DEMENTIA AND DRIVING

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Abstract

Drivers with dementia may have a higher accident risk than comparable drivers without dementia, but the results of studies are ambiguous, as are those linking neuropsychological impairments to driving safety. This study sought to identify neuropsychological tests that could identify dementia patients who are not safe to drive, and to develop a brief test procedure for screening their driving safety. Participants were recruited from the Memory Disorders Study Unit at Repatriation General Hospital, Daw Park. Standardised on-road driving assessments were conducted by the Driver Assessment Rehabilitation Service of the University of SA, and awarded a pass or fail grade. Neuropsychological tests were chosen in six areas of functioning. A total of 55 dementia patients participated, of whom 32 passed the driving test, while 23 failed. Drivers who failed performed more poorly than those who passed, in all neuropsychological test domains, but much of this difference was due to greater cognitive decline. After adjustment for cognitive decline (the Mini Mental State Examination), only the Trail Making Test Part A and the Block Design test successfully identified drivers who failed the driving test. Combining these three tests comprises a potential screening procedure for identifying dementia drivers at risk. This procedure identified 83% of fails and 91% of passes, and should be validated in a new sample.

Keywords

dementia, driving, on-road test, neuropsychological assessment, screening

NOTES:
(1) ATSB Research reports are disseminated in the interests of information exchange.
(2) The views expressed are those of the author(s) and do not necessarily represent those of the Commonwealth Government.

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EXECUTIVE SUMMARY

There is much current interest in the contribution of dementing illnesses such as Alzheimer's disease to increased accident risk of drivers. There is an increasing number of drivers with dementia on Australian roads (Lipski, 1997), and information on risk assessment and appropriate screening methods is urgently needed. Currently, the assessment of the individual's cognitive function and behaviour is left to the doctor, and while there is consensus that patients with moderate or severe dementia should not drive, there is little guidance on the levels of risk in early dementia.

Several studies have suggested that drivers with dementia have a higher accident risk than comparable drivers without dementia, but the results of other studies are ambiguous. A different line of inquiry has considered whether neuropsychological impairments typical of dementia can be used to characterise driving safety. However, the research evidence is again mixed, largely due to problems with the methods used.

The current study sought to clarify the relationship between on-road driving performance and neuropsychological test performance in people with dementia. The principal goal of the study was to identify neuropsychological assessments that could be used to identify dementia patients who are not safe to drive, and thereby to develop a brief neuropsychological test procedure for screening the driving safety of patients with dementia.

Participants were recruited from patients with dementia referred to the Memory Disorders Study Unit at Repatriation General Hospital, Daw Park, in Adelaide, South Australia. The study was designed as a cross-sectional, observational study of a group of drivers with dementia. On-road driving assessments were conducted by an occupational therapist from the Driver Assessment Rehabilitation Service of the University of South Australia, and a professional driving instructor, using a standardised route and scoring procedure. A pass or fail grade was awarded following the driving test, and it was recommended that drivers who failed the test should surrender their license to drive. Neuropsychological tests were chosen in six domains of functioning: memory, scanning and attention, constructional ability, language, premorbid function, and global cognitive function.

Over 18 months, a total of 55 patients consented to participate in the study, representing a participation rate of just over 60%. Patients who participated in the study did not differ significantly from those who refused, in terms of their age, sex, or cognitive status. A total of 32 drivers passed the driving test, while 23 failed.

There was a strong pattern of differences between drivers who passed the driving test and those who failed, in all domains of neuropsychological test performance. However, much of this difference was attributable to the fact that drivers who failed the on-road test showed signs of greater cognitive decline associated with the progression of their illness. After statistical adjustment for this difference in cognitive decline, only two tests successfully discriminated drivers who passed the driving test from those who failed.

The Trail Making Test Part A is a test of scanning and attention, and is also sensitive to declines in reaction time. The Block Design test is a measure of constructional ability, which tests directly the ability to perceive the spatial relationships between objects, and also

reflects to some degree the capacity for strategic and planned actions. These skills are of obvious relevance to driving. Our findings suggest that these two tests, in conjunction with the Mini Mental State Examination (a measure of cognitive functioning), can form the basis of a simple screening procedure for identifying dementia patients whose driving safety may be questionable.

These three tests were used to establish criteria that may be applied to estimate the potential safety of a driver with dementia. Failure of two or more of these three criteria yielded the greatest accuracy in correctly identifying patients who failed the on-road driving assessment. This screening procedure accurately identified 83% of those who failed the driving test and 91% of those who passed it.

At the moment there is no clear guidance for clinicians on which dementia patients should be referred for a driving assessment. Use of these three tests as a screening process would take no more than twenty minutes to carry out, and could be used to identify drivers at risk, who might subsequently be referred for an on-road test of driving ability. However, before this screening procedure is implemented, it should be thoroughly tested and validated in a prospective study involving a new group of patients.

1. INTRODUCTION

1.1 Accident risk and older drivers

The risk of involvement in traffic accidents increases for drivers over the age of 65 years, both as drivers (Evans, 1988; Klein, 1991) and as pedestrians (Holubowycz, 1995; Kong, Lekawa, Navarro, McGrath, Cohen, Margulies & Hiatt, 1996). Moreover, injured elderly road users have a higher mortality rate than younger road accident victims (Freedman & Freedman, 1996). In an American study, Fife, Barancik and Chatterjee (1984) found traffic accidents to be the second most common cause of accidental death and emergency hospital admission in the elderly. Possible reasons for the increased accident risk of older drivers include declines in various aspects of physical function, mobility, vision, and cognition (Duchek, Hunt, Ball, Buckles & Morris, 1997). In particular, there is much current interest in the contribution of dementing illnesses such as Alzheimer's disease (AD) to increased accident risk, especially among drivers.

1.2 Dementia

AD accounts for over half of the cases of dementia in the population (Johannson & Lundberg, 1997), and is usually estimated to affect between 5 and 7% of people over 65 years of age (Cummings & Benson, 1991). However, as diagnosis requires confirmation at autopsy (Mirra, Heyman, McKeel, Sumi, Crain, Brownlee, Vogel, Hughes, van Belle & Berg, 1991), it is possible that such estimates may not accurately reflect the true prevalence of the disease. Indeed, one population-based study suggests that this figure may be as high as 11%, rising to nearly 50% in people over 85 years (Evans, Funkenstein & Albert, 1989).

By 2021 it is estimated that 17.3% of the population will be aged 65 years or more, compared with 10.8% in 1996 (Australian Institute of Health and Welfare, 1997). South Australia has the highest proportion of persons over 65 years in any Australian state or territory, and by 2021 is anticipated to have a proportion of 19.1% in this age group. It is clear that the growing number of older people in Australia will lead to corresponding increases in the prevalence of dementia in general and AD in particular.

1.3 The need for studies of driving and dementia

A driver with dementia may present a danger not only to him or herself, but to the community in general. Lipski (1997) estimated that there may be 40,000 drivers with dementia on Australian roads, and information on risk assessment, appropriate screening methods and psychosocial interventions is urgently needed. Moreover, driving in people with dementia is in principle a modifiable behaviour, whether by education of the patient and family, or by legislation. For example, medical practitioners in Australia are currently under no legal obligation to report persons diagnosed with dementia, but there is pressure (Lipski, 1997) to adopt a similar approach to that used in California, where physicians are required to report a diagnosis of dementia to the state motor vehicle authority, which then makes a decision regarding the patient's capacity to drive (Reuben & St George, 1996).

One of the first decisions a doctor must make when faced with a patient with early dementia is whether to allow them to continue to drive. Doctors in Australia are not legally required to report drivers with dementia, and although federal guidelines exclude a person with dementia from driving a commercial vehicle (Federal Office of Road Safety, 1994), there is no mandatory legal restriction on persons with dementia from driving. Currently, the assessment of the individual's cognitive function and behaviour is left to the doctor, and while there is consensus that patients with moderate or severe dementia should not be driving (Johansson & Lundberg, 1997), there is little guidance in the literature on the levels of risk in early dementia. In the Australian context, Lipski (1997) urged the immediate cancellation of driver's license upon diagnosis. However, many doctors resist this pressure, recognising that the evidence linking early dementia and accident risk is tenuous, and that limiting mobility puts an elderly person and often his or her partner at a social disadvantage. O'Neill (1996) has suggested a more positive partnership model, in which the issue of driving is treated as part of a therapeutic program that provides information and allows the patient to discuss fears and alternatives. However, doctors must recognise that advancing dementia may be associated with a denial of deficits.

1.4 Dementia and accident risk

As noted above, the evidence linking dementia with an increased risk of traffic accidents is mixed. In a neuropathological study, Johansson, Bogdanovic, Kalimo, Winblad and Viitanen (1997) reported that 33% of a sample of drivers killed in traffic accidents had neuritic plaque scores indicating certain AD, and a further 20% had scores suggestive of possible AD. However, no data were presented on the proportion of matched controls with AD, nor on the contribution that AD may have made to specific accidents.

Definitive epidemiological data from large population-based studies are not available, but several studies have suggested that drivers with dementia have a substantially higher accident risk than age-matched controls (Adler, Rotunda &Dysken, 1996; Cooper, Tallman, Tuokko & Beattie, 1993; Dubinsky, Williamson, Gray & Glatt, 1992; Friedland, Ross, Kumar, Gaine, Metzler, Haxby & Moore, 1988; Tuokko, Tallman, Beattie, Cooper & Weir, 1995). However, other well conducted studies have demonstrated either no association (Trobe, Waller, Cook-Flannagan, Teshima & Bielauskas, 1996; Waller, Trobe, Olson, Teshima & Cook-Flannagan), or only weak effects (Drachman & Swearer, 1993).

1.5 Neuropsychological studies

A different line of inquiry has considered neuropsychological impairments typical of dementia, such as impairments of selective attention, speed of information processing, judgment, and visuospatial orientation, all of which might be expected to affect driving. However, the evidence is equivocal. Some studies have reported a relationship between driving performance and selective attention in dementia patients (Duchek *et al*., 1997; Parasuraman & Nestor, 1991). Visuospatial orientation was found to be strongly related to on-road driving performance by Fitten, Perryman, Wilkinson, Little, Burns, Pahana, Mervis, Malmgren, Siembieda and Ganzell (1995), but not by O'Neill, Neubauer, Boyle, Gerrard, Surmon and Wilcock (1992). In a recent Australian study, Fox, Bowden, Bashford and Smith (1997) found that driving performance was not predicted by results of a comprehensive neuropsychological test battery, although the sample used was very small. A major review concluded that neuropsychological test methods have thus far not correlated sufficiently or consistently enough with on-road performance or crash data to be valid predictors (Lundberg, Johansson, Ball, Bjerre, Blomqvist, Braekhus, Brouwer, Bylsma, Carr, Englund, Friedland, Hakamies-Blomqvist, Klemetz, O'Neill, Odenheimer, Rizzo, Schelin, Seideman, Tallman, Viitanen, Waller & Winblad, 1997).

1.6 Methodological issues

The failure of consensus to emerge from the research findings is at least partly due to some prevalent methodological flaws. These problems have included the use of samples too small to provide adequate statistical power, no controls or poorly matched controls, unreliable sources of crash data, and failing to account for the generally lower road exposure of elderly drivers with dementia. The choice of appropriate outcome measures is also crucial, but there are advantages and disadvantages associated with each possibility.

Crash data are the most commonly used outcome measure, but the validity of the source of information (such as police, government records, hospitals, insurance companies, patients and families) must be evaluated. The use of crash data usually requires studies to be retrospective (no really large population-based study using accident data has yet been conducted), which imposes limitations on the questions that can be asked. Driving simulators are very appealing because they are safe and can be used in prospective studies. However, most evidence indicates that performance in driving simulators is not strongly related to on-road driving performance (Lundberg *et al*., 1997). Finally, on-road driving performance is in principle the best outcome measure because of its obvious face validity and applicability in prospective studies. However, there are potential problems with safety, the liability of assessors, and the reluctance of patients to participate because of fears of license cancellation. Moreover, while a given driving assessment can be standardised and validated, this may be difficult to achieve across different locations.

With the exception of the work described by Dobbs (1997), studies that have attempted to relate on-road driving performance to neuropsychological test performance have not in general defined passing or failing a driving test as the ultimate criterion of driver safety. This simple dichotomy should in principle render more visible the factors distinguishing safe from unsafe drivers. However, deterioration in the driving ability of patients with dementia is likely to be associated with general cognitive decline. It is therefore important that the statistical analysis used in such studies enables assessment of the contribution of specific neuropsychological tests to driver safety, above and beyond the effects of disease-associated cognitive decline. This issue is of particular relevance given that the Mini Mental State Examination (MMSE; Folstein, Folstein & McHugh, 1975), a simple screening test of cognitive fnctioning which is widely used with older people, has been advocated as a basis for making decisions about the driving competence of patients with dementia (Lundberg *et al*., 1997). Consensus is yet to emerge on this suggestion, but it is important that any neuropsychological test proposed for the assessment of driver safety should demonstrably provide information additional to that offered by the MMSE.

1.7 Aims of the current study

The current study sought to clarify the relationship between on-road driving performance and neuropsychological test performance in people with dementia, while avoiding the methodological problems described above, and using a sample sufficiently large to detect real associations. The anticipated benefits of the study were to improve our understanding of driving performance in patients with early dementia, and to identify neuropsychological assessments that could be used clinically to identify patients with dementia who are not safe to drive. A second aim was therefore to develop a brief neuropsychological test procedure for screening the driving safety of patients with dementia.

2. METHODS

2.1 Participants

Participants were recruited from patients referred for assessment to the Memory Disorders Study Unit (MDSU) at Repatriation General Hospital, Daw Park, in Adelaide, South Australia. These patients are primarily residents of the southern area of Adelaide.

The criteria for inclusion in the study were that the patient had a diagnosis of probable dementia, a current driving license, was still driving, and had at least 10 years driving experience. Participants were excluded if they were no longer driving, had significant depression or other illness, or failed to meet the minimum vision guidelines for fitness to drive (Austroads, 1998). Participants were free to refuse to participate or to withdraw from the study at any time if they so desire, without any prejudice to ongoing assessment or treatment from the MDSU.

Patients newly referred to the MDSU were first assessed by a geriatrician to identify those who met the entry criteria. Any potential participant and his or her carer was initially approached by a research nurse, who provided an Information Sheet and described the study to them. Informed consent was obtained from each patient and carer. Copies of the Information Sheet and Consent Form are shown in Appendix A.

2.2 Design of the study

The study was designed as a cross-sectional, observational study of a cohort of drivers with dementia.

2.3 Assessments

2.3.1 On-road driving assessment

The driving assessments were conducted by an occupational therapist from the Driver Assessment Rehabilitation Service (DARS; School of Occupational Therapy, University of South Australia) and a professional driving instructor. Staff of the DARS have specific expertise in the assessment of the fitness to drive of people with a range of medical conditions, including dementia and stroke.

A standardised route was devised by DARS staff, and detailed scoring criteria were developed. The route and scoring procedure are described in detail in Appendix B. The skills assessed included: seat and mirror adjustment, fastening seat belt, review of controls, ignition, shifting gears, reaction time, signalling, steering and tracking, cornering, speed and speed control, acceleration, braking and deceleration, lane use, observation of traffic signs and road rules.

2.3.2 Neuropsychological test battery

Neuropsychological tests to investigate the association between driving performance and neuropsychological factors were chosen on the grounds of either empirical evidence or conceptual plausibility. The tests fell into six domains, and are described below.

2.3.2.1 Memory

Immediate and delayed memory were assessed using the Wechsler Memory Scale - Third Edition (WMS-III) Logical Memory Scales 1 and 2 (Hunt, Morris, Edwards & Wilson, 1993; Galski, Bruno & Ehle, 1992, 1993; Rothke, 1989; Wechsler, 1997a). The Logical Memory 1 scale indicates a patient's ability to remember information immediately after it is orally presented. Two short stories (A and B) are presented, with Story B presented twice. Immediately after hearing each story the patient is asked to retell it from memory. The Logical Memory 2 scale indicates the patient's ability to remember orally presented material after a 25-35 minute delay. The patient is asked to retell stories A and B from Logical Memory 1 some 25-35 minutes after the initial presentation. The stories are not reread to the patient. Recognition memory is also tested by asking the patient 30 closed questions about stories A and B requiring a yes or no response.

Working memory was assessed using the Letter-Number Sequencing test from the Wechsler Adult Intelligence Scale - Third Edition (WAIS-III; Wechsler, 1997b). This test comprises a series of orally presented sequences of letters and numbers that the patient simultaneously tracks and orally repeats, with the numbers in ascending order and the letters in alphabetical order, to assess working memory and attention.

Verbal learning and memory were assessed using the Rey Auditory-Verbal Learning Test (Rey, 1964). Patients are asked to immediately recall 15 orally presented words over 5 trials, to recall the words without re-presentation following a list of 15 interference words, to recall the words 20 minutes later without re-presentation, and to recognise the words from an array of 50 words containing a number of phonemically or semantically similar words.

2.3.2.2 Scanning and attention

The Trail Making Test (Odenheimer, Beaudet, Jette, Albert, Grande & Minaker, 1994; Hunt *et al*., 1993; Galski *et al*., 1992, 1993; Kapust & Weintraub, 1992; Partington & Leiter, 1949) provides tests of speed of attention, sequencing, mental flexibility, and of visual search and motor function. It requires the connection, by marking pencil lines, between 25 encircled numbers randomly arranged on a page, in proper order (Part A), and of 25 encircled numbers and letters in alternating order (Part B).

The Stroop Neuropsychological Screening Test (Galski *et al*., 1992; Trenerry, Crosson, DeBoe & Weber, 1989) assesses executive functions, in particular the ability to shift perceptual set to conform to changing demands and to suppress an habitual response in favour of an unusual one. It comprises two sets of written stimuli and corresponding tasks: colour, and colour-word. In the colour task, patients are required to read as many as possible of the words (which are names of colours) presented on a sheet of paper in 120 seconds. In the colour-word task, a page of words (again colour names) is presented to the patient, who is asked to name aloud the colour of the ink in which the words are printed, rather than the words themselves. Again, 120 seconds is allowed to respond.

The Digit Span task from the WAIS-III (Galski *et al*., 1992, 1993; Wechsler, 1997a; Wechsler, 1997b) provides a test of working memory and freedom from distractibility. The patient hears a string of digits ranging in length from three to eight, and must repeat the string. In half the trials the string must be repeated in the order as presented, and in the other half in reverse order.

Digit Symbol-Coding task from the WAIS-III (Hunt *et al*., 1993; Galski *et al*., 1992, 1993; Wechsler, 1997b) also assesses freedom from distractibility. The patient copies symbols that are paired with numbers. Using a key, the patient draws each symbol under its corresponding number, with a time limit of 120 seconds. There are two tasks, pairing and free recall. The pairing task provides a measure of the patient's ability to attend to, process, and remember the symbols and pair them with the correct numbers. The free recall task is a measure of the patient's retention of symbols, and incorrect memory is evidenced by inversion, rotation, or other distortion of the symbols.

The Symbol Search task from the WAIS-III (Wechsler, 1997b) consists of a series of paired groups, each pair consisting of a target group and a search group. The patient indicates, by marking the appropriate box, whether either target symbol appears in the search group. The test provides a measure of processing speed.

2.3.2.3 Constructional ability

The Block Design task from the WAIS-III (Hunt *et al*., 1993; Galski *et al*., 1992; Wechsler, 1997b) is a measure of spatial processing and perceptual organisational ability. The patient is asked to replicate a maximum set of 14 modelled or printed two-dimensional geometric patterns using two-colour cubes. Four designs must be completed within 30 seconds, five within 60 seconds, and five within 120 seconds. A design can be failed because of faulty construction, rotation of 30 degrees or more, or exceeding the time limit.

The Rey-Osterrieth Figure copy & recall (Hunt *et al*., 1993; Galski *et al*., 1992; Rey, 1941) tests visuospatial constructional ability and visual memory. The procedure involves having the patient copy the Rey-Osterrieth complex figure before recalling it from memory, without prior warning, some 3 minutes later, and 30 minutes later.

2.3.2.4 Language

In the Controlled Oral Word Association Test (Hunt *et al*., 1993; Kapust & Weintraub, 1992; Borkowski, Benton & Spreen, 1967), phonemic and semantic verbal fluency are measured by a patient's ability to generate words beginning with the specific letters F, A, and S, with 60 seconds allowed for each letter. Proper nouns and inflections of responses already offered are not allowed.

The Boston Naming Test (Hunt *et al*., 1993; Kapust & Weintraub, 1992; Goodglass & Kaplan, 1987) is useful for detecting relatively mild word retrieval or naming problems. Patients are asked to name 60 line drawn objects of graded difficulty from "bed" to "abacus". If the patient is unable to name the object in the picture without a stimulus cue, the patient is provided with the initial sound (phonemic cue).

2.3.2.5 Premorbid intelligence

The National Adult Reading Test II (NART; Nelson, 1991) provides an indication of the patient's level of functioning prior to the development of the dementing illness. The NART comprises a list of 50 irregularly spelled words printed in order of increasing difficulty. The patient reads the words aloud, and the number of pronunciation errors is recorded, to provide an estimate of premorbid intellectual ability .

2.3.2.6 Orientation

The Mini Mental State Examination (MMSE; Fitten *et al*., 1995; Odenheimer *et al*., 1994; Rebok, Keyl, Bylsma, Blaustein & Tune, 1994; Folstein *et al*., 1975) provides a quick and easily administered assessment of basic cognitive functioning, particularly in the elderly. The MMSE is divided into two sections, the first of which covers orientation, memory, and attention. The second section tests ability to name, follow verbal and written commands, write a sentence spontaneously, and copy a complex polygon.

2.4 Procedure

2.4.1 Neuropsychological test performance

The neuropsychological test battery was administered to participants by a qualified and experienced neuropsychologist. All neuropsychological testing took place in a single session lasting 60-75 minutes, and was completed before the on-road driving assessment was conducted. All instruments were administered at the MDSU.

2.4.2 Driving assessment

Driving performance was evaluated using a standardised route and scoring protocol based on the procedure adopted in similar studies (Parasuraman & Nestor, 1991; Dobbs, 1997; Hunt, Murphy, Carr, Duchek, Buckles & Morris, 1997). The on-road assessment was conducted by a professional driving instructor and an occupational therapist from the DARS with postgraduate training in driving assessment and rehabilitation. Therapists from the DARS regularly conduct assessments of this kind, and the standard of service offered is highly regarded by both referrers and the Department of Transport.

In this study, the same occupational therapist was used for all assessments, to eliminate inter-examiner variability. Before the assessment could proceed, participants were required to sign a release of information form giving the therapist permission to notify the Department of Transport of the outcome of the assessment. Prior to the assessment, participants were advised to arrange for another driver to bring them to the assessment, so that they could be driven home if they failed the assessment. Participants in the study were covered by the indemnity provided by the University of South Australia to DARS clients.

Two vehicles were available for the assessment. Both were fitted with power steering, electronically operated windows, dual-controlled brakes and an engine cut-off switch. All on road assessments were conducted at the same time (mid-morning) on week days, to ensure consistency across assessments in traffic conditions. Road assessments were not conducted in adverse weather conditions.

Each assessment commenced at the Driver Development Centre at Oaklands Park, using its existing course off the public roadway. The first 10 minutes was a familiarisation period. During this time the driving instructor provided standardised information about the test vehicle. The ability of the participant to perform basic motor vehicle operational tasks and his/her ability to follow instructions was assessed (Hunt *et al*., 1997). These basic tasks consisted of the correct procedures to follow when starting a car and moving off, and were taken from recommendations of the Department of Transport. The tasks were: adjust seat position, adjust mirrors, fasten seat belt, start engine, apply brake, select appropriate gear, observe around vehicle, indicate, drive 50 metres, turn left, and stop. Participants were asked to perform four further left hand turns to give them more time to familiarise themselves with the vehicle, and to give the assessors extra time to determine if it was safe to proceed on to the public roadway. Performance during this time was scored on a pass/fail basis, and if the participant failed, the assessment did not proceed. A score of fail was assigned if there were major safety concerns about performance, such as inability to follow instructions, or the need for significant assistance from the driving instructor.

The route took approximately 60 minutes, which is the usual practice for DARS driving assessments. The route included both business and residential areas, and sections of the route required the driver to negotiate multi-laned and single laned roads, controlled and uncontrolled intersections, merging roads, straight and winding roads, pedestrian crossings, posted traffic signs and signals, speed humps, and parking bays. These items were sequenced throughout the route so that the drive was less demanding at the start with gradually increasing complexity. In designing the route, emphasis was given to actions that have been implicated in accidents of older drivers, including right turns, entering traffic, giving way, and responding to traffic signals (Dobbs, 1997; Hunt *et al*., 1997).

During the assessment, the instructor gave standard instructions on where to turn, and ensured safe passage of the vehicle. The occupational therapist recorded the driving performance on a standard protocol. The standard route and scoring protocol developed for the study are described in detail in Appendix B.

At the end of the assessment, the driving instructor and occupational therapist considered the driving performance of the patient, and assigned a pass or fail grade. A borderline rating was not used, so that clear feedback could be given to the licensing authorities about driver safety and competence. The criteria for a pass or fail were based on the usual practice of occupational therapists conducting driver assessments - that is, a consensus judgment of both the occupational therapist and the driving instructor regarding the safety implications of any errors performed by the patient, and the level of assistance required from the driving instructor to ensure safety. If the driving instructor was required to provide any physical assistance to ensure safety, or if the patient's driving presented a risk of crashes or traffic conflict, the patient was failed. Behaviours that might present such a risk include: driving too slowly, requesting verbal assistance when performing a manoeuvre, drifting in a lane, driving too quickly for the traffic environment, stopping without reason, changing lanes without looking for other vehicles, or failing to respond to a traffic light, give way or stop sign. However, bad driver habits that are common to the average driver, such as not coming to a complete stop at a stop sign, did not in themselves result in failure.

2.5 Estimated sample size

Prior to the study, experience and anecdotal reports suggested that twice as many drivers would fail the on-road driving assessment as would pass it. It was assumed that, for any neuropsychological test, a difference of 0.5 of a standard deviation between those drivers who passed and those who failed would be clinically meaningful. To achieve a statistically significant difference of this magnitude, with power of 80%, significance level of 5% (one tailed), 76 subjects were required in the fail group and 38 in the pass group, for a required total of 114 participants (Welkowitz, Ewen & Cohen, 1982). As will be clear from the results presented below, the proportion of fails was rather less than expected. However, the findings demonstrate that the distinction between the pass and fail groups was so clear cut that fewer than 114 participants were required to achieve the desired level of power.

3. RESULTS

3.1 Sample characteristics

Recruitment for the study began in April 1999, since when a total of 100 patients who met the inclusion criteria have been approached. Of these, 4 are still considering their decision about whether or not to participate in the study. Of the remaining 96 patients, 23 (24.0%) patients refused to participate. A further 2 (2.1%) patients withdrew their consent after initially agreeing to participate. Twelve patients (12.5%) refused to participate in the study, but voluntarily stopped driving and surrendered their licenses to drive. This represents a total of 37 (38.5%) patients who refused to participate, for a variety of reasons. The remaining 59 patients represent an effective participation rate of 61.5%. Given the very real risk of loss of license presented by participation in the study, this rate is quite acceptable.

Four patients are yet to undergo their on-road driving assessment, and therefore all data presented here are based on the 55 patients for whom complete neuropsychological test results and on-road performance data are available. The characteristics of this group of patients are shown in Table 1 below.

TABLE 1. Sample characteristics (N = 55)

Sex (N,%)		
Male	43	78.2
Female	12	21.8
Age in years (mean, sd)	74.4	6.6
On-road driving test (N,%)		
Passed	32	58.2
Failed	23	41.8
Diagnosis (N,%)		
Alzheimer's disease	41	74.5
Vascular dementia	6	10.9
Lewy body dementia	2	3.6
Frontotemporal dementia	4	7.3
Age-associated memory loss	2	3.6
Mini Mental State Examination		
Mean, sd	23.7	3.8
Range	15-30	

A number of features of the sample are apparent. First, participants were predominantly male, which is unsurprising for drivers in this age group. Second, the most common diagnosis was Alzheimer's disease, accounting for nearly three-quarters of the sample. As Alzheimer's disease accounts for over half of the cases of dementia in the population (Johansson & Lundberg, 1997), this is to be expected. Third, the rate of failure of the on-road driving test was just over 40%, which was rather lower than the two-thirds which was assumed for sample size estimation, and has implications for the required sample size.

As the refusal rate was relatively high, the possibility arises that the obtained sample was not representative of the broader population of drivers with dementia. As the age, sex, and Mini Mental State Examination (MMSE) score are recorded for all patients referred to the MDSU, participants were compared with refusers on these variables. There was a weak trend towards a higher refusal rate among women than men (52.5% and 32.4%, respectively), although this difference was not significant at the .05 level of significance ($?^2_{(1)} = 2.93$, $p = .09$). The age of refusers (mean 75.3, standard deviation 5.6 years) was not significantly different from that of those who consented ($t_{(94)} = 0.73$). The MMSE scores of refusers (mean 22.9, standard deviation 4.4 years) were not significantly different from those of consenting patients ($t_{(94)} = 0.73$). Therefore the obtained sample did not differ from those who refused to participate in terms of age, sex or cognitive function.

3.2 Neuropsychological test performance by driving test result

The principal objective of the study was to contrast the neuropsychological test performance of those drivers who passed the on-road test with those who failed it. Tables 2 to 7 show the means and standard deviations for each neuropsychological test, broken down by the result of the driving test. Results of assessments from each domain of psychological functioning are shown in separate tables. The statistical significance of the difference between the pass and fail groups was in the first instance tested using multivariate analysis of variance to allow for the correlation between test scores from a given domain. The overall multivariate test of significance is cited before each table, which subsequently details the results of the univariate analyses for each neuropsychological test. The table then indicates those tests for which a significant univariate difference existed between drivers who passed the on-road test and those who failed it.

Table 2 shows the results for the neuropsychological assessments of memory. The multivariate analysis of the difference between the pass and fail groups for assessments in this domain had a power of 74%, and the overall multivariate test of significance approached but did not attain statistical significance ($F_{(10,44)} = 1.89$). The univariate test results shown in the table indicate that there were significant differences for Letter-Number Sequencing and for the Immediate Recall measure from the Logical Memory task.

TABLE 2. Memory assessments by result of driving test

	Pass		Fail		
	Mean	**SD**	**Mean**	**SD**	$\mathbf{F_{(1,53)}}$
Logical memory					
Immediate recall	18.6	11.0	12.0	7.8	5.75[a]
Delayed recall	4.9	6.9	3.2	3.8	1.11
Percent retention	28.0	31.4	31.8	31.8	0.19
Recognition	18.0	3.4	17.4	3.1	0.40
Letter number sequencing	5.0	3.8	2.2	1.9	10.44[b]
Rey Auditory Verbal Learning Test					
Learning over trials	8.6	5.3	9.7	6.2	0.66
Percent short-term recall	48.5	29.2	54.0	41.8	0.32
Percent long-term recall	38.7	28.3	36.3	32.8	0.02
Recall	2.9	1.6	2.4	1.3	1.15
Recognition	2.6	2.3	2.0	2.2	0.56

[a]$p < .05$ [b]$p < .01$

Table 3 shows the results for the neuropsychological assessments of scanning and attention. The multivariate analysis of the difference between the pass and fail groups for assessments in this domain had a power of 99%, and the overall multivariate test was highly significant ($F_{(9,45)} = 6.16$, $p < .001$). The univariate test results shown in the table indicate that there were significant differences for all assessments except for forward Digit Span.

TABLE 3. Scanning and attention assessments by result of driving test

	Pass		Fail		
	Mean	**SD**	**Mean**	**SD**	$\mathbf{F_{(1,53)}}$
Trail making					
Part A (seconds)	66.3	26.0	166.5	127.5	17.96[c]
Part B (seconds)	223.6	111.5	407.9	169.2	23.17[c]
A/B ratio (%)	33.3	12.7	44.6	25.8	4.14[a]
Stroop Test					
Colour Task	125.8	34.3	100.9	35.6	6.91[a]
Colour-Word Task	48.9	29.3	22.5	23.7	12.54[c]
Digit Span					
Forwards	9.9	2.1	9.3	2.2	0.83
Backwards	6.0	2.5	4.3	2.2	6.63[a]
Digit Symbol	37.1	14.3	21.3	11.3	19.55[c]
Symbol Search	16.1	7.2	8.7	5.3	16.91[c]

[a]$p < .05$ [b]$p < .01$ [c]$p < .001$

Table 4 shows the results for the three neuropsychological assessments of constructional ability. The multivariate analysis of the difference between the pass and fail groups for assessments in this domain had a power of 99%, and the overall multivariate test was again highly significant ($F_{(3,51)} = 10.68$, $p < .001$). The univariate test results shown in the table indicate that there were significant differences for all assessments.

TABLE 4. Constructional ability assessments by result of driving test

	Pass		Fail		
	Mean	**SD**	**Mean**	**SD**	$F_{(1,53)}$
Block Design	25.1	9.4	11.0	8.5	32.00[c]
Rey-Osterrieth Complex Figure					
Copy	30.5	5.2	22.7	9.5	15.25[c]
Recall	6.7	6.9	3.0	4.3	5.02[a]

[a]$p < .05$ [b]$p < .01$ [c]$p < .001$

Table 5 shows the results for the two neuropsychological assessments of language. The multivariate analysis of the difference between the pass and fail groups for assessments in this domain had a power of 92%, and the overall multivariate test was highly significant ($F_{(2,52)} = 7.54$, $p < .001$). The univariate test results shown in the table indicate that there were significant differences for both assessments.

TABLE 5. Language assessments by result of driving test

	Pass		Fail		
	Mean	**SD**	**Mean**	**SD**	$F_{(1,53)}$
Controlled Oral Word Association	28.1	11.7	17.8	9.5	11.64[c]
Boston Naming Test	47.1	10.3	38.3	11.1	7.82[b]

[a]$p < .05$ [b]$p < .01$ [c]$p < .001$

Table 6 shows the results for the single neuropsychological assessment of premorbid functioning. The analysis of the difference between the pass and fail groups for assessments in this domain had a power of 99% and, as the table shows, was highly significant.

TABLE 6. Premorbid functioning assessment by result of driving test

	Pass		Fail		
	Mean	**SD**	**Mean**	**SD**	$F_{(1,53)}$
National Adult Reading Test (errors)	19.8	10.5	32.5	8.6	22.43[c]

[a]$p < .05$ [b]$p < .01$ [c]$p < .001$

Finally, Table 7 shows the results for the single neuropsychological assessment of global cognitive functioning. The analysis of the difference between the pass and fail groups for assessments in this domain had a power of 99% and, as the table shows, was highly significant.

TABLE 7. Cognitive functioning assessment by result of driving test

	Pass		Fail		
	Mean	**SD**	**Mean**	**SD**	$F_{(1,53)}$
Mini Mental State Examination	25.4	2.8	21.4	3.8	20.32[c]

[a]$p < .05$ [b]$p < .01$ [c]$p < .001$

Tables 2 to 7 demonstrate a clear distinction in all domains of neuropsychological test performance between drivers who passed the on-road test and those who failed it. The sample size estimate of 114 was predicated on an expected difference of 0.5 standard deviations between the groups. However, the results shown in Tables 2 to 7 indicate that the differences were in general substantially greater than this, and in many instances greater than one standard deviation. Moreover, the obtained power was in excess of 90% for all analyses except for the memory measures, and even there it was an acceptable 74%. As the failure rate of the driving test was much lower than the anticipated two-thirds, it appears that the obtained sample size of 55 has sufficient statistical power.

3.3 Adjustment for cognitive functioning

To some extent, the priority of tests associated with failure can be seen from the significance levels in the tables. While there is a strong pattern of differences in all domains of neuropsychological test performance, there is relatively little light and shade. This makes it difficult to distinguish deterioration in the specific skills required for driving from overall disease-related cognitive decline. This issue was explored by replicating the above analyses, while including cognitive functioning (MMSE) as a covariate. The object of this analysis was to determine the extent to which each test was able to predict passing or failing the driving test, once the effects of cognitive decline had been removed. The results are shown in Tables 8 to 12, which also present the means for each test, broken down by the result of the driving test, and adjusted for the effects of cognitive functioning.

Table 8 shows the results for the neuropsychological assessments of memory, adjusted for cognitive functioning. The multivariate test of the relationship of the covariate (MMSE) to the memory measures was significant ($F_{(10,43)} = 2.94$, $p < .01$). The overall multivariate test of the difference between the pass and fail groups significance was not significant ($F_{(10,43)} = 0.79$). The univariate test results shown in the table indicate that neither of the tasks for which there were significant differences (Letter-Number Sequencing and Logical Memory - Immediate Recall) remained significant after adjustment for MMSE.

TABLE 8. Memory assessments by result of driving test, adjusted for cognitive function

	Pass Adjusted mean	Fail Adjusted mean	$F_{(1,52)}$
Logical memory			
Immediate recall	15.1	15.5	0.02
Delayed recall	3.6	4.6	0.33
Percent retention	23.9	35.8	1.37
Recognition	17.5	18.0	0.22
Letter number sequencing	4.3	3.0	1.78
Rey AuditoryVerbal Learning Test			
Learning over trials	8.3	10.1	2.90
Percent short-term recall	53.8	48.6	0.21
Percent long-term recall	33.8	40.1	0.42
Recall	2.7	2.6	0.01
Recognition	2.0	2.5	0.62

[a] $p < .05$

Table 9 shows the results for the neuropsychological assessments of scanning and attention, adjusted for cognitive functioning. The multivariate test of the relationship of the covariate (MMSE) to the scanning and attention measures was weakly significant ($F_{(9,44)} = 1.95$, $p < .10$). The overall multivariate test of the difference between the pass and fail groups was significant ($F_{(9,44)} = 4.46$, $p < .001$). The univariate test results shown in the table indicate that Trail Making Parts A and B, the Stroop Colour-Word task, Digit Symbol, and Symbols Search remained significant after adjustment for MMSE.

TABLE 9. Scanning and attention assessments by result of driving test, adjusted for cognitive function

	Pass Adjusted mean	**Fail Adjusted mean**	**$F_{(1,52)}$**
Trail making			
Part A (seconds)	66.3	166.5	6.78^{b}
Part B (seconds)	223.6	407.9	11.28^{c}
A/B ratio (%)	33.3	44.6	3.28
Stroop Test			
Colour Task	125.8	100.9	2.81
Colour-Word Task	48.9	22.5	5.48^{a}
Digit Span			
Forwards	9.9	9.3	0.17
Backwards	6.0	4.3	0.65
Digit Symbol	37.1	21.3	7.64^{b}
Symbol Search	16.1	8.7	4.73^{a}

$^{a}p < .05$ $^{b}p < .01$ $^{c}p < .001$

Table 10 shows the results for the neuropsychological assessments of constructional ability, adjusted for cognitive functioning. The multivariate test of the relationship of the covariate (MMSE) to the constructional ability measures was significant ($F_{(3,50)} = 3.63$, $p < .05$). The overall multivariate test of the difference between the pass and fail groups was also significant ($F_{(3,50)} = 5.00$, $p < .01$). The univariate test results indicate that both Block Design and Rey Figure - Copy remained significant after adjustment for MMSE.

TABLE 10. Constructional ability assessments by result of driving test, adjusted for cognitive function

	Pass Adjusted mean	Fail Adjusted mean	$F_{(1,52)}$
Block Design	23.4	12.8	14.33[c]
Rey-Osterrieth Complex Figure			
Copy	29.5	23.6	6.45[a]
Recall	5.3	4.4	0.21

[a] $p < .05$ [b] $p < .01$ [c] $p < .001$

Table 11 shows the results for the neuropsychological assessments of language, adjusted for cognitive functioning. The multivariate test of the relationship of the covariate (MMSE) to the language measures was weakly significant ($F_{(2,51)} = 2.45$, $p < .10$). The overall multivariate test of the difference between the pass and fail groups approached but did not attain significance ($F_{(2,51)} = 2.30$). The univariate test results shown in the table indicate that neither language assessment remained significant after adjustment for MMSE.

TABLE 11. Language assessments by result of driving test, adjusted for cognitive function

	Pass Adjusted mean	Fail Adjusted mean	$F_{(1,53)}$
Controlled Oral Word Association	28.1	17.8	2.90
Boston Naming Test	47.1	38.3	3.36

Table 12 shows the results for the single neuropsychological assessments of premorbid functioning, adjusted for cognitive functioning. The multivariate test of the relationship of the covariate (MMSE) to the premorbid functioning measure was significant ($F_{(1,52)} = 6.28$, $p < .05$). As the table shows, the effect of the National Adult Reading Test remained significant after adjustment for MMSE.

TABLE 12. Premorbid functioning assessment by result of driving test, adjusted for cognitive function

	Pass Adjusted mean	Fail Adjusted mean	$F_{(1,53)}$
National Adult Reading Test (errors)	21.8	30.5	8.41[b]

[a]p < .05 [b]p < .01 [c]p < .001

3.4 A predictive model of driving test outcome

The analyses reported in Tables 8 to 12 suggest that plausible candidates for assessments capable of providing information about driving test outcome additional to that offered by MMSE were: Trail Making Part A, Trail Making Part B, Stroop Colour-Word Task, Digit Symbol, Symbol Search, Block Design, Rey-Osterrieth Figure Copy, and National Adult Reading Test. In order to determine the optimal combination of predictors, hierarchical logistic regression was used to assess their joint effects on driving test outcome. As cognitive decline is central to the result of the driving test (on both empirical and theoretical grounds), MMSE was entered into the analysis first; other predictors were then chosen in a forward stepwise procedure. All estimates of association were therefore adjusted for cognitive function. The results of this analysis are presented in Table 13, which shows each significant predictor, its adjusted odds ratio, and 95% confidence interval for the odds ratio.

TABLE 13. Neuropsychological test predictors of failure of driving test

Neuropsychological test	Adjusted odds ratio	95% confidence limits
Mini Mental State Examination	0.70[a]	0.51 - 0.96
Trail Making Part A	1.05[b]	1.01 - 1.08
Block Design	0.90[a]	0.76 - 0.98

[a]$p < .05$ [b]$p < .01$

Three neuropsychological tests emerged as significant predictors of failure of the driving test: Mini Mental State Examination, Trail Making Part A, and Block Design. The model including these three predictors was highly significant ($\chi^2_{(3)} = 45.66$, $p < .001$), and correctly identified 90.3% of passes and 82.6% of fails, with overall accuracy of 87.0%.

3.5 A screening procedure to identify drivers at risk

These results suggested that a combination of these three tests might be used to develop a screening procedure to identify drivers with dementia who were potentially at risk. In the first step in developing such a procedure, the distributions of passes and fails for each of these tests were examined in order to select optimal diagnostic cutoff points. This process led to the following definitions of drivers at risk: MMSE score less than 24, Trail Making Part A longer than 90 seconds, and Block Design score less than 16. The diagnostic accuracy of each of these classifications, using the epidemiological criteria of sensitivity, specificity, positive predictive value, and negative predictive value, is shown in Table 14.

TABLE 14. Diagnostic accuracy of neuropsychological test predictors of result of driving test

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Mini Mental State Examination < 24	73.9%	78.1%	70.8%	80.6%
Trail Making Part A > 90	78.3%	81.3%	75.0%	83.9%
Block Design < 16	78.3%	90.6%	85.7%	85.3%

The appropriate interpretation of these figures is, for the example of the MMSE, that if drivers who scored less than 24 on the MMSE are classified as at risk: 73.9% of drivers who failed the driving test were classified as at risk (sensitivity); 78.1% of drivers who passed the driving test were classified as not at risk (specificity); 70.8% of drivers who were classified as at risk failed the driving test (positive predictive value); and 80.6% of drivers who were classified as not at risk passed the driving test (negative predictive value). Corresponding interpretations apply for Trail Making Part A and Block design.

The predictive accuracy of these three classifications was further tested in a logistic regression model in order to assess their joint effects on driving test outcome. The results are shown in Table 15. The model including these three predictors was highly significant ($?^{2}_{(3)} = 39.75$, $p < .001$), and correctly identified 90.6% of passes and 82.6% of fails, with overall accuracy of 87.3%.

TABLE 15. Neuropsychological test cutoff scores as predictors of failure of driving test

Neuropsychological test	Adjusted odds ratio	95% confidence limits
Mini Mental State Examination < 24	6.20[a]	2.37 - 14.38
Trail Making Part A > 90	10.97[b]	5.83 - 18.22
Block Design < 16	10.86[a]	4.81 - 22.70

[a]$p < .05$ [b]$p < .01$

These three neuropsychological test criteria can be combined to form a simple index of driver risk, by summing the number of criteria failed. The relationship of number of test criteria failed to driving test outcome is shown in Table 16. As the table shows, there were 12 drivers who failed all three criteria, and while all of these drivers failed the driving test, there were a further 11 drivers who failed the driving test who did not fail all three criteria. Therefore, failure of all three criteria appears to be too stringent a classification rule to identify most drivers at risk. However, if drivers who fail two or more of the neuropsychological test criteria are designated as at risk, then 19 of the 23 driving test failures (82.6%) are successfully identified, and only four (17.4%) are missed. Moreover, this procedure accurately classifies 29 of the 32 driving test passes (90.6%). In other words, a classification rule based on failing any two of the three proposed neuropsychological test criteria has sensitivity of 82.6% and specificity of 90.6%. It has associated positive predictive value of 86.4% and negative predictive value of 87.9%.

TABLE 16. Number of neuropsychological test criteria failed by result of driving test

	Number of criteria failed			
Result of driving test	**0**	**1**	**2**	**3**
Pass	19 (95.0%)	10 (76.9%)	3 (30.0%)	0 (0.0%)
Fail	1 (5.0%)	3 (23.1%)	7 (70.0%)	12 (100.0%)
Total	20 (100.0%)	13 (100.0%)	10 (100.0%)	12 (100.0%)

4. DISCUSSION AND CONCLUSIONS

4.1 The sample

The overarching aim of this study was to clarify the relationship between on-road driving performance and neuropsychological test performance in people with dementia. It was hoped that a subgroup of neuropsychological assessments would identify patients with dementia whose driving safety was questionable, and that these results might be used to develop a brief neuropsychological test procedure for screening the driving safety of patients with dementia.

Over a period of approximately 18 months, a sample of 55 patients was recruited. Contrary to our initial expectations, a sample of this size provided sufficient statistical power for a rigorous examination of the postulated differences between those patients who passed the on-road driving assessment and those who failed it. The principal concern about the sample is the relatively high (38%) refusal rate, although it should be noted that nearly one third of refusals voluntarily surrendered their driving licenses, but were not prepared to undergo a driving test. Given that driving license cancellation was a very real possibility for participants in the study, the refusal rate is not surprising. More importantly, there was no evidence that the proportion of refusals biased the sample in terms of age or cognitive functioning; while there was a slight trend towards a higher refusal rate among female patients, the implications of this are unclear.

4.2 Neuropsychological test predictors of driving test outcome

Unlike many studies conducted previously, neuropsychological test performance emerged as a clear and strong predictor of on-road driving performance of patients with early dementia. This is in part attributable to the use of a clear criterion for driver safety based on passing or failing an on-road assessment. Only the study described by Dobbs (1997) has previously done this, and he also reported significant differences in neuropsychological test performance between the two groups of drivers. The singular advantage of the pass/fail criterion is that it has obvious practical relevance, particularly when, as in our study, failure of the driving test leads to license cancellation. In this situation, failure genuinely carries the implication of "not fit to drive". We strongly recommend that future studies of driving and dementia use a clear pass/fail classification.

Other than memory, all domains of neuropsychological functioning discriminated sharply between drivers who passed and those who failed the driving test. In particular, there were widespread differences in the domains of scanning and attention, constructional ability and language. Clear differences were also observed for premorbid functioning. To some extent this latter result calls into question the validity of the NART with dementia patients, as there is no obvious explanation for the apparent finding that drivers who failed the driving test had substantially lower premorbid intelligence than those who passed it. Indeed, there are previous reports that the NART underestimates premorbid ability in dementia patients, with the degree of underestimation rising with dementia severity (Stebbins, Wilson, Gilley, Bernard & Fox, 1988; Schlosser & Ivison, 1989).

Notwithstanding the observed differences in neuropsychological test performance, there was also a substantial discrepancy between the pass and fail groups in their level of cognitive functioning, a result that strongly suggests that the disease of those patients who failed the driving test was at a more advanced stage. On this basis, it was important to re-evaluate the other differences in neuropsychological functioning while taking account of this disparity in cognitive function. After this adjustment, most tests of neuropsychological performance failed to discriminate between the two groups, suggesting that the majority of the differences between the two groups were the product of differential levels of global cognitive decline. However, two tests - the Trail Making Test Part A and the Block Design Test from the WAIS-III - continued to distinguish those patients who failed the driving test from those who passed. This result indicates that these tests provide information relevant to the driving capacity of dementia patients which is additional to that obtained from a simple measure of cognitive decline.

4.3 A screening test for driver safety

The Trail Making Test Part A is a brief and easily administered test of scanning and attention, and is also sensitive to declines in reaction time. The Block Design test is a measure of constructional ability, which tests directly the ability to perceive the spatial relationships between objects, but also reflects to some degree the capacity for strategic and planned actions. These skills are of obvious relevance to a task of the complexity of driving. Our findings suggest that these two tests, in conjunction with the Mini Mental State Examination (as a measure of cognitive functioning), can form the basis of a simple screening procedure for identifying dementia patients whose driving safety may be questionable.

Optimal diagnostic cutoff values were determined for the Trail Making Test Part A, the Block Design test, and the Mini Mental State Examination that maximised their accuracy in identifying patients who failed the driving test. These cutoff values were then used to establish criteria that may be applied to estimate the potential safety of a driver with dementia. In the current sample, failure of two or more of these three criteria yielded the greatest accuracy in correctly identifying patients who failed the on-road driving assessment.

We recommend that the possibilities offered by this procedure be carefully considered. This screening process would take no more than twenty minutes to carry out, and could be used to identify drivers at risk, who might subsequently be referred for an on-road test of driving ability. At the moment there is no clear guidance for clinicians on which dementia patients should be referred for a driving assessment. It should be emphasised that we do not perceive this procedure as anything more than a mechanism for screening drivers; its predictive accuracy is not such that it could reliably be used as the sole basis for license cancellation, particularly until further validation is carried out.

In this context, it is crucial that before this screening procedure is implemented, it should be thoroughly tested and validated in a prospective study involving a new group of patients. Indeed, it is our intention to continue to recruit patients into this study with this express purpose. We hope that future reports will vindicate the process identified in this study, and thereby provide a valuable mechanism for the practical management of the driving safety of patients with early dementia.

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APPENDIX A

INFORMATION SHEETS AND CONSENT FORMS

CONSENT TO RESEARCH STUDIES AND PROCEDURES

Surname	Christian or given names	File No.
Service No.	Sex	Age

I,

____

(First/or Given names) (Surname)

have had explained to me by the investigator *Dr Jane Hecker* (or her representative)

the nature and effects of the Research Study: *The effect of dementia on driving performance*

I have been provided with an Information Sheet about the study which I have read and understood.

I understand that the study involves the following procedures:

A number of assessments of memory and thinking, lasting about 60 minutes.
An assessment of some skills related to driving, lasting about 60 minutes.
An on-road assessment of driving, lasting about 60 minutes.
In the event that I fail the driving assessment, I will complete a brief questionnaire, lasting about 10 minutes.

- I understand that by entering this study I may lose my driving license.
- I have understood and am satisfied with the explanations that I have been given and hereby consent to the participation in the above study.
- I understand that the results of these studies may be published, but my identity will be kept confidential.

- I understand that the procedure may not be of any benefit to myself, and that I may withdraw my consent at any stage without affecting my rights or the responsibilities of the investigator in any respect.
- I understand that representatives from the Hospital Research and Ethics Committee may need to access my medical record for information related to the study for the purpose of audit. I authorise access to my medical record for this purpose.
- I declare that I am over the age of 18 years.

Signature of witness:

Signature: ______________________________

____

Date:

____

Date: __________________________________

Printed Name of Witness:

____

MEMORY DISORDERS STUDIES UNIT
Department of Rehabilitation and Aged Care
Repatriation General Hospital
Daws Road DAW PARK SA 5041
Telephone: (08) 8275 1103, (08) 8275 1033

The effect of dementia on driving performance

INFORMATION SHEET

The Memory Disorders Study Unit at Repatriation General Hospital is conducting a research study to look at how problems with memory and thinking may affect driving skills.

We are inviting people such as yourself, with probable early dementia, to participate in this study. Your participation will help us to understand whether early problems with memory and thinking affect the ability to drive. We will also learn more about how best to assess driving skills, and whether pen and paper tests can predict driving ability. A total of 114 people with early dementia are participating in the study.

If you agree to participate in this study, you will be asked to attend the Memory Disorders Study Unit for a detailed memory testing session conducted under the supervision of a trained neuropsychologist. An additional measure of skills related to driving will be given on the same day. These assessments will last for approximately two hours.

You will also be asked to attend the Driver Development Centre at Oaklands Park to undergo a driving assessment. You should arrange to be driven to the Driver Development Centre for your assessment. Before the test, you will be asked to complete a brief questionnaire about your previous and current driving habits. The driving assessment will be conducted by a trained occupational therapist and a professional driving instructor. The assessment will begin on the driving course at Oaklands Park, and then continue on a standard route on public roads. A dual controlled car, similar to your own, will be provided for this test, which will take about one hour.

To participate in this study, you will be asked to give the occupational therapist permission to notify the Department of Transport of the outcome of the driving assessment. If you should fail the assessment by the occupational therapist and driving instructor, a recommendation that your driving license be cancelled will be sent to the

Department of Transport. You should be aware that the loss of your driving license is a real possibility. However, in this event you will be offered a second assessment at no cost if you first take some driving lessons.

If you should fail the driving assessment, you will be asked to complete a brief questionnaire concerning the effect on your life of losing your driving license. You will be asked to complete this questionnaire one week after the assessment. The questionnaire will take about 10 minutes to complete.

Participating in this study involves no unusual risks to your health. In the unfortunate event of a traffic or other accident during the test, you will be covered by the indemnity provided by the Driver Access Service at the University of South Australia. The main benefit of your participation is that you will learn whether or not your medical condition is interfering with your capacity to drive safely.

Your participation in this study is completely voluntary and you may withdraw your consent at any time. All records containing personal information will remain confidential, and no person will be identified when the results are published. You will not be asked to cover any costs associated with the study, including the cost of the driving assessment.

If you would like further information about this study, please contact the study nurse, or the Memory Unit specialists, Dr Jane Hecker or Dr Elizabeth Hobbin, on 8275 1033. This study has been reviewed by the Research and Ethics Committee at Repatriation General Hospital, Daw Park. If you would like to discuss this study with someone not directly involved, please contact the Executive Officer of the Research and Ethics Committee, Anne Sutcliffe, on 8275 1876.

APPENDIX B

DRIVING ASSESSMENT ROUTE AND SCORING KEY

ON-ROAD ASSESSMENT
(Developed by R.Lister, June, 1998)

Client Name:	Vehicle:
ID Number:	Time:
Date:	Weather:

FAMILIARISATION PERIOD

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
1.*Starting in the car park*	a) Adjust seat position	l=Yes 0=No
at DDC:	b) Adjust mirrors	l=Yes 0=No
Make yourself	c) Fasten seatbelt	l=Yes 0=No
comfortable in the seat	d) Put key in ignition	l=Yes 0=No
and when ready, start the car.	e) Start engine	l=Yes 0=No
2. Drive straight ahead	a) Apply foot brake	l=Yes 0=No
down the road.	b) Select drive	l=Yes 0=No
	c) Observation	l=Yes 0=No
	d) Indicate to move off	l=Yes 0=No
	e) Speed	l=Safe 0=Unsafe
	f) Positioning	l=Safe 0=Unsafe
3. *Halfway down the road*:	a) Speed of approach	1=Safe 0=Unsafe
At the end of the road turn left.	b) Indicator	l=Yes 0=No
	c) Observation	l=Yes 0=No
	d) Positioning	l=Safe 0=Unsafe
4. Follow the road around	a) Speed of approach	
to the left.	b) Positioning	l=Safe 0=Unsafe
5. At the end of the road	a) Speed of approach	1=Safe 0=Unsafe
turn left.	b) Positioning	l=Safe 0=Unsafe
6. At the next intersection	a) Speed of approach	l=Safe 0=Unsafe
turn left.	b) Indicate	l=Yes 0=No
	c) Observation	l=Yes 0=No
	d) Positioning	l=Safe 0=Unsafe
7. Follow the road	a) Speed of approach	1=Safe 0=Unsafe
through to the end and	b) Indicate	l=Yes 0=No
then turn left.	c) Observation	l=Yes 0=No
	d) Positioning	l=Safe 0=Unsafe
8. *Once around the corner*:	a) Speed of approach	l=Safe 0=Unsafe
Follow the road around the	b) Positioning	l=Safe 0=Unsafe
corner to the left and then stop.	c) Stop	l=Yes 0=No
	FOLLOWING INSTRUCTIONS	PASS FAIL
	FAMILIARISATION PERIOD	SCORE /30
		PASS FAIL

ASSESSMENT ROUTE

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
1. *When facing traffic lights at DD exit*:		1=Correct 2=Incorrect
At the traffic lights go straight ahead	a) Response to lights	l=Safe 0=Unsafe
(into Hendrie Street)		
While in Hendrie Street	b) Positioning in lane	l=Safe 0=Unsafe
2. *When get to Tensing Ave. on*	a) Speed of approach	1=Safe 0=Unsafe
the left:	b) Indicator	l=Yes 0=No
At the 2nd road on your left,	c) Observation	1=Yes 0=No
turn left *(into Quirke St.)*	d) Positioning	l=Safe 0=Unsafe
3. At the end of the road turn left	a) Speed of approach	1=Safe 0=Unsafe
(into Everest Ave.)	b) Indicator	l=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
4. At the end of the road turn left	a) Speed of approach	1=Safe 0=Unsafe
(into Hunt St..)	b) Indicator	l=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
5. At the end of the road turn left	a) Speed of approach	1=Safe 0=Unsafe
(into Hendrie St..)	b) Indicator	l=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
6. *When get to Condada St on right*:	a) Speed of approach	1=Safe 0=Unsafe
At the second turn to your right,	b) Indicator	l=Yes 0=No
turn right *(into Wallala St)*	c) Observation	l=Yes 0=No
	d) Gap Selection	l=Safe 0=Unsafe
	e) Positioning	l=Safe 0=Unsafe
While in Wallala St.	f) Mirror Check	l=Yes 0=No
7. *When get to Rotorua St.*:	a) Sp eed of approach	1=Safe 0=Unsafe
At the next intersection turn left	b) Indicator	l=Yes 0=No
(into Bowoka St.)	c) Observation	l=Yes 0=No
	d) Gap Selection	l=Safe 0=Unsafe
	e) Positioning	l=Safe 0=Unsafe
At give way sign at Nunya St.:		
Continue straight ahead	f) Speed of approach	l=Safe 0=Unsafe
	g) Observation	l=Yes 0=No
	h) Gap Selection	l=Safe 0=Unsafe
At give way sign at Tiparra St.:	i) Speed of approach	l=Safe 0=Unsafe
Continue straight ahead	j) Observation	l=Yes 0=No
	k) Gap Selection	l=Safe 0=Unsafe

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
8. At next intersection turn left	a) Speed of approach	1=Safe 0=Unsafe
(into Nilpena St.)	b) Indicator	1=Yes 0=No
	c) Observation (at giveway sign)	1=Yes 0=No
		1=Safe 0=Unsafe
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
At dip on Nilpena St.	f) Speed of approach	1=Safe 0=Unsafe
9. At the roundabout turn right	a) Speed of approach	1=Safe 0=Unsafe
(into Hendrie St.)	b) Indicator	1=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
While on Hendrie St.	f) Positioning (bike lane)	1=Safe 0=Unsafe
	g) Mirror Check)	1=Yes 0=No
10. At the end of the road turn right.	a) Speed of approach	1=Safe 0=Unsafe
	b) Indicator	1=Yes 0=No
(into Bray St)	c) Stop (at Stop sign)	1=Yes 0=No
	d) Observation	1=Yes 0=No
	e) Gap Selection	1=Safe 0=Unsafe
	f) Positioning	1=Safe 0=Unsafe
At pedestrian bay in centre of road, just past Coles St.	g) Observation	1=Yes 0=No
When driving adjacent to bike lane.	h) Positioning	1=Safe 0=Unsafe
11. At the traffic lights, we'll be going straight ahead, but we need to be in left hand lane.	a) Positioning	1=Safe 0=Unsafe
At the traffic lights:	b) Response to lights	1=Correct 2=Incorrect
Merging with other traffic on the other side of the intersection:	c) Observation	1=Yes 0=No
	d) indicator	1=Yes 0=No
	e) Gap Selection	1=Safe 0=Unsafe
Whilst driving toward roundabout:	f) Positioning	1=Safe 0=Unsafe
12. At the roundabout turn left	a) Speed of approach	1=Safe 0=Unsafe
(into Towers Tce.)	b) Indicator	1=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
While on Towers Tce.:	f) Mirror Check	1=Yes 0=No
At the School Zone:	g) Speed at School Zone	1=Correct 2=Incorrect
Driving next to bike lane:	h) Positioning	1=Safe 0=Unsafe
13. *When get to Wright St on right*:	a) Speed of approach	1=Safe 0=Unsafe
	b) Indicator	1=Yes 0=No
At the next road on your right	c) Observation	1=Yes 0=No
turn right *(into Angus Rd).*	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
Whilst on Angus Rd:	f) Gap Selection	1=Safe 0=Unsafe
At the chicane:	g) Positioning	1=Safe 0=Unsafe
At the give way sign:	h) Observation	1=Yes 0=No
Continue straight ahead		
At the railway crossing:	i) Speed of approach	1=Safe 0=Unsafe
Continue through to end of the road.	j) Observation	1=Yes 0=No

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
14 At the end of the road turn left	a) Speed of approach	1=Safe 0=Unsafe
into the left lane.	b) Indicator	l=Yes 0=No
(into South Road)	c) Stop (at stop sign)	l=Yes 0=No
	d) Observation	l=Yes 0=No
	e) Gap Selection	l=Safe 0=Unsafe
	f) Positioning	l=Safe 0=Unsafe
When turn is completed:	g) Mirror Check	l=Yes 0=No
When it is safe, please move one	h) Indicator	l=Yes 0=No
lane to the right.	i) Blind Spot Check	l=Yes 0=No
	j) Gap Selection	l=Safe 0=Unsafe
	k) Positioning	l=Safe 0=Unsafe
15. *When get to Neville Ave on right*:	a) Speed of approach	1=Safe 0=Unsafe
	b) Indicator	1=Yes 0=No
At the next road on the right,	c) Observation	1=Yes 0=No
turn right.	d) Gap Selection	1=Safe 0=Unsafe
(into Avenue rd.)	e) Positioning	1=Safe 0=Unsafe
While on Avenue Rd:	f) Mirror Check	1=Yes 0=No
	g) Positioning	1=Safe 0=Unsafe
16. *When get to Hession Ave. on right*:	a) Speed of approach	1=Safe 0=Unsafe
	b) Indicator	1=Yes 0=No
At the next road on the right,	c) Observation	1=Yes 0=No
turn right. *(into Winona St.)*	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
When around the corner:	f) Selects location to park	1=Correct 2=Incorrect
Please find a place at the side of	g) Positioning	1=Safe 0=Unsafe
the road to park the car .		
17. When you are ready, move off	a) Indicator	1=Yes 0=No
and continue down the road	b) Mirror check	1=Yes 0=No
	c) Blind spot check	1=Yes 0=No
18. At the end of the road, turn left	a) Speed of approach	1=Safe 0=Unsafe
(into Albert St).	b) Indicator	1=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
Whilst on Albert St.:	f) Speed of approach	1=Safe 0=Unsafe
At speed humps:	g) Mirror check	1=Yes 0=No
At the roundabout continue	h) Speed of approach	1=Safe 0=Unsafe
straight ahead	i) Observation	1=Yes 0=No
	j) Gap Selection	1=Safe 0=Unsafe
	k) Positioning	1=Safe 0=Unsafe
When past the roundabout:	l) Mirror Check	1=Yes 0=No
19. At the end of the road, turn left.	a) Speed of approach	1=Safe 0=Unsafe
Move into the right hand lane	b) Indicator	1=Yes 0=No
closest to the middle of the road.	c) Observation	1=Yes 0=No
(into Goodwood Road)	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
At the pedestrian crossing:	f) Response to lights	1=Correct 2=Incorrect
Whilst driving down the road:	g) Positioning	1=Safe 0=Unsafe

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
20. *When get to Richmond Rd. on right*:	a) Response to lights	1=Correct 2=Incorrect
		1=Safe 0=Unsafe
At the first road on your right	b) Speed of approach	1=Yes 0=No
after the traffic lights turn right.	c) Indicator	1=Yes 0=No
(into Marlborough St)	d) Observation	1=Safe 0=Unsafe
	e) Gap Selection	1=Safe 0=Unsafe
Whilst on Marlborough:	f) Positioning	1=Safe 0=Unsafe
At school zone:	g) Speed at school zone	1=Correct 2=Incorrect
When driving down the road:	h) Mirror check	1=Yes 0=No
21. At the end of the road, turn left	a) Speed of approach	1=Yes 0=No
(at the give way sign)	b) Indicator	1=Yes 0=No
(*into Hilda Tce)*	c) Observation (at give way sign)	1=Yes 0=No
		1=Safe 0=Unsafe
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	
At railway crossing	f) Observation	1=Yes 0=No
22. Once over railway crossing:	a) Speed of approach	1=Yes 0=No
At the next road on the right, turn right.	b) Indicator	1=Yes 0=No
(into Hampton Road)	c) Observation	1=Yes 0=No
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
Whilst on Hampton Rd:	f) Speed of approach	1=Safe 0=Unsafe
At dip:		
At stop sign:	g) Stop	1=Yes 0=No
Continue straight ahead	h) Observation	1=Yes 0=No
	i) Gap selection	1=Safe 0=Unsafe
At speed humps:	j) Speed of approach	1=Safe 0=Unsafe
Whilst driving ahead:	k) Mirror Check	1=Yes 0=No
23. At the end of the road, turn left.	a) Speed of approach	1=Yes 0=No
(into Unley Rd)	b) Indicator	1=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
At the traffic lights continue straight ahead.	f) Response to lights	1=Correct 2=lncorrect
Whilst driving down the road:	g) Positioning	1=Safe 0=Unsafe
	h) Sp eed	1=Safe 0=Unsafe
24. *When approaching the pedestrian crossing*:	a) Response to lights	1=Correct 2=Incorrect
At the first road on your right after	b) Speed of approach	1=Safe 0=Unsafe
the pedestrian crossing, turn right.	c) Indicator	1=Yes 0=No
(into Fisher St)	d) Observation	1=Yes 0=No
	e) Gap Selection	1=Safe 0=Unsafe
	f) Positioning	1=Safe 0=Unsafe
Whilst driving down road:	g) Mirror check	1=Yes 0=No
At the roundabout go straight ahead.	h) Speed of approach	1=Safe 0=Unsafe
	i) Observation	1=Yes 0=No
	j) Gap selection	1=Safe 0=Unsafe
	k) Positioning	1=Safe 0=Unsafe
At the traffic lights continue straight ahead.	l) Response to lights	1=Correct 2=lncorrect

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
25. Once over the traffic lights:	a) Speed of approach	1=Yes 0=No
At the next road on your left, turn left.	b) Indicator	1=Yes 0=No
(into Windsor St)	c) Observation	1=Yes 0=No
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
At half chicane:	f) Gap selection	1=Safe 0=Unsafe
	g) Positioning	1=Safe 0=Unsafe
26. At the end of the road turn left.	a) Speed of approach	1=Safe 0=Unsafe
(into Wattle St)	b) Indicator	1=Yes 0=No
	c) Observation	1=Yes 0=No
	d) Gap Selection	1=Safe 0=Unsafe
	e) Positioning	1=Safe 0=Unsafe
At the traffic lights:		
Continue straight ahead.	f) Response to lights	1=Correct 2=lncorrect
At the roundabout continue	g) Speed of approach	1=Safe 0=Unsafe
straight ahead.	h) Observation	1=Yes 0=No
	i) Gap selection	1=Safe 0=Unsafe
	j) Positioning	1=Safe 0=Unsafe
At school zone:	k) Speed at school zone	1=Correct 2=lncorrect
At children's crossing:	l) Observation	1=Yes 0=No
At speed humps:	m) Speed of approach	1=Safe 0=Unsafe
27. At the traffic lights, we need to	a) Speed of approach	1=Yes 0=N o
go straight over into Park Street.	b) Choice of lane	l=Correct 2=lncorrect
You choose which lane to get into.	c) Response to lights	l=Correct 2=lncorrect
	d) Positioning	l=Safe 0=Unsafe
Whilst in Park St.:	e) Speed (below 40km/hr)	l=Safe 0=Unsafe
At speed humps:	f) Speed of approach	l=Safe 0=Unsafe
28. At the traffic lights, turn left.	a) Speed of approach	1=Yes 0=No
(into King William Rd.)	b) Indicator	l=Yes 0=No
	c) Observation	l=Yes 0=No
	d) Gap Selection	l=Safe 0=Unsafe
	e) Positioning	l=Safe 0=Unsafe
While on King William Rd	f) Mirror Check	l=Yes 0=No
	g) Speed	l=Safe 0=Unsafe
29. At the end of the road, turn right.	a) Speed of approach	1=Yes 0=No
	b) Indicator	l=Yes 0=No
(into Northgate St.)	c) Observation	l=Yes 0=No
	d) Gap Selection	l=Safe 0=Unsafe
	e) Positioning	l=Safe 0=Unsafe
30. At the end of the road, turn left.	a) Speed of approach	1=Yes 0=No
(into Victoria Ave.)	b) Indicator	l=Yes 0=No
	c) Observation	l=Yes 0=No
	d) Positioning	l=Safe 0=Unsafe
While on Victoria Ave.	e) Mirror Check	l=Yes O~NO
	f) Positioning	l=Safe 0=Unsafe
	g) Speed	l=Safe 0=Unsafe

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
31 At the traffic lights, turn left *(into Cross Rd)* and just around the corner we need to turn right.	a) Speed of approach	l=Safe 0=Unsafe
	b) Indicator	l=Yes 0=No
	c) Response to lights	l=Correct 2=lncorrect
	d) Choice of lane	l=Correct 2=lncorrect
	e) Positioning	l=Safe 0=Unsafe
When turning right into Hilda Tce.:	f) Indicator	l=Yes 0=No
	g) Response to lights	l=Correct 2=lncorrect
	h) PosItioning	l=Safe 0=Unsafe
When on Hilda Tce.:	i) Positioning	l=Safe 0=Unsafe
Go straight ahead at the railway crossing.	j) Observation (at crossing)	l=Yes 0=No
32. *When over the railway crossing*: Follow this road through to the very end.	a) Speed of approach	l=Safe 0=Unsafe
	b) Observation	l=Yes 0=No
	c) Gap Selection	l=Safe 0=Unsafe
At roundabout:	d) Positioning	l=Safe 0=Unsafe
Whilst driving toward next roundabout:	e) Mirror Check	l=Yes 0=No
At roundabout:	f) Speed of approach	l=Safe 0=Unsafe
	g) Observation	l=Yes 0=No
	h) Gap Selection	l=Safe 0=Unsafe
	i) PosItioning	l=Safe 0=Unsafe
Whilst driving ahead:	j) Mirror Check	l=Yes 0=No
	k) Positioning	l=Safe 0=Unsafe
	l) Speed	l=Safe 0=Unsafe
33. *When approaching Springbank Rd*.:	a) Speed of approach	l=Safe 0=Unsafe
	b) Ind icator	1=Yes 0=No
At the end of the road turn right	c) Observation	l=Yes 0=No
(into Spingbank Rd)	d) Gap Selection	l=Safe 0=Unsafe
	e) Positioning	l=Safe 0=Unsafe
Whilst on Springbank Rd:	f) Positioning	l=Safe 0=Unsafe
	g) Mirror check	l=Yes 0=No
	h) Speed	l=Safe 0=Unsafe
34. At the traffic lights we need to turn left, and then just around the corner we need to turn right. You choose the best lane to get into.	a) Speed of approach	l=Safe 0=Unsafe
	b) Choice of lane	l=Correct 2=lncorrect
	c) Indicator	l=Yes 0=No
	d)Response to lights	l=Correct 2=lncorrect
	e) Positioning	l=Safe 0=Unsafe
When turning right into Daws Rd.:	f) Indicator	l=Yes 0=No
	g) Response to lights	l=Correct 2=lncorrect
	h) PosItioning	l=Safe 0=Unsafe
Whilst on Daws Road: *At school zone:*	i) Speed at School zone	l=Correct 2=lncorrect
	j) Mirror Check	l=Yes 0=No
When approaching traffic lights: Continue straight ahead.	k) Response to lights	l=Correct 2=lncorrect

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
35. *When driving past the traffic lights*:	a) Mirror check	l=Yes 0=No
	b) Indicator	l=Yes 0=No
When it is safe, can you move one	c) Blind Spot Check	l=Yes 0=No
lane to the right/left please.	d) Gap Selection	l=Safe 0=Unsafe
	e) Positioning	l=Safe 0=Unsafe
At the traffic lights, continue	f)Response to lights	l=Correct 2=lncorrect
straight ahead.		
Whilst driving toward the	g) Mirror Check	l=Yes 0=No
pedestrian crossing:	h) Positioning	l=Safe 0=Unsafe
	i) Speed	l=Safe 0=Unsafe
At pedestrian crossing:	j) Response to lights	l=Correct 2=lncorrect::
	k) Observation	l=Yes 0=No
36. At the traffic lights turn left.	a) Speed of approach	l=Safe 0=Unsafe
(into Marion Road)	b) Indicator	l=Yes 0=No
	c) Observation	l=Yes 0=No
	d) Gap Selection	l=Safe 0=Unsafe
	e) Positioning	l=Safe 0=Unsafe
When in Marion Road:	f) Mirror check	l=Yes 0=No
Can you move into the lane	g)lndicator	l=Yes 0=No
closest to the median strip when	h) Blind Spot Check	l=Yes 0=No
it is safe, please.	i) Positioning	l=Safe 0=Unsafe
	j) Gap Selection	l=Safe 0=Unsafe
When you can see a safe place to	k) Response to traffic lights	l=Correct 2=lncorrect
do a U-turn, please do a U-turn.		
	l)Selects location for U-turn	l=Correct 2=lncorrect
	m) Gap Selection	l=Safe 0=Unsafe
	n) Positioning	l=Safe 0=Unsafe
After U-turn:		
straight ahead down the road.	o) Response to lights	l=Correct 2=lncorrect
37. *Once past Everley Road*:	a) Speed of approach	l=Safe 0=Unsafe
At the next road on your left, turn left.	b) Indicator	l=Yes 0=No
(into Chambers Road)	c) Observation	l=Yes 0=No
	d) Positioning	l=Safe 0=Unsafe
Go into the carpark and when	e) Observation	l=Yes 0=No
you can see a safe place to park,	f) Selects parking bay	l=Correct 2=lncorrect
park the car please.	g) Indicator	l=Yes 0=No
	h) Positioning	l=Safe 0=Unsafe
Once parked:	i) Mirror Check	l=Yes 0=No
Please reverse out of here and go	j) Observation	l=Yes 0=No
over to the exit (*on Oaklands Rd.*)	k) Selects reverse gear	l=Yes 0=No
	l) Indicator	l=Yes 0=No
	rn) Positioning	l=Safe 0=Unsafe
	n) Direction	l=Correct 2=lncorrect
38. Turn left into Oaklands Road,	a) Speed of approach	l=Safe 0=Unsafe
and continue straight ahead to	b) Indicator	l=Yes 0=No
the traffic lights.	c) Observation	l=Yes 0=No
	d) Gap Selection	l=Safe 0=Unsafe
	e) Posltioning	l=Safe 0=Unsafe
Whilst on Oaklands Road:	f) Mirror Check	l=Yes 0=No
	g) Positioning	l=Safe 0=Unsafe

INSTRUCTIONS AND LOCATION	OBSERVATIONS	SCORE
39. At the traffic lights, turn left.	a) Speed of approach	l=Safe 0=Unsafe
(into DDC)	b) Indicator	l=Yes 0=No
	c) Observation	l=Yes 0=No
	d) Positioning	l=Safe 0=Unsafe
Once on DDC grounds:		
At the next road on your right,	e) Speed of approach	l=Safe 0=Unsafe
turn right.	f) Indicator	l=Yes 0=No
	g) Observation	l=Yes 0=No
	h) Gap Selection	l=Safe 0=Unsafe
	i) Positioning	l=Safe 0=Unsafe
Find a safe place to park and		
park the car, please.	k) Selects parking bay	1=Correct 0=Incorrect
	l) Indicator	l=Yes 0=No
	m) Positioning	l=Safe 0=Unsafe
40. Secure the car, please.	a) selects park gear	l=Yes 0=No
	b) Applies handbrake	l=Yes 0=No
	c) Turns engine off	1=Yes 0=No

SCORING KEY

A. POINTS SCORED ON A YES/NO BASIS

Indicator, Adjust seat, Adjust mirror, Key in, Start engine, Apply brake, Select Drive, Select Park, Select Reverse, Engine off, Apply hand brake

Score Yes

- if the action is observed and completed by the participant independently.

Score No

- if the action is not observed.
- if the participant required assistance to complete the action.

Observation

Score Yes

- if participant turns their head or shifts gaze to look for vehicles etc.

Score No

- if they do not turn their head or shift their gaze.

Stop

Score Yes

- if participant brings the car to a complete stop

Score No

- if participant does not bring the car to a complete stop.

Mirror Check

Score Yes

- if participant looks in the central and/ or side mirrors

Score No

- if participant does not look in these mirrors.

B. POINTS SCORED ON A SAFE/UNSAFE BASIS

Speed

Score Safe

- if participant drives under the speed limit
- if participant drives at an appropriate speed for the traffic environment

Score Unsafe

- if participant drives over the speed limit
- if participant drives at an inappropriate speed for the environment

Positioning

Score Safe
- if participant parks at the side of the road with 2 tyres in the gutter
- if participant allows a safe distance between the test vehicle and other vehicles when parking
- if participant parks wholly within a parking bay
- if participant keeps as close as practical to left side of the road on unlaned roads.
- if participant stays wholly within their lane on laned roads (grant an exception if moves out around parked cars as long as they then move back completely into the lane again once past the cars or do a lane change).
- if participant allows a safe distance between the test vehicle and parked cars on the side of the road.

Score Unsafe
- if participant drives in a bike lane
- if participant straddles lanes on laned roads (includes not changing lanes on roads where parked cars take up part of the outside lane).
- if participant drives in the centre of an unlaned road rather than keeping to the left.
- if participant mounts the kerb when undertaking a turn
- if participant cuts a corner when turning (ie does not keep left of the centre of the road when turning)
- if participant drifts toward an adjacent lane or the side of the road.

Speed of approach

Score Safe
- if participant drives at a speed that allows them to control the vehicle safely when negotiating a corner, dip or speed hump without unnecessarily holding up other traffic.

Score Unsafe
- if participant drives at a speed that is too fast to permit them to position the car safely on turns or results in driving over dips/speed humps harshly.
- if participant is required to brake harshly at a corner, dip or speed hump
- if participant approaches a corner, dip or speed hump at a speed that is unnecessarily slow.

Gap Selection

Score safe
- if participant enters a road without causing other vehicles to brake

Score Unsafe
- if participant enters traffic where there was insufficient room to do so causing other vehicles to brake.
- if participant gives way unnecessarily at an intersection.

C. POINTS SCORED O N A PASS / FAIL BASIS

Following instructions

Score Pass
- if participants complete requested actions after the instructor has given them up to 2 times.

Score Fail
- if participant does not complete requested actions after they have been given it up to 2 times.

Familiarisation Period

Score Pass
- if participants are able to negotiate at least 3 of the left turns without physical assistance from the driving instructor.
- if participants are able to follow instructions.

Score Fail
- if participants are unable to follow instructions
- if participants require physical intervention by the instructor on more than one turn.
- if participants have any accidents.

D. POINTS SCORED ON A CORRECT/INCORRECT BASIS

Response to lights

Score Correct
- if participant responds as the law states.

Score Incorrect
- if participant drives against a red light
- if participant drives through an orange light when they were able to stop safely.
- if participant fails to move off on a green light
- if participant fails to give way to oncoming traffic when turning right at lights where there is no turning arrow.

Speed at school zone

Score Correct
- if participant drives at 25 km/hr when children are present

Score Incorrect
- if participant drives in excess of 25 km/hr when children are present
- if participant drives at 25 km/hr when no children are present.

Choice of lane

Score Correct
- if participant positions self in a lane that will enable them to safely negotiate the next turn without needing to change lanes.

Score Incorrect
- if participant positions self in a lane that will require them to perform a lane change quickly in order to be in a position to turn at the next comer.

Selects location to park

Score Correct
- if participant chooses to park in a location where parking is permitted at that time.

Score Incorrect
- if participant chooses to park in a place signposted "no parking"
- if participant parks across a driveway
- if participant parks in a disabled parking bay
- if participant parks across a walkway.

Selects location to do a U-turn

Score Correct
- if participant chooses to negotiate a U-turn in a place where U-turns are permitted

Score Incorrect
- if participant chooses to negotiate a U-turn in a place where there is a "no U-turn" sign or at traffic lights.