Recent developments in developing screening tools for older drivers

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Abstract

Despite the increasing risks associated with driving in later life, driving remains essential to independence and mobility. Driving cessation has been linked with isolation, depression and mortality. It is therefore imperative that the small proportion of older drivers who are truly unsafe are identified, whilst ensuring that safe older drivers maintain their mobility for as long as possible. We describe methodological and practical considerations for evaluating screening measures for older drivers. We then describe and report available validation data for three measures currently being evaluated in Australia by multidisciplinary research teams in the ACT and QLD. They include the Useful Field of View® which is the most widely-used research tool and was developed in the U.S., the POPI battery that was developed in Australia and has been shown to have 91% sensitivity and 70% specificity for classifying older drivers who failed a research-based on road test, and the ACT Hazard Perception Test, which has been developed in Australia and is currently being evaluated against an on-road test.

Keywords

Older Drivers, Driver Screening; Cognitive Assessment, Hazard Perception

Introduction

With an ageing population, and an increasing reliance on private vehicles for transportation, the issue of older driver safety is becoming increasingly important. The percentage of the Australian population aged 65 and over is expected to double from 13% to 25% over the next 50 years [1]. At the same time, future generations of older adults will have higher rates of licensure, retain their licenses and expect to use their cars for longer than any previous generation [2]. This trend towards increasing vehicle usage is a positive indication of greater mobility and independence in later life. However it is also problematic in that driving is a complex task involving the integration of cognitive, visual and psychomotor skills [3], many of which are known to decline with age.

Age-related cognitive changes that affect driving include slowing of reaction times [4], reduction in visual and divided attention [5, 6], and reduction in executive function [7, 8]. Decline in executive function associated with atrophy of the frontal lobes may underpin inconsistency in responding to stimuli, poor planning of responses, and a lack of insight into physical or psychological declines that impact on injury risk [8]. The prevalence of visual impairment also increases significantly with age [9] and age-related changes in visual function have been investigated as risk factors for crashes among older adults, particularly reduced visual acuity and visual field loss [10, 11]. However, research has shown that visual tests alone are a poor predictor of driving performance [12]. In relation to physical abilities, our recent research has also shown that lower limb function is another key component to driving safety [13]. Lower limb proprioception, strength and coordination show age-related declines [14, 15], and can be impacted further by acute and chronic medical conditions that become more prevalent in old age [16]. Lower limb strength and control is likely to be important for vehicle control, particularly in relation to coordinating and adjusting accelerator, brake and clutch pedals, and has been associated with cognitive function [17]. Together, age-related declines in these cognitive, visual and psychomotor skills may contribute to the increased accident and injury risk that is seen in older drivers [18, 19].

The standard approach to dealing with the issue of older driver safety is mandatory age-based medical and visual screening or on-road assessment for older drivers wishing to retain their license [20]. However, apart from cases of extreme impairment, there is little evidence that such procedures are related to
improved road safety outcomes [21]. Instead, studies that have examined prospective and retrospective accident records or on-road performance have identified specific cognitive, sensory and physical factors that appear to be more strongly related to driving safety [e.g., 22, 23], and screening tests developed to assess these specific areas of functioning either individually or as part of multi-modal screening batteries show more promise for identifying at risk older drivers [e.g., 13, 24].

This paper will review research on three such screening instruments that are under development, or being evaluated by, our multidisciplinary research team in Australia. These include:

1. The Useful Field of View® (UFOV®), a widely used measure of visuo-spatial processing speed developed by researchers in the United States;
2. The POPI Battery, developed in Australia as part of the Prevention of Older Persons Injuries study, and including measures of visual, cognitive, and motor function; and
3. The ACT Hazard Perception Test, a video based measure similar to a test used in NSW and Queensland for licensing younger drivers [25], but developed to be appropriate for use with older age groups.

Before focusing on these measures, we will begin with a brief overview of some of the important methodological and practical considerations that need to be taken into account when evaluating screening measures for older drivers.

Methodological and Practical Considerations

The utility of screening tests in relation to older drivers lies in the ability to quickly and reliably detect individuals who are potentially at risk of unsafe driving in order to refer them for further assessment and testing [26]. Specifically, if they are to be implemented on a wide scale, screening tests must consist of practical, affordable, and easily-administered desk- or office-based tests of abilities that have been validated as critical to the capacity to safely drive [27]. Given that driving is such a complex process, and that safe driving behaviour depends on the interaction of physical, cognitive and sensory capacity and metacognitive factors (i.e., insight into one’s limitations, and moderation of behaviours to suit conditions, [3]), the development of appropriate screening measures is challenging. The difficulty of meeting these criteria is also reflected in licensing policy, with requirements for older drivers varying from jurisdiction to jurisdiction both in Australia [21] and overseas [28], and the fact that few, if any, of the screening measures that have been developed in large research projects having yet achieved wide-spread acceptance or implementation [24, 29].

Here we present some of the key methodological and practical considerations relating to screening tests for older drivers.

Methodological Considerations

- **Validation**: The key methodological factor in the consideration of screening tests for older drivers is that of validation. Specifically, it is critical that potential screening tests are validated using appropriate outcome measures. This is especially important in terms of driving because the outcome measures most commonly used – accidents – are extremely infrequent at the level of the individual and can be caused by numerous intrinsic and extrinsic factors. A further complication with accidents is that official accident records are often incomplete, poorly matched across jurisdictions, or lacking in detail [18]. Other measures of driving safety such as on-road tests tend to be more sensitive and reliable. As yet there is no method of standardising such on-road tests between sites. [e.g., 30].

- **Sampling**: Related to validation, another important methodological consideration in screening tests is the sample used in the development and validation stages. Different sample types may either inflate or underestimate the sensitivity of tests. It is important for the population used in validation to be relevant to the population for which the test is intended. Population-based screening measures must preferably be developed and validated using representative population-based samples. This is a much more difficult requirement than it may seem, especially in relation to research with older adults [e.g., 27]. Many of the screening tests that have been reported in the scientific literature have used either clinically referred samples [e.g., 31], in which case the correlations with driving safety are
likely to be inflated, or self-selected community samples [e.g., 13] in which the relationships are likely to be suppressed.

Practical Considerations

- **Duration:** If tests are to be acceptable for mass-screening, they must be of brief duration - no more than 5-10 minutes [e.g., 13]. While longer tests generally produce more reliable results [32], they are impractical for brief screening of large numbers of people in applied settings. One solution to this issue is a multi-tiered screening system, where more extensive tests are administered only to those who fail initial brief screening measures [13].

- **Administration:** If they are to be administered by large numbers of staff in potentially disparate locations and settings, screening tests must also be either automated, or very simple to administer and score, ideally requiring either minimal or no training of staff. Similarly, it is important that any screening test be robust to potential test-related effects such as different examiners or test environments.

- **Equipment:** Ideally, screening tests should require a minimal amount of specialised equipment. This is important not only for reasons of economy, but because more complex or specialised equipment will be likely to require more expertise in administration, and may require additional secondary equipment or special environments in which to operate. Most importantly, if such equipment requires detailed interaction with computers or machinery (even using a computer mouse [33]), this may impact on the ability especially of older adults to undertake such tests at all [e.g., 34].

- **Culture and linguistic factors:** Finally, as with any measure designed for use at a population level, it is important that older driver screening tests are designed to operate either independently of cultural and linguistic factors, or include validated variants appropriate for use with older drivers from different backgrounds and language groups.

**Useful Field of View (UFOV®)**

One of the most intensively researched screening tests for older drivers in recent decades has been a measure called the Useful Field of View or UFOV® [9, 35]. This patented instrument [36, 37] was developed as a test of real-world visual function aimed at understanding the everyday visual difficulties reported by some older adults (with activities such as spotting friends in a crowd or driving in traffic [e.g., 38]) which were only weakly related to standard optometric measures of vision [12]. Specifically, the current version of the UFOV® gives a measure of the speed and efficiency with which an individual can process complex visual displays [39] and, in research conducted throughout the 1990s, it was shown to be one of the best desk- or office-based predictors of older drivers’ accidents, convictions, and on-road driving performance [6, 19, 22, 23, 31, 40, 41]. The UFOV® was also recently evaluated as part of a large-scale field test of a short older driver screening battery (including physical and other cognitive measures) in DMV offices in the US state of Maryland and was shown to be predictive of at-fault crashes over the following 4-5 years [24].

The UFOV® test itself has evolved through several iterations since the 1980s [39]. The screening version [42] is a computer based measure that requires participants to sit facing a standard-sized computer monitor and respond to displays of varying complexity that are presented on the screen for varying lengths of time (between 16 and 500ms). Responses are made using either a mouse, or a touchscreen (the two versions are highly correlated [39]), and the test takes between 10 and 15 minutes to complete. The UFOV® involves three subtests, each requiring the detection of relevant targets (stylised images of a car or a truck) that are presented either centrally (subtest one), centrally and peripherally (subtest two) or centrally, and with the peripheral target presented amongst irrelevant ‘distracter’ items (subtest three). In subtests two and three, the central target requires a discrimination response (i.e., ‘Was it a car or a truck?’), while the peripherally presented target requires a localisation response (‘Where was it located?’). Subtest one is easier and involves only a central ‘discrimination’ target (see Figure 1 for an example trial sequence of UFOV® subtest three).

The computerised scoring algorithm uses a psychophysical estimation procedure to increase the speed of presentation following successive correct responses, and slow it down following an incorrect response, allowing the software to estimate the ‘threshold’ speed at which each individual can perform each subtest.
with 75% accuracy of discrimination and localisation. These threshold scores (either added to form a composite ‘UFOV reduction score’, or used individually) are used to assign the screening candidate a ‘risk category’, and these categories have been shown to have reasonable sensitivity and specificity (the two measures of validity for a screening test) in predicting unsafe older drivers [e.g., 19, 31]. It is purported that the three subtests of the UFOV® measure different aspects of visual attention, specifically: processing speed, divided attention, and distracter inhibition [42].

The UFOV® continues to be evaluated by many research teams around the world; with most of the recent attention focused on using variations of the procedure to improve older drivers’ visual performance [e.g., 43]. Our research on this instrument has focused on assessing the relationship between performance on the UFOV® and visual sensitivity, attention, and on-road driving performance in normal [10, 44] and medically impaired older adults [45]. We have also investigated the cognitive correlates of performance on the test [46] and are assessing the utility of the UFOV® as part of a multi-modal screening battery [13]. Our current research is focusing on the relationship between UFOV® test performance and hazard perception abilities in older drivers.

**Figure 1:** UFOV® Subtest Three trial sequence: i) stimulus presentation (duration: 16-500ms) involving central and peripheral targets amongst distracter triangles; ii) random noise mask (to eliminate visual afterimage, 500ms); iii) central target response (‘Was it a car or a truck?’); iv) peripheral target response (‘On which spoke was the outside object located?’).

**POPI Battery**

The POPI battery was developed after an extensive review of literature on factors associated with unsafe driving and crashes, and the subsequent development of a theoretical model of safe driving behaviour [3]. This model identifies the contribution of cognitive, sensory and psychomotor factors as influences on driving skill and proposes that driving safety is the outcome of both driving skill levels and effective adaptation of behaviour as a result of self awareness of abilities.

To finalise this battery, we conducted a large study involving measures from visual, cognitive, and sensorimotor domains that were selected on the basis of theoretical or empirical links with driving performance and safety. Statistical analysis of the initial test battery identified a final set of three tests that assessed visual motion sensitivity, choice reaction time and postural sway. Along with a measure of self-reported driving exposure, these tests had high sensitivity (91%) and specificity (70%) in classifying older drivers.
who were assessed as safe or unsafe in an on-road driving test [13]. This multifactorial approach to screening for injury risk is consistent with that used in the falls area, where a range of visual, motor, sensory and reaction time tasks are combined to produce the most accurate risk assessment [47]. The battery and some of its components had stronger associations with the road safety measures in the developmental study than the current benchmark in older driver screening, namely the UFOV®. The POPI battery takes approximately ten minutes to administer, is relatively inexpensive and has the potential to be used by a range of trained health professionals. Further prospective work is, however, required to replicate these findings on additional samples.

**ACT Hazard Perception Test**

A critical skill required for safe driving is the ability to detect and attend to potential hazards in such a way as to permit the planning and execution, if required, of appropriate avoidance or danger minimization manoeuvres [48]. This task is complicated in that it depends on more than simple visual sensitivity. Hazard perception is conceptualized as a higher-order cognitive process that involves simultaneous classification and monitoring of numerous visual objects, inference of others’ intentions and action, knowledge of road rules and normal road behaviours, and a degree of understanding of the physical capabilities of drivers and their vehicles [49]. Horswill and McKenna define hazard perception ability as a driver’s ‘situational awareness’ on the road [48].

Importantly, hazard perception ability, generally measured by video-based assessment, has been found to be related to crash risk in younger drivers [50]. It has also been demonstrated that hazard perception ability varies with age and driving experience, with middle-aged drivers usually outperforming both younger and older drivers on such tests [51]. In addition, secondary tasks such as talking or listening have been found to have a more significant impact on the hazard perception performance of older than younger adults [52].

Recent Australian research on older drivers’ hazard perception has focused on evaluating age-related differences in hazard perception abilities into very old age [53], understanding the visual and cognitive correlates of hazard perception ability [49, 54] and assessing the possibilities for improving older adults’ hazard perception using expert training in hazard anticipation [55]. A current study, jointly funded by the Australian Research Council and the NRMA-ACT Road Safety Trust, has developed a video-based hazard perception test specifically for older drivers residing in the Australian Capital Territory. A screenshot of this test, similar to that used with novice drivers in licensing procedures in Queensland and the UK [56], is shown in Figure 2. We are currently investigating the cognitive and visual correlates of this measure, and assessing its potential use as a screening measure through an on-road validation study with a sample of around 60 older drivers [see e.g., 57].
Figure 2: Example of ACT Hazard Perception Test. Observers are required to watch short clips of real traffic environments (each clip approximately 20-60 seconds long), taking the point of view of the driver, and responding to situations they identify as potentially hazardous (i.e., where they might have to slow down or swerve to avoid a collision) by touching the appropriate road user on the screen. The yellow rectangle (not seen by observers) denotes the area within which the observer must touch for a response to be registered.

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References
5. A.B. Sekuler, P.J. Bennett, M. Mamelak, 'Effects of aging on the useful field of view', Experimental Aging Research, 2000 26(2) 103-120.
17. K.J. Anstey, S.J. Lord, P. Williams, 'Strength in the lower limbs, visual contrast sensitivity, and simple reaction time predict cognition in older women', Psychol Aging, 1997 12(1) 137-144.
27. J. Langford, 'Usefulness of off-road screening tests to licensing authorities when assessing older driver fitness to drive', Traffic Inj Prev, 2008 9(4) 328-335.
46. C. Hatherly, K.J. Anstey, 'Extending the Useful Field of View paradigm for screening older drivers', ACRS/Qld Travelsafe Committee Joint Conference, Brisbane, Qld, Australia, 2008.