ELSEVIER

Archives of Clinical Neuropsychology 21 (2006) 405–412

Archives of CLINICAL NEUROPSYCHOLOGY

Cognitive correlates of HVOT performance differ between individuals with mild cognitive impairment and normal controls

Angela L. Jefferson [a,*], Sarah Wong [a,b], Elizabeth Bolen [a,b], Al Ozonoff [c], Robert C. Green [a,d], Robert A. Stern [a]

[a] *Alzheimer's Disease Center & Department of Neurology, Boston University School of Medicine, Robinson Complex, Suite 7800, 715 Albany Street, Boston, MA 02118-2526, United States*
[b] *Department of Biology, Tufts University, Medford, MA, United States*
[c] *Department of Biostatistics, Boston University School of Public Health, Boston, MA, United States*
[d] *Department of Epidemiology, Boston University School of Public Health, Boston, MA, United States*

Accepted 15 June 2006

Abstract

Objective: To clinically characterize performance on the Hooper Visual Organization Test (HVOT) among participants with mild cognitive impairment (MCI) and to identify naming and executive functioning correlates associated with HVOT performance among MCI participants and normal controls (NC).

Background: The HVOT is a common neuropsychological instrument that measures visuospatial skills and agnosia. It has, however, been criticized for its multifactorial nature, as several studies have reported executive or language correlates of HVOT performance. To our knowledge, simultaneous comparison of executive functioning and language demands of the HVOT has never been performed among an older cohort.

Methods: The HVOT, two tests of executive functioning [Trail Making Test, Part B (TMT-B), Controlled Oral Word Association (COWA)] and two tests of naming [abbreviated Boston Naming Test (BNT), Animal Naming] were administered to 222 NC, 166 MCI, and 68 Alzheimer's disease (AD) individuals.

Results: HVOT scores were significantly different between all three groups in the expected direction (AD < MCI < NC). Linear regression among NC participants revealed that COWA, age, and BNT were significantly associated with HVOT scores, accounting for 12%, 6%, and 4% of HVOT variance, respectively. Among MCI participants, the BNT accounted for 43% of HVOT variance. Neither TMT-B nor Animal Naming was a significant predictor for either group.

Conclusion: Among NC participants, rapid word generation (i.e., COWA), a measure of executive functioning, is the most salient predictor of HVOT performance. In contrast, lexical retrieval (i.e., BNT) is the most salient language or executive functioning predictor of HVOT performance among MCI participants. These findings extend previous claims that the HVOT is multifactorial by suggesting that reduced HVOT performance in MCI patients may be related to mild lexical retrieval impairments.

Keywords: Object recognition; Mild cognitive impairment; Hooper Visual Organization Test

* Corresponding author. Tel.: +1 617 414 1129; fax: +1 617 414 1197.
E-mail address: angelaj@bu.edu (A.L. Jefferson).

0887-6177/$ – see front matter © 2006 National Academy of Neuropsychology. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.acn.2006.06.001

1. Introduction

The Hooper Visual Organization Test (HVOT; Hooper, 1983) is a common neuropsychological instrument for assessing agnosia and visuospatial skills. The HVOT consists of 30 line-drawings of segmented objects that require mental integration for identification. Though the HVOT has good psychometric characteristics, including strong test–retest reliability (Lezak, Howieson, & Loring, 2004; Lopez, Lazar, & Oh, 2003) and good construct validity (Nadler, Grace, White, Butters, & Malloy, 1996), previous research in both younger and older adults suggests that multiple cognitive processes such as perceptual integration, naming ability, and executive functioning are necessary for task completion.

Research examining the various cognitive processes necessary for HVOT performance among older adults is limited. Libon et al. (1994) examined the relationship between executive functioning and visuospatial skills among healthy, older adults and found a significant association between HVOT performance and multiple measures of executive functioning. However, findings examining the relevance of naming abilities to HVOT performance have been mixed. Among patients with vascular dementia, Paul et al. (2001) reported that naming was not strongly associated with HVOT performance. In contrast, among older stroke patients (Greve, Lindberg, Bianchini, & Adams, 2000), naming appears to be strongly correlated with HVOT task performance. The discrepancy between these two findings may be secondary to the fact that the patients in the former study suffered primarily from subcortical vascular disease, while the patients in the latter study suffered from cortical strokes. Therefore, participants from the Greve et al. (2000) study may have experienced more aphasia, which could impact their HVOT performance and account for the relevance of naming abilities. To our knowledge, no study has simultaneously compared language and executive functioning demands of HVOT performance among a geriatric cohort to determine the relative contribution of each domain to task completion. Such information would have clinical relevance when interpreting HVOT performances among older adults.

The purpose of the present study was to identify the cognitive correlates of HVOT performance among older adults who are free of cognitive impairment (i.e., normal controls (NC)) as well as those with mild cognitive impairment (MCI). The HVOT has been implemented across numerous studies assessing object recognition in diverse populations (e.g., stroke and dementia patients), but performance among individuals with MCI has not yet been reported. Thus, the aim of this study was to *identify the naming and executive functioning correlates associated with HVOT performance.* Among the NC sample, we hypothesized that performance on executive functioning tasks (e.g., TMT-B, COWA) would be more closely correlated with HVOT performance than naming tasks (e.g., BNT, Animal Naming) because naming abilities are generally more preserved than executive functioning skills in the healthy elderly. However, for the MCI sample, we anticipated that both executive function and naming would be relevant. The rationale for this hypothesis is based on the assumption that MCI is often a prodromal phase of Alzheimer's disease (AD), and these cognitive domains are both affected by the evolving neuropathological burden. As a secondary aim, we compared the HVOT scores of MCI participants to that of NC and AD participants to demonstrate the clinical significance of the MCI group's performance.

2. Methods

2.1. Participants

The present study utilized data from the research registry of the Boston University Alzheimer's Disease Core Center (BU ADCC), which longitudinally follows older persons with and without memory problems. The current study included 456 participants, ranging in age from 55 to 95 years. As part of their annual registry evaluation, participants undergo a comprehensive neurodiagnostic workup, including neurological and neuropsychological examination. Inclusion criteria require that participants be community dwelling and English speaking, with adequate hearing and visual acuity to participate in the examinations. Exclusion criteria include a history of major psychiatric illness (e.g., schizophrenia, bipolar disorder), neurological illness (e.g., stroke, epilepsy) or head injury with significant loss of consciousness. Diagnoses for participants are reached via consensus conference involving a multidisciplinary team that includes a minimum of two board certified neurologists and two neuropsychologists (A.J., R.S.).

After undergoing the aforementioned neurodiagnostic workup and consensus conference, 222 individuals were designated as normal controls (NC). Criteria for inclusion in this group included all objective cognitive performances within the normal range and a Clinical Dementia Rating score (CDR; Morris, 1993) = 0.

MCI participants included 166 individuals meeting widely accepted research criteria (Petersen, 2004; Winblad et al., 2004) that includes a decline from previous level of functioning, a lack of dependence in traditionally defined activities of daily living (Lawton & Brody, 1969), and objective cognitive impairment. Cognitive impairment was based on neuropsychological data from the BU ADCC registry annual visit with impairment defined as performance falling at least 1.5 standard deviations below available normative data on primary variables derived from the ADCC comprehensive neuropsychological protocol. All MCI participants had a CDR = 0.5. Per aforementioned published criteria, MCI participants were categorized into one of four subtypes, including: (1) multiple cognitive domain involvement with amnestic features ($n = 55$), (2) multiple cognitive domain involvement without amnestic features ($n = 13$), (3) single cognitive domain involvement with amnestic features ($n = 66$), (4) and single cognitive domain involvement without amnestic features ($n = 32$).

AD participants included 68 individuals meeting NINCDS-ADRDA criteria (McKhann et al., 1984) for probable ($n = 34$) or possible AD ($n = 34$) with CDR scores ≥ 1.0.

2.2. Neuropsychological evaluation

Participants completed a comprehensive neuropsychological protocol brief enough to enhance compliance but of sufficient length to encompass multiple cognitive components, including global cognition, language, verbal and nonverbal visuospatial memory, attention and information processing speed, executive functioning, visuospatial skills, and motor functions. The following select measures from the protocol are discussed in detail because of their relevance to the current study:

- *Mini-Mental State Examination* (MMSE; Folstein, Folstein, & McHugh, 1975) is a measure of global cognition, and scores range 0–30. Lower scores indicate greater global cognitive impairment.
- *Boston Naming Test* (BNT; Fisher, Tierney, Snow, & Szalai, 1999) is a language measure assessing naming and lexical retrieval abilities. This study included an abbreviated version based on even items from the original 60-item BNT (Kaplan, Goodglass, & Weintraub, 1983). Raw scores range 0–30, and lower scores indicate greater impairment.
- *Animal Naming* (Spreen & Strauss, 1991) is a language measure assessing semantic fluency, which is sensitive to temporal lobe structures (Pihlajamaki et al., 2000). Participants are asked to name all the animals that come to mind during a 60-s trial, and total scores reflect the number of animals recalled (excluding repetitions). Higher scores denote better performance.
- *Controlled Oral Word Association* (COWA; Spreen & Strauss, 1991) is a test of rapid word generation that is considered a measure of executive functioning because of its reported sensitivity to frontal systems (Abrahams et al., 2003). Raw scores reflect the total number of words generated across three letters (F, A, S) during three separate 60-s trials. Lower scores indicate greater impairment.
- *Trail Making Test, Part B* (TMT-B; Reitan, 1958) is an executive function measure that assesses visual search and set shifting abilities. Participants quickly alternate the connection of numbers and letters in order, which are randomly arranged on a page. Time to completion is the dependent variable, and higher scores denote worse performance.
- *Hooper Visual Organization Test* (*HVOT;* Hooper, 1983) is a measure of object recognition. Total scores range 0–30, and greater scores denote better performance.
- *Geriatric Depression Scale* (GDS; Yesavage et al., 1983) is a 30-item, self-report questionnaire assessing mood. Total scores range 0–30. Scores between 0 and 10 suggest the absence of depressed mood, and scores between 11 and 30 suggest the presence of depressed mood.

2.3. Procedure

The local Institutional Review Board approved data collection efforts for this study, and written informed consent was obtained from all participants, as well as co-consent from study partners, prior to testing. Neuropsychological evaluations were conducted in a single session for all participants. With respect to the neuropsychological protocol, it is noteworthy that five participants in the NC group were excluded secondary to the participants' completion of a 15-item version of the BNT, instead of the 30-item version. Therefore, data analyses that included both the HVOT and BNT scores (e.g., regression analyses) consisted of 217 participants secondary to pairwise data deletion.

Table 1
Participant demographic information

Variable	NC participants ($n = 222$)	MCI participants ($n = 166$)	AD participants ($n = 68$)
Age (years)	72.0 (8.4)	71.4 (8.2)	78.4 (7.2)
Education level (years)	16.4 (2.9)	14.7 (3.6)	13.8 (3.2)
MMSE	29.2 (1.2)	28.3 (1.8)	22.9 (4.0)
GDS	3.9 (4.5)	5.3 (5.2)	6.2 (5.9)
Sex (%female)	66	57	52

Values are *M* (S.D.). *Note*. NC, normal control; MCI, mild cognitive impairment; AD, Alzheimer's disease; *M*, mean; S.D., standard deviation; MMSE, Mini-Mental State Examination; GDS, geriatric depression scale.

2.4. Data analysis plan

Descriptive statistics and frequencies were generated to summarize demographic variables (i.e., age, education, sex) as well as global cognitive status (i.e., MMSE) and mood (i.e., GDS). Between-group comparisons were conducted utilizing independent samples *t*-tests for age, education, GDS score, and MMSE.

The sample was trichotomized according to diagnostic category (i.e., NC, MCI, and AD). An analysis of covariance (ANCOVA) was conducted to compare HVOT performance among the groups, while adjusting for age, education, and mood (i.e., GDS). Statistical significance was set a priori at $\alpha = 0.05$. Post hoc pairwise comparisons between groups were conducted using a Bonferroni adjustment to account for multiple testing.

Hypothesis testing was limited to the NC and MCI groups secondary to a relatively small sample size for the AD group ($n = 68$). Prior to analyses, a Pearson correlation matrix was generated among all of the neuropsychological measures of interest (i.e., MMSE, TMT-B, COWA, BNT, Animal Naming, and HVOT). To account for multiple comparisons, a priori significance was set at $\alpha = 0.001$, based on a Bonferroni adjustment. For hypothesis testing, two separate stepwise multiple regressions were utilized to examine the relative contribution of several predictor variables assessing executive functioning (i.e., TMT-B and COWA) and language (i.e., BNT and Animal Naming) to a criterion variable (i.e., HVOT). Three covariates were included in the regression model to account for age, education, and GDS score. The first regression was restricted to the NC group, while the second regression was limited to the MCI group. Statistical significance was set a priori at $\alpha = 0.05$.

3. Results

3.1. Demographic characteristics

Descriptive statistics, including means and standard deviations, were calculated for all participant demographic variables (e.g., age, education level; Table 1) and neuropsychological performances (Table 2). Between-group comparisons of the NC, MCI, and AD groups revealed significant differences for age ($F_{(2,453)} = 23.7$, $p < .0001$), education level ($F_{(2,453)} = 18.9$, $p < .0001$), GDS score ($F_{(2,437)} = 6.9$), $p = .001$), and MMSE ($F_{(2,452)} = 246.2$, $p < .0001$). Post hoc comparisons revealed that the NC group was generally more educated than both MCI ($p < .0001$) and AD ($p < .0001$)

Table 2
Means and standard deviations for cognitive measures

Measure	NC	MCI	AD
Executive functioning			
TMT-B	75.0 (30.3)	126.4 (75.7)	190.4 (92.3)
COWA	48.5 (13.6)	38.1 (14.0)	28.8 (13.2)
Language			
BNT	28.7 (1.7)	25.9 (4.4)	22.4 (4.5)
Animal Naming	21.5 (5.8)	16.1 (5.0)	10.6 (4.8)
HVOT	26.2 (2.6)	23.1 (4.5)	18.5 (5.7)

Note. NC, normal control; MCI, mild cognitive impairment; AD, Alzheimer's disease; TMT-B, Trail Making Test, Part B; COWA, Controlled Oral Word Association; BNT, Boston Naming Test; HVOT, Hooper Visual Organization Test.

Table 3
Correlations among cognitive tests for NC participants

	TMT-B	COWA	BNT	Animal Naming	HVOT
MMSE	−.27**	.20	.17	.09	.25*
TMT-B	–	−.31**	−.23*	−.31**	−.29**
COWA		–	.28**	.44**	.23*
BNT			–	.27*	.28**
Animal Naming				–	.27*
HVOT					–

* $p < .001$.
** $p < .0001$.

groups. AD participants were significantly older than both NC ($p < .0001$) and MCI participants ($p < .0001$). AD participants also had significantly higher GDS scores than NC participants ($p = .001$). NC participants outperformed MCI ($p < .0001$) and AD ($p < .0001$) participants on the MMSE, while MCI outperformed AD participants ($p < .0001$).

3.2. Between group comparisons for HVOT performance

Because of the significant differences noted above, age, education, and GDS score were included as covariates in the between-group analysis for HVOT performance. A significant between-group difference was noted for HVOT performance ($F_{(2,440)} = 54.37$, $p < .0001$). As expected, pairwise comparisons revealed significant differences among all groups, as NC participants outperformed MCI ($p < .0001$) and AD participants ($p < .0001$), and MCI participants outperformed AD participants ($p < .0001$). See Table 2 for group means and standard deviations.

3.3. Correlations

3.3.1. NC participants

Modest correlations were observed between the HVOT and all cognitive measures of interest, including the TMT-B ($r = -.29$, $p < .0001$), COWA ($r = .23$, $p < .001$), Animal Naming ($r = .28$, $p < .001$) and BNT ($r = .27$, $p < .0001$; see Table 3).

3.3.2. MCI participants

Again, significant correlations were noted between the HVOT and all cognitive measures, including TMT-B ($r = -.41$, $p < .0001$), COWA ($r = .34$, $p < .0001$), and Animal Naming ($r = .44$, $p < .0001$). However, the strongest correlation was noted between the HVOT and BNT ($r = .69$, $p < .0001$; see Table 4).

3.4. Multiple regressions

3.4.1. NC participants

Among the NC participants, the regression model was significant ($F_{(3,134)} = 12.7$, $p < .0001$), accounting for 22.1% (Adjusted $R^2 = .204$) of the total variance of the HVOT measure. The final model revealed that three variables accounted

Table 4
Correlations among cognitive tests for MCI participants

	TMT-B	COWA	BNT	Animal Naming	HVOT
MMSE	−.40*	.41*	.48*	.38*	.35*
TMT-B	–	−.33*	−.41*	−.29	−.41*
COWA		–	.37*	.44*	.34*
BNT			–	.52*	.69*
Animal Naming				–	.44*
HVOT					–

* $p < .0001$.

for a significant portion of the variance including COWA (12.1%; $t = 2.64$, $p = .009$), age (6.0%; $t = -3.15$, $p = .002$) and the BNT (4.0%; $t = 2.68$, $p = .008$).

3.4.2. MCI participants

Among the MCI participants, the regression model was also significant ($F_{(1,92)} = 70.04$, $p < .0001$), accounting for 43.2% (Adjusted $R^2 = .43$) of the total variance of the HVOT measure. The final model revealed that only the BNT accounted for a significant portion of the variance ($t = 8.37$, $p < .0001$).

4. Discussion

The primary goal of our study was to assess the independent contribution of executive functioning and language skills to HVOT performance among cognitively intact geriatric participants and individuals with MCI. Our hypotheses were partially supported, as one element of executive functioning (i.e., rapid word generation as assessed by COWA) accounted for the most variance among the NC group. Additionally, age and naming ability were modestly associated with HVOT performance. Collectively, these findings suggest that HVOT performance among geriatric controls is more strongly related to executive functioning; however, to a lesser extent, advanced age and language are associated with task completion. These data compliment the extant literature, as Libon et al. (1994) found that integrative visuospatial tasks, defined as those requiring substantial integrational ability, were strongly correlated with executive function tests, including COWA. Furthermore, neuroimaging evidence among normal controls suggests HVOT performance is associated with bilateral activation that includes not only parietal and occipital areas but also the lateral inferior/middle precentral gyrus within the left frontal lobe (Moritz, Johnson, McMillan, Haughton, & Meyerand, 2004). Thus, our findings are consistent with previous reports of an association between HVOT performance and executive functioning or frontal regions mediating such cognitive tasks.

Among the MCI sample, our hypotheses were again partially supported. HVOT performance was associated with lexical retrieval ability; however, executive functioning measures were not significant predictors. There are a couple of possible explanations for this finding. First, the unexpected association of naming with HVOT performance among the MCI participants may be related to the fact that MCI often reflects prodromal AD (Petersen et al., 1999). It is well known that AD involves progressive deterioration of multiple cognitive systems, of which naming is often a prominent symptom. Therefore, many MCI participants in our sample likely have mild naming difficulties consistent with preclinical AD, which could account for the association between the BNT and HVOT. It is noteworthy to mention that among the non-amnestic single-domain MCI participants ($n = 32$), BNT performance was not utilized in determining language impairment. Rather, alternate language tasks included in the broader ADCC neurodiagnostic workup were responsible for characterizing subgroup membership for those MCI participants with isolated language impairments. Therefore, we submit that the association between BNT and HVOT performance is not statistically driven by the MCI subtype with isolated language deficits restricted to BNT performance. A second explanation for the unique association between BNT and HVOT is task similarity, as both tests include line drawings of common objects that examinees must name. The tasks' shared perceptual features appear to be a logical explanation for our findings; however, this explanation is undermined by the absence of a strong association between HVOT and BNT performance in the elderly control sample. Therefore, we propose that naming ability is uniquely associated with HVOT performance among individuals with MCI.

As a secondary aim, the present study compared HVOT performance across several diagnostic categories, including NC, MCI, and AD participants. Consistent with expectation, the NC group outperformed the MCI and AD groups, while the MCI group outperformed the AD group. These findings are the first to report HVOT performances among MCI participants in comparison to other diagnostic categories, and our data support the notion that MCI is often a transitional stage between normal cognitive function and clinically probable AD (Winblad et al., 2004).

A strength of our study is the examination of MCI participants, as no study has previously reported HVOT performance among this diagnostic group. Furthermore, we extend previous research (e.g., Libon et al., 1994; Paul et al., 2001) by simultaneously examining the impact of executive functioning and language on HVOT performance. Despite these strengths, a few limitations must be considered, which restrict the generalizability of our findings. Though we simultaneously considered the impact of executive functioning and language on HVOT performance, we did not include a visuoperceptual measure to isolate the perceptual demands of the HVOT, as this was not a goal of our study. In the absence of a visuoperceptual covariate, we are unable to specify the extent to which language and or executive function

impact HVOT performance *above and beyond* visuoperceptual skills. Future investigators may want to simultaneously compare perceptual, linguistic, and executive functioning demands to further elucidate the multifactorial nature of HVOT performance among older adults with and without cognitive impairment.

In summary, this study characterized HVOT performance for MCI participants and identified language and executive functioning correlates of HVOT performance among healthy elders and individuals with MCI. Results suggest NC participants outperform both MCI and AD participants, while MCI participants outperform AD participants. Additionally, rapid word generation, a measure of executive functioning, is the most salient correlate of HVOT performance among NC participants. In contrast, among MCI participants, lexical retrieval is the most salient language or executive functioning correlate of HVOT performance. Taken together, these findings support the notion that MCI is often a transitional stage between normal aging and dementia, and variations in cognitive functions associated with the cognitive aging spectrum account for unique correlates of HVOT performance. Such information is useful in clinical practice when interpreting HVOT performance among older patients suspected of having MCI.

Acknowledgement

This research was supported by F32-AG022773 (A.L.J.), K12-HD043444 (A.L.J.), R01-AG009029 (R.C.G.), R01-HG002213 (R.C.G.), P30-AG013846 (Boston University Alzheimer's Disease Core Center), and M01-RR000533 (General Clinical Research Centers Program of the National Center for Research Resources, NIH). The authors wish to thank Dr. Robert Paul for his insightful comments on an earlier version of this manuscript.

References

Abrahams, S., Goldstein, L. H., Simmons, A., Brammer, M. J., Williams, S. C., Giampietro, V. P., et al. (2003). Functional magnetic resonance imaging of verbal fluency and confrontation naming using compressed image acquisition to permit overt responses. *Human Brain Mapping*, *20*(1), 29–40.

Fisher, N., Tierney, M., Snow, W., & Szalai, J. (1999). Odd/even short forms of the Boston Naming Test: Preliminary geriatric norms. *The Clinical Neuropsychologist*, *13*(3), 359–364.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*(3), 189–198.

Greve, K. W., Lindberg, R. F., Bianchini, K. J., & Adams, D. (2000). Construct validity and predictive value of the Hooper Visual Organization Test in stroke rehabilitation. *Applied Neuropsychology*, *7*(4), 215–222.

Hooper, H. (1983). *Hooper Visual Organization Test (HVOT)*. Los Angeles: Western Psychological Services.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *The Boston Naming Test* (2nd ed.). Philadelphia: Lea & Febiger.

Lawton, M. P., & Brody, E. M. (1969). Assessment of older people: Self-maintaining and instrumental activities of daily living. *The Gerontologist*, *9*(3), 179–186.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). New York: Oxford University Press.

Libon, D. J., Glosser, G., Malamut, B. L., Kaplan, E., Goldberg, E., Swenson, R., et al. (1994). Age, executive functions, and visuospatial functioning in healthy older adults. *Neuropsychology*, *8*(1), 38–43.

Lopez, M., Lazar, M., & Oh, S. (2003). Psychometric properties of the Hooper Visual Organization Test. *Assessment*, *10*(1), 66–70.

McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology*, *34*(7), 939–944.

Moritz, C. H., Johnson, S. C., McMillan, K. M., Haughton, V. M., & Meyerand, M. E. (2004). Functional MRI neuroanatomic correlates of the Hooper Visual Organization Test. *Journal of the International Neuropsychological Society*, *10*(7), 939–947.

Morris, J. (1993). The Clinical Dementia Rating (CDR): current version and scoring rules. *Neurology*, *43*(11), 2412–2414.

Nadler, J. D., Grace, J., White, D. A., Butters, M. A., & Malloy, P. F. (1996). Laterality differences in quantitative and qualitative Hooper performance. *Archives of Clinical Neuropsychology*, *11*(3), 223–229.

Paul, R., Cohen, R., Moser, D., Ott, B., Zawacki, T., & Gordon, N. (2001). Performance on the Hooper Visual Organizational Test in patients diagnosed with subcortical vascular dementia: Relation to naming performance. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *14*(2), 93–97.

Petersen, R. C. (2004). Mild cognitive impairment as a diagnostic entity. *Journal of Internal Medicine*, *256*(3), 183–194.

Petersen, R. C., Smith, G. E., Waring, S. C., Ivnik, R. J., Tangalos, E. G., & Kokmen, E. (1999). Mild cognitive impairment: Clinical characterization and outcome. *Archives of Neurology*, *56*(3), 303–308.

Pihlajamaki, M., Tanila, H., Hanninen, T., Kononen, M., Laakso, M., Partanen, K., et al. (2000). Verbal fluency activates the left medial temporal lobe: A functional magnetic resonance imaging study. *Annals of Neurology*, *47*(4), 470–476.

Reitan, R. M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. *Perceptual & Motor Skills*, *8*, 271–276.

Spreen, O., & Strauss, E. (1991). *A compendium of neuropsychological tests*. New York: Oxford University Press.

Winblad, B., Palmer, K., Kivipelto, M., Jelic, V., Fratiglioni, L., Wahlund, L. O., et al. (2004). Mild cognitive impairment—beyond controversies, towards a consensus: Report of the International Working Group on Mild Cognitive Impairment. *Journal of Internal Medicine*, *256*(3), 240–246.

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., et al. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, *17*(1), 37–49.