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Review Article

Review of tests contributing to the occupational therapy off-road driver assessment

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Introduction

In order to make evidence-based decisions in clinical environments, therapists must use psychometrically sound measures of client skill and performance (Ellenberg, 1996). In the area of driver assessment and rehabilitation, suitably qualified occupational therapists in Australia currently use a variety of unstandardised assessments or parts of standardised tests in the off-road environment (Lovell & DiStefano, 2003). Therapists combine the results of these assessments with on-road test results to make licence recommendations for older and functionally impaired individuals to the state licensing authority. The aim of this paper is to document and review off-road driver assessments reported in the published literature or used by occupational therapists in Australia. No other driver test review papers could be found in the published literature. Specifically, the paper examines assessments that purport to measure client skill and performance in the areas of basic cognitive and perceptual skills, reaction time, and road law knowledge. As a resource for clinicians, a summary of each assessment is included in Appendix 1, and it includes information such as aims, scoring, cost and availability, strengths and weaknesses and the level of skills measured according to Michon's model of driver behaviour (van Zomeren, Brouwer & Minderhound, 1987). The findings of this review can be used to guide occupational therapy driver assessors in their selection of off-road assessments, and contribute to future research to develop a standardised off-road driver assessment for occupational therapists.

Assessing drivers: current practice

Initially, functionally impaired or older drivers are evaluated by a medical practitioner to ensure they meet the national medical standards for driving (Austroads, 2003). Then, an occupational therapy driver assessor evaluates the driver using both off-road and on-road procedures. The off-road assessment is conducted in the clinical environment away from the vehicle. The therapist initially ensures the client holds a current licence or is eligible to obtain a licence. The two-fold purpose of the off-road assessment is to provide the occupational therapist with information on client strengths and weaknesses to further investigate during the on-road assessment, and to screen out clients who are not suitable to undertake an on-road assessment. The on-road assessment provides an evaluation of the client's occupational performance of driving, and is undertaken in a dual control vehicle with a driving instructor in the front passenger seat and the occupational therapist in the rear. The competency standards for occupational therapy driver assessors in Victoria (Schneider, 1998) highlight that an on-road assessment is not required if functional status (as determined through an off-road assessment) precludes the safe operation of a motor vehicle. However, our review of the literature suggests that given the poor

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criterion-related validity of current off-road procedures in predicting on-road performance, the majority of clients should be tested on-road (Korner-Bitensky, Sofer, Kaizer, Gelinas & Talbot, 1994; Korteling & Kaptein, 1996; Klavora, Heslegrave & Young, 2000). Hence, clients, occupational therapy driver assessors and driving instructors may be placed at risk by undertaking an on-road assessment. The Medical Review Section at the state licensing authority in Victoria (VicRoads) estimate that during the 12 months of 2001, some 2500 OT driver assessments were conducted, and we can expect this to increase as the population ages, and our expectations that people drive increase (Denmark & Toepfer, 2002). Given the number of occupational therapy off-road assessments conducted each year, the expected increase in assessments as our population ages, and the potentially risky nature of on-road driver assessments, it is imperative that therapists use psychometrically sound off-road assessments of older and functionally impaired drivers (Korner-Bitensky *et al*.; Sprigle, Morris, Nowachek & Karg, 1995). Administering psychometrically sound off-road assessments will ensure that occupational therapy driver assessors have adequate information about clients who will have difficulty during an on-road evaluation, and the likely nature of these difficulties.

Cognitive and perceptual skills (such as scanning and attention, visual perception, hazard perception, executive functions and awareness of both visual hemispheres), fast reaction time, and knowledge of road law are all essential to the driving task and can be assessed with clients in off-road testing situations (Hunt, Morris, Edwards & Wilson, 1993; Lloyd *et al*., 2001; Owsley *et al*., 1998; Stutts, Steward & Martell, 1998; Wheatley, 2001). As part of a more comprehensive battery, the two off-road assessments used by most occupational therapists in Victoria are a 'Visual Recognition Slide Test', which shows 12 road traffic signs or road scenes and asks the client to describe the scene and what they would do, and a written test of road law and knowledge. Similar tests are conducted by occupational therapists throughout Australia. These assessments provide information on client knowledge of road laws and infer cognitive and perceptual capacities. While they have been in use since 1986, only preliminary data is available to support their use (Macdonald, Griffith, Gregory & Jones, 1992; Macdonald, 1992). In addition, anecdotal evidence suggests that some occupational therapy driver assessors are dissatisfied with the use of these assessments. However, there are many other standardised assessments of cognition and perception, which could replace or be added to these to gain more information about the client's suitability to take on-road evaluation and potential issues that might arise as the client undergoes an on-road evaluation. Although examination of an assessment's psychometric properties is essential prior to its adoption in the clinic, occupational therapy driver assessors may also wish to consider what the assessment may reveal about a driver's behaviour.

Models of driver behaviour

Three models have been developed to understand driver behaviour: The Cybernetic model (Galski, Bruno & Ehle, 1992), Michon's model (van Zomeren *et al*., 1987), and Grandenigo's model (Gradenigo, 2002). However, of these three, it is Michon's model that has been most widely applied in research in the field. Michon developed a hierarchical model in which three interdependent levels of driving skill and control have been identified: (i) strategical (planning); (ii) tactical (manoeuvering); and (iii) operational (control). The strategic level is the highest level in Michon's model and is the general planning stage of a driving trip. The strategic level includes the identification of trip goals, the route to take, time of day to travel in, cost of the trip and consideration of the risks of traffic and weather conditions. At this level, a person also decides on the adjustments of the car, which need to be made (e.g. car seat, mirror, radio). The tactical level is the second level in the hierarchy and it looks at how traffic situations are mastered (Laapotti, Keskinen, Hatakka & Katila, 2001). It includes the skills and behaviours required to negotiate a vehicle safely in traffic. Examples of skills at the tactical level are turning, overtaking, obstacle avoidance, gap selection, adapting speed, planning ahead, responding to traffic signs and knowledge and application of road laws and craft.

The lowest level of Michon's model is the operational level. Procedures and routines of driving occur at this level and it refers to the sensory-motor, behavioural and cognitive skills required when driving (Gradenigo, 2002). The operational level includes the skills required to steer a car, control the brake, accelerator and clutch and attend, process and respond to relevant environmental and sensory information. In 1996, a Finnish researcher named Keskinen, further developed Michon's model and added a fourth level. This fourth level was named 'Goals for life and skills for living' and looks at the importance of cars and driving for a driver's personal development and their skills of self-control (Laapotti *et al*., 2001). Michon's model is widely used in the driving field, which is probably related to its direct clinical applicability. Off-road assessments may also be evaluated against Michon's model. Assessments may provide the therapist with information in relation to one, two or all three of Michon's levels.

Method

A literature search was undertaken on the data bases CINAHL, Medline and OTDBase from 1980 to 2003, using the search terms: driving, driver, assessment, cognition, perception, memory and reaction time, and commonly used assessments such as the Cognitive Behavioural Driver Inventory (CBDI). The search was kept broad to capture articles that included an off-road driver assessment as part of the method, and over 1000 articles were examined.

Criteria were then developed to select assessments to be included in the review. These criteria were that the assessment: (i) is cited in at least one peer-reviewed publication; (ii) can be completed in approximately 50 min or less by an occupational therapist; and (iii) assesses more than reaction time alone. This last criterion excluded assessments such as the Reaction Test (Neuwirth & Schuster, 2001), Abrans (2002), Servicing Optics Portable Reaction Timer (SOPRT) (Croft & Jones, 1987) and the Complex Reaction Timer by Die-A-Matic (Korner-Bitensky *et al*., 1994; Mazer *et al*., 1998). Although the Hazard Perception Tests (Congdon, 1999; Road Traffic Authority, 2003) are not usually administered by occupational therapists, these were included in the review because all applicant drivers in Victoria and New South Wales seeking a licence are required to undergo this assessment, and many of these clients with functional impairments are working with occupational therapists.

Next, it was decided to record basic information and features of the assessments such as: aims and population (applicability for particular client groups), the focus of the assessment using Michon's Driving Model, research using the assessment, researcher comments on strengths and weaknesses, procedure, scoring, and time taken, and cost and availability.

In addition, the assessments were scored by using a modified version of the procedure developed by Thomas, Moore, Nay, Hawthorne and Fonda (2004) in their review of incontinence assessments. There are few methods available to numerically score assessments, and the Thomas *et al*. procedure has the advantage of providing a weighted score to give an indication of the assessment's potential value to occupational therapists. The scoring procedure for reviewing assessments is outlined in Table 1. Together, the authors scored each assessment by using each evaluation criterion in Table 1 column 1 and multiplied this by the specified weight in column 2. The scores for the nine criteria were then tallied for each assessment, and the assessments were ranked with higher scores indicating potentially more valuable assessments.

Results

The assessments selected for the review are presented below. Assessments that were not reviewed, which are commonly seen in the driving literature include the Weschler Adult Intelligence Test (WAIS), which is not available for occupational therapists to use, and the Melbourne Slide Test (Lovell & DiStefano, 2003) and Sydney Slide Test (School of Occupation and Leisure Sciences, 2001), which are both unstandardised. Although some assessments had poor face validity for driving (such as the Trail Making Tests (Reitan, 1985)), they were retained in the review because research findings suggest that these assessments are predictive of on-road driver performance. Finally, the Elemental Driving Simulator (EDS) developed by Gianutsos and Beattie (2003) for Life Science Associates, New York, was not reviewed because sufficient information about this assessment could not be obtained. Assessments included in the review are divided into those developed specifically for drivers and those that were not.

Assessments developed to screen functionally impaired drivers

Method including pen and paper/computer/simulated driving or mixed:

1. Cognitive Behavioural Driver's Inventory (CBDI).
2. Gross Impairment Screening Battery of General Physical and Mental Abilities (GRIMPS).
3. Stroke Driver Screening Assessment (SDSA).
4. Useful Field of View (UFOV).
5. Dynavision Performance Assessment Battery.
6. Hazard Perception Test.

Predominantly computer-based/video assessments:

7. California Test (CALTEST).
8. DriveABLE.
9. Driver Performance Test (DPT).
10. Doron Driving System Analyser.

Assessments not developed to screen functionally impaired drivers

11. Bells Test.
12. Charron Test.
13. Rey-Osterrieth Complex Figure Test.
14. Mini Mental Status Examination (MMSE).
15. Motor Free Visual Perception Test (MVPT).
16. Neurobehavioural Cognitive Status Examination (Cognistat).
17. Quick Cognitive Screening Test (QCST).
18. Single Letter and Double Letter Cancellation Tasks from the Behavioural Inattention Test (BIT).
19. Trail Making Tests A and B.
20. Predriver Evaluation (PDE).

TABLE 1: *Criteria for reviewing off-road driver assessments (adapted from Thomas* et al.*, 2003)*

Evaluation criteria	Scoring system	Weight
Prevalence of use	1 = not widely used in Australian and international driving research/clinical settings 2 = some use in Australian and international driving research/clinical settings 3 = wide use in Australian and international driving research/clinical settings	2
Length, ease & time to complete	1 = longer instrument (over 60 min) 2 = medium length instrument (30–60 min) 3 = short instrument (less than 30 min)	2
Method of administration	1 = interviewer required 2 = self-completion	2
Adaptable for use in Australia*	1 = not able to be adapted to use in Australia 2 = some parts able to be adapted 3 = ready for use in Australia	1
Ease of scoring	1 = scoring complex 2 = scoring reasonably straightforward 3 = scoring easy with computer code available	2
Driver specific	1 = not developed for drivers 2 = not developed for drivers, but shown to be sensitive 3 = developed for driver assessment	3
Reliability evidence available	1 = no or little published evidence identified 2 = evidence suggests moderate reliability 3 = evidence suggests good reliability	3
Validity evidence available	1 = no published validity evidence identified 2 = evidence suggests moderate validity 3 = evidence suggests good validity	3
Cost of using the instrument	1 = costs charged for using instrument 2 = costs charged for commercial use 3 = instrument available free of charges	2

*These assessments are able to be used in countries other than where they were designed.

Appendix 1 presents a summary of the features of these 20 assessments, while Table 2 presents the scores awarded and rank assigned to each assessment using the Thomas *et al*. (2004) procedure. As a result of this process, eight assessments scored 40–51 points, and 12 assessments scored 30–39 points. As there was no obvious breakpoint between the scores of higher and lower ranking assessments, an arbitrary breakpoint was set at 40. Therefore, it is suggested that assessments scoring 40 or over should be considered for use by occupational therapists conducting off-road driver assessments, with careful consideration given to the top three.

Summary and conclusion

Driving is viewed as a skill fundamental to our lifestyle. Driving affords independence, mobility and freedom (Korteling & Kaptein, 1996). However, drivers have the responsibility of ensuring the safety of all road users, and occupational therapists play an important role in advising the licensing authority of older and functionally impaired drivers who are, and are not fit to drive. This paper has summarised and reviewed a range of assessments that may be included as part of an occupational therapy off-road assessment, and therefore acts as a valuable resource for occupational therapy driving assessors. Through applying the review criteria, the following assessments ranked highly, and therefore appear to be worthy of consideration for inclusion in the occupational therapy off-road driver evaluation; the Mini Mental Status Examination, the Rey-Osterrieth Complex Figure Test and Trail Making Tests A and B. These assessments have scored well because of their longevity and therefore frequency of use in driving research.

TABLE 2: *Comparative analysis of off-road driver assessments*

	Tools																			
Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Prevalence-use	4	4	4	4	2	2	4	4	2	4	2	2	2	6	4	2	2	4	4	4
Length	2	6	4	6	6	4	4	4	4	2	6	6	6	6	6	6	6	6	6	2
Self-admin	2	2	2	2	2	4	2	2	2	2	4	4	4	2	2	2	2	4	4	2
Adaptable	3	3	1	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3	3	3
Scoring	6	6	4	4	4	6	6	6	4	4	4	4	4	4	4	4	4	4	4	4
Driving specific	9	6	9	6	3	9	9	9	9	9	3	3	6	6	6	3	3	3	6	9
Reliability	9	3	6	6	6	3	3	6	3	3	3	3	9	9	9	9	6	9	9	3
Validity	6	3	6	6	3	3	3	6	3	3	3	3	9	9	9	9	6	6	6	3
Cost	2	2	2	2	2	2	2	2	2	2	6	6	6	6	2	2	6	2	6	2
Outcome score	43	35	38	39	31	36	36	42	30	30	34	34	49	51	45	40	38	41	48	32
Outcome rank	5	12	10	9	15	11	11	6	16	16	13	13	2	1	4	8	10	7	3	14

Assessment tools: 1, Cognitive Behavioural Driver's Inventory (CBDI), 2, Gross Impairment Screening Battery of General Physical and Mental Abilities (GRIMPS); 3, Stroke Driver Screening Assessment (SDSA); 4, Useful Field of View (UFOV); 5, Dynavision Performance Assessment Battery; 6, Hazard Perception Test; 7, California Test (CALTEST); 8, DriveABLE; 9, Driver Performance Test (DPT); 10, Doron Driving System Analyzer; 11, Bells test; 12, Charron Test; 13, Rey-Osterrieth Complex Figure Test; 14, Mini Mental Status Examination (MMSE); 15, Motor Free Visual Perception Test (MVPT); 16, Neurobehavioural Congitive Status Examination (Cognistat); 17, Quick Cognitive Screening Test (QCST); 18, Single Letter and Double Letter Cancellation Tasks from the Behavioural Inattention Test (BIT); 19, Trail Making Tests A and B; 20, Predriver Evaulation (PDE).

However, relatively 'new' assessments that have been developed specifically for driving such as the CBDI may be worth considering in the future.

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Appendix 1

Summary of off-road driver assessments included in the review

Cognitive Behavioural Driver's Inventory (CBDI)	
Authors	Engum, Cron, Hulse, Pendergrass & Lambert (1988), USA.
Michon's level	Strategic, tactical, operational.
Assessment used in research	Brouwer & Withaar (1997); Engum *et al*. (1988); Engum, Lambert & Scott (1990); Galski, Ehle & Williams (1997); Klavora *et al*. (2000); Lambert & Engum (1990); Withaar, Brouwer & Zomeren (1999).
Aims/population	To assess the integrity of brain injured individuals' cognitive skills in relation to safe driving of a car (Lambert & Engum, 1990).
Procedure	27 tests addressing attention, concentration, reaction time, decision making, visual scanning, visual alertness, attention to detail, shifting attention, stimulus discrimination, visual motor coordination and visual sequencing completed in psychology (Engum *et al*., 1988; Galski *et al*., 1997). Components of the WAIS and Trails A and B are completed. Visual acuity, colour blindness, visual fields and brake reaction time are assessed by an occupational therapist (OT).
Scoring	Each subtest is scored separately and standard scores are calculated. The computer program then calculates an overall composite score. If a client's composite score is 52 or higher it is recommended that s/he does not drive. Composite scores between 48 and 51 indicate the client is on the borderline level and the OT and psychologist discuss whether the client should complete an on-road assessment. If the composite score is 47 or less client completes an on-road assessment (Engum *et al*., 1988; Klavora *et al*., 2000).
Standardised	Reliable (Engum *et al*., 1988; Engum *et al*., 1990; Klavora *et al*., 2000), strong criterion related validity (Engum *et al*., 1990), Norms available for brain-injured clients (Engum *et al*., 1990).
Time to complete	1–1.5 h. OT component takes approximately 30 min.
Strengths	Withaar *et al*. (1999) reported almost 90% correct predictions of success in on-road assessment with a sample of neurological clients. 95% of clients who passed CBDI were judged by the driving instructor as safe to drive, all clients who failed CBDI were judged as unsafe on the road (The Neurosciences Center of Indianapolis). Engum *et al*. (1990) found a highly significant relationship ($r = 0.81$) between CBDI results for 175 clients, psychologist recommendation for driving and on-road result.
Weaknesses	Brouwer and Withaar (1997) reported that in borderline cases (e.g. clients with closed head injury) there may be no relationship between on-road and CBDI performance. Withaar *et al*. (1999) found that in elderly clients, on-road driving was judged to be better than the CBDI score predicted. Klavora *et al*. (2000) studied 56 clients with stroke who had visual scanning or attention problems and found that the CBDI was only 66% accurate in predicting success or failure on-road. Client needs to be able to use basic joystick and keyboard.
Cost and availability	Need to purchase CBDI, WAIS, Trails A and B (refer to other sections in the Appendix) and brake pedal reaction timer. CBDI scoring forms cost $55 (US) for five tests. Scoring forms and computerized test items available from Psychological Software Services. Ph — USA 317 2579672.
Gross Impairment Screening Battery of General Physical and Mental Abilities (GRIMPS)/Driving Health Inventory	
Authors/development	Staplin, Loccoco, Stewart and Decina (no reference). Manufactured by Scientex, Washington. Has been developed by Trans Analytics into a computer program called Driving Health Inventory.
Michon's level	Operational.
Assessment used in research	Charlton (2002); Monash University Accident Research Centre (2001).
Aims/population	Screening test to assess people's visual, physical and mental abilities, which are thought to be important for driving.

Appendix 1: *Continued*

Procedure	Trails A and B and Motor Free Visual Perceptual Test (visual closure subtest) completed (reviewed in other sections of the Appendix). Other subtests include: rapid pace walk, foot tapping, move between pedals, cued recall, arm reach, head/neck rotation, delayed recall, scan test, visual acuity, control steering wheel, and head checks. Tests assess ability to recognise incomplete views of signs or hazards, remember instructions and road laws, detect hazards, divide attention between looking at road, hazards and dash information and visual ability to read signs (Monash University Accident Research Centre, 2001). In the computer program, instructions are provided on screen and are narrated (TransAnalytics, 2003).
Scoring	Tasks are timed, given a pass or fail, or scored for quality and accuracy. During GRIMPS assessment, an electronic scoresheet is used and responses are automatically scored as average, above or below average. At the completion of assessment, the client is given a total wrong score (Monash University Accident Research Centre, 2001). On the computer program, results are separated into no deficit, mild deficit, serious deficit. Results are also provided in graph form (TransAnalytics, 2003).
Standardised	Motor Free Visual Perceptual Test and Trails A and B are standardised, however, standardised information was not found for the GRIMPS test as a whole. Website reports that Driving Health program is valid (TransAnalytics, 2003).
Time	20–30 min.
Strengths	In a preliminary study of 1000 drivers over 79 years of age, GRIMPS showed strong relationship with on-road outcome (Charlton, 2002). Driving Health program provides advice about what to do if results fall in the mild or serious deficit area (TransAnalytics, 2003).
Weaknesses	No external studies completed on whole test could be located. No norms located.
Cost and availability	Driving Health program costs $2250 (US) annually for unlimited use on computers in one location, $225 (US) annually for unlimited use on one computer, $15 (US) for one test administration (TransAnalytics, 2003). Order forms are available on the website *www.drivinghealth.com.*

Stroke Driver Screening Assessment (SDSA)

Authors	Nouri & Lincoln (1992a) UK.
Michon's level	Strategic, tactical, operational.
Assessment used in research	Barnes (1997); Department of Health (2002); Nouri & Lincoln (1992a); Nouri & Lincoln (1992b); Nouri & Lincoln (1993); Radford *et al*. (1999).
Aims/population	Screening measure of driving ability that can be used by therapists and nurses (Nouri & Lincoln, 1993). Developed for clients with stroke. Can be used for clients with other acquired neurological disabilities.
Procedure	Assess visual inattention, concentration, reasoning abilities and executive function, ability to follow directional arrows, to put information together to make a decision of what to do, to distinguish between objects that look similar and knowledge of road signs. Subtests include: cancellation test where the client is presented with a page of groups of 3, 4 or 5 dots, and subject crosses out groups of 4 dots only (Barnes, 1997), What's in a square? test — matching car directions with directions on a compass and arrow (Nouri & Lincoln, 1992b), what else is in the square?, test match 2 car directions with points on compasses (Nouri & Lincoln, 1992b), and road sign recognition test in which client matches correct road signs with 12 pictures of road situations (Barnes, 1997).
Scoring	The three scores are added into an equation to give a pass or fail (Barnes, 1997). If client fails, they can be reassessed in 3–4 months (Nouri & Lincoln, 1992a).
Time	Up to 40 min.
Standardized	Valid and reliable (Barnes, 1997).

Appendix 1: *Continued*

Strengths	Acceptable re-test reliability, however, some practice effects noted (Nouri & Lincoln, 1992a). 70% specificity, 55% sensitivity reported in a study of 143 clients, with acquired neurological disability other than stroke (Department of Health, 2002). Better able to predict those who fail on-road test than those who pass. Barnes (1997) correctly predicted 80% of cases who passed or failed on-road test. Nouri & Lincoln (1993) studied 52 clients with stroke (mean age = 59 years) and found that SDSA correctly predicted on-road performance for 81% of the sample.
Weaknesses	Poor face validity when administered to an Australian population. If client passes this assessment, authors still recommend that the client's physical and mental abilities are also evaluated before they return to driving (Nouri & Lincoln, 1992b). Authors recommend on-road testing after the SDSA is completed (Nouri & Lincoln, 1993).
Cost and Availability	Costs $567 (AUD) from Nottingham Rehabilitation. Readily available.
Useful Field of View (UFOV)	
Authors	Karlene Ball developed this assessment in the USA in 1985.
Michon's level	Operational.
Assessment used in research	Cahan (1998); De Raedt & Ponjaert Kristoffersen (2000); Fisk, Novack, Mennemeier & Roenker (2002); Lengenfelder, Schultheis, Al Shihabi, Mourant & DeLuca (2002); Mazer, Sofer, Korner Bitensky & Gelinas (2001); Owsley *et al*. (1998); Withaar *et al*. (1999).
Aims/population	UFOV is the visual angle within which you are able to complete a visual attention task (De Raedt & Ponjaert Kristoffersen, 2000). The UFOV test estimates risk by quantifying the visual field over which a driver can process rapidly presented visual information and therefore drive safely (Lengenfelder *et al*., 2002). Recommended for clients over 55 years of age and those with cognitive problems (Cahan, 1998).
Procedure	Subtests include: speed of information processing, divided attention, selective attention. Tests ability to see objects in front of and to side of car, how quickly client sees objects and ability to focus on driving when many distractions are present (Withaar *et al*., 1999). Pictures are presented on a computer screen and clients identify and touch images on the screen. The pictures are presented many times at increasingly rapid intervals (Cahan, 1998).
Scoring	Response time to driving situations is measured and the client's ability to respond correctly within an identified visual field is calculated by the computer program. Percentage reduction in UFOV for each subtest is given by the computer as a score in milliseconds (Mazer *et al*., 2001). Overall, the time taken places the client in a category: 1-very low risk, 2-low risk, 3-low to moderate risk, 4-moderate to high risk, 5-high to very high risk (Cahan, 1998).
Time	15 min.
Standardised	Test-retest reliability ICC = 0.70 indicating moderate reliability (Mazer *et al*., 2001).
Strengths	A study of 294 drivers over 55 years found drivers with 40% or greater impairment in UFOV are more than 2.1 times as likely to be involved in a crash (Owsley *et al*., 1998). Similarly, Fisk *et al*. (2002) found older adults with UFOV deficits are several times more likely than unimpaired older adults to be involved in a car crash. Available in English and French (Mazer *et al*., 2001).
Weaknesses	Large and not portable.
Cost and Availability	Available from The Psychological Corporation (ph-1800 2118378). Costs approx $445 (AUD).
Dynavision Performance Assessment Battery	
Authors/development	Manufactured by Performance Enterprises in 1990.
Michon's level	Operational.
Assessment used in research	Klavora *et al*. (2000); Klavora, Gaskovski, Heslegrave, Quinn & Young *et al*. (1995a); Klavora, Gaskovski, Martin, Forsyth, Heslegrave, Young & Quinn (1995b); Klavora, Gaskovski & Forsyth (1994).

Appendix 1: *Continued*

Aims/population	Designed to test and train visual scanning, peripheral visual awareness, visual attention and visuomotor reaction time (Klavora *et al*., 2000). Assesses skills required to scan road and areas around it and to respond quickly to what is seen (Klavora *et al*., 2000).
Procedure	Four tasks completed on the Dynavision board where client presses buttons sequentially in different locations. Client keeps their eyes focused straight ahead and uses peripheral vision to see buttons (Klavora *et al*., 2000).
Scoring	Number of correct responses on Dynavision board are recorded (Klavora *et al*., 2000).
Standardised	High test-retest reliability (Klavora *et al*., 2000). Moderate reliability shown for speed and digit tasks (Klavora *et al*., 1994).
Time	15–20 min.
Strengths	Accuracy of Dynavision subtests to predict on-road performance varied from 66% (for simple dynavision task) to 75% (for endurance task). Only the endurance dynavision task significantly predicted on-road performance of post stroke drivers (Klavora *et al*., 2000). Low maintenance costs (Klavora *et al*., 2000).
Weaknesses	Further research on predictive validity of the test is required (Klavora *et al*., 2000).
Cost and availability	Cost $7495 (US). Available from Performance Enterprises-76 Major Button's Drive, Markham, Ontario, Canada, L3P 3G7 *www.dynavision 2000.com*

Hazard Perception Test — RTA — NSW
Hazard Perception Test — VicRoads-VIC

Authors/development	State licence authority in NSW (RTA, 2003) and Victoria (Congdon, 1999), Australia.
Michon's level	Tactical, operational.
Assessment used in research	None reported.
Aims/population	Measures novice drivers' ability to recognise potentially dangerous situations on-road and to react appropriately to these situations (Congdon, 1999; RTA, 2003).
Procedure	Two practice and 15 test film clips of real traffic situations are shown on a computer-based assessment. Client touches screen when they think it is safe to do what has been asked (RTA, 2003).
Scoring	Pass or fail score given at end of test. Test is timed and computer tallies correct number of answers (Monash University Accident Research Centre, 2001).
Standardised	No information located.
Time to complete	Maximum time allowed 45 min (in Victoria).
Strengths	Computer provides feedback on areas person needs to improve.
Weaknesses	Is available for use only for novice drivers through the state licensing authority.
Cost and availability	Not available for sale. *www.vicroads.vic.gov.au*, *http://www.rta.nsw.gov.,au*

CALTEST

Authors/development	The California Test (Department of Motor Vehicles, US Government) and parts of the Hazard Perception Test (developed by VicRoads-reviewed above) were adapted by Monash University Accident Research Centre (MUARC) to form CALTEST. The California Test includes Auto Trails (developed by Frank Schieber, Heimstra Human Factors Laboratories, University of Sth Dakota) and UFOV (reviewed above).
Michon's Level	Tactical, operational.
Assessment used in research	Charlton (2002); Monash University Accident Research Centre (2001).
Aims/population	Screening test that aims to assess client's perceptual-response time, visual search and attention skills and hazard recognition skills. Tests skills required to see objects in front of and to side of car, and the speed in which objects are seen and responded to. Tests ability to focus on driving with distractions and client's hazard perception skills.
Procedure	Subtests include: Auto Trails II test (computer screen has road scene picture with numbered dots over it, client touches dots in ascending or descending order), Useful Field Of View, Hazard Perception Test (Monash University Accident Research Centre, 2001).

Appendix 1: *Continued*

Scoring	Auto Trails test is timed. The UFOV computer measures where client can't accurately see information on screen. The Hazard Perception Test is timed and computer tallies correct number of answers.
Standardised	UFOV component standardised (refer above).
Time	40 min.
Strengths	Step-by-step directions for administration are available. (Monash University Accident Research Centre, 2001). Charlton (2002) studied 1000 drivers over 79 years, and found a strong relationship between CALTEST results and on-road driving performance.
Weaknesses	Clients need to have sufficient cognitive capacity to use a computer touch screen. Whole assessment has only been used as a research tool and has not been standardised.
Cost and availability	UFOV costs $445 (US), Auto Trails is free of charge and is available on the World Wide Web (http://www.usd.edu/~schieber/AutoTrailsIntro.html).
DriveABLE	
Authors/development	DriveABLE Assessment Centres Inc. (Alan Dobbs), Canada. Includes the UFOV (reviewed above).
Michon's level	Tactical, operational.
Assessment used in research	Charlton (2002), Monash University Accident Research Centre (2001).
Aims/population	Off-road screening test of skills related to driving to predict on-road assessment failure (Monash University Accident Research Centre, 2001). Assesses ability to complete head checks, quickly and accurately move steering wheel in response to what's seen, locate hazards on-road quickly, remember where things are on-road with distractions around you; assesses road law knowledge (Monash University Accident Research Centre, 2001).
Procedure	Mental and motor skills are assessed first. If there are still uncertainties about client's driving competence after this an on-road assessment takes place. Assesses range of movement, motor speed/control, complex judgement skills (move box on computer without it touching any moving lines), attention skills (quickly indicating where an object has been seen on screen), executive function skills (touch screen where shape was after a second shape has been shown) and component driving abilities (watch video showing driving scenes and answer multiple choice question on it).
Scoring	Pass, fail or indeterminate score given for mental and motor skills. If a fail or indeterminate score is given, client undergoes an on-road assessment. Tasks are timed and errors made are recorded by the computer. The results are sent to DriveABLE head office via the Internet and an overall score is calculated.
Standardised	UFOV is standardised.
Time	50 min.
Strengths	Charlton (2002) studied 1000 drivers over 79 years, and found a strong relationship between DriveABLE results and on-road performance. Step-by-step instructions provided. Promotional video reports that DriveABLE is able to correctly predict on road pass/fail in 95% of cases.
Weaknesses	No standardised studies on whole assessment or norms have been found. Has not been independently evaluated.
Cost and availability	DriveABLE centres are currently only established in Canada. Clients are referred to these centres and assessments cost approximately $220 (AUD). *www.driveable.com*
Driver Performance Test (DPT)	
Authors/development	Developed by Advanced Driving Skills Institute (USA). Used since 1985.
Michon's level	Tactical, operational.
Assessment used in research	Gouvier *et al.* (1989); Okkema (1993); Wheatley (2001).
Aims/population	Assesses road knowledge, and client's ability to make quick observations and decisions to avoid driving hazards.

Appendix 1: *Continued*

Procedure	40 videotaped scenes of potentially hazardous driving situations are viewed. The client chooses the best way to safely respond out of four alternatives given. The client is only given seconds to make a decision (Gouvier *et al*., 1989).
Scoring	Overall score and score for each subskill is given with ratings of excellent, above average, average, below average, poor (Okkema, 1993).
Standardised	No information located on standardisation.
Time	50 min.
Strengths	Does not require specialist training to administer test (Gouvier *et al*., 1989). Closely simulates potentially dangerous driving situations, in the safe environment of a testing room (Wheatley, 2001). Valuable for observing client's problem solving (Okkema, 1993).
Weaknesses	Not effective in predicting on-road driving performance of clients with Traumatic Brain Injury (TBI) (Gouvier *et al*., 1989). Due to the small amount of time given to observe each scene, even cognitively intact people find the test difficult to complete (Okkema, 1993).
Cost and availability	Video costs $99 (US). Advanced Driving Skills Institute Ph — USA 800 3276781; *www.advdrivskills.com*

Doron Driving System Analyser

Authors/ Development	Manufacturer — Doron Precision Systems, USA.
Michon's level	Operational.
Assessment used in research	Galski, Bruno & Ehle (1993); Galski *et al*. (1997).
Aims/population	To simulate driving situations on a computer (Galski *et al*., 1993).
Procedure	Computerised simulator shows road traffic films of varying difficulty and the client is asked to respond to traffic conditions by braking, accelerating and steering appropriately (Galski *et al*., 1993). Galski *et al*. (1997) reported that additional behaviours scored by an occupational therapist (e.g. distractibility, inattention, mental slowness, difficulty following directions) could also provide useful information.
Scoring	Number of errors made are calculated and reaction times can be measured (Galski *et al*., 1993).
Standardised	No standardised information has been located.
Time	Approximately 1 h.
Strengths	Galski *et al*. (1993) found that the test was 80% sensitive for predicting failures on-road. Tests ability to complete actual driving tasks such as holding and controlling steering wheel, using brake and accelerator. Allows for trial of various adaptive equipment such as a spinner knob (Galski *et al*., 1993). Videos can simulate a variety of driving conditions, for example, rural, suburban and city roads, different weather and light conditions.
Weaknesses	Requires dedicated space to set up and expensive. Most of the individual simulator measures (braking, reaction time, steering, accelerating) are ineffective predictors of on-road performance (Galski *et al*., 1992). Clients' report that the test does not feel like 'real driving' (Galski *et al*., 1992).
Cost and availability	Base model costs $114, 960 (US). Available from Doron Precision Systems — PO Box 400, Binghamton, New York, 13902, *www.doronprecision.com*

Bells Test

Authors/development	Gauthier, DeHaut & Joanette (1989).
Michon's level	Operational.
Assessment used in research	Gauthier *et al*. (1989), Korner-Bitensky *et al*. (1994), Mazer *et al*. (1998).
Aims/population	Assess selective attention and visual scanning (Mazer *et al*., 1998).
Procedure	Clients are presented with a page with 35 bells drawn and 264 distracters. The page is placed in midline of client who is asked to circle the bells (Mazer *et al*., 1998).

Appendix 1: *Continued*

Scoring	The number of bells circled and time taken to complete form the score (Mazer *et al*., 1998). Three omissions is described as an attentional deficit, six or more bells missed on one side of sheet is a visual neglect (Korner-Bitensky *et al*., 1994). The order in which the sheet is scanned is assessed by the examiner marking a separate score sheet (Gauthier *et al*., 1989).
Standardised	No standardised information located.
Time	5–10 min.
Strengths	Better at predicting those who failed than those who passed on-road assessment (Mazer *et al*., 1998). Assesses ability to pick out relevant signs or hazards on-road.
Weaknesses	Does not have face validity for driving task.
Cost and availability	Contact authors to obtain copy of the test — Louise Gauthier, Laboratoire Th-Alajouanine, CHCN, 4565 Ch. de la Reine-Marie, Montreal, Quebec H3W IW5, Canada.
Charron Test	
Authors/development	Based on the Minnesota Clerical Test (Andrew, Paterson & Longstaf, 1979).
Michon's level	Operational.
Assessment used in research	Korner-Bitensky *et al*. (1994); Mazer *et al*. (1998).
Aims/population	Assess visual attention processing (Mazer *et al*., 1998).
Procedure	Client discriminates between similar pairs of objects or numbers. 19 object pairs, 37 number pairs. Client places a mark next to each pair that is not identical (Mazer *et al*., 1998).
Scoring	The number of incorrect marks or marks left out are counted and tallied. The time taken is recorded (Korner-Bitensky *et al*., 1994; Mazer *et al*., 1998).
Standardised	Not standardised (Korner-Bitensky *et al*., 1994).
Time to complete	5–10 min.
Strengths	Better at predicting those who failed than those who passed on-road assessment (Mazer *et al*., 1998).
Weaknesses	Does not possess good face validity for driving.
Cost and availability	To obtain, contact the authors.
Rey–Osterrieth Complex Figure Test	
Authors	Rey, 1959.
Michon's level	Operational.
Assessment used in research	Akinwuntan *et al*. (2002).
Aims/population	Assesses perception, organisation, visual inattention and spatial abilities in clients with brain damage (Akinwuntan *et al*., 2002).
Procedure	Client copies a complex figure.
Scoring	Many scoring systems have been used. Standardised version is to score the picture out of 36. The picture has been divided into 18 scoring units and each one is scored for accuracy and placement (Psychological Assessment Resources, 2003).
Standardised	Convergent and discriminant validity has been established. Reliable assessment — discriminates between brain damaged, psychiatric and normal populations (Psychological Assessment Resources Inc., 2003).
Time	10 min.
Strengths	Akinwuntan *et al*. (2002) studied 104 clients with stroke and found that combining client visual acuity and Figure of Rey test results were the best predictor of on-road performance. Assesses skills, which are required to attend to the road, park accurately and keep car in safe position on-road.
Weaknesses	Designed for use with brain injured clients. Poor face validity for driving.
Cost and availability	Full manual and test booklets cost $225 (US). Available through psychological test distributors.
Mini Mental State Examination (MMSE)	
Authors/development	Folstein, Folstein & McHugh (1975).

Appendix 1: *Continued*

Michon's level	Tactical, operational.
Assessment used in research	Carr *et al*. (1991); Crum, Anthony, Bassett & Folstein (1993); Fox, Bowden, Bashford & Smith (1997); Irwin (1988); Mate-Kole, Major, Lenzer & Connolly (1994); Odenheimer *et al*. (1994); Tombaugh & McIntyre (1992).
Aims/population	Used to estimate the severity of cognitive impairment and document cognitive change over time (Folstein *et al*., 1975).
Procedure	11 questions assessing orientation, memory, attention, ability to name, follow verbal and written commands, write a sentence and copy a polygon (Folstein *et al*., 1975).
Scoring	Scored out of 30 and this places the client on a continuum of cognitive function (Crum *et al*., 1993). Scores of 23 or less indicates the presence of cognitive impairment (Tombaugh & McIntyre, 1992). Specific subtest scores (e.g. visuospatial and attention scores) may be more informative in regards to driving than the whole test (Carr *et al*., 1991).
Standardised	Extensive documentation of good reliability and validity (Folstein *et al*., 1975; Irwin, 1988; Tombaugh & McIntyre, 1992).
Time	5–10 min.
Strengths	Shows little practice effect (Folstein *et al*., 1975). Has been translated into other languages (Crum *et al*., 1993). Strong correlation between MMSE and on-road driving performance found in a study of 30 people over 60 with a variety of cognitive deficits (Odenheimer *et al*., 1994) and in a study of 19 clients with Alzheimer's disease (Fox *et al*., 1997).
Weaknesses	Has a high false-negative rate (not detecting clients with problems) in driving studies (Mate-Kole *et al*., 1994). Lack of sensitivity to mild cognitive impairments (Tombaugh & McIntyre, 1992). Specificity and sensitivity of MMSE not sufficient for effective prediction of on-road performance (Odenheimer *et al*., 1994; Fox *et al*., 1997). Poor face validity for driving, although the test assesses ability to follow and remember verbal directions (e.g. a driving routes).
Cost and availability	Available free of charge through texts or World Wide Web (http://endeavour.med.nyu.edu/research/pda/pilot/downloads/psychiatry/folstein/folstein.htm and www.minimental.com)

Motor Free Visual Perceptual Test (MVPT)

Authors/development	Colarusso & Hammill (1972).
Michon's level	Operational.
Assessment used in research	Burtner, Ortega, Morris, Scott & Qualls (2002); Korner-Bitensky *et al*. (1994), Mazer *et al*. (1998).
Aims/population	Assesses spatial relations, visual discrimination, figure ground, visual closure, and visual memory (Mazer *et al*., 1998).
Procedure	Client matches a picture to a choice of pictures.
Scoring	Scored out of 36. Time to complete each item recorded and average time calculated (Korner-Bitensky *et al*., 1994). Raw scores are converted to perceptual quotients and perceptual age scores (Burtner *et al*., 2002).
Standardised	Standardised on a normal adult population, and age-specific norms available (Korner-Bitensky *et al*., 1994). Valid and reliable (Burtner *et al*., 2002).
Time to complete	25 min.
Strengths	Better at predicting those who failed than those who passed on-road driving assessment (Mazer *et al*., 1998). These authors also found a 94% positive predictive value (for clients with right hemisphere strokes) and 80% positive predictive value (for clients with left hemisphere strokes).
Weaknesses	Only assesses visual perceptual aspects of perception. Has poor face validity for driving.
Cost and availability	Costs $270 (US). Available from Psychological and Education Tests (Ph — USA 630 8609775).

Neurobehavioural Cognitive Status Examination (Cognistat)

Authors	Kiernan, Mueller, Langston and Van Dyke, 1987.
Michon's level	Strategic, tactical, operational.

Appendix 1: *Continued*

Assessment used in research	Marcotte, van Gorp, Hinkin & Osato (1997); Nabors, Millis & Rosenthal (1997); Osmon, Smet, Winegarden & Gandhavadi (1992).
Aims/population	A screening test to assess general cognitive function (Osmon *et al*., 1992)
Procedure	Subtests: orientation, attention, language, constructional skills, memory, calculation, reasoning (Nabors *et al*., 1997). Most subtests begin with one or two brief questions as a screen. If client passes the screen, no further testing in that subtest occurs, if client fails the screen s/he completes all the questions in the subtest (Marcotte *et al*., 1997).
Scoring	Subtests and total scores can be calculated.
Standardised	Is reliable and normative data available (Nabors *et al*., 1997). Valid assessment (Nabors *et al*., 1997; Osmon *et al*., 1992). Good sensitivity (Marcotte *et al*., 1997).
Time	10–30 min.
Strengths	Nabors *et al*. (1997) found the Cognistat to be better predictor of functional outcome than the MMSE. Can be used with healthy adults and neurological and psychiatric clients (Nabors *et al*., 1997).
Weaknesses	Poor face validity for driving. Relationship between results and on-road performance not known.
Cost and availability	Costs $130 (US). Available from Psychological Assessment Resources (2003).

Quick Cognitive Screening Test (QCST)

Authors	Mate-Kole *et al*. (1994) developed and adapted the QCST from the work of McFie (1975).
Michon's level	Strategic, tactical, operational.
Assessment used in research	Mate-Kole *et al*. (1994).
Aims/population	Screening test, which may indicate need for more comprehensive cognitive testing.
Procedure	17 subtests: orientation, attention/concentration, verbal immediate memory, verbal delayed memory, visual attention/visuospatial, constructional praxis, visual delayed memory, vocabulary, naming, similarities, analogies, mental arithmetic, arithmetic, object identification, geometric designs, perceptual closure and memory for new learning (Mate-Kole *et al*., 1994).
Scoring	Each subtest given score and global score available.
Standardised	Internally consistent, valid assessment of cognitive status (Mate-Kole *et al*., 1994).
Time	15–30 min.
Strengths	Portable and only requires test pages and pen (Mate-Kole *et al*., 1994). All health professionals can administer it and it is sensitive to cognitive impairment (Mate-Kole *et al*., 1994).
Weaknesses	Poor face validity for driving. Relationship between results and on-road performance not known. Only assesses cognitive and visual abilities.
Cost and availability	Available by contacting the author at Department of Psychology, Nova Scotia Rehabilitation Centre, Halifax, Nova Scotia.

Single and Double Letter Cancellation Test from the Behavioural Inattention Test (BIT)

Authors	Wilson, Cockburn & Halligan (1987); UK.
Michon's level	Operational.
Assessment used in research	Mazer *et al*. (1998), Taylor (2003).
Aims/population	Assess visual scanning and attention (Mazer *et al*., 1998).
Procedure	Single — Paper with six lines of 52 letters on each line, H is present 105 times. Client crosses out each H. Double — Client crosses out the letters C and E (Mazer *et al*., 1998).
Scoring	The number of omissions recorded, and scored.
Standardised	Test-retest and interrater reliability reported to be good (Taylor, 2003). Normative data available (Korner-Bitensky *et al*., 1994; Mazer *et al*., 1998). Criterion validity established, however, only preliminary data on content validity of BIT available (Unsworth, 1999).
Time	Approximately 5 min.

Appendix 1: *Continued*

Strengths	Better at predicting those who failed on-road assessment than those who passed. BIT score significantly associated with on-road outcome (Mazer *et al*., 1998).
Weaknesses	Poor face validity for driving.
Cost and availability	Behavioural Inattention Test costs $764 (AUD). Available from Australian Council for Educational Research Ph — (03) 9835 7447.
Trail Making Tests A and B	
Authors/development	Army Individual Test Battery (1944).
Michon's level	Operational.
Assessment used in research	Brooke, Questad, Patterson & Valois (1992); Brouwer & Ponds (1994); Marottoli *et al*. (1998); Mazer *et al*. (1998); Stutts *et al*. (1998).
Aims/population	Assess visual conceptual and visuomotor tracking, attentional flexibility (changing from one method of problem solving to another), divided attention and executive function (Brouwer & Ponds, 1994; Marottoli *et al*., 1998; Mazer *et al*., 1998; Unsworth, 1999).
Procedure	Trail A — Numbers 1–25 are written on a page. The client connects numbers sequentially. Trail B — Numbers 1–13 and letters A–L are written on a page. The client connects letters and numbers sequentially (1-A, 2-B, etc.). The tasks are timed and the client is told to complete the test quickly and accurately without lifting pen from paper. Errors are pointed out as they occur and timer continues.
Scoring	Number of errors and time taken to complete are recorded (Mazer *et al*., 1998).
Standardised	Good reliability, and age norms are available (Okkema, 1993; Mazer *et al*., 1998).
Time to complete	5–10 min.
Strengths	Better at predicting those who failed than those who passed on road assessment (Mazer *et al*., 1998). Significant correlations to pass/fail rating of on-road performance (Brooke *et al*., 1992; Mazer *et al*., 1998). Trails A sensitive to mild levels of cognitive impairment (Stutts *et al*., 1998). Showed significant correlation to on-road performance in a study of 105 over 65 years old drivers who volunteered for 1993 study (correlation coefficient = −0.42) (US Department of Transport, 2003). Subjects who take more than 2 min for Trails B are at nearly twice the crash risk level (study of 3238 over 65 years old drivers getting licenses renewed in 1994 and 1995) (US Department of Transport, 2003). Assesses ability to shift between two types of cognitive abilities and to alternate attention and these skills as required in driving (Okkema, 1993; Brouwer & Ponds, 1994). Sensitive to mild levels of cognitive impairment (Stutts *et al*., 1998). Assesses client's ability to scan the road effectively and with good speed, to attend to information presented on-road and to shift attention from one type of object on-road to another.
Weaknesses	Not appropriate for aphasic clients. Poor face validity for driving.
Cost and availability	Test forms and administration manual available from Reitan Neuropsychology Laboratory, 1338 East Edison St, Tucson, AZ 85719. Can also be found in many neuropsychology texts.
Predriver Evaluation (PDE)	
Authors/development	Kessler Institute for Rehabilitation, East Orange, New Jersey.
Michon's level	Tactical, operational.
Assessment used in research	Galski *et al*. (1993).
Aims/population	Assess perceptual and cognitive abilities believed by the developers to be important for driving (Galski *et al*., 1993).
Procedure	Compilation of 21 physical and neuropsychological tests or subtests including the WAIS-R Block Design and Digit Symbol Test, Double Letter Cancellation, Porteus Maze Test, Ravens Progressive Matrices, Rey-Osterreith Complex Figure Test, Trail Making Test, and Visual Form Recognition Test (Galski *et al*., 1993).

Appendix 1: *Continued*

Scoring	Each test scored individually.
Standardised	Some individual tests are standardised.
Time	1.5 h.
Strengths	Assesses a range of abilities required for driving.
Weaknesses	Only four of 21 tests significantly predicted the PDE outcome, and only one was significantly correlated with on-road performance, therefore no internal or criterion validity (Galski *et al*., 1993). Requires neuropsychologist to administer a number of the tests.
Cost and availability	Need to purchase WAIS ($1,826 (AUD)) and several other assessments which were reviewed earlier in the Appendix. Currently only being used at Kessler Institute for Rehabilitation.