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Abstract

Hooper Visual Organization Test (VOT) (Hooper, 1983) items were correlated with driving status of geriatric individuals with dementia to help screen for high-risk drivers. A retrospective review of 87 medical chart on patients, 60 – 91 years, who underwent a neurocognitive evaluation at the University of North Texas Health Science Center in Fort Worth, Texas, with a complete VOT, driving status, dementia diagnosis, and demographic descriptors (age, gender, marital status) were selected for analysis. Of the 55.2% participants who reported a current driving status, VOT scores ranged: 20.8% normal, 43.8% mildly impaired, 31.3% moderately impaired, and 4.2% severely impaired. An item analysis was followed by direct logistic regression analysis which correctly predicted 85% of the drivers and 74% of the nondrivers with an overall success rate of 80.5% (*p*=.001). The Wald criterion selected 4 VOT items as reliably predicting driving status: items 6 (hammer), 19 (teapot/pitcher), 22 (mouse), and 25 (block). Models run with gender and/or marital status was not reliably different. These 4 items may add to a brief screening test to identify drivers with dementia potentially at risk. In addition, the large number of current drivers scoring in the impaired range suggests that individuals, their families and others are not intervening with driving behavior, possibly placing the individuals and public at risk.

HOOPER VISUAL ORGANIZATION TEST (VOT)

AS A PREDICTOR OF DRIVING STATUS

OF INDIVIDUALS WITH DEMENTIA

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Hooper Visual Organization Test (VOT) as a Predictor of Driving Status of Individuals with Dementia

The United States has seen a steady increase in the number of older drivers. Marottoli et al. (1998) estimate that by 2020, 17% of the driving population will be over the age of 65. Similar estimates predict that 25% of drivers will be over 65 by 2024 (Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Zuin, Ortiz, Boromei, & Lopez, 2002). Moreover, these estimates could be considered low in light of the fact that the current figures are computed using a cohort of females who have never driven whereas the future figures will include an entirely different cohort where most women will likely have had a driving history (Retchin & Anapolle, 1993; Taylor & Tripodes, 2001). The increase in elderly drivers has a number of implications for public health. One is that, per-mile, the accident rate for those aged 65 and older is second only to that for teenagers (Daigneault, Joly, & Frigon, 2002). Another is that when involved in an accident, older individuals are more likely than those in other age groups to suffer severe injuries or death (Owsley, Ball, Sloane, Roenker, & Bruni, 1991). Finally, as the population of elderly drivers increases, so does the number of drivers suffering neurocognitive conditions associated with aging, such as dementia (Mungas, Wallace, & Reed, 1998), leading to greater concerns over driver safety (Hakamies-Blomqvist & Wahlstrom, 1998; MacGregor, Freeman, & Zhang, 2001; Valcour, Masaki, & Blanchette, 2002; Taylor & Tripodes, 2001).

A medical examination alone is generally considered insufficient to determine fitness to drive (Valcour et al., 2002), and Nouri and Lincoln (1993) believe that the current system permits many unsafe drivers to continue to drive. Because MRI and CT results do not show the numerous intra-cerebral neural connections that affect cognitive functions (Lundqvist, 2001), judgments about a person's fitness to drive an automobile are often solicited from supplementary health care professionals (Lundqvist, 2001; Myers, Ball, Kalina, Roth, & Goode, 2000), especially if a medical diagnosis such as dementia has been made. Elderly individuals with varying degrees of functional deterioration can pose a probable risk to themselves and to the public if their driving capabilities are not properly evaluated (Klavora & Heslegrave, 2002).

Dementia has been linked to driving ability (Klavora & Helsegrave, 2002; Lucas-Blaustein, Filipp, Dungan, & Tune, 1988; Valcour et al., 2002) in both industrial and in developing countries (Zuin et al., 2002) and is the most frequent cause of cognitive impairment in older individuals (Zuin et al., 2002). Over the course of the disease, all individuals with dementia will lose their ability to drive safely, often posing significant transportation challenges for these individuals as well as their spouses and adult children (Taylor & Tripodes, 2001).

Valcour et al. (2002) have found that medical doctors often overlook the issue of driving ability in patients with dementia, especially if the dementia is mild. Although many individuals with mild dementia are competent to drive (Fox, Bowden, Bashford, & Smith, 1997), some researchers insist that even mild dementia presents serious concerns with a person's ability to drive (Zuin et al., 2002) since individuals with dementia often overestimate their abilities due to lack of insight into their deficits (Lucas-Blaustein, Dungan, & Tune, 1988). When executive functions are impaired a person looses the feedback they receive during poor driving experiences (e.g. near accidents), causing the driver to not notice driving errors and thus maintain behaviors or driving habits that are a safety risk (Daigneault et al., 2002). A decrease in executive functioning is a common part of the dementia disease process. Individuals with dementia are especially prone to driving past their abilities due to the day-by-day variability in their reduced cognitive capacity and forgetfulness (Taylor & Tripodes, 2001). Consequently, with regard to dementia, "self-regulation" often must be facilitated and augmented with the help of family, friends and health professionals (MacGregor et al., 2001). In the absence of clear-cut indicators of when a person can no longer drive safely, and given the variability among individuals with dementia (Klavora & Heslegrave, 2002), more education concerning the risks of driving is warranted for physicians (Valcour et al., 2002) as well as for psychologists, patients and families beginning in the mild stages of dementia. Studies have shown that once individuals are made aware of their risks for accidents they frequently modify or curtail their driving behaviors (Ball et al., 1993), especially if they possess appropriate cognitive abilities (Klavora & Heslegrave, 2002) and have other transportation options (Chipman, Payne, & McDonough, 1998; Taylor & Tripodes, 2001). However, the standard deviation of this self-limiting group of drivers is rather large (MacGregor et al., 2001) suggesting that many individuals do continue to drive despite potential limitations. In addition, Daigneault et al. (2002) found that these self-modulated changes in driving behaviors did not inevitably relate to reduced accident risk.

It may also be possible to discover reliable indicators of when to recommend driving reduction or cessation. There are many variables that factor into a person's competency to drive (Daigneault et al., 2002; Klavora & Heslegrave, 2002; Meyers, Ball, Kalina, Roth, & Goode, 2000; Owsley et al., 1991). On a very simple level, the neurocognitive variables for driving utilize both automized processing and controlled processing (Ranney, 1994), with controlled processing being necessary when automatic reactions are insufficient. There is evidence that elderly drivers without dementia typically do not experience a loss in automatic processing skills (Lee, Drake, & Cameron, 2002). Controlled processing engages working memory, and thus is affected by difficulties in encoding, storing, and retrieving information from long-term memory (Lundqvist, 2001), deficits that are particularly associated with dementias in general (Mungas, Wallas, & Reed, 1998) and deficits that are inextricably related to driving ability (Owsley et al., 1991). Lundqvist (2001) discovered performance on tests of working memory separated brain injured patients from controls as well as successfully predicting driving skill.

Because impaired cognitive functioning is the main defining characteristic of dementia, neuropsychological assessment is integral in the clinical evaluation and diagnosis of the disease (Mungas et al., 1998). Cognitive functioning is very important to driving behavior because driving depends largely on working memory and problem-solving skills (Owsley et al., 1991). It is important to know which tests or instruments are better predictors of driving ability for this population. The Hooper Visual Organization Test (VOT) is often part of a standard neuropsychological assessment (Lezak, 1995; Spreen & Strauss, 1998) and has been found to be sensitive to even mild dementia when compared to age-matched controls (Zec, Vicari, Kocis, & Reynolds, 1992). The VOT has been identified as one predriver screening variable (Marottoli et al., 1998) that could be used to predict the outcome of an on-road driving test (Meyers et al., 2000). However, Galski, Ehle and Bruno (1990) found the VOT, as well as other neuropsychological measures, not to be significantly correlated with an on-road evaluation in patients with cerebral damage, and Merten and Beal (2000) concluded that the VOT is an invalid screening instrument for cognitive deficits.

Factor analysis has shown that the VOT measures a factor that correlates with the Wechsler's Perceptual Organization factor (Sherman, Strauss, Spellacy, & Hunter, 1995) and the VOT correlates with the Rey Complex Figure test (Spreen & Strauss, 1998), together signifying that VOT scores load strongly on a visuospatial/perceptual factor. Although a study by Hills (1980, as cited by Ranney, 1994) concluded that high-risk drivers cannot be identified by vision and perception tests, many studies have linked visual and perceptual factors with accident rates (Ball et al., 1993; Daigneault et al., 2002; Owsley et al., 1991).

There are many factors that could alert assessing clinicians to potential driving risks. Our intent was not to predict actual driving ability but to help develop clues to screen out patients who are potentially unsafe. The purpose of our study was to increase the clinician's awareness of potential risks while assessing individuals with dementia, in office, using a common neurocognitive instrument that has been previously associated with driving ability (Marottoli et al., 1998; Meyers et al., 2000). The authors chose to focus on individual elements of VOT performance rather than factors that may already alert the clinician to potential risk such as specific medications or poor driving history. A neuropsychological evaluation could provide a base from which recommendations are made (Lundqvist, 2001). Identifying predictive qualities of neurocognitive instruments could help identify the need to further assess certain individuals (Meyers et al., 2000) especially if the person at risk is a current driver. Identifying specific items on the Hooper VOT that correlate with driving status may help further develop an inexpensive and convenient method of accurately screening high-risk drivers without unnecessarily imposing on competent drivers.

Methods

Sample

A retrospective review of medical charts was performed on patients who were between the ages 60 and 91 years old who underwent a neurocognitive evaluation at the University of North Texas Health Science Center (UNTHSC) in Fort Worth Texas between July 1, 1999 and August 1, 2002. The UNTHSC Institutional Review Board approved the study. Approximately 150 charts were reviewed. Cases with a complete VOT, information on current driving status, a diagnosis of dementia, and demographic descriptors (age, gender, marital status) were selected for analysis. Patients with documented visual deficits or impairment other than dementia were excluded from analysis leaving eighty-nine cases in the study sample.

Diagnostic criteria

A licensed neuropsychologist who conducted all patient interviews and cognitive assessments made the diagnosis of dementia. Diagnosis was based on criteria from ICD-9-CM codes and the Diagnostic and Statistical Manual of Mental Disorders (1994)

(DSM-IV). Included in the sample were: Dementia of the Alzheimer's Type (45), Vascular Dementia (14), Dementia Not Otherwise Specified (14), Frontotemporal Lobe Dementia (6), Dementia with Mixed Etiology (Vascular and Alzheimer's Type) (4), Dementia due to Parkinson's Disease (2), Dementia with Lewy bodies (2), Alcohol-Induced Persisting Dementia (1), and Dementia due to Meningioma (1). Of these diagnoses, 58.2% were mild, 38% were moderate, and 3.8 % severe. (Refer to Table 1).

Table 1. Dementia Diagnosis and Severity.

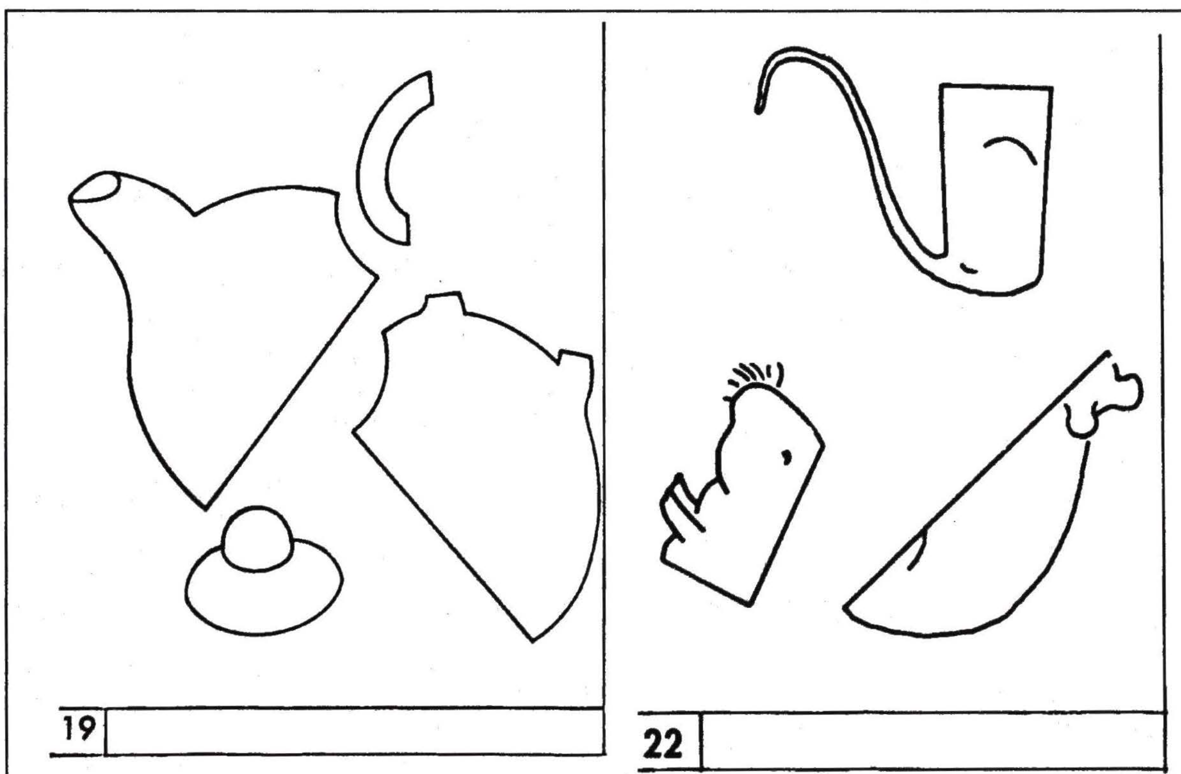
Dementia Diagnosis, n = 87	**Frequency**	**Percentage**
Alzheimer's	45	50.5%
Vascular	14	16.0%
Dementia NOS	14	16.0%
Frontotemporal	6	6.8%
Mixed Etiology	4	4.5%
Due to Parkinson's Disease	2	2.2%
With Lewy Bodies	2	2.2%
Alcohol-Induced	1	1.1%
Due to Meningioma	1	1.1%
	Severity	
	Mild	58.2%
	Moderate	38.0%
	Severe	3.8%

Hooper Visual Organization Test (VOT)

The VOT was designed as a brief screening instrument to measure the ability of adults and adolescents to conceptually organize visual stimuli (Hooper, 1983). The test contains 30 line drawings of simple objects that have been cut into pieces and arranged in a puzzle-like fashion (see Figure 1). The task is to correctly name the object if the pieces were arranged correctly, each item receives a score of 0, .5 or 1. Performance depends upon “visual analytic and synthetic abilities, and on the capacity to label objects either verbally or in writing” (Hooper, 1983, p. 1.).

A Total Score is obtained after adding the number of correct responses, with a maximum score possible of 30. More than 11 incorrect responses are indicative of organic pathology (Lezak, 1995).

Figure 1. VOT items numbered 19 (Teapot, Cream Pitcher) and 22 (Mouse).



Procedure

Each selected case received a subject number and remained anonymous; no names or identifying information were contained in the data collection file. Information retrieved from individual files included: demographics of age, gender, dementia diagnostic category, marital status; driving status; VOT Total Score, and raw score of the 30 individual items contained in the VOT.

Results

Prior to analysis, all variables were examined through various SPSS programs for accuracy of data entry, missing values, and fit between their distributions and the assumptions of multivariate analysis. Two cases identified by Cook's Distance were found to be multivariate outliers with $p = .001$. The two cases, both diagnosed as Alzheimer's Type, Mild, were deleted leaving 87 cases for analysis. Descriptive data for the remaining participants is presented in Table 2. The group was composed of 24 females and 63 males with a mean age of 77.55 years ($SD = 6.8$; range: 60 to 91). About 32% of the sample were married and 63% were not married. Current drivers comprised 55.2% and non-drivers comprised 44.8% of the sample.

Table 2. Demographic data.

Age (years)	**Mean**	**SD (Range)**
N = 87	77.55	6.8 (60-91)

	n	**Frequency**	**%**
Gender	87		
Females		24	27.6
Males		63	72.4
Marital Status	84		
Married		28	32.2
Not Married		55	63.2
Driving Status	87		
Driving		48	55.2
Nondriving		39	44.8

Of the 55.2% who reported being current drivers, only 20.8% had VOT scores within the normal range per published norms (Hooper, 1983). Table 3 shows that of the current drivers: 43.8% scored in the mildly impaired range, 51.3% scored in the moderately impaired range, and 4.2% scored in the severely impaired range. In comparison, among scores for the 44.8% comprising reported non-drivers, 2.6% were unimpaired, 28.2% were mildly impaired, 64.1% were moderately impaired, and 5.1% were severely impaired. Table 3 shows that the majority of the non-drivers scored in the moderately impaired range.

Table 3. Driving Status and Impairment level on VOT scores.

	VOT IMPAIRMENT LEVEL			
Driving Status	**None**	**Mild**	**Moderate**	**Severe**
Current Driver	20.8%	43.8%	31.3%	4.2%
Not Driving	2.6%	28.2%	64.1%	5.1%

Item Analysis

The VOT has been found to have some defective test items (see Merten, 2002; Merten & Beal, 2000). In our sample, some VOT items were missed more often relative to other items and other VOT items were correct, regardless of driving status. For example, 97.7% of the sample answered item 2 (saw) correctly and 93.1% of the sample answered item 30 (broom) incorrectly. Therefore, item analysis in relation to overall total performance was used to determine which items were strong discriminators in overall Total Score. Spearman's rho nonparametric correlations compared subject's VOT total score with responses to the 30 VOT individual test items. The correlations between each of the 30 items and the total score are presented in Table 4. Individual test items with a correlation coefficient of $r \geq .4$ were selected as being the highest discriminators of overall performance. Fourteen VOT test items fit the criteria and were selected for further analysis.

Table 4. Total HVOT score and Spearman's rho correlation for all thirty HVOT Individual Items.

HVOT Item Number and Full-credit Response	**Spearman's rho Correlation Coefficient**
1. Fish	.232*
2. Saw	.021
3. Table, Bench	.171
4. Airplane	.372**
5. Baseball, round ball	.291**
6. Hammer	.429**
7. Dog, Sheep	.253*
8. Truck	.246*
9. Cup	.431**
10. Hand	.378**
11. Apple, Peach, etc.	.451**
12. Basket	.370**
13. Scissors	.439**
14. Cane, Hockey Stick	.361**
15. Sailboat, Boat	.353**
16. Teakettle	.320**
17. Chair	.506**
18. Candle	.377**
19. Teapot, Cream Pitcher	.561**
20. Cat	.582**
21. Flower, Pansey, etc.	.359**
22. Mouse, Guinea Pig, etc.	.582**
23. Book	.457**
24. Rabbit	.432**
25. Block	.681**
26. Lighthouse	.538**
27. Shoe	.333**
28. Key	.520**
29. Ring	.417**
30. Broom	.219*

* Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).

Logistic Regression

A direct logistic regression analysis was performed on the 14 discriminating test items with a correlation coefficient of $r \geq .4$. A test of the full model with all fourteen predictors against a constant-only model was statistically reliable, χ^2 (14, $N = 87$) = 46.66, $p = .001$, indicating that the predictors, as a set, reliably distinguished between elderly people who drive and those who do not drive. The variance in driving status was moderate with Nagelkerke $R^2 = .56$. Prediction success was impressive, with 85% of the drivers and 74% of the non-drivers correctly predicted, for an overall success rate of 80.5%.

Table 5 shows regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for odds ratios for each of the 14 predictors. According to the Wald criterion, only four of these selected individual test items reliably predicted driving status: items 6 (hammer), 19 (teapot/cream pitcher), 22 (mouse), and 25 (block) (italicized items in Table 5). Models run with gender and/or marital status were not reliably different from a constant-only model, however, this model was reliably different from the full model. This confirms the finding that the four individual test items (6, 19, 22, and 25) are the only reliable predictors of driving status among the 14 predictor variables. However, the odds ratios show little change in the likelihood of driving status on the basis of one unit change in item score except for item 25 (block) (odds ratio = 5).

Table 5. Logistic Regression Analysis of Driving Status as a function of fourteen VOT individual test items. Four HVOT items (**italics*) were significant predictors of driving status.

HVOT Item	β	Wald Test (z-ratio)	Sig.	Odds Ratio	95% Confidence Interval for Odds Ratio *Lower*	*Upper*
*#6. Hammer**	*-3.260*	*8.829*	*.003*	*.038*	*.004*	*.330*
#9. Cup	.976	1.670	.196	2.653	.604	11.653
#11. Apple	.905	.707	.400	2.472	.300	20.390
#13. Scissors	-.609	.624	.429	.544	.120	2.465
#17. Chair	-.668	.394	.530	.513	.064	4.128
*#19. Teapot, Cream Pitcher**	*-1.753*	*4.649*	*.031*	*.173*	*.035*	*.852*
#20. Cat	.755	.507	.476	2.128	.266	17.019
*#22. Mouse**	*-2.221*	*7.927*	*.005*	*.108*	*.023*	*.509*
#23. Book	-1.301	1.528	.216	.272	.035	2.143
#24. Rabbit	-.208	.093	.760	.812	.214	3.080
*#25. Block**	*1.609*	*3.341*	*.068*	*4.996*	*.890*	*28.043*
#26. Rocket	.421	.328	.567	1.523	.361	6.429
#28. Iron	-2.425	1.240	.266	.088	.001	6.320
#29. Key	1.187	.255	.614	3.279	.003	329.896
(Constant)	4.518	1.621	.005	91.672		

* Significant.

Discussion

The current results suggest that four items on the VOT may be a useful part of a brief and efficient screening test to identify drivers who are at potential risk and who should or should not be referred for further testing. There are several advantages to using the VOT as a screener for neurocognitive abilities related to driving. The VOT can be administered and scored in less than 15 minutes, can be administered by both professionals and paraprofessionals, and can be used in a variety of settings (Hooper, 1983). Assuming the participants in this study had a neurocognitive basis for their decision to drive or not drive, the four VOT items appear to be useful in predicting driving status in dementia individuals with an 85% accuracy. Therefore, those individuals who pass the four identified discriminating VOT items -- Hammer, Teapot/Pitcher, Mouse, and Block – have a high predicted probability of being active drivers. It is interesting to note that item analysis by Merten and Beal (2000) specifically showed item number 6 (Hammer) as a poor correlate to other neurocognitive measures.

Valcour et al. (2002) found driving frequency to decrease as cognitive test performance decreased. To a point, we found similar results in that the majority of those not driving scored in the moderately impaired range compared to the majority in the driving category who scored in the mildly impaired range. However, those in the driving category had more than 35% of the sample score in the moderate to severely impaired range, which according to Lezak (1995) is indicative of organic brain pathology. The large percentage of driving individuals scoring in the impaired range suggests that individuals, their families and others are not intervening with driving behavior, possibly placing the individual and the public at risk.

It appears that the restricted driving status of those in our study sample was self-regulated based on neurocognitive factors and not due to other reasons. Marital status and gender were not significant predictors in determining driving status with individual VOT items, or with VOT Total Score. This provides further support that our findings are due to VOT performance, and that driving restrictions were not due to confounding factors such as reliance on a spouse regardless of self-perceived cognitive status, nor that the non-driving females in this cohort have no driving history and would not be driving regardless of cognitive abilities.

It should be noted that the VOT's predictive ability should remain only as part of a larger screening battery. Although cognitive function tests are considered an improvement over statistical attempts to identify unsafe drivers (Ranney, 1994), cognitive tests alone have been considered insufficient predictors of driving performance (Brooke, Questad, Patterson & Valois, 1992; Lundqvist, 2001). The VOT in particular is not intended to be used as a unitary tool (Hooper, 1983). Many (Lundqvist, 2001; Myers et al., 2000; Nouri & Lincoln, 1993) contend it remains imperative to evaluate neurocognitive performance relative to a road test to validate inept driving ability. In fact, taken individually, on-road driving ability has often been found to differ from the capabilities of drivers (Ranney, 1994), and neuropsychological measures often show a high rate of interindividual variability in how the elderly perform (Owsley et al., 1991). Even though Galski et al. (1990) found little correlation between individual neuropsychological measures and an on-road evaluation outcome, it appears that when used together, difficulties with processing simultaneous and successive information not found with a neuropsychological test may be evident when actually driving (Lundqvist, 2001) and vice versa. When used in combination, empirically-validated neurocognitive evaluations could identify relevant cognitive factors and road tests could demonstrate any utilized compensatory mechanisms that may permit a person to continue to drive safely. It appears that in order to understand driving problems, collaboration between a mentally based neurocognitive evaluation and an activity based road test is essential. Driving simulators may be an alternative to on road evaluation's additional usage of time, money, and energy requirements. With appropriate evaluative measures, early reports (Lee et al., 2002) suggest that driving simulators have been found to measure "driving skills at the controlled processing level" and to be effective in differentiating levels of driving skill in elderly individuals (p. 143). After the initial cost, driving simulators could be a safe and less expensive way to evaluate skills used during actual driving. Nevertheless, dementia, by nature is progressive and neurocognitively degenerative. Early cognitive signs of risk can alert clinicians to the need for specific and close monitoring and to the need for an actual road test, or to undergo a simulator test when simulator tests are further validated.

Future studies examining specific test items used to predict driving status might provide additional insight, but should also include a larger study population, the experience of drivers and the reasons an individual is a non-driver. One limitation in the current study is that the sample size was not large enough for a direct logistic analysis of all thirty VOT items. Only patients who completed the VOT and who had a diagnosis of some form of dementia were included in the sample. A form of item analysis was the intended goal of the study, however, a larger sample size would have permitted an additional statistical logistic regression analysis of the entire VOT battery regardless of correlation with total score.

A second limitation present in this study is that driving experience was not known. As stated above, driving experience has great potential to impact a person's performance on an on-road evaluation and may also correlate with an individual visual-perceptual strength that affected HVOT performance. Experienced drivers may have more adaptive capacities on the road than inexperienced drivers, despite neurocognitive impairments (Lundqvist, 2001), and this cognitive strength may also transfer to neuropsychological measures.

Many unknown confounds could be present if a person in our sample ceased driving due to reasons other than neurocognitive decrements. Most of our sample contained individuals with mild dementia which poses more ambiguity with decisions impacting driver safety (Valcour et al., 2002). Separating specific reasons for not driving -- financial, having a spouse or other person to transport -- may further differentiate correlates of neurocognitive performance and driving status. Other studies that explored reasons older persons stopped driving yielded differing results. From a large population-based health survey, Chipman et al. (1998) found that gender and marital status were more influential than the presence of chronic disease as the reason for driving cessation. Chipman et al. further concluded that married people of either gender or unmarried males were more likely to be drivers, and people living in households of three or more people were less likely to be drivers. In contrast, Hakameies-Blomqvist and Wahlstrom (1998) found that deteriorating health was the most influential reason for elderly men to stop driving, and women were more likely to experience driving-related stress and thus avoid driving frequency. Ball, Owsley, Stalvey, Roenker, Sloane, & Graves (1998) found that older drivers who had a history of automobile accidents and/or who had impairments self-regulated their driving more and avoided potential risks more frequently than crash-free and /or non-impaired drivers. The reasons a person stops driving appear to be multifaceted, however, when trying to predict or influence an individual's driving status, the reason for the current status can provide useful and relevant information regarding appropriate interventions.

Using self-reported driving status may be considered a limitation, however, there are more potential advantages than disadvantages to using self-reported driving status versus state recorded driving status. A person legally holding a license to drive a vehicle does not necessarily indicate his or her driving status and/or driving ability. In addition, if a person does not legally have a license to drive, there is no certainty of absent driving behavior.

It is important to note that although identifying problem drivers is a significant public health issue, it is equally important to not discriminate against many older people who remain competent drivers. It is not inevitable that age-related declines will affect driving abilities (Klavora & Heslegrave, 2002). Studies have shown that restricting driving based solely on age or age-related declines in vision and cognition are unfounded (Ball et al., 1993). Driving is important to an individual's sense of independence (Daigneault et al., 2002; Valcour et al., 2002). Our society is very automobile dependent and prohibition of driving privileges leads to increasing isolation (Klavora & Heslegrave, 2002) and many limitations for elderly individuals for whom transportation is unavailable (Taylor & Tripodes, 2001). Daigneault et al. (2002) found that in order to preserve their autonomy many at-risk drivers continued to drive because alternative transportation was not available. The loss of driving privileges has been associated with adverse effects on an elderly individual's independence, quality of life, and level of depression (Marottoli et al., 1997). These issues are especially relevant for a person in a mild stage of dementia. In the case of those with advanced dementia, however, the transportation problems may be less than for other non-demented, non-driving elderly because these individuals are less likely to live alone and thus have a potential driver available (Taylor & Tripodes, 2001).

Although studies have shown older individuals with driving difficulties can improve the necessary skills through training programs (Ball et al., 1993), there is little that can be done to improve driving performance in individuals with dementia (Klavora & Heslegrave, 2002). Driving is an obviously complex activity that intrinsically involves personal, familial, and public health factors. Social factors of employment, marital status, living arrangements, and available transportation have a profound effect on individual's experience when they cease driving (Chipman et al., 1998). There is an explicable cognitive component to driving safely (Owsley et al., 1991). In general, as cognitive impairment increases driving risk increases (Daigneault et al., 2002; Ranney, 1994). Therefore, as part of a healthcare team, neuropscyhologists can play an important role in assessing and monitoring the cognitive processes related to driver safety as well as the personality and familial issues that can impact driving behaviors while keeping a balance between preserving personal autonomy along with maintaining personal and public safety.

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