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Can we improve clinical prediction of at-risk older drivers?

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ABSTRACT

Objectives: To conduct a pilot study to evaluate the predictive value of the Montreal Cognitive Assessment test (MoCA) and a brief test of multiple object tracking (MOT) relative to other tests of cognition and attention in identifying at-risk older drivers, and to determine which combination of tests provided the best overall prediction.

Methods: Forty-seven currently licensed drivers (58–95 years), primarily from a clinical driving evaluation program, participated. Their performance was measured on: (1) a screening test battery, comprising MoCA, MOT, Mini-Mental State Examination (MMSE), Trail-Making Test, visual acuity, contrast sensitivity, and Useful Field of View (UFOV) and (2) a standardized road test.

Results: Eighteen participants were rated at-risk on the road test. UFOV subtest 2 was the best single predictor with an area under the curve (AUC) of .84. Neither MoCA nor MOT was a better predictor of the at-risk outcome than either MMSE or UFOV, respectively. The best four-test combination (MMSE, UFOV subtest 2, visual acuity and contrast sensitivity) was able to identify at-risk drivers with 95% specificity and 80% sensitivity (.91 AUC).

Conclusions: Although the best four-test combination was much better than a single test in identifying at-risk drivers, there is still much work to do in this field to establish test batteries that have both high sensitivity and specificity.

1. Introduction

The number of older drivers is growing rapidly. In 2009 there were 7.7 million drivers ≥80 years in the U.S. (Federal Highway Administration Department of Transportation (US), 2009); a 47% increase compared to 1999 (Federal Highway Administration Department of Transportation (US), 1999). Drivers in this age group are at an elevated risk for accidents relative to middle-aged drivers (McGwin and Brown, 1999) and are more likely to be fatally injured (Lyman et al., 2002). However, it is not appropriate to simply prohibit people from driving on the basis of chronological age. For many older people, driving is important for independence and quality of life; indeed, driving cessation is linked with social isolation and depression (Marottoli et al., 1997; Fonda et al., 2001; Edwards et al., 2009). Thus, it is important to be able to accurately distinguish between older drivers who are safe to continue driving, and those who might be at-risk and should cease driving. Unfortunately, this is not a straightforward problem.

Since driving is a complex task, a combination of multiple tests may be more likely to predict driver performance than any single test (Wood et al., 2008). Failures in sensory, cognitive, or motor abilities with increasing age could all contribute to driving failures, and no one test would be likely to capture all these aspects (Anstey et al., 2005). This is the approach adopted by clinical driver evaluation programs, which typically include a battery of screening tests and an on-road driving test (Korner-Bitensky et al., 2006). A growing number of test batteries have been proposed and examined (Hoffman et al., 2005; Oswanski et al., 2007; Bédard et al., 2008; Wood et al., 2008, 2013; Kay et al., 2009; Korner-Bitensky and Sofer, 2009; Dobbs and Schopflocher, 2010; Carr et al., 2011). However, as yet, none provide sufficiently good sensitivity *and* specificity either

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for mass screening of older drivers or to be a replacement for an on-road test (Bédard et al., 2008; Kay et al., 2012). Therefore, at the moment, screening batteries in driver evaluation programs are mainly used to provide information to supplement the road test, and possibly identify drivers for whom an on-road test would be unsafe.

A recent review suggested that a screening battery, as a replacement for a road test, should achieve both sensitivity and specificity of at least 90% (Kay et al., 2012); however, none of the batteries tested to date have reached that goal for a binary classification of safe vs. at-risk drivers (Table 1). For example, although a multi-disciplinary battery including vision, cognitive and motor performance tests evaluated in a non-clinical population was relatively good at identifying at-risk drivers (91% sensitivity), 30% of safe drivers were incorrectly categorized as being unsafe (70% specificity) (Wood et al., 2008). On the other hand, in clinical populations (people referred to a driving assessment program), the DriveAble screen battery was relatively good at identifying safe drivers (specificity 90%), but failed to identify almost one-quarter of at-risk drivers (sensitivity 76%) (Korner-Bitensky and Sofer, 2009), while the DriveSafe/DriveAware battery (Kay et al., 2009) and the SIMARD battery (Dobbs and Schopflocher, 2010) both achieved high sensitivity (97% and 93%, respectively), but lower specificity (58% and 40%) for a binary classification (Table 1).

These findings underscore the importance of continuing to evaluate individual tests and combinations of tests with the aim of achieving both high sensitivity and high specificity with as few tests as possible. One approach to developing such a battery would be to incorporate tests that precisely target different functions that are both critical to driving and sensitive to aging (and accompanying medical conditions). In this study we examined the predictive ability of two such tests that had not, to our knowledge, previously been evaluated as predictors of at-risk older drivers.

The first test was the Montreal Cognitive Assessment (MoCA, Nasreddine et al., 2005), which is a cognitive screening task similar in design to the Mini-Mental State Examination (MMSE), but with additional subtests focusing on multi-tasking aspects of attention relevant to driving. It is also more sensitive to mild cognitive decline than the MMSE (Nazem et al., 2009; Freitas et al., 2013). Thus our hypothesis was that the MoCA might be a better predictor of on-road driving than the MMSE. The other test, Multiple Object Tracking (MOT; Pylyshyn and Storm, 1988), is a computerized measure of visual attention, like the well-established Useful Field of View (UFOV; Ball et al., 1988). However, while the UFOV involves brief (<500 ms) presentations of static stimuli, MOT requires continuous attention to multiple moving objects over several seconds. Our hypothesis was that the sustained, dynamic nature of the task captures cognitive skills important for driving (Kunar et al., 2008) and may provide additional information about sustained attentional capabilities relevant to driving.

A cohort of older drivers underwent a comprehensive evaluation comprising a road test and a standard clinical cognitive assessment battery (including the MMSE and the Trail-Making Test) as used by DriveWise, a clinical driving assessment program (O'Connor et al., 2008). In addition, they completed the MoCA test, a brief MOT test developed for clinical populations (Bowers et al., 2011) and the UFOV (as a comparison for the MOT). We had three primary goals: (1) determining whether the MoCA and MOT provided new information regarding critical aspects of the cognitive abilities needed for safe driving; (2) determining whether adding MoCA and/or MOT and/or UFOV improved the predictive value of the standard clinical cognitive assessment battery; and (3) determining the combination of tests that provided the best overall prediction of the road test outcome. The study was conducted as a pilot in preparation for a future, larger sample study.

2. Methods

2.1. Participants

As this was a pilot study, we recruited a convenience sample of 32 consecutive participants from DriveWise, a clinical driving assessment program at Beth Israel Deaconess Medical Center to which people are referred if there is a concern about whether or not they should be driving (O'Connor et al., 2008). Only DriveWise clients who were eligible for inclusion in the study were invited to participate. In addition, 15 older volunteers (with normal cognition) were included; they had previously participated in studies at Schepens Eye Research Institute, mostly as normally sighted controls in driving simulator studies (Bronstad et al., 2013). Inclusion criteria were: a current valid driver's license, vision meeting the requirements for licensure in MA (visual acuity of at least 20/40 and visual field of at least 120° horizontal diameter), and no physical impairments that would limit interaction with a touch screen.

The age and sex distributions were similar for the two recruitment sources, but the proportion with mild cognitive impairment was higher in the DriveWise group (DriveWise 34%; Schepens 0%). Mild cognitive impairment was diagnosed by a cognitive neurologist or neuropsychologist using the Petersen (2004) criteria. Education data were available for 26 participants in the DriveWise group; of these, 22 had more than high-school education, two had 12 years, one had 10 years and one had 9 years education. All participants in the Schepens group had more than high-school education.

The study adhered to the tenets of the Declaration of Helsinki and was approved by the Institutional Review Boards (IRB) at Beth Israel and Schepens. All participants provided written informed consent.

2.2. Test battery

All participants were administered a test battery comprising: vision measures; the standard DriveWise clinical cognitive test battery (O'Connor et al., 2008); the MoCA; and two visual attention tests, the UFOV and a brief MOT test, both presented on a touch-screen monitor. Habitual eye glasses were worn for all tests.

The test battery took about 1–1.5 h to complete, with breaks, as needed. At DriveWise, the tests were administered within the clinic schedule. Therefore, due to time limitations (such as participants arriving late for their appointment but having to start the on-road test on time), not all of the DriveWise participants were able to complete all tests; however, all Schepens participants completed all tests. The tests were administered in a standardized order at Schepens by author RJA (all tests), and at DriveWise, by RJA (MOT and MoCA) and author AMH (vision tests, MMSE, Trails and UFOV).

2.2.1. Vision measures

Binocular visual acuity was measured using an ETDRS acuity chart, either freestanding or computerized, with each letter scored as 0.02 log units (higher scores indicating worse performance). Binocular letter contrast sensitivity was measured using a MARS chart (Arditi, 2005), with each letter scored as 0.05 log units (higher scores indicating better performance). The MARS chart has good repeatability and is comparable to the well-established Pelli-Robson letter contrast sensitivity chart (Dougherty et al., 2005). Contrast sensitivity was measured as deficits in this aspect of visual function have been associated with mild cognitive impairment (Risacher et al., 2013), and it may be a better predictor of driving performance than visual acuity (Owsley and McGwin, 2010).

2.2.2. DriveWise clinical cognitive test battery

The clinical cognitive test battery included the MMSE (Folstein et al., 1975) and the Trail-Making Tests (parts A and B) (Reitan,