic	Urban	Rural
Percentage in private practice	86%	100%
Mean number of years in practice	18	18
Number who have had specialist geriatric training	7	8
Mean percentage of patients over age 65	27%	25%

Participants were asked questions regarding systems their practice has in place to assist elderly patients. The majority of both main and minor urban respondents provided assistance in some form (88% and 82% respectively). The most common service offered by both groups was home/residential visits either by the doctor, or a nurse (80% main, 77% minor). While very few from either group offered a pick up service (2% main, 2%

minor), a number of practices offered more than one form of assistance (18% main, 22% minor).

With regards to methods of assessment, when respondents were asked questions relating to the procedures used to measure fitness to drive in their elderly patients, as shown by Figure 6, both groups had an analogous preference towards the use of a standard medical examination. However, the responses did display some regional tendencies. Practitioners in minor urban areas were more likely to apply their general knowledge of the patient, as well as utilise cognitive questions and tests (such as the Mini Mental State Examination, and clock face drawing), whereas those in main urban areas were more inclined to simply conduct tests of vision and/or hearing, and other uncommon methods (such as road code questions, interrogation of the patient, and questioning of patients family and friends).

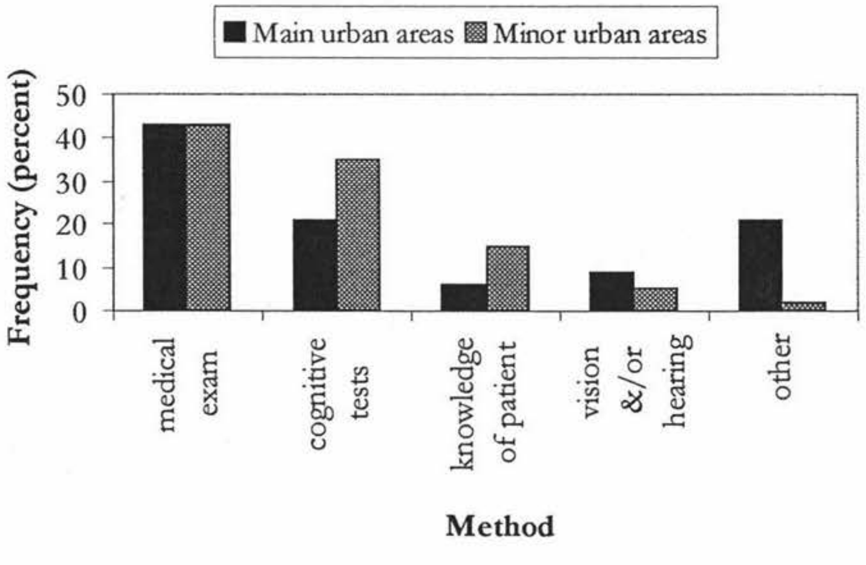


Figure 6. Main and minor urban comparison of commonly used methods for assessing fitness to drive in the elderly.

When comparing how potential driving problems were first bought to the Practitioners attention, for those doctors practicing in main urban areas, notification from the patient's family was the most common means, more so than doctors in minor urban areas (58% main, 48% minor). Medical examinations were a less common form of detection amongst both groups (16% main, 18% minor), as was notification of a problem from the patient (2% main, 4% minor).

Once problems were noted, doctors in minor urban areas tended to refer immediately more so than their counterparts in main urban areas (6% minor, 2% main), whereas doctors in main urban areas tended to discuss the issue with the patient (94% major, 82% minor),

The use of discussion was similar for both groups. Predominantly used as an explanation of the problem (75% main, 73% minor), it was occasionally used as an alternative to referral (13% main, 16% minor).

Once referral was deemed necessary, an Occupational Therapist was the preferred choice for both groups (64% main, 69% minor). Referral to another General Practitioner was less common (2% main, 2% minor), with doctors in main urban areas tending towards an appropriate specialist more so than doctors in minor urban areas (34% main, 27% minor). Doctors in minor urban areas were the only group to refer patients to the Land Transport Safety Authority (LTSA) (2%),

When asked whom they believe to be the most appropriate person/organisation to evaluate driving skills in the elderly, as shown by Figure 7, while doctors in both main and minor urban areas tended to opt for an Occupational Therapist (OT) as the most appropriate, there were some regional differences. A greater percentage of practitioners in minor urban areas felt they were the most appropriate to assess driving skills, and had more faith in the LTSA, while a greater percentage of doctors in main urban areas felt their skills, combined with and OT were most appropriate, and had a more positive view towards the use of appropriate specialists.

When asked to voice their opinion of the ethical dilemma posed by referral with regards to patient/doctor confidentiality, the majority of opinion tended to cluster around the view that there was a small to moderate ethical dilemma (as shown by Figure 8), however, there was no predominant point of view

General Practitioners in minor urban areas appeared to be slightly more aware of the licensing changes for older drivers than urban doctors (58% minor, 52% main),

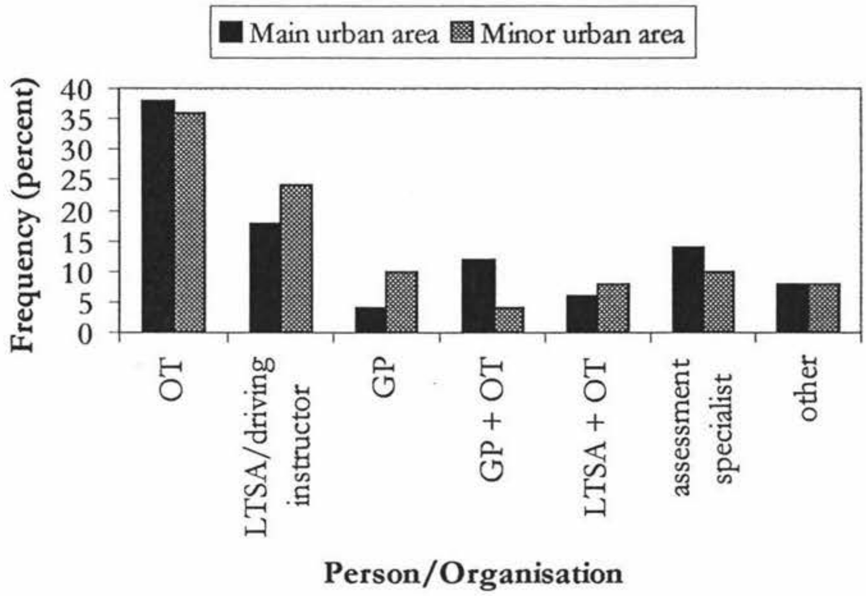


Figure 7. Main and minor urban comparison as to who GP's regard as the most appropriate to assess driving skills in the elderly.

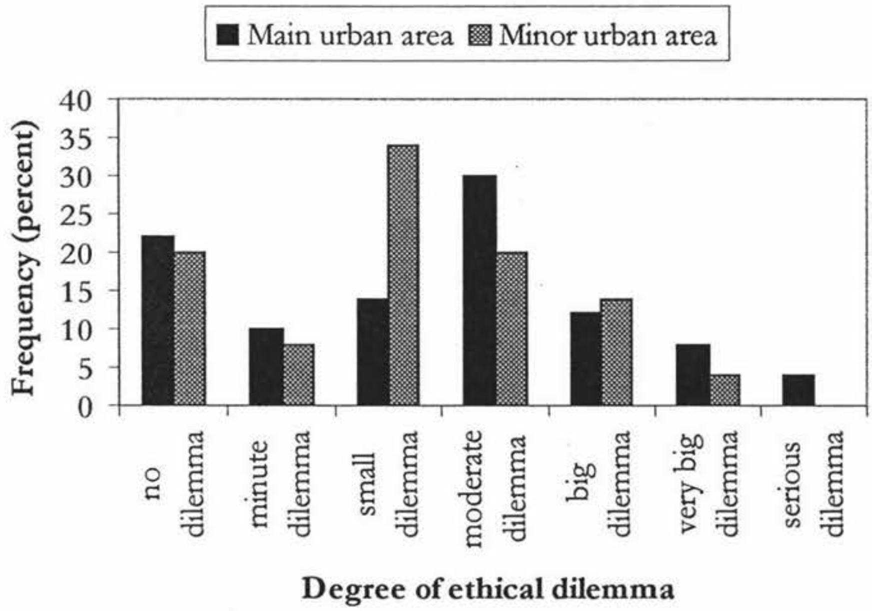


Figure 8. Main and minor urban comparison of the association between referral and breeching patient/doctor confidentiality.

DISCUSSION

O'Neill's (1996) suggestion that an individual's ability to maintain independence in the community is an important marker to successful aging certainly rings true for the population aged over 65 who are living in our countries less populated areas. In the Twenty First Century, a driver's licence signifies independence, autonomy, responsibility and competence (Persson, 1993). Nowhere in the country is this point more salient than for the 22% of over 65's living in either minor urban or rural areas. With a lack of widespread public transport, the loss of a licence impacts on the individual's ability to maintain social contacts, and carry out daily tasks and routines. Moreover, with a number of older drivers providing informal support to functionally impaired older people, the impact is more widespread, and creates interpersonal as well as personal losses (Kington, Reuben, Rogowski & Lillard, 1994; Pachana & Long, 2000). As a result, accurate assessment of driving ability is of particular importance in these areas. A recent Australian study indicates discrepancies between urban and rural communities with respect to assessment, referral and use of secondary health professionals. While minor and major urban areas are comparable in many aspects of driving assessment, there <u>are</u> indications that similar discrepancies are also visible to a degree within New Zealand.

As stipulated in the previous chapter, while medical practitioners are given guidelines as to the areas that need to be examined when assessing medical fitness to drive, the methods they use to reach their conclusions (with the exception of vision) are left to their discretion. With results from Chapter 3 indicating that the range of assessment procedures used is wide ranging and lacks general consistency, when results are analysed based on population size, there <u>do</u> appear to be some regional tendencies. Practitioners in minor urban areas are more likely to apply their general knowledge of the patient in assessment (6% main, 15% minor) and use cognitive tests than their main urban counterparts (21% main, 35% minor) On the other hand, those doctors practicing in main urban areas use uncommon methods (such as road code questions, and interrogation of the patient) more frequently than those in minor urban areas (21% main, 2% minor).

This is perhaps not surprising, given the nature of medical practice within the two areas. By virtue, General Practitioners (GP's) within minor urban areas are more likely to have smaller practices, know their patients outside of work (through community activities), and live in an area that is more oriented towards the traditional 'family GP' way of thinking. This means that they have more opportunity to develop relationships with their patients, and as a result, get to know them well on a personal as well as medical basis. Therefore, knowledge of the individual comes readily into play, and use of medical examination becomes less important. Consequently, it is possible that cognitive tests are used more frequently to confirm suspicion, rather than for strict diagnostic purposes. As one doctor stated, "...in general practice you get to know your patients well, and can use this knowledge when ascertaining fitness to drive".

Conversely, for those GP's practicing within main urban areas, the opportunity to develop relationships with patients is diminished due to the large numbers of patients both on file, and seen each day, as well as the reduced likelihood of interacting with their patients outside of work in community based activities. Within main urban areas there is also a tendency for GP's to work strictly 9 to 5, or on a roster (shift basis), and as a result, patients are more likely to visit the Practitioner who is available at the time, rather than waiting to see the 'family GP'. Understandably, this could possibly result in 'big city' Practitioners developing their own assessment methods to simplify and standardise the process, as they cannot fall back on prior knowledge as readily as those GP's in smaller areas.

These points can also be illustrated by the methods in which GP's most commonly notice potential driving problems in their elderly patients. Doctors practicing within minor urban areas are more likely to notice potential driving problems through medical examination (18% minor, 16% main) and through notification from the patient themselves, (4% minor, 2% main) than those in main urban areas. Not only does this indicate that knowing the patient improves the possibility of detecting a problem through examination, but that having a relationship with the patient makes it easier for them to approach their GP with any concerns. Conversely, for the GP's practicing in main urban areas, there is an increased reliance on notification from family and friends (58% main, 48% minor), which indicates a general lack of trust between the patient and GP, as well as less effective assessment methods.

The reduced likelihood of notifcation from family and friends of potential driving problems in minor urban areas is perhaps also indicative of the support role played by many older drivers. As previously stated, a number of elderly drivers provide much of the informal support for functionally impaired older drivers (Kington, Reuben, Rogowski and Lillard, 1994)). Pachana and Long (2000) speculated that the importance of this role may result in a general reluctance for family and friends to report their suspicions, even more so if individual concerned is the sole driver in the group. The fact that friends and family of elderly drivers living in minor urban areas are a less likely source for revealing potential driving problems may serve to exemplify this point.

Assessment discrepancies are not the only issue raised by this survey. The process of referral once potential problems are noted also highlights regional differences. Whereas results from Fox, Withaar and Bashford (1996) indicated that assessment conducted in rural areas was less likely to result in referral to the RTA, although not statistically significant, this study indicated that GP's in minor urban areas are actually more likely to refer to the LTSA than main urban doctors (2% minor, 0% main). This, combined with the fact that a greater number of GP's in minor urban areas considered the LTSA as the most appropriate organisation to assess driving skills (24% minor, 18% main), indicates that they have more faith in their application than doctors living in main urban areas. This is possibly due to the fact that a practical driving test within a small rural community is less complicated than one taken in a main urban area (due to reduced traffic flow and less complicated street design), which implies fewer chances for making mistakes, and failing.

GP's practicing in main urban areas had results analogous to the Australian study, and were more likely to refer to a specialist than those in minor urban areas (34% main, 27% minor). They were also more likely to view specialists as the most appropriate person to assess driving skill (14% main, 10% minor). Not surprisingly, referral to specialists within main urban areas is perhaps more indicative of access than anything else – for example, you are more likely to find a geriatrician in Auckland than Eketahuna. Unlike the elderly in minor urban areas, patients in the main centres don't have to travel great distances to make their appointments, and therefore, GP's in these areas are more likely to make use of them than those in smaller areas.

It would appear from these results that, while there are slight discrepancies between minor and main urban doctors with respect to assessment, use of secondary health professionals and referral, they are somewhat dissimilar to those found in Australia, perhaps due to variations in our policy and lifestyle. Indicative more of the different lifestyles found within the two areas, rather than conflicting attitudes towards the elderly, assessment of the older driver, in all of its facets, has been adapted to suit the nature of medical practice within each group. There is a possibility that the use of a simple dichotomy in categorisation of population size may have overshadowed the discrepancies found and resulted in the insignificant findings, so further research is needed to investigate the differences between all four population groups, to see if there is greater variation in practice than is indicated by this study.

Increasing Age And Dementia: The Effect On Perception-Reaction Time In Older Drivers

Abstract

With the aging of the population, and increased reliance on the automobile for mobility and independence, there is a call for an adjustment of the roadway system in order to better meet the needs and abilities of older drivers. Despite the importance of reaction time and information processing to the driving task, the relationship of these cognitive skills to increasing age (both primary and secondary aging) and driving performance is still not well established. In order to examine this relationship, a perceptual experiment was conducted, comparing speed and accuracy of road sign recognition amongst individuals with early onset Alzheimer's disease (AD), cognitively unimpaired older drivers, and younger controls. Results indicate that while there were no significant differences between younger controls and either drivers with AD ($t(8)=-1.62$, $p>.05$) or older controls ($t(10)=-.944$, $p>.05$), on verbal test scores, there were significant differences in reaction time on a semi-realistic driving task, both in relation to the speed traveled and the sign displayed ($F(2,13)=19.48$, $p<.01$). The ability to accurately recognise the road sign also declined with age and cognitive state, dropping from accuracy rates of 100% (in younger controls) to 88% (older controls) to 74% (those with AD). This indicates that the ability to perceive and react to traffic sign information decreases with healthy aging, a decrement that is exacerbated by the presence of early onset AD.

Introduction

Within industrialised societies, driving an automobile is the preferred mode of transportation, and according to a recent study conducted by Jette and Branch (1992), a substantial number of older adults continue to rely on the motor vehicle for mobility and independence well into the eighth and ninth decades of life. With the aging of the world's population, the proportion of older road users will continue to increase. Therefore, in order to allow older persons to meet their basic mobility requirements in safety, the roadway system will need to be adjusted to better suit the needs and abilities of older drivers (Transportation Research Board, 1988).

In 1998, only 10% of all full license holders in New Zealand were aged over 65 (Land Transport Safety Authority, 1999a). Although accounting for only a minority of the total number of injuries and fatalities resulting from automobile accidents (8% and 17% respectively in 1998), when accident rates are adjusted for the number of miles driven, crash rates for older drivers are comparable to the 15 to 24 demographic (Evans, 1988; Land Transport Safety Authority, 1999a). It has been suggested that this phenomenon may in fact be a result of normal age related physiological changes, as well as being influenced by the various medical diseases that are prevalent in older age groups which can affect performance behind the wheel, in particular neurological and cardiovascular conditions (Carr, Jackson, Madden and Cohen, 1992).

Smith (1968) has described the act of driving as consisting of four phases. Not only must the driver be able to see and hear a situation developing, they must also be able to recognise it, decide how to respond and then execute the physical maneuver. Fundamental to the successful recognition and response of a given stimuli is proficiency in cognitive performance, particularly perception reaction skills. The degree to which an older driver is able to perform this task is dependent on the cognitive changes that accompany aging, and to date, the most universally replicated finding is the slowing of response to a given stimulus (Kausler, 1991; Transportation Research Board, 1988). Diminished reaction time with age can be seen as one of life's certainties, with the process of aging affecting reaction time to the extent that both movement initiation and execution are slowed down (Belsky, 1999; Perryman & Fitten, 1996). Consequently, the precision crucial to the effective operation of an automobile is reduced, increasing the potential for motor vehicle accidents (Perryman & Fitten, 1996).

However, before a response can be made, the older driver must first recognise the stimulus, and the effect of age on information processing is not as straightforward. While it would appear that the ability to process information remains relatively intact with increasing age, deficits have been noted in processing speed (Rybash, Roodin & Hoyer, 1995). Referring to information interpretation and organisation, literature on information processing indicates a decline amongst older persons, particularly when required to make complex decisions (Transportation Research Board, 1988). According to Salthouse (1991), if we are unable to think quickly, then by definition we cannot think well, and if older drivers require more time than younger drivers to complete the cognitive component of the Smith's (1968) four driving phases, then there lies the possibility for more severe consequences on the road.

While slower reaction time and information processing appear to be a normal part of aging, diseases commonly related with advanced age, particularly Alzheimer's disease (AD), can also cause loss in cognitive ability, compounding the deficits associated with primary aging, and further impacting on an individuals ability to successfully negotiate the cognitive components of driving (Kapust & Weintraub, 1992; Transportation Research Board, 1988). The relationship between AD and functional driving ability has only begun to be examined relatively recently, however, it would seem that people with AD display an annual accident rate that is two and a half times higher than cognitively unimpaired older drivers (Donelly & Karlinsky, 1990; Drachman & Swearer, 1993). In fact, it has been suggested that AD patients who continue to drive pose a significant traffic safety risk, with one third experiencing at least one motor vehicle incident in the past 6 months (Dubinsky, Williamson, Gray & Glatt, 1992; Gilley, et al, 1991).

Despite this fact, while it would appear that a severely impaired individual with AD should not be driving, the impact of mild or moderate cognitive changes resulting from early onset AD is yet to be clearly established (Donelly & Karlinsky, 1990). According to Kapust and Weintraub (1992) it has been assumed that the cognitive changes occurring as a result of AD will affect driving, leading to arguments that a diagnosis of dementia should necessitate the loss of a licence. With the exception of memory capacity, there is indication that skills related to driving ability may be preserved in the early stages of the disease, particularly procedural learning such as over learned motor and visual responses (Kapust & Weintraub, 1992). It would also appear that disease duration is not a good predictor of driving ability, with the degree of disability and rate of decline varying between individuals (Drachman and Swearer, 1993; Pachana & Long, 2000).

With the number of affected individuals in New Zealand projected to increase by almost 100% by the year 2016 (compared with a population increase of between 18 and 26%), the true impact of mild to moderate AD on driving ability needs to be determined (Pachana & Long, 2000). However, while research data on the relationship between normal, or primary, aging and the cognitive skills involved in driving is readily available, there appears to be a fundamental lack of comparable information on the impacts of secondary aging, in particular, the effect of AD on driving ability (Kapust & Weintraub, 1992). Compounding this issue is that despite the important role of perception reaction time to driving skill, and the fact that cognitive decline with age has been the subject of considerable research, little is known about the relationship of cognitive status to driving performance (Fitten et al, 1995; Land Transport Safety Authority, 1994). Therefore, in order to assess the impact of age related decrements in perception reaction time (resultant from both primary and secondary aging) on driving performance, a semi-realistic driving experiment was conducted comparing speed and accuracy of road sign recognition between individuals with early onset AD, cognitively unimpaired older drivers, and younger controls

METHOD

PARTICIPANTS

A total of 16 participants were selected to take part in the study. All participants gave informed consent, had a visual acuity of 12/6 (20/40) or better in both eyes (the legal requirement for driving in New Zealand), and possessed current drivers licences. A payment of $10.00 was made to each participant to cover any travel expenses incurred travelling to and from the University. Participants were categorised into three specific groups according to age and cognitive state. These included:

1. Cognitively unimpaired mid-aged drivers aged between 35 and 55 (n=6)
2. Cognitively unimpaired older drivers aged over 65 (n=6)
3. Older drivers with mild Alzheimer's disease (AD) (n=4)

Older drivers diagnosed with mild AD (determined by a Folstein Mini Mental State Examination [MMSE] score between 24 and 27) met the National Institute of Neurological and Communicative Disorders and Stroke – Alzheimer's Disease and Related Disorders Association clinical criteria for probable AD (McKhann et al, 1984). The 2 men and 2 women aged between 69 and 75 ($\bar{x}$=71) were recruited through Services for the Elderly in Palmerston North hospital.

The first 12 cognitively unimpaired older drivers, aged 66 to 74 ($\bar{x}$=69), and mid-aged drivers, aged 35 to 55 ($\bar{x}$=44), that met the aforementioned inclusion criteria, and who had a MMSE score of 28 or over were selected for participation. Each group contained

3 men and 3 women with mid-aged drivers consisting of volunteers recruited from both staff and students from the school of psychology and the community. Cognitively intact older drivers were also volunteers consisting of community members who had prior contact with the School of Psychology (through organisations such as Age Concern).

Apparatus And Procedure

After ethical approval was granted from the Massey University Human Ethics Committee (see Appendix E), participants were given an information sheet (see Appendix F), followed by the administration of a short questionnaire in order to determine each participant's driving history and demographics (see Appendix G). This was followed by a visual acuity test using a Snellen wall chart viewed at a distance of 6 metres – the required measure of acuity as stipulated by the New Zealand Land Transport Safety Authority (LTSA) (Land Transport Safety Authority, 1999d). Overall cognitive functioning was then determined using the Folstein Mini-Mental State Examination (MMSE) – a measure with demonstrated reliability and validity (Folstein, Folstein & McHugh, 1975) (see Appendix H). Participants were then administered the LTSA's common traffic signs driving assessment tool (see Appendix I) to allow comparison of assessment using a written tool as opposed to a simulated driving task. Responses to the driving assessment tool were audio taped to allow measurement of inter-rater reliability (resulting in a 96% accuracy rate).

Finally, participants were asked to take part in a semi-realistic driving task. Using a chin support, they were placed 800 mm in front of a 20 inch television monitor, which displayed a series of randomly selected video clips with the view of driving down a road and passing one of a set of road signs. The participant was instructed to depress a response pad as soon as the sign was recognised, and then verbally identify the sign. The response also identified and recorded the video frame displayed at that point, from which the distance to the sign was calculated. The subject's response immediately cleared the display preventing any further assistance in identifying the sign.

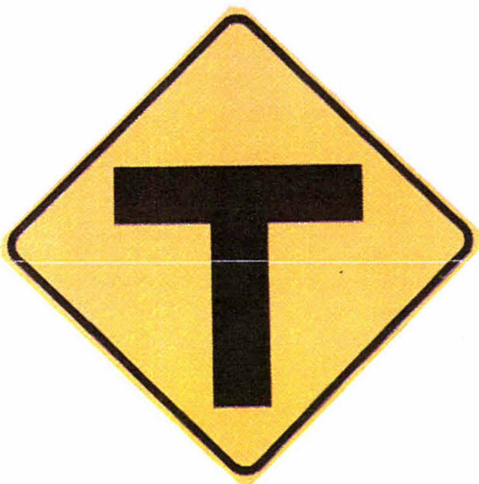
The experimental trials used the same 6 road signs used in the LTSA common traffic signs driving assessment tool (see Figure 9) with three vehicle speeds of 50, 80 and 100 kph. Initial practice trials using 'Giveway' and 'Stop' signs at the same 3 speeds were given to each participant to guide them through the process and to set them at ease. The complete experiment consisted of running 2 blocks of 6 practice trials followed by the experimental section of 3 blocks of 18 trials each. Each block of the experimental section consisted of trials randomly selected from a set of video clips of the 6 road signs at the 3 speeds of 50, 80 and 100 kph. For the purposes of this process, the room was kept at a constant ambiance of 4 lm/m^2 (no monitor showing) to reduce screen glare, compared to 1,000 lm/m^2 at the same eye level (above the chin rest) with full lights. The 5 'Hazard Warning' signs consisted of visual angles 2° 6 minutes in both height and width, while the 'Railway Crossing' sign consisted of visual angles 3^0 36 minutes in width, 2^0 54 minutes in height and 3^0 54 minutes in length. The entire procedure took no longer than one hour to complete.

TECHNICAL INFORMATION

Each video clip displaying the view driving down a road, approaching and passing a road sign was recorded on the same section of country road. The signs were changed as required after each set of speed trials had been successfully recorded. This straight section of road had no white line and few other sources of reference to identify speed. The distance of 436 m displayed in each clip was traveled at a constant speed, which was accurately measured 100 m from the displayed road sign. Three vehicle speeds of 50, 80 and 100 kph were recorded which corresponded to travel times for this section of road of approximately 30, 19 and 15 seconds.

Road travel was recorded in S-VHS on a Panasonic MS 1 video camera securely mounted on the front right fender of a vehicle (see Figure 10). This provided a typical driver perspective to the road traveled without the distractions of a vehicle bonnet or windscreen. Distances were measured with an infrared rangefinder made by Bushnell (Model Yardage Pro 400), which was accurate to 1 m.

The speed measurement apparatus consisted of two pneumatic tubes attached to the road, spaced a separation of 2 m. These in turn activated a signal from a pneumatic sensor which triggered start and stop modes of a crystal controlled reaction timer. The combination of timer accuracy ($\pm$ 0.1 msec) and tube placement ($\pm$ 5 mm) provides a real speed accuracy of better than $\pm$ 0.5 kph. It was found that this real speed measurement revealed inaccuracy in the speedometer of the vehicle of more than 5 kph.



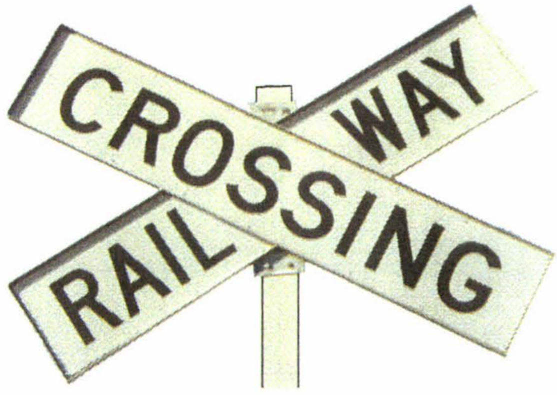
Tee

Right Turn

Pedestrian

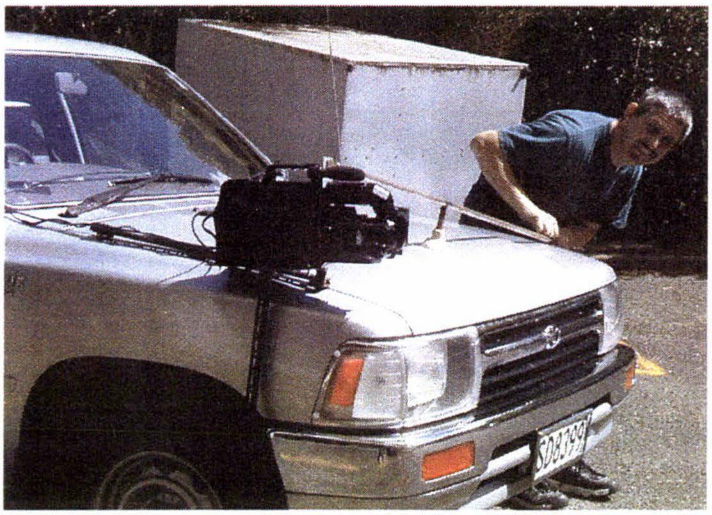
Roundabout

Road Narrows

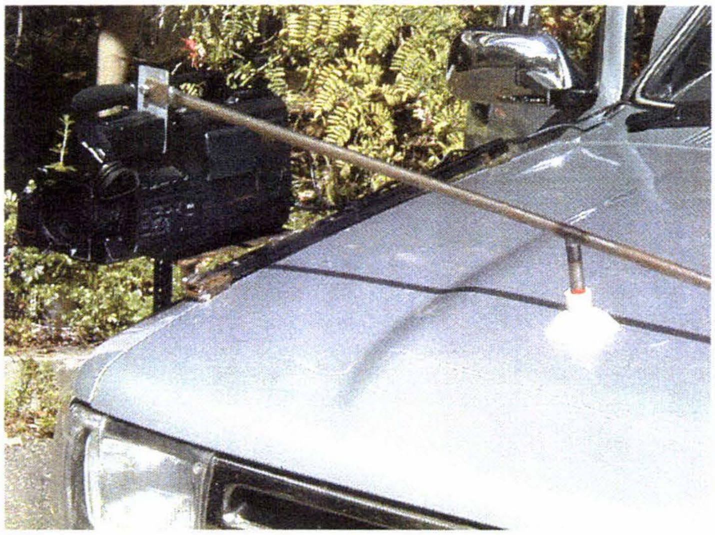


Railway Crossing

Figure 9. The six road signs used in both the LTSA common traffic signs driving assessment tool and the perceptual experiment.



(i)



(ii)

(iii)

Figure 10. Photographs depicting the position of the video camera (i and ii) and the placement of the sign on the side of the road.

Due to limitations in availability of all the signs required from the road transport authority and their variability in appearance, all but the railway sign were printed as required. They were created from digital camera images, which were edited to provide identical colouring and size as the normal road signs. Once backed on to a solid backing board and trimmed as required, they were indistinguishable from a standard sign when traveling the road. Using a 1^0 narrow angle luminance probe, it was found that contrast between the black and yellow of the road signs varied between 19.1 and 21.1 cd/m^2 while contrast between the yellow and black varied between 16.2 and 19.3 cd/m^2.

RESULTS

Participants in the younger control group (n=6) and cognitively intact older control group (n=6) all achieved MMSE scores of 30, and had driving experience ranging from 20 to 39 years ($\bar{x}$=27, SD=7.9) and 46 to 56 years ($\bar{x}$=51, SD=3.98) respectively. In contrast, participants within the AD group (n=4) achieved MMSE scores ranging from 24 to 27 ($\bar{x}$=25, SD=1.29), and had driving experience ranging from 40 to 59 years ($\bar{x}$=52, SD=8.5). All participants rated their general level of health as either good or excellent. As there were no significant differences between men and women on any measure taken during the course of the experiment, gender was not considered as a variable.

Participants were initially administered the LTSA common traffic signs driving assessment tool, the scores for which were calculated by the number of correct responses given to two questions – what the sign meant and what action the driver should take (see Appendix I). The results on this measure ranged from 50 to 67 (out of a possible 72) with mean scores of 58 for the AD group (SD=5.9), 60 for the older control group (SD=5.35) and 63 for the younger controls (SD=2.82). There were no significant differences noted between the scores of either the AD group and younger controls ($t(8)=-1.63$, $p>.05$) or the cognitively intact older control group and the younger controls($t(10)=-.944$, $p>.05$) on this measure.

Participants then completed the perceptual component of the experiment. Scores on this instrument were calculated by measuring reaction time, which was then converted into distance in metres (i.e. a reaction time of 15 sec at 50 kph correlates to a distance of

218 m). These scores were then analysed using the Kruskal Wallis non-parametric test in accordance to the procedure outlined in Pallant (2001). There was a significant difference in stopping distance from the sign for each of the 6 signs across the 3 groups. These 6 signs consisted of the T Intersection ($x^2(2)=9.28$, $p<.01$), Right Turn ($x^2(2)=8.19$, $p<.05$), Pedestrian Crossing ($x^2(2)=9.13$, $p<.01$), Road Narrows ($x^2(2)=7.93$, $p<.05$), Roundabout ($x^2(2)=7.78$, $p<.05$), and Railway Crossing signs ($x^2(2)=10.64$, $p<.01$). These differences in stopping distance from the sign for each of the 3 groups can be seen in Figure 11, which shows there not only is there a relationship between a reaction response and a drivers age and cognitive states, but that the majority of reaction response from the AD group occurred after the vehicle had passed the sign. The only exception to this is the Railway Crossing sign, which was recognised significantly sooner than the Hazard Warning signs across all three groups.

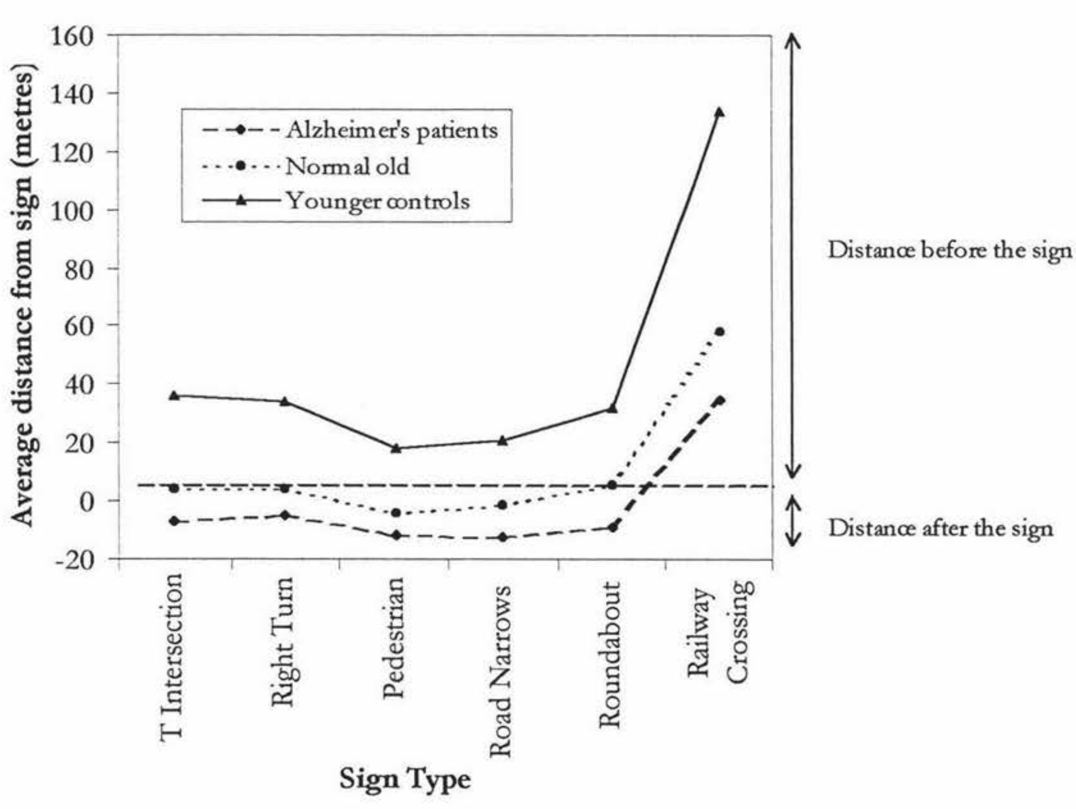


Figure 11. Average distance from the sign for each of the 6 signs across all 3 groups of participants.

In addition to this, significant differences were also noted in stopping distance from the sign for each of the 3 speeds for each of the 3 groups. These 3 speeds consisted of 50kph ($x^2(2)=9.84$, $p<.01$), 80kph ($x^2(2)=9.57$, $p<.01$), and 100kph ($x^2(2)=8.07$, $p<.05$), the differences for which are shown in Figure 12. While the effect shown in the graph may be inflated due to the increased visibility of the Railway Crossing sign (in comparison to the Hazard Warning signs), this figure not only highlights the difference in reaction time associated with age and cognitive state, but it also shows that as vehicle speed increases, there is an analogous increase in the average stopping distance across each of the 3 groups.

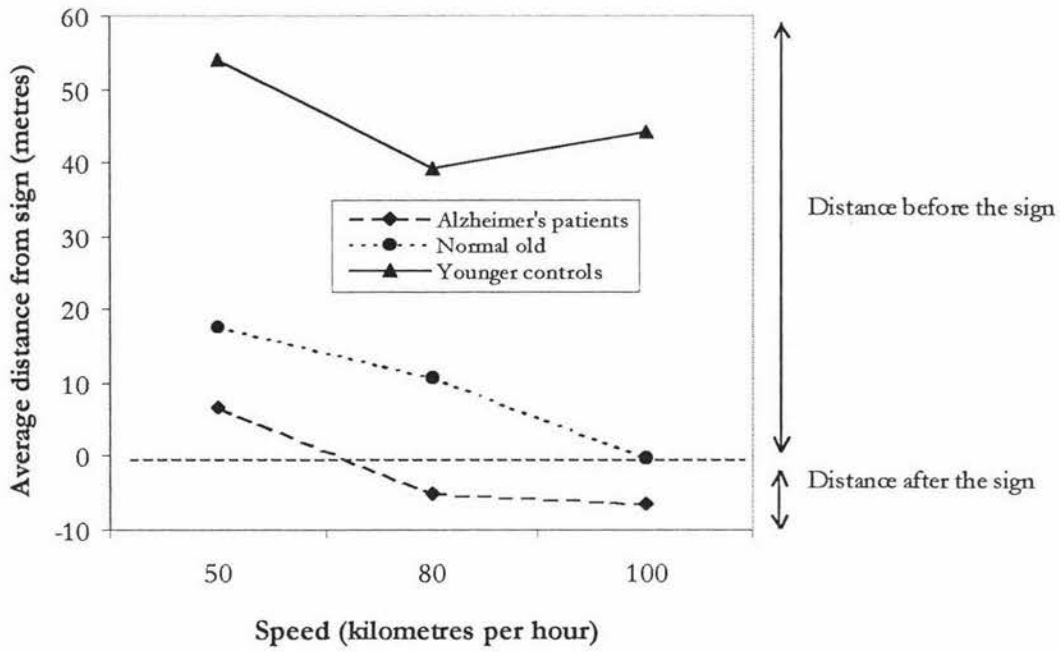


Figure 12. Average distance from the sign for each of the 3 vehicle speeds across all 3 groups of participants

When these results were analysed across all of the 3 variables, significant differences in stopping distance from the sign were noted for each of the 6 signs across each of the 3 speeds by each of the 3 groups. These findings are summarised in Table 6.

The significant relationship of both the sign used and the speed traveled to each of the three groups highlighted by non-parametric testing is verified when the same data is analysed using ANOVA. Despite the small sample size, parametric testing confirmed the finding that there were significant differences between the three groups on the simulated driving task, both in relation to the speed at which the vehicle was moving ($F(2,13)=19.48$, $p<.01$) and the sign that was displayed ($F(2,13)=19.48$, $p<.01$). It must be noted that caution is necessary when evaluating these parametric results due to the small sample size. However, the results of the ANOVA do aid in the confirmation that the significant trends noted through non-parametric testing are a robust finding.

Table 6.
Differences in stopping distance from the sign for each of the 6 signs and 3 speeds.

Sign	Speed (kph)	x^2	df	p
T Intersection	50	9.80	2	.01*
	80	8.92	2	.01*
	100	9.54	2	.01*
Right Turn	50	9.50	2	.01*
	80	7.67	2	.02**
	100	8.07	2	.02**
Pedestrian Crossing	50	8.30	2	.02**
	80	8.78	2	.01*
	100	10.49	2	.00*
Road Narrows	50	7.80	2	.02**
	80	7.43	2	.02**
	100	9.15	2	.01*
Roundabout	50	6.99	2	.03**
	80	8.78	2	.01*
	100	7.78	2	.02**
Railway Crossing	50	10.65	2	.00*
	80	11.78	2	.00*
	100	9.25	2	.01*

*= $p<.01$
**= $p<.05$

Age and cognitive state not only impact on a driver's reaction time, but they also appear to have a deleterious effect on an individual's ability to accurately recognise the sign on display. As shown by Tables 7 and 8, the ability to perceive road sign information decreases both with increasing age and declining cognitive state, and is influenced by both the speed at which the vehicle is traveling, and the specific sign on display. When both speed and sign are taken into account, the overall ability to recognise road sign information dropped from 100% (in younger controls) to 88% (in cognitively unimpaired older drivers) to 74% (in those with AD).

Table 7.
The influence of vehicle speed on the ability to accurately perceive sign information.

Speed	Percentage of Correctly Identified Signs		
	Alzheimer's Patients	Normal Old	Young Controls
50kph	82	91	100
80kph	76	89	100
100kph	64	85	100

Table 8.
The influence of road signs on the ability to accurately perceive sign information.

Sign	Percentage of Correctly Identified Signs		
	Alzheimer's Patients	Normal Old	Young Controls
T Intersection	97	92	100
Bend to the Right	97	93	100
Pedestrian Crossing	22	59	100
Road Narrows	61	88	100
Railway Crossing	100	100	100
Roundabout	67	98	100

The semi-realistic driving task used in this experiment required sensory-motor skills, which involved the correct identification of a road sign as well as a reaction response. This complex visuo-motor task will now be referred to as perception-reaction time in accordance with the previous use of the term described by both Evans (1988) and Lerner (1994).

DISCUSSION

According to the Transportation Research Board (1988), there is a vast amount of literature indicating that older drivers suffer from a number of driving difficulties and risks. With traffic accident statistics for the over 65 population comparable to the 15 to 24 demographic (when adjusted for the number of miles driven), it has been suggested that a major underlying factor may be normal age related physiological changes, in particular, the slowing of perception reaction time (Evans, 1988; Lerner, 1994). When healthy aging is further complicated by a secondary factor, such as Alzheimer's disease, an individual's ability to function as a safe, effective driver is further compromised, with the illness compounding the deficits associated with normal senescent processes. However, despite the recognised importance of perception reaction time to driving ability, and evidence suggesting that our capacity in these skills change with normal aging and in early onset AD, the manner and degree to which these changes affect driving performance remains a question (Fitten et al, 1995; Land Transport Safety Authority, 1994).

It has been suggested that the increased incidence of traffic accidents in older drivers are often a result of failure to respond to the prescriptions of some traffic signs (Lambert & Fleury, 1994). Indeed, to date, a large amount of research has been directed toward the measurement of traffic sign legibility and conspicuity, as well as the accuracy and speed with which people are able to comprehend the information, and it would appear that such studies can yield information regarding driver capabilities and perception (MacDonald & Hoffman, 1991). With the main objective of the current research to identify the potential impact of primary and secondary aging on driving performance, results indicate that both increasing age and the presence of dementia impede the ability to perceive and process relevant traffic sign information.

Primarily, the results demonstrate that both age and cognitive state are associated with a significant decrease in an individual's ability to accurately perceive and react to the information contained within a given road sign, a phenomenon evident across both speed and the type of sign displayed. Results from the study clearly display that the distance needed for cognitively intact older controls to react to a given road sign is increased significantly when compared to younger controls. When these natural decrements were compounded by the presence of early onset AD, reaction time was hindered further, with participants requiring an even greater (significant) increase in the distance traveled before offering a reaction to the road sign. Similar levels of decline were also evident in an individual's ability to accurately perceive traffic sign information. Cognitively intact older drivers tended to perform worse on road sign recognition than younger controls, with accuracy rates displaying a 12% decrease (compared to a 100% accuracy rate in younger controls). In turn, overall perceptual ability is further exacerbated by the presence of early onset AD, in which the ability to perceive road sign information displayed a decrease in accuracy of 26%.

As previously stated, age related slowing is one of the most well established of research findings. When this is applied to the operation of a motor vehicle, the generalised slowing that accompanies advancing age can result in an increase in the time it takes to perceive and interpret a stimulus, and select, plan and initiate a response to it. This process is commonly referred to as driver perception-reaction time, and while the magnitude of age related slowing varies greatly from task to task, it can be said that if older drivers take substantially longer to react in a given situation, there lies the potential for greater risk in the driving environment. With this in mind, the observed decreases in perception-reaction time both with increasing age and cognitive state may provide insight as to the manner in which driving performance will be affected as a consequence.

It has been said that there is a high correlation between traffic sign recognition and performance on a behind the wheel road driving test (Brashear et al, 1998). If we are less able to accurately comprehend traffic sign information, and react in the appropriate manner within the allotted time, we are more likely to commit traffic violations and increase our potential for becoming involved in potentially serious traffic accidents. When the situation is further complicated by the presence of early onset AD, the risk is even more palpable. Of particular note is the fact that the majority of reaction responses for older drivers with AD occurred after the sign (i.e. once the sign had been 'driven' past). Additionally, as the computer was programmed to automatically stop the video clip a specific number of frames after the sign had been passed, the average distances for AD drivers stipulated above are underestimated, as many did not offer a reaction until the clip had ended. Given that traffic signs are designed to impart important information about the driving environment, such serious delays in perceiving and reacting to road signs indicate that driving performance is seriously compromised by the presence of early onset AD.

Moreover, it has been noted that the complexity of a driving situation will influence the delay in perceiving and reacting to a sign (Land Transport Safety Authority, 1994). Of particular importance is the fact that video clips presented in the computer programme were free of any 'noise' that could potentially influence the perception-reaction response.

Depicting a simple driving situation, filming was made under clear, fine conditions on a quiet country road without the presence of other traffic, which eliminated the possibility of driver distraction. In addition, (as depicted in Figure 10), road signs were not obscured, in essence creating a driving situation free from visual clutter. In reality, drivers would have to cope with a large number of additional distractions, such as pedestrians, and compensate for the complexity of an urban driving environment (such as lane changes). Given that an undemanding traffic situation resulted in significant decreases in perception-reaction time, it can only be assumed that under normal driving conditions, these effects would be exaggerated, further compromising driving performance and increasing the potential risk for traffic accidents.

Not only does this study give an indication of a decrease in perception-reaction time with age and cognitive style, the results offer the suggestion that there may be an influence of both the speed at which each video clip was presented, and the road sign used. It appears that the delays in both reaction time and perception for all three groups were exacerbated by the speed at which each video clip was presented, with an increase in speed resulting in an increase in the distance required before reacting to a road sign, and a decrease in the ability to recognise the sign. Perhaps not surprisingly, it would appear that an increase in speed decreases the total available reaction time. With a driver expected to process the same amount of information in a smaller amount of time, a faster vehicle speed compromises driver performance, and results in an increase in the distance covered before a reaction is offered, as well as a decrease in perceptual accuracy (with accuracy rates between 50 and 100kph dropping from 82% to 64% in AD participants, and 91% to 85% in cognitively intact older controls).

When perceptual skills and reaction times were analysed according to the responses given to each individual road sign, additional trends were noted. Reaction times to the Railway Crossing sign were significantly faster than the other 5 diamond shaped signs. Moreover, recognition of this road sign was the only one to achieve a 100% accuracy rate across all three groups. This sign was able to be recognised from as far as 243 m away, indicating that people were responding to the unique size colour and shape of the sign, rather than the words contained within it. However, there were also noticeable trends within the 5 diamond shaped signs (classified as hazard warning signs). In general, people were able to react faster and more accurately to the T Intersection and Right Turn signs. With these 2 signs containing large, simple, and bold images, this finding is in keeping with Kline and Fuchs (1993) study in which it was discovered that increases in contour size and separation (through simplification and enlargement of road sign images) improved the visibility of road signs by approximately 50%.

When coupled with the results from the oral road sign recognition test, these findings have implications for future pathways in the assessment of driving ability in older adults. Surprisingly, it would appear that while road sign recognition testing is a successful discriminate of driving performance in a semi-realistic setting, when the same road signs are presented in paper format requiring a verbal response, the procedure does not appear to be sensitive enough to determine the effects of either age or cognitive state in driving performance. With no significant differences in responses between any of the three groups, results from the oral road sign recognition test indicate that assessments conducted in this manner are not appropriate measures of discriminating between safe and potentially unsafe drivers. Several studies have examined the efficacy of behind-the-wheel driving tests in order to examine driving performance in individuals with early onset AD (Fitten et al, 1995). Results are promising, with indications that driving tests conducted in this manner are useful determinants of an individuals level of driving performance. However, while on-the-road driving tests form the basis of state licencing regulations both in New Zealand and internationally, managing driving in this manner is both time consuming and expensive, and to date, there is no quick and easy test that can be performed in either a clinical or office setting, which can successfully assess an individual's driving capabilities.

It would appear that verbal responses to road sign recognition are unsuccessful in an assessment capacity as many responses (such as slowing down, indicating and applying give way rules) are over learned, and automatic. We do not consciously analyse our actions as we drive, and this fact comes across on verbal testing, with many respondents claiming that they "don't think like this" when they drive and that they "do these things automatically". Additionally, verbal tests are only able to assess theory, and cannot indicate the level of functional skill. So, while behind the wheel driving tests are successful discriminates of driving performance, they are disadvantaged by both monetary and time expenditures. At the other end of the spectrum, verbal testing, while quick and easy to use, is not sensitive enough to discriminate between individual levels of driving performance. It would appear that a median is needed, and semi-realistic driving settings, such as the one used here provide insight to future pathways. Not only are they successful at determining level of functional skill, but the procedure is quick and inexpensive, with the only requirement being a computer with CD Rom drive (which nearly all modern clinics and offices have), and the programme itself.

In summary, the current results indicate that the ability to perceive and react to road signs decreases significantly with age and cognitive state. Given that road signs are designed to impart important information about the driving environment, it would appear that changes in perception-reaction time (resultant of both primary and secondary aging) can become a serious disadvantage for older drivers, increasing the possibility of traffic violation or vehicle accident. Additionally, these results may also shed some light on future pathways for older driver assessment, with semi-realistic driving settings providing inexpensive, quick and accurate assessment of driving ability.

Where To From Here?

The Focus of The Thesis

As stipulated in Chapter 1, the aging of populations is an international concern, and has led to an upsurge of research focusing on issues of the elderly. The continued investigation into the effect of increasing age on driving ability is no exception, and it would appear that over the years, almost all aspects of aging and driving have been investigated. According to O'Neill (1997), the focus thus far has tended to be on the detection of aging decrements (resultant from both primary and secondary aging) and how they can potentially influence driver performance. While this has helped to identify issues of concern, the international concentration of research in this area has also served to highlight the dearth of New Zealand literature in this field.

With motorisation, and more importantly the ability to drive, becoming a progressively important aspect of daily life, it is important to ensure that increasing age does not hinder an individual's mobility or ability to travel freely and safely. With life expectancy continually improving, and baby boomers advancing into their later years, the proportion of elderly in the population will steadily increase. In fact, statisticians predict that almost one quarter of New Zealand's population will be aged over 65 by the year 2031, and as such, people aged over 65 will not only form a steadily increasing proportion of our population, but also our country's road users (Land Transport Safety Authority, 1994; Statistics New Zealand, 1998).

With this point in mind, the focus of this thesis is the overall safety of road users in New Zealand – both maintaining the independence and safety of older drivers by investigating assessment techniques implemented by General Practitioners, and promoting the safety of the public, by investigating both primary (normal mild age related memory loss) and secondary (dementia) age related declines in reaction and perception time. Overviews of the principle findings from all three studies are given below, along with their relationship to models of driving behaviour, and recommendations for areas warranting further investigation.

Older Driver Assessment

An Overview Of The Principle Findings

Within New Zealand, as in most countries internationally, the responsibility for assessing an older person's driving ability is conducted by both health professionals and licensed Government agencies. With the general aging of the world's population, concern has been raised internationally regarding the use of medical doctors in an assessment capacity, and the validity of screening for medical fitness. Not only would it appear that clinical practices vary widely (both between the locality of the practice, and between individuals), but there are also concerns regarding the breech of patient/doctor confidentiality, and the lack of a reliable and valid assessment tool for GP's. The studies outlined in Chapters 3 and 4 not only bring to light the existence of similar issues in New Zealand, but also serve to substantiate the fears surrounding the efficacy of medical assessment in driving assessment.

While the issue of patient doctor confidentiality is not as prevalent in New Zealand as it is in other countries, there does appear to be a general concern over the ethics of referral. However, while international literature tends to place emphasis on the ethical dilemma of breeching confidentiality (through referral of potentially unsafe drivers), within New Zealand, it would appear that the central issue is a fear of "letting patients down" and the subsequent effect referral will have on the doctor/patient relationship. More importantly however, it would appear that three main issues hinder the effective assessment of older drivers by medical professionals. Primarily, there is a lack of effective communication between medical professionals and licensed Government agencies (highlighted by a lack of knowledge regarding the 1999 changes to the licensing system and a general unawareness of the LTSA common traffic signs driving assessment tool). Lastly, It would also appear that older driver assessment is also hindered by inconsistent assessment and referral procedures.

When these results were analysed according to the size of the area in which GP's practiced (in this instance either main or minor urban areas), although not statistically significant, there tended to be discrepancies with regards to method of assessment, use of secondary health professionals and referral procedures. However, while these tendencies are similar to those found in Australia, discrepancies could be attributed more towards the different lifestyles in the two areas, as opposed to conflicting attitudes towards older people.

The Basis of Assessment In Driver Behaviour Models

As outlined in Chapter 2, the increasing popularity of automobile travel at the beginning of the Twentieth Century (and the subsequent increase in the number of road traffic accidents) led to the development of the driving skill model – the notion that driving is a perceptual-motor skill, and any accident an inherent failure of this skill. Despite the skepticism that began to emerge during the 1950's, and subsequent evidence in opposition to the concept, according to Hopewell and Van Zomeren (1990), these early skill models have formed the basis of most international licence examinations, which centre driver assessment on basic psychomotor ability and knowledge of driving regulations. Older driver assessment in New Zealand is no exception to this rule, and it is the role of the medical professional to assess the level of decrement in a set number of psychomotor skills. Any failure on the driver's part to attain the required standard results in licence loss.

The use of skill based models in the assessment of older drivers is of concern, given that the group considered to have optimal psychomotor skills (namely young males) have the highest accident/traffic violation risk – statistics that are comparable to drivers aged over 65, the group considered to have the least optimal skills (when adjusted for the number of kilometres driven) (Evans, 1991; Land Transport Safety Authority, 1996). Compounding this issue is the fact that very few of the diseases and functional measures tested during medical examination of older drivers have been critically linked to motor vehicle accident risk – a necessity if any screening program was to be deemed worthwhile (Wallace & Retchin, 1992). With research results from Chapters 3 and 4 indicating a lack of consensus regarding the appropriate assessment and management of older drivers, it is clear that the current re-licensing system based on driver skill is not functional, and is increasing the potential for both false positives (people who retain their licence when they should be revoked) and false negatives (people whose licences are revoked when they should be renewed).

The failure of the current licencing system is indicative of the need for a paradigm shift, and Michon's three level hierarchy model may perhaps shed some light on future pathways to redefining alternative measures of safe driving. Based on the notion that there is a hierarchical cognitive structure of human behaviour in a traffic environment, Michon (1985) conceptualised driving as a concurrent activity at three levels – strategic (formation of plans), tactical (driver behaviour and traffic decisions) and operational (basic actions of driving), which allows control to be switched between levels as necessary. When it comes to assessing driving ability in older adults, not only do they need to be physically capable of operating a motor vehicle (operational), but they also need to be ale to make quick, correct and accurate decisions while in traffic (tactical). These points, when combined with the older driver's ability to accommodate strategic planning (such as avoiding driving during rush hour) are indicative of a persons general level of functioning, and within this concept lies the opportunity for more accurate assessment.

According to Waller (1992), It is highly likely that accidents in the elderly are a combination of more than one problem, and therefore it is inappropriate to evaluate drivers in the context of specific conditions, as is currently occurring with medical examinations. Instead, the general consensus appears to be a propensity towards the value of assessing the combined physical, mental and social functioning of older drivers – in effect quantifying the net functional impact of disease and the subsequent effects on human performance (Wallace & Retchin, 1992). Widely accepted by geriatricians, the concept of functional assessment has already proven to be a more significant indicator for the need for institutionalisation of older adults than diagnosis (Rubenstein et al, 1984). Research conducted by Yelin, Meenan, Nevitt and Epstein (1980) also reported that disease indicators in rheumatoid arthritis were less predictive of work capacity than functional indicators. Developing new function status measures that critically reflect driving performance are needed to enable the application of the same principle to the assessment of older drivers. In this way, it will perhaps be possible to move away from the antiquated driver skill model, and fashion assessment methods which encompass the strategic, tactical and operational levels of driving behaviour.

Study Limitations And Directions For Future Research

Despite every effort, it is important to note that the results from Chapters 3 and 4 should be approached with a degree of trepidation due to the inherent limitations of the study. In general, there are two sources of error within a mail survey, sampling and non-sampling error (Statistics New Zealand, 1995). Due to both time and cost constraints, both of these issues are present to some degree within these studies, and can potentially have an impact on the significance of the results.

Despite attempts to minimise sampling error through the use of systematic random sampling, and a national subset of General Practitioners (as opposed to a regional subset), the sampling technique was far from ideal, due to the nature of telephone directory listings of New Zealand medical practitioners. As the focus of the study was the approach of General Practitioners to the medical assessment of older drivers, and the directory listings included all aspects of the medical profession (such radiologists, geriatricians, and obstetricians), there was a need for the development of exclusion criteria. In this instance, any listed specialist was omitted, as was any medical centre that failed to list their Practitioners names (since the questionnaire needed to be directed towards a specific individual as opposed to a clinic). Individuals who simply listed a phone number and no address were also excluded from the final list.

As information on the directory listings was limited, when combined with the aforementioned exclusion criteria, the omission of all doctors who were not practicing GP's was not guaranteed, and neither was the possibility that all practicing GP's were included, which introduces a degree of sampling bias, and places constraints on the ability to generalise the findings. Therefore, it may be worthwhile considering alternative sampling techniques for future research, in particular, the benefits of using General Practitioner listings generated from approaching the President of each regional Independent Practice Association – an organisation based around General Practice in New Zealand.

While the numbers of non-sampling errors that may occur are wide, perhaps the most insidious with regards to mail surveys is the percentage of the sample that is willing to respond. Typically, if mail surveys are sent out once, a response rate of 30% can be expected (Schweigert, 1998). In this instance, the response rate from 2 successive mailings of questionnaires to General Practitioners was 21% (initially) and 26% (after the second mailing) – much lower than the expected average. The poor response rate for this mail out only further confounds the ability to generalise results, as lack of response has been known to invalidate the effort put into selecting a representative sample of the population and introduces self-selection biases (Atkisson & Greenfield, 1994; Schweigert, 1998). It is possible that the percentage that responded could be a subset with a specific interest in older driver assessment, and may not represent the general population, even though the original sample did. As the suggested minimum of responses is 50%, and the response rate for this mail out was significantly less, it is difficult to verify that the respondents and non-respondents are similar, threatening the validity of the reported findings.

In addition to this, the validity of the findings in Chapters 3 and 4 may also be limited by the simple fact that mail surveys are self-administered. As a result, questionnaires fundamentally lack the ability to explain a question or provide additional information. Although contact details were offered on the cover letter that accompanied the mail out, there was a degree of partial non-response in that a number of respondents failed to provide all requested information, particularly questions relating to methods of assessment and referral. It is unclear whether this phenomenon was a result of inadequate phrasing or simply an unwillingness to respond to questions related to their methods of practice. Either way, this partial non-response needs to be taken into consideration when analysing results from the two studies.

Given the exploratory nature of the present study, and its inherent limitations, there is a need to refrain from over-interpretation of the results until further research is conducted to substantiate the validity of the reported findings. However, with results indicating confusion and inconsistencies regarding the attitudes awareness and practices of GP's towards older drivers, if we are to effectively maintain an older persons driving ability while balancing the safety of the general public, there are issues that necessitate further investigation. In its current state, the clinical decision can be seen as subjective, primarily due to a lack of valid paper and pencil, or GP administered tests of driving competence, and the general unawareness of assessment standards. It is this lack of precise guidelines that should be the basis for further research.

While much is known about the sensory, cognitive and physical changes associated with age, to date, their relationship with performance behind the wheel has been purely speculative. In order to establish effective, standardised assessment procedures, we need to determine the useful predictors of driving ability in old age by establishing the impact of age related changes (resultant from both primary and secondary aging) to driving performance. According to O'Neill (1992) screening for age related illness and decrement in drivers should be based on research findings, and by examining the predictors of driving ability, it is possible to create effective, objective and standardised assessment methods, with the goal of enabling the older driver and limiting the possibility for false positives and false negatives.

However, improving assessment procedures is only one part of the puzzle. There is also an immediate need to ascertain the general level of knowledge amongst GP's with regard to legal requirements of older driver assessment. It is important that the physicians conducting older driver assessments are aware not only of the policy and regulations, but also the clinical situations where issues of driving should be raised and referred. Once the general level of awareness is ascertained, improved education (as part of the curriculum while in medical school and once established in practice), when coupled with effective assessment procedures should enhance awareness of both when elderly drivers can safely continue to use the road and when underlying medical problems should prompt referral. It is important to note, that the assessment of fitness to drive is not the sole responsibility of the medical practitioner. It is not enough to simply improve one half of the procedure. Education needs to extend to the licensing authorities also, with a particular emphasis on the encouragement of a sensitive response to the older driver.

With particular emphasis on Chapter 4 (differences between main and minor urban areas in older driver assessment), due to time constraints and the fact that both of the investigations into driving assessment were designed to be preliminary inquiries, categorisation of the location size of the medical practice was made into a simple dichotomy. As a result, the discrepancies noted in the study may have been overshadowed by the dichotomized grouping structure, resulting in the insignificant findings. As there are indications of regional tendencies, there is a need for further study between all four recognised population sizes within New Zealand, to determine whether there is potentially a greater discrepancy than indicated by this preliminary study.

AGE, COGNITIVE STATE AND PERCEPTION-REACTION TIME

AN OVERVIEW OF THE PRINCIPLE FINDINGS

In 1998, older drivers in New Zealand accounted for only 10% of all full licence holders in the country. Despite this fact, when accident rates are adjusted to take into account the number of kilometres driven, crash statistics for drivers over age 65 are comparable to the 15 to 24 demographic. Carr, Jackson, Madden and Cohen (1992) have suggested that this occurrence is resultant from healthy senescent processes, as well as being influenced by common medical conditions of old age, especially cardiovascular and neurological conditions

While research indicates that reaction and perception times slow as a result of normal, age related physiological changes, the impact of mild or moderate cognitive changes associated with early onset AD is yet to be clearly established. While it has been widely assumed that these cognitive changes will affect driving, there are indications that a diagnosis of AD does not necessitate licence loss. However, while much is known about age related slowing and the cognitive skills necessary for driving, there is a notable lack of comparable information on the impacts of AD on driving ability. Even more alarmingly, even less is known about the relationship of increasing age and cognitive state to driving performance. The study outlined in Chapter 5 not only helps to assess the impact of primary and secondary age related decrements in perception-reaction time, but also provides insight to future pathways for the assessment of driving ability.

It would appear from the results that the normal aging process is associated with significant decreases in an older drivers perception-reaction time. Not only did healthy older adults need a greater distance to react to a given road sign, but accuracy rates displayed a 12% decrease. When these natural decrements were compounded by the presence of AD, the decreases were exacerbated, with perception-reaction times worsening significantly. There is also indication that perception-reaction time is influenced by both increased vehicle speed the complexity of the road sign. With research suggesting that a correlation exists between traffic sign recognition and performance behind the wheel (Brashear et al, 1998), if drivers are less able to accurately comprehend traffic sign information, and react within the allotted time, then there lies the possibility for more severe consequences on the road.

Despite the significant differences noted between age and cognitive state in a semi-realistic setting, when participants were given a verbal road sign recognition test, no significant differences were noted between any of the three groups. With behind the wheel testing both time consuming and expensive, and given the fact that verbal tests are apparently not sensitive enough to discriminate between safe and potentially unsafe drivers, semi-realistic driving settings, such as the one used for this perceptual experiment, may provide an accurate and inexpensive alternative to the driver assessment procedure.

PERCEPTION-REACTION TIME AND DRIVER BEHAVIOUR MODELS

It would appear that while the relationship between aging, senescence and driving performance has been intensely investigated in recent years, theories of traffic psychology have yet to satisfy the demand for a comprehensive model of driver behaviour (Huguenin, 1988; Ranney, 1994). Despite this fact, of all the proposed models concerning driver behaviour, the one that has made the most significant contribution to the conceptualisation of the driving task is Michon's (1985) three level hierarchy model. Although it has not been rigorously tested through empirical measurement, it has been widely recognised as providing a new impetus to modeling efforts, and as such, forms the basis for discussion of perception-reaction time in older drivers (Ranney, 1994)

Under Michon's (1985) hierarchy model, the act of driving a motor vehicle is conceptualised as a behavioural process containing three levels of cognitive involvement. The primary, and most complex stage is the strategic level, in which planning is an important feature. It is here that choices are made regarding the route, the setting of trip goals and the evaluation of costs and risks. This is followed by the tactical level, at which the predominant concern is driver behaviour and decisions in traffic, and involves the ability to negotiate common driving situations such as driving speed and braking distances. Finally, at it's most basic, is the operational level, which encompasses the perceptual-motor skills needed to successfully control the motor vehicle during both normal and emergency circumstances.

With crash statistics for older drivers comparable to the 15 to 24 demographic (when adjusted for the number of kilometres driven), according to Perryman and Fitten (1996) a large body of research exists which suggests that the healthy aging process is associated with decreases in both tactical and operational driving abilities. It would appear that the results from the study outlined in Chapter 5 validate this claim, with data indicating that both the healthy aging process and the presence of AD may have an effect on some of the operational skills involved in the control of a motor vehicle.

As stated, at the operational level of Michon's (1985) hierarchy model, the integrity of perceptual-motor skills is key. Despite the importance of these skills to an individual's ability to drive at this level, evidence suggests that the aging process is associated with a decline in perceptual-motor performance (Perryman & Fitten, 1996). Within healthy aging, decrements in motor ability are well established, especially reaction time, which is affected to the extent that both initiation and execution of movements are slowed down and performed with less precision (Perryman & Fitten, 1996). Perceptual ability also declines with age, with the speed of information processing showing considerable deficit. When these deficits are compounded by the presence of AD, the integrity of an older driver's perceptual-motor skills are further compromised, placing older drivers at a distinct disadvantage in terms of their operational driving ability.

Results from Chapter 5 corroborate these research findings, and indicate that there are significant decreases in reaction-perception time associated with both age and cognitive state. The healthy aging process compromises an older driver's reaction time and ability to accurately perceive road sign information. These deficits are exacerbated by the presence of AD, which exaggerates the deficits noted with primary aging, further increasing reaction time and decreasing accuracy rates. At the operational level, the degree of associated risk involves the driver's ability to manage the performance of appropriate maneuvers in order to avoid acute danger and threats. With both age and cognitive state associated with deficits in the perceptual-motor skills necessary to perform successfully at the operational level, a driver's ability to perform the maneuvers necessary to avoid danger are compromised – after all, if we cannot read the road sign accurately or react quickly enough to the information contained within it, then the risk of traffic violation increases.

Not only does Chapter 5 give an indication of the degree to which operational skills are compromised with age and cognitive state, but it would seem that studies of operational ability could have implications for the future of research into the effects of AD on driving. The influence of AD on driving performance is a controversial one, and while it would appear that a severely impaired individual should not be driving, the impact of mild to moderate AD is yet to be established (Donelly & Karlinsky, 1990). Despite the increased risk of traffic violation and accident, there are indications that skills related to driving ability may be preserved in the early stages of the disease (Kapust & Weintraub, 1992). As previously stated, an individual's ability to recognise road signs is directly related to performance on a behind the wheel road driving test (Brashear et al, 1998). Given the significant findings from this study, it would appear that measures of operational ability may help to provide an accurate index of the cognitive abilities necessary to safely operate a motor vehicle in modern societies congested traffic conditions (Perryman & Fitten, 1996).

STUDY LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Once again, despite every effort, the study outlined in Chapter 5 needs to be approached with a degree of caution due to the inherent limitations of the study. In order to draw a causal conclusion from experimental results, control must be exerted over any possible confounds, as their presence introduces an element of ambiguity to any findings (Schweigert, 1998). While every attempt was made to maximize internal validity within this study, the potential influence of confounds is of concern, and as a result, there are a number of issues that need to be addressed which may have affected the final outcome.

It would appear that of all possible confounds that could potentially influence the studies findings, sampling issues are of the greatest concern, and in this instance, it would seem that results may have been affected by both sampling technique and sample size. Primarily, it needs to be acknowledged that the sample sizes used in this study were unusually small. With only 6 participants in both the younger and cognitively intact older control groups, it is important to note that a small sample size not only affects the ability to generalise findings to the wider population, but it is also known for decreasing the reliability of measurement, and reducing the influence of a study, making it increasingly difficult to prove any form of statistical significance (Leavitt, 1991). The fact that there were only 4 participants in the AD group (due to the restricted population from which it was possible draw participants) only serves to exacerbate the potential influence of these limitations on the studies results.

Even though small sample size can add a degree of uncertainty to a set of results, the study outlined in Chapter 5 was designed to describe a set of characteristics, as opposed to implementing a change in behaviour, and as such, can tolerate a larger amount of error (Schweigert, 1998). In addition, it was believed that since changes in perception-reaction time were such an inherent part of the aging process (Belsky, 1999), they would be able to be observed from a minimal number of participants. Nevertheless, despite the reasoning behind the small sample, the potential implications it may have on the studies results must be taken into consideration and the findings regarded with a degree of caution.

Small sample sizes not only impact the quality of the results, but may also influence the statistical procedures used to analyse the raw data. The use of analysis of variance (or ANOVA) on such a small sample is of concern given that the correlations used to calculate the statistics are not very stable when based on small sample sizes (Borden & Abbott, 1996). This instability can result in a less accurate estimate of the degree of relationship amongst the variables (Bordens & Abbott, 1996). Even so, while it is acknowledged that because of the sample size used for this study, the results of the ANOVA conducted in Chapter 5 should be approached with a degree of trepidation, it is important to note that the findings were all significant, which is in accordance with the results of the Kruskal Wallis non-parametric test, a method of analysis suggested as a suitable alternative when sample sizes are small (Bordens & Abbott, 1996).

While the potential influence of sample size on the outcome of this study is undeniable, the sampling technique used to recruit participants must also be taken into consideration as a potential source of sampling error. As previously stated, there were a number of limitations on the recruitment of AD participants due to the studies requirements. The individuals not only needed to be in the initial stages of the disease, but as the equipment was not transportable, the experiment needed to be conducted at Massey University, narrowing the area from which participants could be drawn, which in turn, further limited the number of individuals suitable for participation. Although the use of random assignation increases the chance of obtaining equivalent groups, because of these factors, the selection of participants using this technique was not a viable option. Therefore, in order to standardise selection methods across all 3 groups, participants were selected according to a set of prescribed inclusion criteria (such as visual acuity, and the possession of a current drivers licence), and were matched according to gender (resulting in an equal number of males and females in the final subset), a process which not only threatens the study's internal validity, but once again, limits the ability to generalise the findings. In addition, this selection process, in conjunction with the small sample size, does not allow confidence over the removal of extraneous variables that may have impacted on perception-reaction responses, such as the level of driving skill or presence of chronic health problems (even though all participants rated their level of general heath as either good or excellent).

While sampling procedures may have introduced an element of confound to the studies findings, they are not the only potential source of error. The procedure in which the participants were asked to take part may also play a part. The perceptual experiment required the participant to respond to 6 road signs presented at 3 different speeds. This combination of 18 clips was presented three successive times, establishing the potential for practice effects. Although care was taken to distribute the potential effects of this phenomenon by counterbalancing the order of the conditions (through computer generated random presentation of the 18 clips in each of the 3 trials), there appeared to be a tendency for improved reaction and perceptual responses as the trials progressed, with perceptual accuracy tending to increase quite noticeably amongst the AD participants.

In addition to practice effects, there is a possibility that the inherent nature of simulated driving tasks may have had a negative influence on the findings. While a number of studies have demonstrated the effectiveness of simulated driving tasks in addressing driving problems (Harvey et al, 1995; Quigley & DeLisa, 1983), there are difficulties that need to be addressed. Primarily, concerns have been voiced that there is a lack of interaction between the driver's actions and those depicted in the film. According to Glaski, Bruno and Ehle (1992), this lack of interaction results in an absence of the feeling of driving, and indeed, this sense of detachment was raised by a number of participants, who made comments such as "It doesn't feel anything like when I'm driving my car". In effect, this sense of disengagement reduces the face validity of the simulated exercise and raises questions about the predictive validity of the findings outlined in Chapter 5.

Given the potential consequences of these limitations, the findings outlined in Chapter 5, despite their significance, must, once again, be viewed as exploratory until further research is conducted to substantiate the claims made. Despite this, while it is impossible to generalise the observed impact of both age and cognitive state to the wider population, these findings may provide the impetus for future pathways into both the assessment of drivers with dementia and highway design strategy for older drivers.

The studies outlined in Chapters 3 and 4 offered an insight to the current state of driver assessment, highlighting the lack of precise guidelines, and the potential impact this may have on a physician's ability to accurately arrive at a clinical impression of fitness to drive. It was suggested that in order to establish effective, standardised assessment procedures, there is a need to determine useful predictors of driving ability in old age by establishing the impact of both primary and secondary age related changes. When the healthy aging process is complicated by the presence of AD, driver assessment procedures can be seen as imprecise, with research offering contradictory evidence on the true relationship between AD and driving performance, raising such questions as 'how impaired must memory performance be before it interferes with safe driving?'

While it is evident that a severely impaired individual with AD should not be driving, the impact of mild or moderate cognitive changes resulting from early onset AD is yet to be clearly established (Donelly & Karlinsky, 1990), an issue which is compounded by the fact that little is known about the relationship between cognitive state and driving performance (Fitten et al, 1995; Land Transport Safety Authority, 1994). If we are to extrapolate on O'Neill's (1992) suggestion that screening for age related illness and decrement should be based on research findings and the examination of predictors of driving ability (discussed in relation to Chapters 3 and 4), and given the insight Chapter 5 offers into the relationship between cognitive state and perception-reaction time, further investigations into other driving performance measures (such as attention) should be able to provide an index of the mental status abilities necessary to operate a motor vehicle, and how the presence of AD can impact on them. Once these guidelines emerge, they will be able to form the basis for improved assessment procedures by physicians, resulting in a more accurate medical decision.

A continued effort into the establishment of crash risk in older drivers with AD can not only offer insight into the development of screening tools, but it may also aid in the modification of the driving environment in order to improve the safety of older drivers with dementia. With Chapter 5 indicating significant differences in both perception and reaction time between the three groups with respect to road sign recognition, it would appear that there is a need to examine how much longer older drivers require under various conditions to react to traffic sign information, and compare this to the level of protection offered by current design practices. Further study into safer road sign design may lead to the development of improved traffic environments through simple modifications such as increasing the number of signs, extending the distance between the sign and the 'hazard', reducing the number of complex roading situations, or improving sign legibility. The importance of road signs to the driving environment cannot be overlooked, and from the results outlined in the previous chapter, it would appear that they are not purveying the necessary information in an optimal fashion. Exactly what modifications are needed and what changes will prove to be most effective needs to be determined through continued research in the area.

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APPENDICES

APPENDIX A
ETHICAL APPROVAL
(For Study I and II)

Massey University Human Ethics Committee
Room 2.02, Main Building, Turitea
http://www.massey.ac.nz/~muhec

Telephone: 64 6 350 5249
Fax: 64 6 350 5622
Email: S.V.Rumball@massey.ac.nz

Massey University

Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099

9 May 2000

Ms Anita Ciesionik
PG Student
Psychology
TURITEA

Dear Anita

Re: Human Ethics PN Protocol – 00/31
Assessment of older person's driving ability: A general practitioner's view

Thank you for your letter dated 1 May and the amended protocol.

The amendments you have made now meet the requirements of the Massey University Human Ethics Committee and the ethics of your protocol are approved.

Any departure from the approved protocol will require the researcher to return this project to the Massey University Human Ethics Committee for further consideration and approval.

Yours sincerely

Sylvia Rumball

Professor Sylvia V Rumball
Chair
Massey University Human Ethics Committee: Palmerston North

cc Dr Nancy A Pachana
Psychology
TURITEA

APPENDIX B
THE OLDER DRIVER ASSESSMENT QUESTIONNAIRE

(Developed by Ciesionik & Pachana, 2000)

1. How many years (in total) have you been in practice? ______

2. What type of practice do you work in?

   public hospital ☐ **private hospital** ☐ **private practice** ☐

   other ☐ (please describe)

   ____

3. What type of area is your practice (or the majority of your practice) located?

   major urban area (population 30,000+) ☐

   minor urban area (population 1,000 – 30,000) ☐

   rural area (population less than 1,000) ☐

4. Do you have any specialist training in geriatrics or working with older patients more generally? **YES** ☐ **NO** ☐

1. Where did you receive your training in medicine?

   New Zealand ☐ **U.K** ☐ **other** ☐ (where?) ________________

6. What percentage of your patients would you estimate are over the age of 65? ___

7. Do you have any systems in place (within your practice) to aid elderly clients (i.e. a pick up service, home visits)? **YES** ☐ **NO** ☐

8. If you answered yes to Q7, then what type of aid do you provide?

   ____

   ____

9. Do you work primarily alone or with other practitioners? (tick whichever best applies)

   primarily alone ☐ **with other GP's** ☐ **with a multidisciplinary team** ☐

10. Have you ever received a copy of the mini-driving test which was mailed to GP's some time ago? (LTSA Fact Sheet 23: dementia and driving. Sept. 1995 – copy attached) **YES** ☐ **NO** ☐

11. If you haven't received a copy of this test, then have you ever seen it before elsewhere? **YES** □ **NO** □

12. How suitable do you feel this mini-driving test is (or could be) for assessing older persons driving skills?

1----------------2---------------3----------------4---------------5---------------6-------------7

completely unsuitable	very unsuitable	slightly unsuitable	neutral	slightly appropriate	very appropriate	perfect

13. Are there any comments you wish to make regarding this mini driving test?

____

____

____

14. Do you perform any clinical evaluation on older people (over age 65) with regards to their driving skills? **YES** □ **NO** □

15. If you answered yes to Q14, then do you personally use the LTSA mini-driving test? **YES** □ **NO** □

16. If you answered no to Q14, then what (if any) test(s) do you most commonly use?

____

17. What is the most common way in which potential driving problems in older adults are first bought to your attention?

Through the patient □ **Through patients family** □

Through examination □ **Other** □ (please describe)

____

18. If a problem is noted during the course of your examination, or if you have any further questions about this patients driving ability, do you refer the patient on immediately, or is there initial discussion with either the patient or the patients family?

Immediate referral □ **Initial discussion** □

Is the discussion an alternative to referral (making private arrangements) or is it simply an explanation of the problem before referral?

An alternative to referral □ **An explanation of the problem** □

Once referral takes place, to whom do you most commonly refer the patient? (i.e. a psychologist, an occupational therapist etc).

____

____

Under which circumstances do you most commonly refer?

____

____

19. Whom do you consider the best person(s) to evaluate driving skills in older adults?

____

20. How much of an ethical dilemma do you feel exists regarding the reporting of potentially unsafe drivers as a breech of patient/doctor confidentiality

1--------------2--------------3--------------4--------------5--------------6--------------7

1	2	3	4	5	6	7
no dilemma	minute dilemma	small dilemma	moderate dilemma	big dilemma	very big dilemma	serious dilemma

21. How big of a problem do you feel exists with respect to some elderly individuals driving who probably should not be driving, for either a cognitive or medical reason?

1--------------2--------------3--------------4--------------5--------------6--------------7

1	2	3	4	5	6	7
no problem	minute problem	small problem	moderate problem	big problem	very big problem	serious problem

22. How much of an impact do you feel the aging of the general population will have on general driver safety?

1--------------2--------------3--------------4--------------5--------------6--------------7

1	2	3	4	5	6	7
no impact	minute impact	small impact	moderate impact	big impact	very big impact	serious impact

23. How do you think this question of impaired older drivers compares with road safety issues of younger individuals?

1--------------2--------------3--------------4--------------5--------------6--------------7

1	2	3	4	5	6	7
older much bigger	older a lot bigger	older slightly bigger	both the same	younger slightly bigger	younger a lot bigger	younger much bigger

24. Are you aware of the recent changes in licensing laws for older drivers? (LTSA Fact Sheet 57: the older driver test. December 1999). **YES** □ **NO** □

25. If you are aware of the licensing laws, how beneficial do you feel these changes will be for the older driver?

1---------------2--------------3--------------4--------------5--------------6------------7

1	2	3	4	5	6	7
great hinderance	small hinderance	slight hinderance	neutral impact	slightly beneficial	very beneficial	extremely beneficial

26. How effective do you feel these new laws will be in improving road safety?

1---------------2-------------3--------------4--------------5--------------6--------------7

1	2	3	4	5	6	7
no effect	minute effect	small effect	moderate effect	big effect	very big effect	enormous effect

APPENDIX C
THE FACTS ON AGING QUIZZ

Mark the statements 'T' for true, 'F' for false or ? for don't know.

1. _____ The majority of old people (age 65+) are senile, have defective memory, are disoriented or demented.
2. _____ The five senses (sight, hearing, taste, touch and smell) all weaken in old age.
3. _____ The majority of old people have no interest in, nor capacity for, sexual relations
4. _____ Lung vital capacity tends to decline in old age.
5. _____ The majority of old people feel miserable most of the time.
6. _____ Physical strength tends to decline in old age.
7. _____ At least one tenth of the aged are in long-stay institutions (such as nursing homes, mental
   homes, homes for the aged, etc.).
8. _____ Aged drivers have fewer accidents per driver than those under 65.
9. _____ Older workers usually cannot work as effectively as younger workers.
10. _____ Over three fourths of the aged are healthy enough to do their normal activities without help.
11. _____ The majority of old people are unable to adapt to change.
12. _____ Old people usually take longer to learn something new.
13. _____ Depression is more frequent among the elderly than among younger people.
14. _____ Older people tend to react slower than younger people.
15. _____ In general, old people tend to be pretty much alike.
16. _____ The majority of old people say they are seldom bored.
17. _____ The majority of old people are socially isolated.
18. _____ Older workers have fewer accidents than younger workers.
19. _____ Over 20% of the population are now aged 65 or over.
20. _____ The majority of medical practitioners tend to give low priority to the aged.
21. _____ The majority of old people have incomes below the poverty line (as defined by the Government).
22. _____ The majority of old people are working or would like to have some kind of work to do (including housework and volunteer work).
23. _____ Old people tend to become more religious as they age.
24. _____ The majority of old people say they are seldom irritated or angry.
25. _____ The health and economic status of old people has stayed the same or worsened in the last 20 years (compared to that of younger persons).

Appendix D
Information Sheet
(For Study I and II)

Massey University
COLLEGE OF HUMANITIES & SOCIAL SCIENCES

School of Psychology
Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099
Facsimile: 64 6 350 5673

Information Sheet

My name is Anita Ciesionik. As part of my completion of my Masters degree in Psychology I am undertaking a year long research project under the supervision of Dr. Nancy Pachana. I am interested in exploring General Practitioners views towards older drivers, and older people in general, in the hopes that insight can be gained into more accurate licensing assessment methods.

If you choose to participate in this study, you will first be asked to complete a simple questionnaire, taking around 20 minutes to complete, which asks you:

- Questions about your practice
- The process by which you test older drivers
- Your opinion of recent changes to the countries licensing laws
- Your personal view of older driver issues

Secondly, you will be asked to complete the Facts on Aging Quiz, taking around 10 minutes to complete.

You have the right to decline to take part in this study. The act of sending back a completed survey will imply consent has been given. If you do not wish to participate in this study, then simply throw the survey away. You may refuse to answer any question in either the questionnaire or the quiz.

All responses to both sections of this study will be kept strictly confidential to the researcher and her supervisor. There will be no codes or marks to link your name with your response, so anonymity and confidentiality can be assured.

A summary of the results of this study will be made available at the end of the project. The research findings will be presented as a thesis, and submitted for publication in professional journals. No information that could identify any individual will be presented. If you wish to receive a summary of the results, please fill out the enclosed form and if you wish, return it separately from the questionnaire.

Both my supervisor and myself can be contacted by mail at:

School of Psychology
Massey University
Private Bag 11 222
Palmerston North

Thank you for your consideration of participation in my research.

Anita Ciesionik

Appendix E
Ethical Approval
(For Study III)

Massey University Human Ethics Committee
Room 2.02, Main Building, Turitea
http://www.massey.ac.nz/~muhec

Telephone: 64 6 350 5249
Fax: 64 6 350 5622
Email: S.V.Rumball@massey.ac.nz

Massey University

Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099

7 July 2000

Ms Anita Ciesionik
PG Student
Psychology
TURITEA

Dear Anita

Re: Human Ethics PN Protocol – 00/78
Perception and reaction time in older drivers

Thank you for your letter dated 30 June 2000 and the amended protocol.

The amendments you have made now meet the requirements of the Massey University Human Ethics Committee and the ethics of your protocol are approved.

Any departure from the approved protocol will require the researcher to return this project to the Massey University Human Ethics Committee for further consideration and approval.

Yours sincerely

Sylvia Rumball.

Professor Sylvia V Rumball, Chair
Massey University Human Ethics Committee: Palmerston North

cc Dr Nancy Pachana
Psychology
TURITEA

APPENDIX F
INFORMATION SHEET
(For Study III)

Massey University
COLLEGE OF HUMANITIES & SOCIAL SCIENCES

School of Psychology
Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099
Facsimile: 64 6 350 5673

Information Sheet

My name is Anita Ciesionik, and, under the supervision of Dr. Nancy Pachana, I am currently beginning research toward a Masters degree in Psychology. We can be contacted at either the above address, or by telephone on 354 8123.

WHAT IS THE STUDY ABOUT?
I am particularly interested in the issues surrounding the safety and mobility of older drivers. For this piece of research I am investigating whether perception and reaction times change as people age, and the implications any changes within normal aging may have for the safety of older road users. This data will then be compared to older drivers suffering from memory lapses, too see what impact this may have on a persons perception and reaction times.

WHAT WILL I HAVE TO DO?
If you choose to participate in this study, you will first be asked to fill in a demographic questionnaire, which asks simple questions such as age and gender. You will then be asked a few simple attention and perception questions before we give you a road sign recognition test. The entire procedure should take no longer than one hour.

WHAT WILL HAPPEN TO THE INFORMATION?
Your responses to the driving simulation will be recorded and used to answer our research questions. All of the results will be anonymous, and nobody's real name will be used. All contact information (names and addresses) will be completely confidential to the researchers and kept in a safe place. Contact information will *not* be connected with the interview information at any time. We plan to present the findings in professional journals, and every participant who wishes, will receive a summary of the results at the end of the study (which is around March 2001).

AM I ELIGIBLE TO TAKE PART?
If you wish to take part in the study, you should fall into either one of two age groups:
- 35-55 or
- 65 and over

You must also have a current driver's license. Participation in the study is completely voluntary. If you do choose to take part in our study, please know that you have the right to withdraw at any time.

WHAT ARE MY RIGHTS?
If you choose to participate in the study you have the right to:
- Receive information about the results at the conclusion of the study.
- Contact the researchers at any time during the study.
- Decline to take part of withdraw from the study at any time.
- Withdraw any piece of information that you have volunteered.
- Ask any questions about the study at any time during participation

Thank you for your consideration of participation in my research

APPENDIX G
DEMOGRAPHIC SHEET

1. My date of birth is: ____________________
2. I am (tick one): male _____ female _____
3. My ethnic background is (please tick one):

   _____ New Zealand European

   _____ New Zealand Maori

   _____ Pacific Islander

   _____ Asian

   _____ Other (please specify): ____________________
4. How much schooling have you had? (please tick one):

   _____ no school qualification

   _____ school certificate passed in one or more subjects

   _____ sixth form certificate

   _____ university bursary or scholarship

   _____ trade or professional certificate or diploma

   _____ university undergraduate degree or diploma

   _____ postgraduate qualification

   _____ other (please specify): ____________________
5. I would rate my own general health as (please tick one):

   _____ excellent

   _____ good

   _____ fair

   _____ below average

   _____ poor
6. I have been driving for _____ years (please fill in the number in years).
7. Are you still driving now? Yes/No (circle one)

APPENDIX H
MINI MENTAL STATE EXAMINATION

Folstein Mini-Mental State

I. Orientation

Ask "What is today's date?" [Then ask specifically for parts omitted, e.g., "Can you tell me what season it is?"]

Ask "Can you tell me the name of this clinic [hospital]?" "What floor are we on?" "What city [town] are we in?" "What region are we in?" "What country are we in?"

II. Registration

Ask the subject if you may test his memory. Then say, "ball", "flag", and "tree" clearly and slowly, about one second for each. After you have said all 3 ask him to repeat them. This first repetition determines his score [0 - 3] but keep saying them until he can repeat all 3. If after 6 trials, he does not learn all 3, recall cannot be meaningfully tested.

III. Attention and Calculation

Ask the subject to begin with 100 and count backwards by 7. Stop after 5 subtractions [93, 86, 79, 72, 65]. Score the total number of correct answers. If the subject cannot or will not perform this task, ask him to spell the word "world" backwards. The score is the number of letters in correct order. For example: dlrow = 5, dlorw = 3, dolorw = 2. Record how subject spelled "world" backwards.

Item 20 is scored only if items 15 thru 19 are blank.

I. Orientation	Score
1. Date	
2. Year	
3. Month	
4. Day	
5. Season	
6. Place [Clinic or Hospital]	
7. Floor	
8. City [Town]	
9. Region	
10. Country	
II. Registration	
11. "Ball"	
12. "Flag"	
13. "Tree"	
14. # of Trials ________	
III. Attention and Calculation	
15. "93"	
16. "86"	
17. "79"	
18. "72"	
19. "65"	
20. "WORLD" spelled backwards D L R O W [Score 0 - 5]	
___ ___ ___ ___ ___	

Folstein
Mini-Mental State

IV. Recall

Ask the subject to recall the 3 words you previously asked him to remember. Score 0 - 3.

V. Language

Naming: Show the subject a wrist watch and ask him what it is. Repeat for pencil.

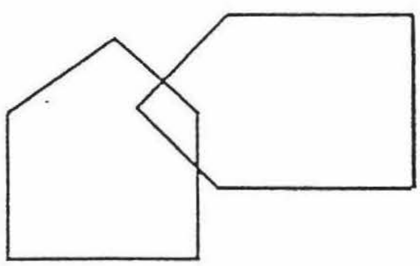
Repetition: Ask the subject to repeat, "No ifs, ands, or buts."

3-Stage Command: Give the subject a piece of blank paper and say "Take the paper in your right hand, fold it in half and put it on the floor."

Reading: On a blank piece of paper, print the sentence, "Close your eyes" in letters large enough for the subject to see clearly. Ask him to read it and do what it says. Score correct only if he actually closes his eyes.

Writing: Give the subject a blank piece of paper and ask him to write a sentence. It is to be written spontaneously. It must contain a subject and verb and be sensible. Correct grammar and punctuation are not necessary.

Copying: On a clean piece of paper, draw intersecting pentagons, each side about 1 inch, and ask subject to copy it exactly as it is. All 10 angles must be present and two must intersect to score 1 point. Tremor and rotation are ignored.



VI. Level of Consciousness

Rate the subject as to his level of consciousness.

IV. Recall	Score
21. "Ball"	
22. "Flag"	
23. "Tree"	
V. Language	
24. Watch	
25. Pencil	
26. Repetition	
27. Takes paper in right hand	
28. Folds paper in half	
29. Puts paper on Floor	
30. Closes eyes	
31. Writes sentence	
32. Draws pentagons	

Total Score

All Items Except No. 14 and No. 20 are each scored 1 if correct and 0 if incorrect.

Item No. 20 is scored 0 - 5.

The Total Score is the Sum of Items 1 Through 32 Excluding No. 14.

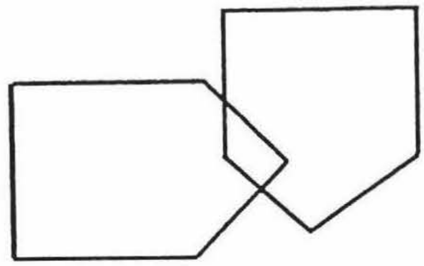
TOTAL SCORE __ __

VI. Subject's level of Consciousness

Check one :

☐ Coma = 1 ☐ Drowsey = 3

☐ Stupor = 2 ☐ Alert = 4



CLOSE YOUR EYES

APPENDIX I
COMMON TRAFFIC SIGNS DRIVING ASSESSMENT TOOL

Uncontrolled T intersection ahead

What does this sign mean?

Answer
Uncontrolled T intersection
(3 points)

Prompt
It has something to do with an intersection
(2 points)

Choice
Is it a Stop sign, a **T intersection sign**, or a Road narrows sign?
(1point)

If choice answered incorrectly, score 0 points

What action should the driver take?

Answer
Slow down
Indicate a left or right turn
Apply the give way rules
(3 points per answer)

Prompt
Is there something you might do with regard speed?
Is there something you might do with regard to indicating?
Is there something you might do with regard to the road code?
(2 points per answer)

Choice
With regard to speed would you **slow down**, speed up, or stop?
With regard to indicating would you **indicate**, not indicate or back-up?
With regard to the road code would you stop, **give way** or proceed ahead?
(1 point per answer)

Score 0 points for each incorrect choice

1. **Uncontrolled T intersection ahead**

Meaning: .... (3)
Action 1: .... (3)
Action 2: .... (3)
Action 3: .... (3)
Total: (12)

Sharp bend ahead to the right.

What does this sign mean?

Answer
Sharp bend ahead to the right
(3 points)

Prompt
It has something to do with a corner
(2 points)

Choice
Is it a Giveway sign, a **sharp bend to the right** sign, or a T intersection sign?
(1 point)

If choice is answered incorrectly, score 0 points

What action should the driver take?

Answer
Slow down
Keep left
Do not cut the corner
(3 points per answer)

Prompt
Is there something you might do with regard speed?
Is there something you might do with regard to position on the road?
Is there something you might do with regard to commonsense safety?
(2 points per answer)

Choice
With regard to speed would you **slow down,** speed up, or stop?
With regard to your position would you **keep left,** keep right, keep to the centre?
With regard to commonsense safety would you cut the corner, **not cut the corner**, or not worry
(1 point per answer)

Score 0 points for each incorrect choice

2. **Sharp bend ahead to the right.**

Meaning: .... (3)
Action 1: .... (3)
Action 2: .... (3)
Action 3: .... (3)
Total: (12)

Pedestrian crossing ahead

What does this sign mean?

Answer
Pedestrian Crossing
(3 points)

Prompt
It has something to do with crossing the street
(2 points)

Choice
Is it a railway crossing sign, a roundabout sign, or a **pedestrian crossing** sign**?**
(1 point)

If choice answered incorrectly, score 0 points

What action should the driver take?

Answer
Slow down
Look for pedestrians crossing the road
Stop if you have to
(3 points per answer)

Prompt
Is there something you might do with regard speed?
Is there something you might do with regard to commonsense safety?
Is there something you might do with regard to the road code?
(2 points per answer)

Choice
With regard to speed would you **slow down**, speed up, or stop?
With regard to commonsense safety would you look for pedestrians on the footpath, **look for pedestrians crossing the road**, look for the cross now sign?
With regard to the road code would you get ready to slow down, **get ready to stop**, get ready to speed up?
(1 point per answer)

Score 0 points for each incorrect choice

Roundabout ahead

What does this sign mean?

Answer
Roundabout ahead
(3 points)

Prompt
It has something to do with an intersection
(2 points)

Choice
Is it a **roundabout sign**, a speed camera sign, or a one way street sign
(1 point)

If choice answered incorrectly, score 0 points

What action should the driver take?

Answer
Choose the correct lane
Slow down
Apply the give way rules
(3 points per answer)

Prompt
Is there something you might do with regard to anticipating your direction?
Is there something you might do with regard speed?
Is there something you might do with regard to the road code?
(2 points per answer)

Choice
With regard to anticipating your direction would you choose your lane **before the roundabout**, after entering the roundabout, or not choose it at all?
With regard to speed would you **slow down**, speed up, **or stop**?
With regard to the road code would you get ready to slow down, **get ready to stop**, get ready to speed up?
(1 point per answer)

Score 0 points for each incorrect choice

2. Pedestrian crossing ahead

Meaning: .... (3)
Action 1: .... (3)
Action 2: .... (3)
Action 3: .... (3)
Total: (12)

3. Roundabout ahead

Meaning: .... (3)
Action 1: .... (3)
Action 2: .... (3)
Action 3: .... (3)
Total: (12)

Road narrows

What does this sign mean?

Answer
Road narrows ahead
(3 points)

Prompt
It has something to do with the size of the road
(2 points)

Choice
Is it a children crossing sign, a road works sign, or a **road narrows sign**?
(1 point)

If choice answered incorrectly, score 0 points

What action should the driver take?

Answer
Slow down
Keep well to the left
Scan the road for oncoming traffic
(3 points per answer)

Prompt
Is there something you might do with regard speed?
Is there something you might do with regard to position on the road?
Is there something you might do with regard to commonsense safety?
(2 points per answer)

Choice
With regard to speed would you **slow down,** speed up, or stop?
With regard to your position on the road would you **keep left**, keep right, keep to the centre?
With regard to commonsense safety would you look for traffic behind you, look for **traffic ahead of you**, look for traffic all around you?
(1 point per answer)

Score 0 points for each incorrect choice

5. Road narrows

Meaning: .... (3)
Action 1: .... (3)
Action 2: .... (3)
Action 3: .... (3)
Total: (12)

Level railway crossing ahead

What does this sign mean?

Answer
Railway crossing
(3 points)

Prompt
It has something to do with trains
(2 points)

Choice
Is it a **railway crossing sign**, a give way sign or a no right turn sign
(1 point)

If choice answered incorrectly, score 0 points

What action should the driver take?

Answer
Slow down
Look for trains
Stop if you have to
(3 points per answer)

Prompt
Is there something you might do with regard speed?
Is there something you might do with regard to commonsense safety?
Is there something you might do with regard to the road code?
(2 points per answer)

Choice
With regard to speed would you **slow down,** speed up, or stop?
With regard to commonsense safety would you **look for trains**, look for trucks, or look for horses?
With regard to the road code would you get ready to slow down, **get ready to stop**, get ready to speed up?
(1 point per answer)

Score 0 points for each incorrect choice

4. Level railway crossing ahead

Meaning: ....(3)
Action 1: ....(3)
Action 2: ....(3)
Action 3: ....(3)
Total: (12)