Driving Scenes test of the Neuropsychological Assessment Battery (NAB) and on-road driving performance in aging and very mild dementia

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Abstract

The Driving Scenes test of the new Neuropsychological Assessment Battery (NAB; [Stern, R.A., & White, T. (2003a). *Neuropsychological Assessment Battery*. Lutz, FL: Psychological Assessment Resources, Inc.]) measures several aspects of visual attention thought to be important for driving ability. The current study examined the relationship between scores on the Driving Scenes test and on-road driving performance on a standardized driving test. Healthy participants performed significantly better on the Driving Scenes test than did very mildly demented participants. A correlation of 0.55 was found between the brief, office-based Driving Scenes test and the 108-point on-road driving score. Furthermore, the Driving Scenes test scores differed significantly across the driving instructor's three global ratings (safe, marginal, and unsafe), and results of a discriminant function analysis indicated that the Driving Scenes test correctly classified 66% of participants into these groups. Thus, the new NAB Driving Scenes test appears to have good ecological validity for real-world driving ability in normal and very mildly demented older adults.

Keywords

Driving; Aging; Dementia; Neuropsychology; Attention; Visual

Ecological validity has been defined as the relationship between performance on a neuropsychological test and behavior in real-world settings (Sbordone, 1996). This concept is of particular interest in clinical and forensic evaluations, during which psychologists are often asked to make predictions about an individual's functional abilities based on his or her

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test scores. Specific areas of interest often include vocational ability, self-care "activities of daily living," problem solving ability, and appropriate social behavior. In efforts to establish ecological validity, previous studies have shown relationships between specific neuropsychological tests and real-world activities such as money, home, and health management (Baird, Podell, Lovell, & McGinty, 2001), work performance (Ready, Stierman, & Paulsen, 2001), and instrumental activities of daily living (Cahn-Weiner, Malloy, Boyle, Marran, & Salloway, 2000).

The ability to safely drive a car is often one of the most important functional questions that arise during a neuropsychological evaluation, particularly during the assessment of older adults with both normal and impaired cognitive abilities. Although there is evidence to suggest that some individuals with early dementia are impaired drivers, some retain their driving abilities during the initial stages of dementia (Hunt, Morris, Edwards, & Wilson, 1993; Hunt et al., 1997; Rebok, Keyl, Bylsma, Blaustein, & Tune, 1994; Rizzo, McGehee, Dawson, & Anderson, 2001). The relationship between office-based assessment and real-world driving ability is unclear. For example, although the Mini-Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 2002) may correlate with driving scores at the middle range of the scale, this relationship is weaker at the higher range of the scale (i.e., 27/30 and higher) (Fitten et al., 1995). Moreover, in two prospective studies, the MMSE was not found to predict future crashes or violations among older individuals (Fox, Bowden, Bashford, & Smith, 1997; Trobe, Waller, Cook-Flannagan, Teshima, & Bieliauskas, 1996). Given this evidence, it is important to identify more specific neuropsychological tests that can predict driving capacities among older adults.

Some progress has been made in identifying tests with good ecological validity for driving abilities, such as tests of executive functioning including Porteus Mazes (Ott, Heindel, Whelihan, Caron, Piatt, & DiCarlo) and the Trail Making Test (Odenheimer et al., 1994; Rizzo, Reinach, McGehee, & Dawson, 1997). One recent study employed a computerized executive functioning mazes test, and found a relationship between errors and driving ability ratings (Ott et al., 2003). In particular, computerized tests of visuospatial abilities have also been found to have relatively good ecological validity for driving abilities. Owsley, Ball, Sloane, Roenker, and Bruni (1991) developed a computerized paradigm, "useful field of view" (UFOV), that captures both speed of visual attention and ability to focus visual attention despite distractions. In two prospective studies, UFOV was found to predict crashes over a three year time period (Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Owsley et al., 1991) in a sample of older adults. Moreover, in patients with mild dementia, visual selective attention has been related to on-road driving performance. In fact, visual search abilities were predictive of driving abilities above and beyond dementia severity (Duchek, Hunt, Ball, Buckles, & Morris, 1998). Other cognitive measures, including memory scores, did not further predict driving performance. In a recent meta-analysis of the relationship between performance on neuropsychological tests and on-road driving ability in patients with dementia and elderly controls, measures of visuospatial abilities were more strongly associated with driving than were other cognitive domains (Reger et al., 2004).

Given the good ecological validity for driving abilities of attention measures in general and computerized visual attention tasks in particular, the Driving Scenes test of the new Neuropsychological Assessment Battery (NAB; Stern & White, 2003a) was designed as a similar, non-computerized clinical measure. Driving Scenes is one of the five "Daily Living" tests included in the comprehensive, 33-test NAB. In particular, it incorporates several aspects of visual attention including working memory, visual scanning, attention to detail, and selective attention. The purpose of the present study was to assess the ecological validity of the NAB Driving Scenes using performance on a standardized road test as our measure of driving ability. It was anticipated that the Driving Scenes test would be strongly

related to driving performance in a sample of older adults, including healthy controls and individuals with very mild dementia.

1. Methods

1.1. Participants

Participants included 55 individuals taking part in a longitudinal study of driving and dementia, and were comprised of 24 healthy elderly controls (Clinical Dementia Rating Scale = 0 [CDR; Hughes, Berg, Danziger, Coben, & Martin, 1982; Morris, 1993]) and 31 individuals with very mild dementia (CDR = 0.5). Diagnosis of very mild dementia was made based upon a complete diagnostic evaluation by a neurologist, and all dementia participants met NINCDS-ARDRDA criteria for possible (13) or probable (18) Alzheimer's disease (McKhann et al., 1984). Healthy controls were recruited from family members of dementia patients. All healthy control participants had no history of dementia and an MMSE score of greater than 26. All participants were currently driving, had a valid driver's license, and did not have any reversible causes of dementia, or ophthalmologic, physical, or neurological disorders, other than dementia, that might impair driving abilities. The demographic and driving characteristics of the participants are summarized in Table 1.

1.2. Procedure and measures

Participants were administered an on-road driving test by an experienced and licensed driving instructor during daylight hours under good conditions (e.g., no precipitation or wet roads). The instructor was blinded to the participant's diagnosis (i.e., control versus dementia). The driving test was based on a published, reliable driving measure, the Washington University Road Test (WURT; Hunt et al., 1997) adapted for comparable streets in Rhode Island. Subjects received a total score based on safe completion of each of the required maneuvers, ranging from 0 (best) to 108 (worst). The instructor also made a trichotomous global rating of the participant's driving ability: "safe," "marginal," or "unsafe." Total administration time was 30–40 min.

Participants were also administered the NAB Driving Scenes test (Stern & White, 2003a) by a neuropsychologist or a trained research assistant. The Driving Scenes test (Form 1) was administered and scored according to directions provided in the NAB Administration, Scoring, and Interpretation Manual (Stern & White, 2003b). In this test, participants are shown color drawings of a road scene from the perspective of sitting behind the steering wheel of the car. After a 30-s exposure, participants are then shown another similar picture, and are asked to point to and tell the examiner everything that is new or missing. They are given up to 2 min to respond, and then another scene is presented and they are again asked to identify new and missing items relative to the previous scene. One point is awarded for each new or missing detail the participant identifies relative to the previous scene. Administration time is approximately 5–10 min. A total of six driving scenes are presented. Total scores range from 0 (worst) to 70 (best). Raw scores were converted into demographically-corrected T scores, based on normative data for age, education, and gender in the NAB Demographically Corrected Norms Manual (White & Stern, 2003).

2. Results

As seen in Table 1, the healthy control group performed significantly better than the very mildly demented group on both the on-road driving test and the NAB Driving Scenes test (raw and demographically-corrected T scores). Moreover, across the entire sample, the correlation between the Driving Scenes test and the on-road driving score was strong ($r(55) = -.55, P < .01$).

NAB Driving Scenes test scores were further analyzed by global rating of driving ability made by the driving instructor, revealing significant group differences ($F(2, 52) = 7.75$, $P < .01$). Student–Newman–Keuls post hoc analyses revealed that participants rated as "safe" scored better on the Driving Scenes test ($M = 38.11$, S.D. $= 10.86$) than either those rated as "marginal" ($M = 28.81$, S.D. $= 10.91$) or those rated as "unsafe" ($M = 20.25$, S.D. $= 7.41$). Those rated "marginal" and "unsafe" did not differ significantly. A discriminant function analysis resulted in one function that was significant (Wilks' lambda $= .77$, $P < .01$) and accurately classified 66% of cases.

3. Discussion

The new NAB Driving Scenes test appears to have good ecological validity for on-road driving abilities in older adults, including healthy elderly and individuals with very mild dementia. Our findings revealed a strong association between scores on the NAB Driving Scenes test and on-road driving test score. Moreover, those rated as "safe" by the driving instructor performed significantly better on the NAB Driving Scenes than those rated as either "marginal" or "unsafe." The NAB Driving Scenes test was able to correctly classify 66% of the participants into these three driving safety categories.

These findings suggest that the NAB Driving Scenes test has utility in clinical evaluations of older adults whose driving abilities are in question. Difficulty on the NAB Driving Scenes test suggests that a formal driving evaluation should be recommended, particularly in combination with findings on other neuropsychological tests associated with driving abilities, such as the Trail Making Test (DeRaedt & Ponjaert-Kristoffersen, 2001; Odenheimer et al., 1994; Rizzo et al., 1997). As with any neuropsychological measure, when interpreting test results or making recommendations pertaining to driving ability, alternate explanations for poor performance must be entertained (e.g., fatigue, poor motivation) as well as converging evidence from a wide range of sources, such as clinical history and significant others (Sbordone & Purisch, 1996).

Another advantage of the NAB Driving Scenes test for use with older adults is its face validity for driving abilities. The stimuli are digitally-smoothed, life-like color drawings of a visual perspective from behind the steering wheel of a car driving on a two-lane road through the downtown of a small city. In addition, aspects of the pictures that change or are added are commonly encountered events while driving (e.g., stop light turns red, child runs into road, engine heat indicator increases). The face validity of the test makes it more palatable to examinees, and may also decrease the likelihood of the examinees refusing participation altogether. Patients, their families, and caregivers will likely be more open to driving-related recommendations when they are made and explained on the basis of a test (such as the NAB Driving Scenes) that clearly appears to be related to aspects of real-world driving. The NAB also includes two equivalent forms, as well as six-month test–retest data, thus making reevaluation with the Driving Scenes test possible with little or no practice effects. Finally, the NAB may also have advantages over computerized tests, such as ease and convenience of administration and acceptableness to older adult examinees.

In one review of the literature, the relationship between most neuropsychological test scores and various measures of everyday functioning was estimated to range between 0.20 and 0.50, which are low to moderate correlations (Williams, 1996). In a recent meta-analysis of the relationship between neuropsychological test performance and on-road driving skills (Reger et al., 2004), the mean correlations were 0.36–0.48. Laudably, the NAB Driving Scenes test's association with driving abilities falls at the upper end or greater of those previous findings. One limitation of our findings is the small sample size in the discriminant

function analysis, which may create instability in those findings. Thus, replication is warranted with a larger sample.

In summary, the NAB Driving Scenes test provides an ecologically valid measure of driving abilities. As pressure increases from clinical, legal/forensic, and research-oriented consumers/users of neuropsychological test data for ecologically-valid information, this test may be an appropriate addition to a testing battery for a variety of purposes.

Acknowledgments

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Table 1

Means (and standard deviations) of demographic and driving characteristics of participants

	Healthy controls (CDR = 0), n =24	Very mild dementia (CDR = 0.5), n =31	t/X^2
Men/Women (n)	10/14	20/11	2.85
Age	72.04 (10.28)	76.87 (5.41)	−2.25[*]
Education	14.79 (3.02)	13.58 (3.58)	1.35
MMSE	29.13 (1.19)	25.06 (3.59)	5.32[**]
Driving trips per month	17.65 (15.57)	8.63 (7.13)	2.82[**]
On-road driving test	4.92 (5.06)	14.03 (8.34)	−4.72[**]
NAB Driving Scenes	43.79 (8.18)	26.61 (8.58)	7.51[**]
NAB Driving Scenes T score	49.13 (11.87)	30.10 (8.20)	7.03[**]

[*]
$P < .05$.

[**]
$P < .01$.