SAGE-Hindawi Access to Research
Journal of Aging Research
Volume 2011, Article ID 428132, 7 pages
doi:10.4061/2011/428132

Research Article

Estimating Premorbid Intelligence among Older Adults: The Utility of the AMNART

Deborah A. Lowe and Steven A. Rogers

Department of Psychology, Westmont College, 955 La Paz Road, Santa Barbara, CA 93108, USA

Correspondence should be addressed to Deborah A. Lowe, delowe@westmont.edu

Received 7 July 2010; Revised 7 January 2011; Accepted 24 February 2011

Academic Editor: Astrid E. Fletcher

This study examines the utility of the American version of the National Adult Reading Test (AMNART) as a measure of premorbid intelligence for older adults. In a sample of 130 older adults, aged 56 to 104, the AMNART was compared to other tests of premorbid intelligence. The results revealed that AMNART-estimated IQ was significantly higher than other premorbid estimates. Across specific educational groups (i.e., 0–12, 13–16, and 17 or more years of education), AMNART-estimated IQ was inflated relative to all other premorbid estimates. The AMNART also declined as cognitive impairment increased, and there was a significant interaction between aging-related diagnostic group and premorbid estimate. The AMNART may therefore overestimate premorbid ability relative to other premorbid measures, particularly among those with greater cognitive impairment and lower levels of education. These results suggest that the AMNART should be used cautiously among older adults and in conjunction with other estimates of premorbid ability.

1. Estimating Premorbid Intelligence among Older Adults: The Utility of the AMNART

Considering the rapidly burgeoning older population, increased attention is being given to an accurate assessment of older adults' cognitive and neuropsychological functioning. Part of this process involves obtaining a viable estimate of their premorbid cognitive ability or their expected performance prior to any injury or relative decline in cognitive functioning. These premorbid estimates are critical toward determining the nature, type, and severity of cognitive impairment. It is vital when estimating the level of cognitive decline to account for variations in premorbid ability. For example, an older adult might be performing in the average range relative to his or her peers, but this could be a potential decline if his or her previous premorbid abilities were in the high average or superior range. It is also important to obtain a premorbid indicator in addition to age-based norms to account for other factors, such as formal education and occupation, that can contribute to one's intellectual abilities. To this end, various approaches have been developed to estimate premorbid intelligence.

One approach to assessing premorbid functioning among older adults involves the use of demographic variables, such as education, sex, handedness, and occupation [1]. This approach can be useful because the data are gained without lengthy or invasive testing and independent of the patient's current cognitive functioning and therefore remain constant throughout the patient's adult life without being affected by any cognitive decline that may occur [2]. The use of demographic variables has been shown in some studies to be a good estimate of premorbid intelligence among healthy controls [3] and has been recommended over other premorbid estimates for those with Alzheimer's disease [4]. Demographic variables have been found in some cases to improve the accuracy of alternative approaches [5]. However, other studies have found that demographic indices involving education in particular are not always the most accurate estimates of premorbid intelligence in normal aging and Alzheimer's disease [6–8], perhaps reflecting the intellectual development that may occur beyond formal education and continue throughout one's life.

To address some of the inadequacies in relying solely upon demographic variables, other methods of estimating

premorbid intelligence have been suggested, such as the Wechsler Adult Intelligence Scale (WAIS) Verbal IQ, Information, and Vocabulary subtest scores [2, 9]. The most common approach is the use of word reading tests, which require the participant to verbally pronounce orthographically irregular words (e.g., "ache" or "hyperbole"). It is assumed that correct pronunciation of these words, which do not follow common English grammatical rules, implies prior knowledge of them and therefore a higher premorbid intelligence [2]. A variety of different word reading tests have been developed, all of which have their own particular strengths and weaknesses.

One of the most common word reading tests is the National Adult Reading Test (NART) [10, 11], which requires participants to read aloud a list of 50 irregular words. The NART appears to be a good estimate for healthy older adults [12] and has been shown to be more resistant to the effects of age than the WAIS Vocabulary subtest [13–15]. Although some researchers have found the NART to be a good premorbid estimate among those with dementia [12, 15–17], others have found that it actually declines in dementia, therefore implying that it is not impervious to the effects of cognitive impairment [4, 18–20]. Similarly, while some researchers recommend that the NART should not be used among all adult populations, particularly those with organic conditions such as schizophrenia, Korsakoff psychosis, or Huntington's disease [13, 21], others have not found any declines related to these conditions [16].

There has also been mixed evidence regarding the utility of other word reading tests. Alexander and colleagues [6] found that the reading subtest of the Wide Range Achievement Test (WRAT) [22] correlated better than demographic estimates as a cerebral metabolic measure of premorbid cognitive functioning. The North American Adult Reading Test (NAART) [23] was also found to be better than education as an estimate of both premorbid intelligence and overall cognitive functioning [7, 9]. Johnstone et al. [24] found that both the WRAT and the NAART were equally accurate premorbid estimates for those in the average range of intelligence, but they were significant overestimates for those with lower intelligence and underestimates for those with higher intelligence. The Spot-the-Word Test [25], which allows participants to choose the correct low-frequency English word from a pair of words that includes a nonword, has been found to be a good estimate for older adults with normal aging and even mild forms of dementia [3], but it appears to significantly decline in moderate-to-severe forms of dementia [26, 27]. The Cambridge Contextual Reading Test [28], which places NART words within a semantic context, seems to be a better estimate than the NART for those who have dementia or lower reading ability [26–30].

Another commonly used word reading test, the American version of the NART (AMNART) [31], was developed for American English speakers in the USA. Depending on the version, this test consists of either 45 or 50 orthographically irregular English words, with about half identical to NART items [2]. During administration, participants are instructed to pronounce each word out loud, beginning at the top of the list and continuing through the end. Some researchers have suggested that the AMNART is a good estimate of premorbid ability for older adults [31–33]. Pavlik et al. [34] discovered that it was a better premorbid estimate than demographic variables, which do not account for intellectual development occurring after the completion of one's formal education. However, Gladsjo and colleagues [32] found that the AMNART's predictive strength was improved when it was used in conjunction with demographic estimates.

One limitation of the AMNART and similar word reading tests (e.g., NART, NAART) is that they were developed as premorbid estimates in comparison with the WAIS-Revised (WAIS-R) [35]. AMNART-estimated IQ, as calculated by using Grober and Sliwinski's regression equation [31], therefore predicts premorbid intelligence in comparison with WAIS-R normative values. Updated regression equations have not been published to convert AMNART-estimated IQ to the newer normative samples of the WAIS-Third Edition (WAIS-III) [36] or WAIS-Fourth Edition (WAIS-IV) [37]. Despite the slightly outdated regression equation, the AMNART remains a commonly used premorbid estimate, even in conjunction with the WAIS-III [38–42]. In fact, even after the publication of the WAIS-III, Schinka and Vanderploeg [43] still recommend using the AMNART or a similar reading test along with demographic information (e.g., education level) and select WAIS-III subtests (e.g., Information, Vocabulary) when attempting to predict premorbid performance. In the absence of regression equations that are updated for WAIS-III or WAIS-IV normative values, the AMNART is still commonly used as a premorbid estimate.

In addition, there is insufficient amount of data regarding the utility of the AMNART as a premorbid estimate for older adults. Some researchers have argued that the AMNART is not an equally valid measure for all populations and that it should be used with caution. Boekamp et al. [44] found that the AMNART is an overestimate of premorbid functioning for those with lower intelligence, which may reflect a floor effect in the regression equation or a third, mediating variable. In addition, researchers have indicated that the AMNART significantly declines in dementia and have recommended against its use among those with cognitive impairment [44–46]. AMNART scores have even been found to decline before the diagnosis of dementia is ever made, perhaps suggesting a link to the depletion of one's cognitive reserve [47], which is the ability to employ compensatory cognitive strategies and utilize a variety of neural networks for problem solving. Cognitive reserve is developed by factors such as education, occupation, and leisure activities and has been shown to act as a buffer against cognitive decline [48–51]. The larger one's cognitive reserve, the greater the degree of cognitive deterioration that must occur before symptoms of dementia or other forms of cognitive impairment can be detected. Therefore, a decline in AMNART-estimated IQ, even before any formal diagnosis of cognitive impairment, may indicate an insidious depletion of one's cognitive reserve.

In light of the inconclusive data regarding the AMNART, this study examined the utility of AMNART-estimated intelligence scores as a measure of premorbid cognitive ability in older adults. This included examining how it compared to

other commonly used measures of premorbid intelligence, namely, education, WAIS-III Verbal IQ, and the WAIS-III Information subtest [2]. To specifically examine the AMNART's utility among adults with varying levels of education, premorbid measures were examined between different educational groupings. Similarly, the AMNART was compared to other premorbid estimates among different aging-related diagnostic groups to consider its utility as cognitive functioning declines. In light of the limitations highlighted by other researchers, it was hypothesized that AMNART-estimated premorbid ability would be significantly higher than all other premorbid measures and that it would be an overestimate of premorbid functioning for those with dementia and lower levels of education. The final results can help clarify and illuminate the most accurate assessment of older adults' premorbid cognitive and intellectual abilities.

2. Method

2.1. Participants. One hundred and thirty community-dwelling older adults (69% female, 95% Caucasian) between the ages of 56 and 104 voluntarily completed a comprehensive neuropsychological battery (see Table 1 for demographic information). All data were gathered in compliance with the Institutional Review Board affiliated with the authors' institution.

For purposes of examining measures of premorbid ability among older adults at various levels of educational attainment, the sample was divided into three educational groups: those with 0–12 years of education (i.e., high school or lower; $n = 17$), those with 13–16 years of education (i.e., college; $n = 68$), and those with 17 or more years of education (i.e., graduate school; $n = 45$).

Participants were classified as having normal aging ($n = 35$), age-associated memory impairment (AAMI; $n = 21$), mild cognitive impairment (MCI; $n = 59$), or dementia ($n = 15$). AAMI was diagnosed according to Crook and colleagues' criteria [52], MCI was classified according to Petersen and colleagues' criteria [53], and dementia was assessed using the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed. text revision) [54]. Mean scores on the Mini-Mental Status Examination (MMSE) [55] were 29.23 ($SD = 0.81$) for the normal aging group, 28.81 ($SD = 1.44$) for the AAMI group, and 27.98 ($SD = 1.85$) for the MCI group. The dementia group had a mean MMSE score of 22.93 ($SD = 3.83$).

2.2. Materials. The 45-item AMNART [31] was administered as the primary estimate of premorbid ability as part of a larger neuropsychological battery that included the MMSE [55] and eight subtests of the WAIS-III [34]. On the AMNART, errors in pronunciation were tallied and served as the raw score. AMNART-estimated IQ score was calculated using Grober and Sliwinski's formula [31], which also accounts for years of education. Other premorbid estimates included WAIS-III Verbal IQ (VIQ) and WAIS-III Information subtest (Information) scores [34, 56]. All scores were then converted to z-scores for standardization and ease in statistical analyses. Information z-scores were based on the normative data provided in the administration manual [34]. VIQ and AMNART-estimated IQ scores were converted to z-scores based on a mean IQ score of 100 and standard deviation of 15.

Table 1: Correlations between AMNART and variables of interest.

Variable	r	M	SD
Age	−0.01	78.70	10.34
Education	0.42*	15.62	2.61
MMSE	0.41*	27.87	2.67
Premorbid estimate			
AMNART z-score	—	1.31	0.51
VIQ z-score	0.70*	0.78	0.97
Information z-score	0.68*	0.94	0.99

Note. Due to occasional missing data, the smallest sample size was 124.
* $p < .001$.

2.3. Procedure. All participants were given information about the study, and they provided informed consent. They were notified that they would have the option for free feedback at a later time. A brief interview was conducted to gather demographic information, as well as to ascertain the presence of subjective memory complaints and difficulties with activities of daily living. Participants were then administered a comprehensive neuropsychological battery that took approximately three hours to be completed.

2.4. Statistical Analyses. Correlations were conducted between the AMNART and demographic variables, as well as between the AMNART and all other estimates of premorbid functioning (i.e., WAIS-III VIQ and Information). To explore differences in means between the AMNART and other premorbid estimates, a one-way, repeated measures ANOVA was conducted, with the premorbid estimates entered as different levels of the within-subject variable.

To specifically compare premorbid estimates between those with different levels of education, a one-way MANOVA was conducted, which examined performance on tests of premorbid intelligence among different educational groups (i.e., 0–12, 13–16, and 17 or more years of education). To account for an interaction between the variables, a mixed-model ANOVA was run with educational group entered as the between-group independent variable and premorbid estimate entered as the within-subject dependent variable.

Similarly, to assess differences among those with varying degrees of cognitive impairment, a one-way MANOVA was conducted that examined premorbid estimates between diagnostic groups. To consider an interaction, a mixed-model ANOVA was run with diagnostic group entered as the between-groups independent variable and premorbid estimate entered as the within-subjects dependent variable.

3. Results

AMNART-estimated IQ was significantly correlated with education, MMSE, VIQ, and Information (see Table 1 for

descriptive and inferential statistics). AMNART performance was not correlated with age, and a t-test did not reveal significant gender differences in amnart scores, ps = ns.

3.1. Differences between AMNART and Other Premorbid Estimates. A one-way, repeated measures ANOVA revealed significant differences between premorbid estimates, $(3, 369) = 35.61$, $p < .001$. A Scheffe's post hoc test indicated that AMNART-estimated IQ was significantly higher than all other premorbid estimates, ps < .01.

3.2. Premorbid Estimates and Education. A one-way MANOVA indicated significant differences between educational groups for AMNART-estimated IQ, $F(2, 127) = 11.95$; VIQ, $F(2, 123) = 6.17$; and Information scores, $F(2, 124) = 5.69$, ps < .01 (see Table 2 for means). Scheffe post hoc analyses revealed that the participants with 0–12 years of education had significantly lower scores on all premorbid measures than those with 17 or more years of education, ps < .02. AMNART scores for those with 0–12 years of education were significantly lower than scores for those with 13–16 years of education, which in turn were significantly lower than scores for those with 17 or more years of education, ps < .03.

A mixed-model ANOVA did not reveal a significant interaction between educational group and premorbid estimate scores, $F(6, 363) = 0.60$, p = ns.

3.3. Premorbid Estimates and Diagnostic Groups. A one-way MANOVA indicated significant differences among diagnostic groups for AMNART-estimated IQ, $F(3, 126) = 8.60$; VIQ, $F(3, 122) = 15.85$; Information scores, $F(3, 123) = 6.58$, ps < .001 (see Table 2 for means). Scheffe post hoc analyses revealed that AMNART-estimated IQ and VIQ scores were significantly lower for those in the dementia group than for those in all other diagnostic groups, ps < .05. VIQ scores were significantly lower in the MCI group than in the normal aging and AAMI groups, ps < .01, and there was a trend toward significance for AMNART scores to be higher in the MCI group than in the normal aging group, $p < .06$. In addition, Information scores were significantly lower in the dementia group than in the normal aging and AAMI groups, ps < .01.

A mixed-model ANOVA revealed a significant interaction between diagnostic group and premorbid estimate, $F(9, 360) = 8.39$, $p < .001$, such that the discrepancy between AMNART scores and other premorbid estimates increased with greater cognitive impairment (see Figure 1).

Table 2: Premorbid estimate means among diagnostic and educational groups.

Group	AMNART z-score	VIQ z-score	Information z-score
Diagnostic Group			
Normal Aging	1.56	1.27	1.24
AAMI	1.34	1.30	1.38
MCI	1.28	0.53	0.78
Dementia	0.83	−0.31	0.13
Educational group			
0–12 years	0.88	0.18	0.35
13–16 years	1.28	0.70	0.86
17+ years	1.53	1.10	1.26

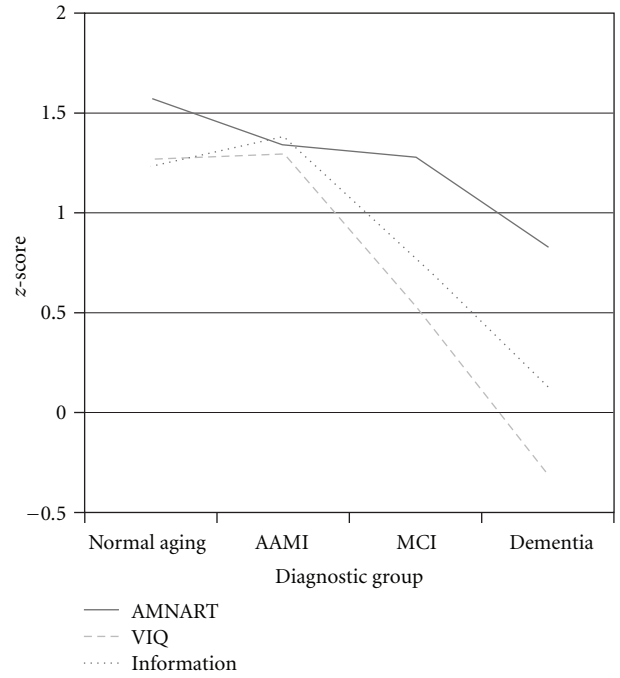

Figure 1: Interaction between diagnostic group and premorbid estimate.

4. Discussion

This study was designed to investigate the AMNART's utility as an estimate of premorbid functioning for older adults. Consistent with the original hypotheses and the intimations of other research [44–46], the results suggest that the AMNART may overestimate premorbid ability relative to other tests of premorbid intelligence. In particular, it may overinflate premorbid estimates among those with greater cognitive impairment and lower levels of education.

Overall, AMNART-estimated IQ was found to be significantly higher than scores on other indices of premorbid ability, namely, WAIS-III VIQ and Information. In fact, the mean AMNART score was an average of one-half standard deviation above the other premorbid estimates. This suggests that the AMNART may be an overestimation of premorbid ability in comparison with other established premorbid measures. While it is important not to underestimate premorbid IQ, it is also equally crucial to avoid overestimation of premorbid ability. For instance, if an older adult was premorbidly performing in the average range but is estimated to have high average premorbid intelligence on the AMNART, this would alter the threshold for determining the level or extent of cognitive impairment. For this individual, a

clinician using the AMNART might classify cognitive decline as any score in the lower end of the average range, when in fact these scores may be within normal limits and consistent with that older adult's premorbid functioning. Thus, an overestimation of premorbid intelligence is linked to an increased false positive rate for diagnosing the presence and severity of cognitive impairment. Patients may be diagnosed with a more severe form of cognitive impairment than is objectively present. In addition, clinicians will have difficulty providing the best treatment to a patient without a clear and accurate assessment of his or her premorbid functioning. These are potentially detrimental and misleading errors.

When educational groupings were examined, there were significant differences among all groups for all premorbid estimates. It would be expected that those who have completed more years of education would have a higher level of premorbid functioning, which is consistent with our findings. However, a qualitative analysis of the premorbid estimate means for those with 0–12 years of education yields interesting results. WAIS-III VIQ Information scores for those with 0–12 years of education were in the average range (57th and 64th percentiles, resp.), whereas mean AMNART-estimated IQ was in the high average range (81st percentile). This raises an important question of whether the premorbid ability of those with 0–12 years of education, whose highest educational attainment would be a high school diploma, should be estimated in the high average range based on the AMNART. Rather, those who have a high school education should generally cluster around average premorbid skills [9]. This again suggests that the AMNART may overestimate premorbid ability among older adults.

It was also discovered that there was a significant decline in AMNART-estimated IQ scores among those with dementia, implying that the AMNART does not remain unaffected by increased cognitive impairment. This is consistent with previous research [44–47] and is expected considering that as a performance-based cognitive measure, the AMNART should be somewhat affected by progressive dementia. This finding could also suggest that the AMNART is increasingly less valid as individuals develop a greater degree of cognitive decline. This is supported by the finding that the discrepancy between AMNART-estimated IQ and all other premorbid estimates increased with greater cognitive impairment. AMNART-estimated IQ was particularly inflated relative to other premorbid estimates among older adults with MCI and dementia. It may be that the AMNART is most accurate as a premorbid estimate among those with normal aging, but the evidence from this study suggests that it even overinflates premorbid functioning in the normal aging group, as well as other aging-related diagnostic groups. Another possibility is that AMNART-estimated IQ may be less affected by cognitive impairment and may be a better premorbid estimate among those with more severe forms of cognitive impairment. However, it still does not interact with cognitive decline in the same way as other commonly used premorbid measures, and therefore the AMNART's criterion validity decreases in the presence of greater cognitive impairment. It seems that the AMNART overestimates premorbid ability across diagnostic groups, particularly among those with the greatest cognitive impairment. This overestimation of premorbid IQ among those with greater cognitive impairment is particularly troubling, since premorbid measures are often of greater importance when working with individuals whose current level of cognitive functioning no longer matches their premorbid abilities, such as older adults with dementia.

When interpreting and generalizing these results, one should keep in mind particular limitations. AMNART-estimated IQ was calculated using a regression equation that was developed in conjunction with the WAIS-R [31]. Therefore, any comparison between AMNART-estimated IQ and WAIS-III scores should be held with a degree of tentativeness. Considering the present study's participants, a convenience sample was used; therefore, those who participated may be more concerned about their memory or interested in scientific research than those who chose not to participate. In addition, the sample was highly educated, with the average level of education just under 16 years (i.e., a bachelor's degree). There were a limited number of participants with a high school education, so the present findings regarding educational groups should be interpreted with some degree of caution. Similarly, the diagnostic group sizes were not equivalent. Finally, the sample was predominantly Caucasian. Future research should continue to explore these issues with a sample that is more evenly distributed and representative of the population. The implementation of a longitudinal design may contribute important information as to how premorbid estimates change with time and the development of cognitive decline. Finally, this study should be replicated to compare AMNART-estimated IQ with WAIS-IV premorbid estimates.

5. Conclusions

Overall, the AMNART appears to be an overestimation of premorbid ability in older adults. Comparison with other premorbid measures indicates that the AMNART seems to be most appropriate for use with those with higher levels of education, as well as with those experiencing normal aging. However, for all groups, the AMNART appears to yield an inflated estimate of premorbid ability. These overestimates are clinically relevant, since such discrepancies between actual premorbid ability and AMNART-estimated IQ may lead to misdiagnosis of cognitive impairment or to the overestimation of the severity of cognitive decline. Collectively, these results suggest that the AMNART should be used cautiously with older adults, especially those with cognitive impairment or lower levels of education. Future research should further examine the utility and accuracy of the AMNART as a premorbid measure among older adults, and clinicians using this test should interpret AMNART-estimated IQ scores in conjunction with other premorbid estimates to guard against questionable estimates of premorbid functioning.

References

[1] A. Barona, C. R. Reynolds, and R. Chastain, "A demographically based index of premorbid intelligence for the WAIS-R," *Journal of Consulting and Clinical Psychology*, vol. 52, no. 5, pp. 885–887, 1984.

[2] M. D. Lezak, D. B. Howieson, and D. W. Loring, *Neuropsychological Assessment*, Oxford University Press, New York, NY, USA, 4th edition, 2004.

[3] J. McFarlane, J. Welch, and J. Rodgers, "Severity of Alzheimer's disease and effect on premorbid measures of intelligence," *British Journal of Clinical Psychology*, vol. 45, no. 4, pp. 453–463, 2006.

[4] A. M. Paolo, A. I. Tröster, J. J. Ryan, and W. C. Koller, "Comparison of NART and Barona demographic equation premorbid IQ estimates in Alzheimer's Disease," *Journal of Clinical Psychology*, vol. 53, no. 7, pp. 713–722, 1997.

[5] D. Willshire, G. Kinsella, and M. Prior, "Estimating WAIS-R IQ from the National Adult Reading Test: a cross-validation," *Journal of Clinical and Experimental Neuropsychology*, vol. 13, no. 2, pp. 204–216, 1991.

[6] G. E. Alexander, M. L. Furey, C. L. Grady et al., "Association of premorbid intellectual function with cerebral metabolism in Alzheimer's disease: implications for the cognitive reserve hypothesis," *American Journal of Psychiatry*, vol. 154, no. 2, pp. 165–172, 1997.

[7] D. E. Barnes, I. B. Tager, W. A. Satariano, and K. Yaffe, "The relationship between literacy and cognition in well-educated elders," *Journals of Gerontology. Series A*, vol. 59, no. 4, pp. 390–395, 2004.

[8] D. M. Rentz, T. J. Huh, R. R. Faust et al., "Use of IQ-adjusted norms to predict progressive cognitive decline in highly intelligent older individuals," *Neuropsychology*, vol. 18, no. 1, pp. 38–49, 2004.

[9] E. Strauss, E. M. S. Sherman, and O. Spreen, *A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary*, Oxford University Press, New York, NY, USA, 3rd edition, 2006.

[10] H. E. Nelson and A. O'Connell, "Dementia: the estimation of premorbid intelligence levels using the new adult reading test," *Cortex*, vol. 14, no. 2, pp. 234–244, 1978.

[11] H. E. Nelson and J. R. Willison, *The Revised National Adult Reading Test Manual*, NFER-Nelson, Windsor, UK, 1991.

[12] D. J. Schretlen, A. L. H. Buffington, S. M. Meyer, and G. D. Pearlson, "The use of word-reading to estimate "premorbid" ability in cognitive domains other than intelligence," *Journal of the International Neuropsychological Society*, vol. 11, no. 6, pp. 784–787, 2005.

[13] J. R. Crawford, D. M. Parker, and J. A. O. Besson, "Estimation of premorbid intelligence in organic conditions," *British Journal of Psychiatry*, vol. 153, pp. 178–181, 1988.

[14] A. M. Maddrey, C. M. Cullum, M. F. Weiner, and C. M. Filley, "Premorbid intelligence estimation and level of dementia in Alzheimer's disease," *Journal of the International Neuropsychological Society*, vol. 2, no. 6, pp. 551–555, 1996.

[15] K. Sharpe and R. O'Carroll, "Estimating premorbid intellectual level in dementia using the national adult reading test: a Canadian study," *British Journal of Clinical Psychology*, vol. 30, no. 4, pp. 381–384, 1991.

[16] P. Bright, E. Jaldow, and M. D. Kopelman, "The National Adult Reading Test as a measure of premorbid intelligence: a comparison with estimates derived from demographic variables," *Journal of the International Neuropsychological Society*, vol. 8, no. 6, pp. 847–854, 2002.

[17] B. McGurn, J. M. Starr, J. A. Topfer et al., "Pronunciation of irregular words is preserved in dementia, validating premorbid IQ estimation," *Neurology*, vol. 62, no. 7, pp. 1184–1186, 2004.

[18] C. Brayne and L. Beardsall, "Estimation of verbal intelligence in an elderly community: an epidemiological study using NART," *British Journal of Clinical Psychology*, vol. 29, no. 2, pp. 217–223, 1990.

[19] J. Cockburn, J. Keene, T. Hope, and P. Smith, "Progressive decline in Nart score with increasing dementia severity," *Journal of Clinical and Experimental Neuropsychology*, vol. 22, no. 4, pp. 508–517, 2000.

[20] R. E. O'Carroll, N. Prentice, C. Murray, M. Van Beck, K. P. Ebmeier, and G. M. Goodwin, "Further evidence that reading ability is not preserved in Alzheimer's disease," *British Journal of Psychiatry*, vol. 167, pp. 659–662, 1995.

[21] A. J. Russell, J. Munro, P. B. Jones, P. Hayward, D. R. Hemsley, and R. M. Murray, "The National Adult Reading Test as a measure of premorbid IQ in schizophrenia," *British Journal of Clinical Psychology*, vol. 39, no. 3, pp. 297–305, 2000.

[22] J. F. Jastak and S. R. Jastak, *The Wide Range Achievement Test Manual*, Guidance Associates, Wilmington, Del, USA, 1965.

[23] J. R. Blair and O. Spreen, "Predicting premorbid IQ: a revision of the National Adult Reading Test," *The Clinical Neuropsychologist*, vol. 3, pp. 129–136, 1989.

[24] B. Johnstone, C. D. Callahan, C. J. Kapila, and D. E. Bouman, "The comparability of the WRAT-R reading test and NAART as estimates of premorbid intelligence in neurologically impaired patients," *Archives of Clinical Neuropsychology*, vol. 11, no. 6, pp. 513–519, 1996.

[25] A. Baddeley, H. Emslie, and I. Nimmo-Smith, "The Spot-the-Word test: a robust estimate of verbal intelligence based on lexical decision," *British Journal of Clinical Psychology*, vol. 32, no. 1, pp. 55–65, 1993.

[26] L. Beardsall and F. Huppert, "Short NART, CCRT and spot-the-word: comparisons in older and demented persons," *British Journal of Clinical Psychology*, vol. 36, no. 4, pp. 619–622, 1997.

[27] R. Law and R. E. O'Carroll, "A comparison of three measures of estimating premorbid intellectual level in dementia of the Alzheimer type," *International Journal of Geriatric Psychiatry*, vol. 13, no. 10, pp. 727–730, 1998.

[28] L. Beardsall, "Development of the Cambridge contextual reading test for improving the estimation of premorbid verbal intelligence in older persons with dementia," *British Journal of Clinical Psychology*, vol. 37, no. 2, pp. 229–240, 1998.

[29] L. Beardsall and F. A. Huppert, "Improvement in NART word reading in demented and normal older persons using the Cambridge Contextual Reading Test," *Journal of Clinical and Experimental Neuropsychology*, vol. 16, no. 2, pp. 232–242, 1994.

[30] S. C. Conway and R. E. O'Carroll, "An evaluation of the Cambridge Contextual Reading Test (CCRT) in Alzheimer's disease," *British Journal of Clinical Psychology*, vol. 36, no. 4, pp. 623–625, 1997.

[31] E. Grober and M. Sliwinski, "Development and validation of a model for estimating premorbid verbal intelligence in the elderly," *Journal of Clinical and Experimental Neuropsychology*, vol. 13, no. 6, pp. 933–949, 1991.

[32] J. A. Gladsjo, R. K. Heaton, B. W. Palmer, M. J. Taylor, and D. V. Jeste, "Use of oral reading to estimate premorbid intellectual and neuropsychological functioning," *Journal of the International Neuropsychological Society*, vol. 5, no. 3, pp. 247–254, 1999.

[33] G. E. Smith, D. L. Bohac, R. J. Ivnik, and J. F. Malec, "Using word recognition tests to estimate premorbid IQ in early dementia: longitudinal data," *Journal of the International Neuropsychological Society*, vol. 3, no. 6, pp. 528–533, 1997.

[34] V. N. Pavlik, R. S. Doody, P. J. Massman, and W. Chan, "Influence of premorbid IQ and education on progression of Alzheimer's disease," *Dementia and Geriatric Cognitive Disorders*, vol. 22, no. 4, pp. 367–377, 2006.

[35] D. Wechsler, *Wechsler Adult Intelligence Scale*, Psychological Corporation, San Antonio, Tex, USA, 1981.

[36] D. Wechsler, *Wechsler Adult Intelligence Scale*, Psychological Corporation, San Antonio, Tex, USA, 3rd edition, 1997.

[37] D. Wechsler, *Wechsler Adult Intelligence Scale*, Psychological Corporation, San Antonio, Tex, USA, 4th edition, 2008.

[38] I. T. Z. Dew and K. S. Giovanello, "The status of rapid response learning in aging," *Psychology and Aging*, vol. 25, no. 4, pp. 898–910, 2010.

[39] E. B. Elbogen, J. W. Swanson, P. S. Appelbaum et al., "Competence to complete psychiatric advance directives: effects of facilitated decision making," *Law and Human Behavior*, vol. 31, no. 3, pp. 275–289, 2007.

[40] T. C. Durazzo, S. L. Fryer, J. C. Rothlind et al., "Measures of learning, memory and processing speed accurately predict smoking status in short-term abstinent treatment-seeking alcohol-dependent individuals," *Alcohol and Alcoholism*, vol. 45, no. 6, pp. 507–513, 2010.

[41] T. C. Durazzo, J. C. Rothlind, S. Gazdzinski, and D. J. Meyerhoff, "The relationships of sociodemographic factors, medical, psychiatric, and substance-misuse co-morbidities to neurocognition in short-term abstinent alcohol-dependent individuals," *Alcohol*, vol. 42, no. 6, pp. 439–449, 2008.

[42] J. C. Rothlind, T. M. Greenfield, A. V. Bruce et al., "Heavy alcohol consumption in individuals with HIV infection: effects on neuropsychological performance," *Journal of the International Neuropsychological Society*, vol. 11, no. 1, pp. 70–83, 2005.

[43] J. A. Schinka and R. D. Vanderploeg, "Estimating premorbid level of functioning," in *Clinician's Guide to Neuropsychological Assessment*, R. D. Vanderploeg, Ed., pp. 39–68, Lawrence Erlbaum Associates, Mahwah, NJ, USA, 2nd edition, 2000.

[44] J. R. Boekamp, M. E. Strauss, and N. Adams, "Estimating premorbid intelligence in African-American and white elderly veterans using the American version of the National Adult Reading Test," *Journal of Clinical and Experimental Neuropsychology*, vol. 17, no. 5, pp. 645–653, 1995.

[45] M. Storandt, K. Stone, and E. LaBarge, "Deficits in reading performance in very mild dementia of the Alzheimer type," *Neuropsychology*, vol. 9, no. 2, pp. 174–176, 1995.

[46] K. I. Taylor, D. P. Salmon, V. A. Rice et al., "Longitudinal examination of American National Adult Reading Test (AMNART) performance in dementia of the Alzheimer type (DAT): validation and correction based on degree of cognitive decline," *Journal of Clinical and Experimental Neuropsychology*, vol. 18, no. 6, pp. 883–891, 1996.

[47] E. Grober, C. B. Hall, R. B. Lipton, A. B. Zonderman, S. M. Resnick, and C. Kawas, "Memory impairment, executive dysfunction, and intellectual decline in preclinical Alzheimer's disease," *Journal of the International Neuropsychological Society*, vol. 14, no. 2, pp. 266–278, 2008.

[48] L. L. Barnes, C. F. Mendes De Leon, R. S. Wilson, J. L. Bienias, and D. A. Evans, "Social resources and cognitive decline in a population of older African Americans and whites," *Neurology*, vol. 63, no. 12, pp. 2322–2326, 2004.

[49] L. Fratiglioni, S. Paillard-Borg, and B. Winblad, "An active and socially integrated lifestyle in late life might protect against dementia," *Lancet Neurology*, vol. 3, no. 6, pp. 343–353, 2004.

[50] N. Scarmeas, G. Levy, M. X. Tang, J. Manly, and Y. Stern, "Influence of leisure activity on the incidence of Alzheimer's disease," *Neurology*, vol. 57, no. 12, pp. 2236–2242, 2001.

[51] N. Scarmeas and Y. Stern, "Cognitive reserve and lifestyle," *Journal of Clinical and Experimental Neuropsychology*, vol. 25, no. 5, pp. 625–633, 2003.

[52] T. Crook, R. T. Bartus, S. H. Ferris, P. Whitehouse, G. D. Cohen, and S. Gershon, "Age-associated memory impairment: proposed diagnostic criteria and measures of clinical change—report of a national institute of mental health work group," *Developmental Neuropsychology*, vol. 2, pp. 261–276, 1986.

[53] R. C. Petersen, R. Doody, A. Kurz et al., "Current concepts in mild cognitive impairment," *Archives of Neurology*, vol. 58, no. 12, pp. 1985–1992, 2001.

[54] American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders*, American Psychiatric Association, Washington, DC, USA, 2000.

[55] M. F. Folstein, S. E. Folstein, and P. R. McHugh, ""Mini mental state". A practical method for grading the cognitive state of patients for the clinician," *Journal of Psychiatric Research*, vol. 12, no. 3, pp. 189–198, 1975.

[56] R. D. Vanderploeg and J. A. Schinka, "Predicting WAIS-R IQ premorbid ability: combining subtest performance and demographic variable predictors," *Archives of Clinical Neuropsychology*, vol. 10, no. 3, pp. 225–239, 1995.