2011

The Impact of Non-Reading Language Performance on the Estimation of Premorbid IQ among Normal Elderly Individuals

Abraham Maniparambil-Eapen
Wright State University

THE IMPACT OF NON-READING LANGUAGE PERFORMANCE ON THE ESTIMATION OF PREMORBID IQ AMONG NORMAL ELDERLY INDIVIDUALS

PROFESSIONAL DISSERTATION

SUBMITTED TO THE FACULTY

OF

THE SCHOOL OF PROFESSIONAL PSYCHOLOGY

WRIGHT STATE UNIVERSITY

BY

ABRAHAM M. EAPEN, PSY.M.

IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE
OF
DOCTOR OF PSYCHOLOGY

Dayton, Ohio **September, 2012**

COMMITTEE CHAIR: Jeffery Allen, Ph.D., ABPP

Committee Member: Julie Williams, Psy.D., ABPP

Committee Member: Rose Mary Shaw, Psy.D.

WRIGHT STATE UNIVERSITY

SCHOOL OF PROFESSIONAL PSYCHOLOGY

June 30, 2011

I HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER MY SUPERVISION BY **ABRAHAM M. EAPEN** ENTITLED **THE IMPACT OF NON-READING LANGUAGE PERFORMANCE ON THE ESTIMATION OF PREMORBID IQ AMONG NORMAL ELDERLY INDIVIDUALS** BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PSYCHOLOGY.

____
Jeffery Allen, Ph.D., ABPP
Dissertation Director

____
Eve M. Wolf, Ph.D.
Associate Dean for Academic Affairs

Abstract

The influence of non-reading language ability was studied in the context of estimating premorbid IQ among normal elderly individuals. Non-reading language performance was measured by the Controlled Oral Word Association (COWA) Test and the Animal Naming (AN) Test. Non-reading language disturbances were divided into three levels (i.e., no disturbance on COWA and AN, either COWA or AN disturbance, and both COWA and AN disturbances). Intellectual ability was primarily measured by the Wechsler Abbreviated Scale of Intelligence (WASI). Additionally, reading measures such as the New Adult Reading Test- Revised (NART-R) and the Wide Range Achievement Test- Fourth Edition (WRAT-4) Word Reading subtest were used to predict premorbid intellectual ability. Results indicated that the scores on the WASI Full Scale IQ (FSIQ), NART-R estimated FSIQ, and WRAT-4 Word Reading subtest decreased when the severity of the non-reading language disturbances increased. Results also suggested that non-reading language performance did not predict intellectual ability across the three levels of disturbances. Instead, the NART-R was found to account for more variance in WASI FSIQ scores when there were no non-reading language disturbances (83.4%) and COWA or AN disturbance (52.4%). The WRAT-4 Word Reading subtest was found to account for more variance (84.1%) in WASI FSIQ scores when there were disturbances on both COWA and AN. Limitations of the study, directions for future research, and diversity issues were also addressed.

List of Tables

Acknowledgements

I am thankful to all my family members for their motivation and support. I was able to complete the dissertation especially due to the immense support and fun from Sheeba, Krista, my parents, Neethu, Megha, and Ajith. I am also thankful to Elizabeth for her input. I am also grateful to Drs. Allen, Williams, and Shaw for their input, support, and encouragement. Finally, I am thankful to all the staff, faculty, and friends at the School of Professional Psychology who motivated and helped me to explore my potential.

The Impact of Non-Reading Language Performance on the Estimation of Premorbid IQ among Normal Elderly Individuals

An accurate understanding of premorbid cognitive functioning helps clinicians to determine the extent of brain trauma (Klesges, Wilkening, & Golden, 1981; Schinka & Vanderploeg, 2000). Ideally, premorbid cognitive functioning can be obtained by comparing the performance on an objective test conducted before and after the brain trauma (Klesges et al., 1981; Schinka & Vanderploeg, 2000). Unfortunately, in most occasions, the results are not available, and clinicians have to depend on various methods in order to estimate individuals' premorbid cognitive functioning (Klesges et al, 1981; Schinka & Vanderploeg, 2000). Consequently, clinicians have considered various approaches to estimate the premorbid cognitive functioning of individuals.

Approaches to Estimate Premorbid IQ

Demographically based index. A regression equation based on demographic variables such as age, race, occupation, and education was the first approach that was utilized to estimate premorbid ability (Barona, Reynolds, & Chastain, 1984; Crawford et al., 1989; Wilson et al., 1978). Demographically based regression equations have been utilized to predict premorbid intellectual ability and are based on the well-established relationship between demographic variables and IQ (Crawford, Millar, & Milne, 2001). The first regression equation to estimate IQ for adults based on multiple demographic variables was developed by Wilson et al. (1978). Wilson et al. developed a regression equation based on the following demographic variables: age, sex, race, education, and occupation. The equation, Predicted FSIQ = (.17) Age – (1.53) Sex – (11.33) Race + (2.97) Education + (1.01) Occupation + 74.05; 10.2 standard errors of estimate, predicted 54% of the variance in WAIS Full Scale IQ (FSIQ) scores. Wilson et al. identified education and race as the "most powerful predictors" (p. 1555) of cognitive functioning.

Barona et al. (1984) also developed a regression equation to estimate IQ based on the six demographic variables of age, sex, race, education, occupation, and region. The regression equation, Predicted FSIQ = 54.96 + 0.47 (age) + 1.76 (sex) + 4.71 (race) + 5.02 (education) + 1.89 (occupation) + 0.59 (region); 12.14 standard errors of estimate, predicted 60% of the variance in WAIS-R FSIQ scores (Barona, Reynolds, & Chastain, 1984). Barona et al. identified education, race, and occupation as the "powerful predictors" (p. 886) of cognitive functioning.

In addition to equations that have been developed for the United States (U.S.) population, there have also been demographically based regression equations that have been developed for the adult UK population. Crawford et al. (1989) pointed out that U.S. based regression equations are not applicable in the UK population mainly due to the differences in demographic variables between both countries. Crawford et al. developed the following regression equation based on the demographic variables of social class, age, education, and sex: Predicted FSIQ = 104.12 – 4.38 (class) + 0.23 (age) + 1.36 (education) – 4.7 (sex). The standard error of estimate of this equation was 9.08. The coding of an individual's social class was determined by the Office of Population Censuses and Surveys (OPCS) Classification of Occupations in the UK (Crawford et al.). The regression equation by Crawford et al. predicted 50% of the variance in WAIS FSIQ scores. In the Crawford et al. regression equation, social class was the “single best predictor” (p. 276) of FSIQ as measured by the WAIS.

Another regression equation for the UK population was developed by Crawford and Allan (1997). Their regression equation, Predicted FSIQ = 87.14 – (5.21 occupation) + (1.78 education) + (.18 age); 9.11 standard errors of estimate, was based on the demographic variables of occupation, education, and age and predicted 53% of the variance in WAIS-R FSIQ scores. Crawford and Allan found occupation as the “single best predictor” (p. 193) of FSIQ scores.

Although some researchers have utilized demographic based regression equations when predicting FSIQ scores, Sweet, Moberg, and Tovian (1990) have questioned the accuracy and prediction of cognitive functioning based on demographic variables. They assert that demographic based equations are less likely to predict FSIQs within the upper and lower IQ ranges. Similarly, Goldstein, Gary, and Levin (1986) as well as Silverstein (1987) also concluded that regression equations based on demographic variables could not accurately estimate all the Wechsler classifications of IQ scores. For instance, Goldstein et al. (1986) found that the regression equation by Wilson et al. (1978) overestimated and underestimated the intellectual ability in the lower and higher IQ ranges respectively. Finally, another problem with estimating cognitive ability from demographic variables such as education and occupation is that it is based on the assumption that these variables are only determined by intellectual ability (Schinka & Vanderploeg, 2000). However, other variables such as low socioeconomic status, lack of family support, and limited funding for higher education may contribute to academic and occupational success (Schinka & Vanderploeg, 2000). Therefore, estimating cognitive decline solely on a demographic based index can be an inaccurate estimation of premorbid IQ.

Clinicians' judgment. A second approach that was employed by clinicians to estimate IQ was based on clinicians' judgment (Kareken, Gur, & Saykin, 1995; Kareken & Williams, 1994). Clinicians base their premorbid estimations on their knowledge about the well-established relationship between demographic variables and cognitive functioning (Kareken & Williams, 1994). However, Faust (1986) pointed out that actuarial methods were superior to clinical judgment. Specifically, Faust (1986) pointed out that judgment is influenced by clinicians' "problematic judgment habits and human cognitive limitations" (p. 420). Similarly, Kareken (1997) also pointed out various judgment biases such as "representative heuristics" (p.703) and "labeling" (p. 705) that interfere with clinicians' ability to provide accurate estimates about premorbid functioning. For instance, Crawford, Millar, and Milne (2001) found that clinicians tend to overestimate cognitive decline among the older population.

Wedding and Faust (1989) and Faust and Nurcombe (1989) provided strategies and recommendations to improve the accuracy of clinical judgment in estimating premorbid IQ. However, Wedding and Faust also pointed out that corrective measures do not eradicate errors related to clinical judgment. Extensive reviews and research studies indicate that actuarial methods provided better premorbid intellectual estimates than clinical judgment (Dawes, Faust, & Meehl, 2002; Meehl, 1954; Wedding, 1983).

The best performance method. A third approach to predict premorbid cognitive functioning is the Best Performance Method (Lezak, Howieson, Loring, Hanny, & Fischer, 2004). The Best Performance Method estimates premorbid cognitive functioning by using the highest level of cognitive ability based on current or past evaluations (Lezak, Howieson, Loring, Hanny, & Fischer, 2004). These evaluations can include “current test scores, behavioral observations, reports from family or friends, previous test scores, prior academic or vocational achievement, and/or other historical information” (Schinka & Vanderploeg, 2000, p. 46). Lezak et al. (2004) suggested that the Best Performance Method is more appropriate because it considers individual differences among various cognitive skills or abilities. An individual’s cognitive ability is highly influenced by personal interests and experiences as well as inherent capacities or deficits. In addition, Lezak et al. pointed out that external factors such as anxiety, quality of education, and illness can significantly influence one’s performance on a cognitive measure. In other words, evaluating one’s performance based on a single measure does not provide an accurate estimate of premorbid functioning. Lezak et al. emphasized that the Best Performance Method is more appropriate only if clinicians consider detailed information about the individuals’ past or current abilities and accomplishments as well as qualitative evaluation of test performances.

Mortensen, Gade, and Reinisch (1991) criticized the Best Performance Method by pointing out that the highest performance only indicates a unique ability or interest rather than the general intellectual functioning of individuals. Mortensen et al. (1991) found that the Best Performance Method overestimated the intellectual functioning among both normal and neurologically impaired individuals.

Hold - don’t hold index. A fourth approach that was utilized to understand premorbid cognitive functioning is the Hold - Don’t Hold Index. The Hold - Don’t Hold Index is based on the assumption that the Hold tests such as Vocabulary are resistant to brain impairment and, therefore, these tests are the best estimates of premorbid cognitive ability (McFie, 1975; Yates, 1956). Wechsler (1958) identified the following WAIS subtests as Hold tests: Vocabulary, Information, Object Assembly, and Picture Completion. The Don't Hold tests include the following WAIS subtests: Digit Span, Similarities, Digit Span, and Block Design (Wechsler, 1958). Yates (1956) provided a detailed review on the use of the Vocabulary subtest to estimate premorbid intellectual ability. McFie (1975) pointed out that Vocabulary (verbal ability) and Picture Completion (nonverbal ability) are utilized as estimates of premorbid intellectual ability because both are resistant to neurological deterioration.

However, the study by Russell (1972) indicated that all the subtests of the WAIS are affected by neurological impairment. Performances on each WAIS subtest is adversely influenced by the location and severity of the brain injury (Klesges, Wilkening, & Golden, 1981). For instance, performance on the Vocabulary subtest of the WAIS cannot be used as an estimate of premorbid intellectual ability if there is any damage in the left hemisphere (Klesges et al., 1981). Furthermore, Schinka and Vanderploeg (2000) pointed out that only one or two measures (e.g., Vocabulary and/or Picture Completion) do not take into account all the variability in cognitive ability among individuals. The WAIS subtests are also sensitive to the cognitive impairment of Alzheimer's disease (Larrabee, Largen, & Levin, 1985). Due to the aforementioned reasons, some believe that the Hold tests provide an inaccurate premorbid cognitive estimate, and the tests also do not accurately classify all the Wechsler FSIQ scores (Klesges & Troster, 1987).

Reading performance. A fifth approach to estimate premorbid cognitive functioning was based on the reading ability of the individual (Schinka & Vanderploeg, 2000; Wiens, Bryan, & Crossen, 1993). The National (or New) Adult Reading Test (NART; Blair & Spreen, 1989; Crawford, Parker, Stewart, Besson, & Lacey, 1989) and the Wide Range Achievement Test (WRAT) Reading subtest (Kareken, Gur, & Saykin, 1995) are commonly used instruments to measure the reading ability of individuals. Estimating intellectual ability based on reading scores was first introduced by Nelson and McKenna (1975). Nelson and McKenna (1975) predicted WAIS Full Scale IQ scores based on subjects' performance on the Schonell Graded Word Reading Test (GWRT). The equation they used was as follows: (44.1 + Schonell raw score ÷ 8.6 [standard errors of estimate]). Currently, the most commonly used reading measures to estimate premorbid cognitive ability are based on the NART and the WRAT Reading subtest.

National (or new) adult reading test. The National Adult Reading Test (NART) consists of 50 irregular pronunciations (e.g., aisle or bouquet) that do not follow common phonetic usage (Schinka & Vanderploeg, 2000; Crawford, Parker, Stewart, Besson, & Lacey, 1989). Pronunciation of irregular words is found to be a reliable measure of premorbid functioning because individuals respond accurately only if they have premorbid familiarity with those words (Hart, Smith, & Swash, 1986; Nelson & O'Connell, 1978). Nelson (1982) developed a regression equation (i.e., Predicted FSIQ = 128.50 – 0.84 [NART errors]; standard error of estimate = 7.68) to predict WAIS FSIQ scores based on the performance on the NART among the UK population (as cited in Crawford et al., 1989). Crawford et al. (1989) found that Nelson's regression equation accounted for 57 % of the variance in WAIS FSIQ scores when they combined Nelson's (1982) original standardized sample and the cross validated sample of healthy normal individuals among the UK population.

The first North American version of NART (AMNART) was developed by Schwartz and Saffran in 1987 (as cited in Grober and Sliwinski, 1991). The AMNART by Schwartz and Saffran consisted of 50 North American irregular words (as cited in Grober and Sliwinski, 1991). The revised New Adult Reading Test (NART-R) by Blair and Spreen (1989) was based on the North American population and consisted of 61 irregular words that are applicable to both U.S. and Canadian populations. They developed a regression equation (i.e., Estimated FSIQ = 127.8 - .78 [NART-R Errors]; 7.63 standard errors of estimate) to predict intellectual ability that was based on the NART-R performance. Blair and Spreen (1989) found that the NART-R alone is a good predictor of intellectual functioning in U.S. and Canadian populations. Including the demographic variables such as age, sex, or education did not increase the variance in the FSIQ among U.S. and Canadian populations (Blair & Spreen, 1989).

A study conducted by Crawford, Deary, Starr, and Whalley (2001) provided strong support for using NART scores as an estimate of premorbid intelligence. This study examined the relationship between IQ scores at age 11 and NART performance at age 77. The results showed that there is a positive correlation between the IQ and NART scores and, therefore, concluded that the NART can be used to estimate prior intellectual ability (Crawford et al., 2001).

Several research studies further supported that NART performance provided an accurate estimate of premorbid intellectual ability. For instance, Nelson and O'Connell (1978) found that the word-reading ability measured by NART accurately predicted premorbid intellectual ability among patients with cognitive atrophy. NART is found to be the "best indicator" (p. 119) of premorbid intellectual functioning among patients with dementia of the Alzheimer's type (Hart, Smith, & Swash, 1986). O' Carroll and Gilleard (1986) as well as O'Carroll, Baikie, and Whittick (1987) found the NART to be a "dementia insensitive" measure (p. 316). Crawford, Parker, and Besson (1988) found that the NART is a valid measure for estimating premorbid functioning for various organic conditions such as alcoholic dementia, dementia of the Alzheimer's type, multi-infarct dementia, and closed head injuries. Crawford, Besson, Parker, Sutherland, and Keen (1987) found that the NART provided a valid measure for premorbid intellectual ability among depressed patients. Crawford et al. (1992) found that the NART provided a valid premorbid intellectual estimate for outpatient schizophrenics.

Despite the aforementioned research support in favor of using the NART as the sole predictor of premorbid intellectual functioning, other research studies indicated that the NART alone did not accurately predicted premorbid intellectual ability (e.g., Stebbins, Gilley, Wilson, Bernard, & Fox, 1990; Stebbins, Wilson, Gilley, Bernard, & Fox, 1990; Wiens, Bryan, & Crossen, 1993). The main criticism of using the NART is that there is only a certain range of WAIS FSIQ scores that can be predicted (Wiens et al., 1993). For instance, the maximum and minimum WAIS scores that can be predicted by the NART-R equation by Blair and Spreen (1989) are 127.8 and 80.2 respectively (Wiens et al., 1993). Therefore, any WAIS FSIQ score above 127.8 or below 80.2 cannot be predicted by the NART-R (Wiens et al., 1993). One study by Stebbins, Wilson, et al. (1990) found that the NART underestimated premorbid IQ among people with mild, moderate, and severe dementia. Stebbins, Wilson, et al. (1990) also found out that NART scores are not applicable for individuals who have only a high school education or less. Another study indicated that NART based IQ scores were adversely impacted when there were language disturbances as measured by the Visual Naming Test and the Controlled Oral Word Association Test (COWA) (Stebbins, Gilley, et al., 1990).

Several studies have indicated that combining NART performance and demographic variables better estimated premorbid intellectual ability (e.g., Crawford, Stewart, Garthwaite, Parker, & Besson, 1988; Crawford, Stewart, Parker, Besson, & Cochrane, 1989). Crawford et al. (1989) developed a regression equation that incorporated NART performance and the demographic variables of sex, social class (or occupation), and age. The regression equation, Predicted FSIQ = 135.96 – 0.789 (NART errors) – 4.6 (sex) – 2.15 (class) + 0.112 (age), produced 73% of the variance in FSIQ scores (Crawford et al., 1989). Crawford et al. pointed out that using NART scores alone and demographic variables alone showed only 66% and 50% of the variance in FSIQ scores respectively. Crawford, Nelson, Blackmore, Cochrane, and Allan (1990) also concluded that combining NART performance and demographic variables provided a more accurate estimate of premorbid intellectual ability than NART or demographic variables alone. Crawford, Cochrane, Besson, Parker, and Stewart (1990) found that the regression equation based on NART performance and the demographic variables are more related to general intelligence (g) then any WAIS subtests.

Wide range achievement test. The Wide Range Achievement Test- Revised (WRAT-R), which was developed by Jastak and Wilkinson (1984), is a screening instrument of reading, arithmetic, and spelling (as cited in Kareken, Gur, & Saykin, 1995). The reading subtest of the WRAT-R consists of 74 words that test-takers have to pronounce accurately (Kareken et al., 1995). Spruill and Beck (1986) found a high correlation between the reading subtest of the WRAT-R with Verbal IQ (.70), Performance IQ (.68), and FSIQ (.71) of the WAIS-R in a sample of 45 clients. Cooper and Fraboni (1988) also found a significant positive correlation between the reading subtest of the WRAT-R with VIQ (.53), PIQ (.46), and FSIQ (.56) of the WAIS-R in a sample of 121 clients. Furthermore, the reading subtest of the WRAT-R was found to account for a significant amount of the variance in the estimation of VIQ, PIQ, and FSIQ of the WAIS-R (Kareken et al.). A study by Johnstone and Wilhelm (1996) compared the WRAT-R Reading subtest and the WAIS-R of 31 individuals with cognitive dysfunction. Johnstone and Wilhelm (1996) found that the WRAT-R Reading subtest can be considered a Hold test for individuals who had demonstrated decline in intellectual functioning. The WRAT- Third Edition (WRAT-3) reading subtest is more appropriate for individuals with mild to moderate Traumatic Brain Injury (TBI) individuals to estimate IQ (Orme, Johnstone, Hanks, and Novack, 2004).

Despite support discussed above, there is some research indicating that clinicians must be cautious about estimating IQ scores based on the reading subtest of the WRAT-R (Johnstone, Hexum, & Ashkanazi, 1995; Johnstone & Wilhelm, 1996; Kareken, Gur, & Saykin, 1995; Orme, Johnstone, Hanks, & Novack, 2004). Johnstone and Wilhelm (1996) pointed out that clinicians must be cautious about interpreting the WRAT-R Reading subtest for individuals who have not completely recovered from brain damage because of the likelihood of improvement of cognitive functioning over a period of time after the brain trauma. Orme, Johnstone, Hanks, and Novack (2004) studied premorbid intellectual ability by administering WRAT-3 to 60 participants who were diagnosed with mild to severe TBI. They found that the WRAT-3 reading subtest tends to underestimate intellectual functioning among individuals with severe TBI.

Kareken, Gur, and Saykin (1995) noted that some studies that found a correlation between the reading subtest and the WAIS-R are based on the responses of young normal adults. The mean age of the sample of the research studies by Spruill and Beck (1986), Cooper and Fraboni (1988), and Kareken et al. (1995) was 24 (SD = 7), 34.85 (SD = 8.49), and 27.18 (SD = 7.42) respectively. Therefore, the results based on these studies cannot be generalized to older populations or individuals with brain damage. Kareken et al. also noted that individuals who are unfamiliar with the words on the reading subtest of the WRAT-R may pronounce the words based on his/her knowledge of English pronunciation. Therefore, it is difficult to conclude if the proper pronunciation of the words on the reading subtest of the WRAT-R is due to his/her premorbid ability. Furthermore, it should be noted that Kareken et al. stated that the reading subtest of the WRAT-R was developed as a screening instrument for academic skills rather than to use as a measure of the estimation of intellectual ability. Instead, Kareken et al. reported that the NART was primarily developed to estimate the intellectual ability. Finally, Johnstone, Hexum, and Ashkanazi (1995) suggested that estimating of premorbid ability based on a reading test such as the WRAT-R is not appropriate for populations with "learning disabilities, aphasias, and more severe/acute brain injuries" (p. 383).

National adult reading test and wide range achievement test. Wiens, Bryan, and Crossen (1993) examined the predictability of WAIS-R FSIQ scores based on the NART-R error scores and the WRAT-R reading scores among normal subjects. They found that the NART-R equation (Blair & Spreen, 1989) accurately estimated the intellectual ability of the subjects having a FSIQ between 100 and 109 (Wiens et al., 1993). However, the NART-R equation overestimated the intellectual ability of subjects who had a FSIQ below 100 and underestimated the intellectual ability of subjects with a FSIQ above 110 (Wiens et al.). On the other hand, WRAT-R reading scores accurately estimated the intellectual ability of subjects having low FSIQ scores ranging from 80 to 99 (Wiens et al.). However, WRAT-R reading scores underestimated the intellectual ability of individuals with FSIQ scores above 100 (Wiens et al.).

Johnstone, Callahan, Kapila, and Bouman (1996) focused on the estimation of premorbid intellectual ability based on the NART-R and WRAT-R reading subtest scores among neurologically impaired subjects. They found that the NART-R and WRAT-R reading subtest accurately estimated the intellectual ability of neurologically impaired subjects in the average IQ range (Johnstone et al., 1996). However, the NART-R and WRAT-R reading subtest did not provide an accurate estimate of the intellectual ability for subjects who had a FSIQ in the above or below average range (Johnstone et al.). Griffin, Mindt, Rankin, Ritchie, and Scott (2002) found that the WRAT-3 reading subtest more accurately classified non-neurological subjects in the below average IQ range (69%) when compared to the premorbid estimates based on the North American Adult Reading Test (NAART; 42%). Griffin et al. (2002) found that the NAART-based premorbid estimate accurately classified non-neurological subjects in the average (80%) and above average IQ range (67%) when compared to the WRAT-3 Reading subtest (73% and 33% respectively).

***Reading ability as the measure of educational quality*.** Research studies have found that reading ability (as measured by WRAT-3 reading scores) is an accurate indicator of an individual’s quality of education (Manly, Jacobs, Touradji, Small, & Stern, 2002; Manly, Schupf, Tang, & Stern, 2005). Manly et al. (2005) found that assessing an individual's reading level is more important in determining cognitive ability than the number of years of education an individual completed. There is some research support that this is true even among ethnic minorities (Manly et al., 2005). For example, Manly et al. (2002) found that there is no difference in performance between African American seniors and Caucasian seniors on a cognitive test when reading ability is used as the measure of quality of education.

Non-Reading Language Performance

It is noteworthy that the aforementioned methods did not consider the impact of non-reading language ability on the estimation of premorbid cognitive ability. Non-reading language tests such as verbal fluency measures are commonly used in neuropsychological assessments (Epker, Lacritz, & Cullum, 1999; Silva, Petersson, Faisca, Ingvar, & Reis, 2004). Verbal fluency is evaluated by measuring the subject's phonemic fluency and category or semantic fluency (Ardila, Ostrosky-Solis, & Bernal, 2006). One test that measures phonemic fluency is the FAS test. In this test, the subject has one minute to produce as many words as possible that start with the letters F, A, and S (Ardila et al., 2006; Strub & Black, 2000). In category or semantic verbal fluency tasks, the subject has to produce words based on specific categories such as animals, fruits, or vegetables (Ardila et al.). An example of such a test is the Animal Naming Test in which the subject has one minute to produce as many names of animals as possible (Ardila et al.; Strub & Black, 2000).

Silva, Petersson, Faisca, Ingvar, and Reis (2004) studied the qualitative aspects of verbal fluency tasks by evaluating the strategies which underlie fluency tasks such as clustering and switching. Clustering is "the production of related words within a semantic subcategory involving semantic categorization." Switching "requires initiating a strategic search of subcategories through semantic memory and cognitive flexibility to shift efficiently between semantic subcategories" (Silva et al., 2004, p. 268). The brain structures that are activated during verbal fluency tests include the "left inferior frontal cortex, the left dorsolateral prefrontal cortex, the supplementary motor cortex, the anterior cingulate cortex and the cerebellum" (Ravnkilde, Videbech, Rosenberg, Gjedde, & Gade, 2002, p. 534). Schlosser et al. (1998) found brain activation in the left prefrontal cortex and right cerebellum when healthy subjects engaged in verbal fluency tests.

Johnson, Flicker, and Lichtenberg (2006) pointed out that measures such as the WRAT-R reading subtest are dependent on the reading ability of the individual. Therefore, estimation of premorbid intellectual ability based on the reading tests of individuals who do poorly on reading tests or with low quality of education is likely to predict only pathology among them (Johnson et al., 2006). Johnson et al. have noticed that tests such as drawing a clock or animal naming produced less anxiety due to individuals' familiarity with the task than the tests that measured reading ability. Brayne and Beardsall (1990) pointed out that the individuals with "little formal education" experienced "embarrassment" (p. 221) while responding to tests such as the NART and the Mini Mental Status Examination. Silva, Petersson, Faisca, Ingvar, and Reis (2004) pointed out that verbal fluency tests such as the Animal Naming Test are applicable for "illiterate and other low-level educational groups" (p. 266) because they are less influenced by reading ability. Verbal fluency tests such as the Animal Naming Test are applicable to everyone irrespective of their educational quality or cultural background (Ardila, Ostrosky-Solis, & Bernal, 2006). A study by Silva et al. (2004) compared the performance of literate and illiterate subjects on two verbal fluency tasks: a supermarket fluency task and an animal fluency task. Silva et al. analyzed the performance of literate and illiterate subjects by evaluating the qualitative and quantitative aspects of their performance. Quantitatively, they found no significant differences on the supermarket fluency task but found significant differences on the animal fluency tasks between the two groups (Silva et al.). Qualitatively, researchers found that the literate group performed significantly better than the illiteracy group in switching (Silva et al.).

Research studies have been focused on understanding the quantitative and qualitative aspects of verbal fluency among individuals' with dementia (Epker, Lacritz, & Cullum, 1999; Gomez & White, 2006). For instance, Epker et al. (1999) found that subjects diagnosed with Alzheimer's disease were able to cluster efficiently even though there was a reduction in total words recalled than the normal controls. Epker et al. also found that subjects with greater cognitive impairment switched less than normal controls on verbal fluency tasks. Epker et al. asserted that the quantitative score is more helpful in differential diagnosis and is more clinically significant than the qualitative analysis of verbal fluency tests. However, Epker et al. suggested that the qualitative analysis of verbal fluency tests can be applicable to individuals with mild cognitive impairment. Gomez and White (2006) found that both the qualitative and quantitative aspects of verbal fluency tasks were impaired in very mild dementia of the Alzheimer's type (DAT). Gomez and White (2006) also found that semantic fluency differentiated between healthy aging and very mild DAT. Murphy, Rich, and Troyer (2006) compared the performance of verbal fluency tests among individuals with amnestic mild cognitive impairment (aMCI), DAT, and normal controls. The aMCI group performed similar to the control group on the verbal fluency tests despite their decline in semantic fluency relative to phonemic fluency (Murphy et al., 2006). The aMCI group also performed better than the DAT group on both the semantic and phonemic verbal fluency tests (Murphy et al.).

Verbal fluency tests are cognitive measures commonly used in detecting dementia (Crossley, Arcy, & Rawson, 1997; Pasquier, Lebert, Grymonprez, & Petit, 1995). For instance, Pasquier et al. (1995) found that patients with DAT and dementia of the frontal lobe type performed poorly on verbal fluency tests when compared to individuals with no neurological or psychiatric history. Crossley et al. (1997) also found that verbal fluency was better among normal seniors than individuals with dementia of the Alzheimer's or vascular type. Several studies indicate that there is a significant difference in the performance between semantic and phonemic fluency among various groups (e.g., Jones, Laukka, & Backman, 2006; Henry, Crawford, & Phillips, 2004; Salvatierra, Rosselli, Acevedo, & Duara, 2007). For instance, Henry et al. (2004) conducted a meta-analysis on the performance of individuals with DAT on semantic and phonemic fluency tests. Henry et al. found that DAT patients showed impaired performance in semantic fluency when compared to phonemic fluency. Salvatierra et al. (2007) found that when compared to normal bilingual (i.e., Spanish and English) subjects, bilingual Alzheimer's subjects showed significant decline in semantic fluency relative to phonemic fluency. Jones et al. (2006) found that patients in the preclinical stage of Alzheimer's disease were impaired for both semantic and phonemic fluency. Jones et al. found that patients in the preclinical stage of vascular dementia were impaired only on the letter fluency.

Verbal fluency performance was also analyzed among patients with TBI and Parkinson's disease (Henry & Crawford, 2004; Raskin & Rearick, 1996; Scholtissen, Dijkstra, Reithler, & Leentjens, 2006). Henry and Crawford (2004) found that the performance on phonemic and semantic fluency tests among TBI patients was impaired. Raskin and Rearick (1996) also found that the total number of words produced by mild TBI patients on phonemic and semantic fluency tests was significantly less when compared to subjects with no history of any neurological impairment or psychiatric problems. The performance on verbal fluency tests was also studied among patients with Parkinson's disease (e.g., Scholtissen, Dijkstra, Reithler, & Leentjens, 2006). Scholtissen et al. (2006) did not find any significant differences in semantic and phonemic test results among individuals with Parkinson's disease and healthy subjects. Scholtissen et al. also found that the strategies (i.e., clustering and switching) employed to retrieve the words were similar in both groups.

Research studies have shown that education (Kempler, Teng, Dick, Taussig, & Davis, 1998; Ardila, Ostrosky-Solis, & Bernal, 2006), age (Crossley, Arcy, & Rawson, 1997), and information processing speed (Raskin & Rearick, 1996) impact performance on verbal fluency tasks. With regard to education and age, Kempler et al. (1998) found that younger subjects with high education performed better on semantic fluency tasks than older subjects with less education. The percentage of variance accounted for by education was 38.5 for phonemic fluency and 23.6 for semantic fluency (Ardila et al., 2000). Tombaugh, Kozak, and Rees (1999) found that education accounted for 21.7% of the variance for phonemic fluency and 13.6% for semantic fluency. Tombaugh et al. (1999) found that age accounted for 11.8% of the variance for phonemic fluency and 23.4% of the variance for semantic fluency. Crossley et al. (1997) found that semantic fluency tests are age sensitive but less influenced by educational level when compared to phonemic fluency. In terms of information processing speed, Raskin and Rearick (1996) pointed out that the difficulty in generating words for mild TBI patients during verbal fluency tests can be due to slow retrieval and processing speed. Bryan, Luszcz, and Crawford (1997) pointed out that the decline in information processing speed was the main reason for poor performance among older adults during verbal fluency tests.

Relationship between Reading and Non-Reading Language Performances

Crawford, Moore, and Cameron (1992) found that NART errors are significantly correlated with verbal fluency (VF) scores after analyzing the performance of healthy subjects and those with neurological disorders. Crawford et al. (1992) developed a regression equation to predict verbal fluency scores based on NART performance (i.e., Predicted VF = 57.5 – [0.76 X NART errors]; 9.09 standard errors of estimate). Tests like verbal fluency tap into various cognitive abilities. For instance, performance on verbal fluency tests is found to be directly influenced by information processing speed and ability to retrieve words (Raskin & Rearick, 1996). These cognitive abilities are not measured by reading tests such as the NART or the WRAT Reading subtest. There is a possibility that non-reading language tasks, including those that measure verbal fluency, may account for cognitive abilities that are not measured by reading tests such as the NART or the WRAT Reading subtest. Stebbins, Gilley, Wilson, Bernard, and Fox (1990) conducted the only study that estimated premorbid intellectual ability based on the performance of non-reading language tasks. Stebbins et al. (1990) found that language disturbances measured by the Visual Naming Test and the Controlled Oral Word Association Test underestimated NART based Full Scale IQ (FSIQ) scores among mildly demented individuals. Based on the study by Stebbins et al., it is difficult to clearly understand the effect that non-reading language disturbances have on the estimation of premorbid intellectual ability. The main reason is that Stebbins et al. utilized NART based FSIQ scores to study the influence of language disturbances on intellectual ability among individuals with mild dementia. Stebbins et al. cannot conclude that NART underestimated intellectual ability among mildly demented individuals because there are no previous research studies that examined the relationship between non-reading language performance and intellectual ability. There is a possibility that NART might have accurately estimated intellectual ability when there are language disturbances among individuals with mild dementia. Consequently, using normal individuals as well as including multiple estimates of FSIQ may provide more clarity in understanding the relationship between non-reading language performance and intellectual ability. Therefore, the current study focused on the influence of non-reading language performance (measured by the Controlled Oral Word Association Test and Animal Naming Test) on intellectual ability as measured by the Wechsler Abbreviated Scale of Intelligence (WASI), the New Adult Reading Test- Revised (NART-R), and the Wide Range Achievement Test- Fourth Edition (WRAT-4) Word Reading subtest among normal elderly individuals.

Method

Participants

This study utilized archival data from the Community Memory Clinic (CMC) at the Ellis Human Development Institute in Dayton, Ohio. The data was initially collected by the CMC to study the impact of education on the estimation of premorbid intellectual ability. The director of the CMC provided the authorization to review and analyze the data. The current study included data of participants who had no history of psychiatric or neurological problems. The archival data had 71 participants who met the inclusion criteria. The participants were comprised of 18 males (25.4%) and 53 females (74.6%). The age of the participants ranged from 55 to 92 with a mean of 72.08 and a standard deviation of 10.24. In terms of ethnicity, 56.3% and 43.7% of participants identified themselves as Black/African American and White/non-Hispanic, respectively. Years of education ranged from 7 to 20 years with the greatest frequency being 12 years (31%) followed by 16 years (18.3%), 14 years (11.3%), and then 10 years (9.9%). With regard to participants’ marital status, the majority of them were widowed (31%) followed by married (29.6%), separated/divorced (29.6%), and then never married (9.9%).

The participants’ non-reading language performance was measured by the Controlled Oral Word Association Test (COWA) and Animal Naming (AN) Test. Three levels of non-reading language tasks were determined based on the performance of COWA and AN. In the first level, there were no disturbances on non-reading language tasks. In the second level, there was a disturbance on one of the non-reading language tasks. In the third level, there were disturbances on both the non-reading language tasks. Performing in the Low Average, Borderline, and Very Poor ranges on the COWA and AN were considered disturbances on non-reading language task. Performing in the Superior, Above Average, and Average ranges on the COWA and AN were not considered disturbances on non-reading language tasks. Table 1 displays the descriptive statistics for the three levels of non-reading language tasks.

Table 1

Descriptive Statistics for Three Levels of Non-Reading Language Tasks

Non-Reading Language Disturbances	Frequency	Percentage
None	39	54.9
AN or COWA	21	29.6
AN and COWA	11	15.5

Materials

Two tests were administered to measure the reading ability of the participants: the Wide Range Achievement Test - Fourth Edition (WRAT-4; Wilkinson & Robertson, 2006) and the New Adult Reading Test- Revised (NART-R; Blair & Spreen, 1989). Non-reading language abilities were measured by the Controlled Oral Word Association (COWA) Test and the Animal Naming (AN) test. Cognitive ability was measured by the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999).

Wide range achievement test- Fourth edition (WRAT-4). The WRAT-4 is an achievement test designed to measure basic skills of reading, spelling, and mathematics of individuals aged 5 to 94 years. The WRAT-4 consists of four subtests: Word Reading, Sentence Comprehension, Spelling, and Math Computation. Only the Word Reading subtest was utilized in this study. In the Word Reading subtest, the raw score was calculated by counting the number of accurately pronounced words. The Word Reading subtest consists of 55 words with increasing order of difficulty. The raw scores are converted to standard scores for comparison with other measures in the study.

New adult reading test - Revised (NART-R). The New Adult Reading Test- Revised (NART-R) by Blair and Spreen (1989) is normed on the North American population. The NART-R consists of 61 irregularly pronounced words printed in order of increasing difficulty. The subjects would only be able to read irregularly spelled words if they have premorbid knowledge about the pronunciation of these words. The total number of errors is calculated to predict the full scale IQ (FSIQ). The formula developed by Blair and Spreen (1989) to estimate FSIQ is 127.8 - .78 (NART-R Errors); 7.63 is the standard errors of estimate.

Controlled oral word association (COWA) test. Phonemic fluency is measured by the COWA test, which is taken from the Multilingual Aphasia Examination- Third Edition (MAE-3) by Benton, Hamsher, and Silven (1994). In the COWA, the participants have to orally produce as many words as possible excluding proper nouns that begin with the letters C, F, and L in 60 seconds. The raw score for COWA is calculated by counting the total number of words recalled within 60 seconds (Strub & Black, 2000). The COWA

Test raw scores are converted into a standard score using the norms for an elderly sample that is stratified by age and education.

Animal naming (AN) test. Semantic fluency is measured by the Animal Naming Test. In the Animal Naming Test, the participants have to name as many animals as possible in 60 seconds (Strub & Black, 2000). The number of animals recalled within 60 seconds constitutes the total score (Strub & Black, 2000). The Animal Naming Test raw scores are converted into a standard score using the norms for an elderly sample that is stratified by age and education.

Wechsler Abbreviated Scale of Intelligence (WASI). Cognitive ability is measured by the Wechsler Abbreviated Scale of Intelligence (WASI), which is a brief and reliable intelligence test (Wechsler, 1999). The FSIQ is calculated by two subtests of the WASI: Vocabulary and Matrix Reasoning (Wechsler, 1999). The WASI is found to be highly correlated (.84 to .94) with WAIS-III FSIQ scores.

Procedures

All data were entered into SPSS Student Version 16.0. Descriptive statistics were generated for age, gender, marital status, ethnicity, and years of education. The impact of non-reading language performances (i.e., COWA and AN scores) on the estimation of premorbid intellectual ability (i.e., WASI FSIQ scores) were analyzed under four research questions. Descriptive statistics, paired t-tests, partial correlations, and stepwise multiple regressions were employed to address the following four research questions.

First research question. What variables influenced the estimation of intellectual ability when there are no non-reading language disturbances?

Second research question. What variables influenced the estimation of intellectual ability when there was disturbance in one of the non-reading language tasks (i.e., AN or COWA)?

Third research question. What variables influenced the estimation of intellectual ability when there was disturbance on both non-reading language tasks (i.e., AN and COWA)?

Fourth research question. What is the influence on WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading scores when the severity of non-reading language disturbances increases?

Results

The current study focused on the impact of non-reading language performance on the estimation of premorbid IQ among normal elderly individuals. The results are presented below based on the four research questions.

First Research Question

What variables influenced the estimation of intellectual ability when there were no non-reading language disturbances? The results related to the first research question are shown in Table 2, Table 3, Table 4, and Table 5.

The means and standard deviations of the WASI FSIQ (113.38; 18.69), NART-R estimated FSIQ (107.14; 11), WRAT-4 Word Reading subtest (107.77; 18.05), Animal Naming (AN) test (53.62; 6.58), Controlled Oral Word Association (COWA) test (51.38; 4.51), and years of education (14.21; 2.84) without any non-reading language disturbance are shown in Table 2. The corresponding ranges are also presented in Table 2. The results from Table 3 indicated that the WASI FSIQ mean is significantly different from the means of the NART-R estimated FSIQ and WRAT-4 Word Reading subtest. It is noteworthy that the both the NART-R estimated FSIQ (107.14) and WRAT-4 Word Reading subtest (107.77) have similar means when there are no non-reading language disturbances. However, both the NART-R estimated FSIQ (107.14) and WRAT-4 Word Reading subtest (107.77) underestimated the WASI FSIQ based on the results from Table 3.

Table 2

Descriptive Statistics for Intellectual and Reading Ability Without Non-Reading Language Disturbances (Total: 39 participants)

	Mean	Standard Deviation	Minimum	Maximum
WASI FSIQ	113.38	18.69	69	134
NART-R Estimated FSIQ	107.14	11	80.39	122.34
WRAT-4 Word Reading Subtest	107.77	18.05	75	145
AN T Score	53.62	6.58	44	70
COWA T Score	51.38	4.51	44	61
Years of Education	14.21	2.84	7	20

Table 3

Paired t-test to Understand the Relationship of WASI FSIQ with NART-R Estimated FSIQ and WRAT Word Reading Subtest Without Non-Reading Language Disturbances

	t	Significance (2-tailed)
WASI FSIQ and NART Estimated FSIQ	4.027	.000
WASI FSIQ and WRAT-4 Word Reading Subtest	3.465	.001

Partial Correlation between WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest after controlling for the years of education are displayed in Table 4. Results from Table 4 showed that there is a statistically significant positive correlation between the WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest after controlling for years of education of participants. This indicated that years of education did not influence the relationship between the WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest.

Table 4

Partial Correlation among Variables Without Non-Reading Language Disturbances after Controlling for Years of Education (Total: 36 Participants)

	WASI FSIQ	NART-R Estimated FSIQ	WRAT-4 Word Reading Subtest
WASI FSIQ	1.000	.825*	.757*
NART-R Estimated FSIQ	.825*	1.000	.754*
WRAT-4 Word Reading Subtest	.757*	.754*	1.000

*p value < 0.001

Stepwise regression analysis was employed to understand the variables that predict WASI FSIQ. The results are displayed in Table 5. The results from Table 5 suggested that the NART-R estimated FSIQ alone accounted for 83.4% of the variance in WASI FSIQ when there were no disturbances in non-reading language tasks (Step 1). Stepwise regression analysis excluded WRAT-R Word Reading subtest, Animal Naming T-scores, COWA T-scores, and years of education from Step 1. It is noteworthy that both the NART-R estimated FSIQ and WRAT-4 Word Reading scores accounted for only 84.9% of the variance in FSIQ as measured by the WASI (Step 2). Animal Naming T-scores, COWA T-scores, and years of education are excluded in Step 2 during stepwise regression analysis.

Table 5

Stepwise Multiple Regression of WASI FSIQ on Intellectual Ability, Reading Ability, and Years of Education Without Non-Reading Language Disturbances

		R	Adjusted R Square	Standard Error of the Estimate	Percentage of Variance	Significance
Step 1	NART-R Estimated FSIQ	.916	.834	7.61	83.4	.000
Step 2	NART-R Estimated FSIQ and WRAT-4 Word Reading Subtest	.926	.849	7.26	84.9	.000

*Significance of R Square tested by applying F test

Second Research Question

What variables influenced the estimation of intellectual ability when there was disturbance in one of the non-reading language tasks (i.e., AN or COWA)? The results related to the second research question are shown in Table 6, Table 7, Table 8, and Table 9.

The means and standard deviations of WASI FSIQ (94.76; 19.17), NART-R estimated FSIQ (99.46; 9.19), WRAT-4 Word Reading subtest (96.24; 16.98), Animal Naming (AN) test (43.62; 11.41), Controlled Oral Word Association (COWA) test (46.62; 7.24), and years of education (12.61; 2.18) when there was disturbance in one of the non-reading language tasks are shown in Table 6. The corresponding ranges of scores are also presented in Table 6. The results from Table 7 indicated that the WASI FSIQ mean is not significantly different from the means of NART-R estimated FSIQ and WRAT-4 Word Reading subtest. Even though there is a trend for NART-R estimated FSIQ and WRAT-4 Word Reading subtest to overestimate WASI FSIQ, there are no significant differences between the mean of WASI FSIQ when compared to NART-R estimated FSIQ and WRAT-4 Word Reading subtest when there was disturbance in one of the non-reading language tasks.

Table 6

Descriptive Statistics for Intellectual and Reading Ability With Disturbances in One of the Non-Reading Language Tasks (Total: 21 participants)

	Mean	Standard Deviation	Minimum	Maximum
WASI FSIQ	94.76	19.17	66	121
NART-R estimated FSIQ	99.46	9.19	84.9	117.66
WRAT-4 Word Reading Subtest	96.24	16.98	66	140
Animal T Score	43.62	11.41	30	69
COWA T Score	46.62	7.24	38	68
Years of Education	12.61	2.18	8	18

Table 7

Relationship of WASI FSIQ with NART-R Estimated FSIQ and WRAT Word Reading Subtest With Disturbances in One of the Non-Reading Language Tasks

	t	Significance (2-tailed)
WASI FSIQ and NART Estimated FSIQ	-1.557	.135
WASI FSIQ and WRAT-4 Word Reading	-.476	.639

Partial Correlation between WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest after controlling the years of education are displayed in Table 8. Results from Table 8 showed that there is a statistically significant positive correlation between the WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest after controlling years of education. This indicated that years of education did not influence the relationship between the WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest.

Table 8

Partial Correlation among Variables With Disturbances in One of the Non-Reading Language Tasks (Total: 21 participants)

	WASI FSIQ	NART-R Estimated FSIQ	WRAT-4 Word Reading Subtest
WASI FSIQ	1.000	.687*	.638*
NART-R Estimated FSIQ	.687*	1.000	.811*
WRAT-4 Word Reading Subtest	.638*	.811*	1.000

*p value < 0.001

Stepwise regression analysis was employed to understand the variables that predict WASI FSIQ. The results were displayed in Table 9. The results from Table 9 suggested that the NART-R estimated FSIQ alone accounted for 52.4% of the variance in the WASI FSIQ when there was disturbance in one of the non-reading language tasks (Step 1). Stepwise regression analysis excluded WRAT-R Word Reading subtest, Animal T Score, COWA T score, and years of education from Step 1.

Table 9

Stepwise Multiple Regression of WASI FSIQ on Intellectual Ability, Reading Ability, and Years of Education With Disturbances in One of the Non-Reading Language Tasks

		R	Adjusted R Square	Standard Error of the Estimate	Percentage of Variance	Significance
Step 1	NART-R Estimated FSIQ	.740	.524	13.22	52.4	.000

*Significance of Adjusted R Square tested by applying F test

Third Research Question

What variables influenced the estimation of intellectual ability when there were disturbances on both non-reading language tasks (i.e., AN and COWA)? The results related to the third research question are shown in Table 10, Table 11, Table 12, and Table 13.

The means and standard deviations of WASI FSIQ (82.18; 19.40), NART-R estimated FSIQ (89.72; 8.4), WRAT-4 Word Reading subtest (78.73; 14.19), Animal Naming (AN) test (32.91; 9.77), Controlled Oral Word Association (COWA) test (34.36; 6.02), and years of education (11.82; 2.27) without any non-reading language disturbances are shown in Table 10. The corresponding ranges are also presented in Table 10. The results from Table 11 indicated that the WASI FSIQ mean is not significantly different from the means of the NART-R estimated FSIQ and WRAT-4 Word Reading subtest. It is noteworthy that the NART-R FSIQ overestimated the WASI FSIQ even though the difference between both is not statistically significant.

Table 10

Descriptive Statistics for Intellectual and Reading Ability With Disturbances in Both Non-Reading Language Tasks (Total: 11 participants)

	Mean	Standard Deviation	Minimum	Maximum
WASI FSIQ	82.18	19.40	64	128
NART-R Estimated FSIQ	89.72	8.40	81	111.42
WRAT-4 Word Reading Subtest	78.73	14.19	61	111
Animal T Score	32.91	9.77	10	42
COWA T Score	34.36	6.02	25	43
Years of Education	11.82	2.27	9	17

Table 11

Relationship of WASI FSIQ With NART-R Estimated FSIQ and WRAT Word Reading Subtest With Disturbances in Both Non-Reading Language Tasks

	t	Significance (2-tailed)
WASI FSIQ and NART Estimated FSIQ	-2.046	.068
WASI FSIQ and WRAT-4 Word Reading Subtest	1.389	.195

Partial correlation between WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest after controlling the years of education are displayed in Table 12. Results from Table 12 showed that there is a statistically significant positive correlation between the WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest after controlling years of education. This indicated that years of education did not influence the relationship between the WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest.

Table 12

Partial Correlation Among Variables With Disturbances in Both Non-Reading Language Tasks after Controlling for Years of Education (Total: 11 Participants)

	WASI FSIQ	NART-R Estimated FSIQ	WRAT-4 Word Reading Subtest
WASI FSIQ	1.000	.702*	.727*
NART-R Estimated FSIQ	.702*	1.000	.736*
WRAT-4 Word Reading Subtest	.727*	.736*	1.000

*p value < 0.05

Stepwise regression analysis was employed to understand the variables that predict WASI FSIQ. The results are displayed in Table 13. The results from Table 13 suggested that the WRAT-4 Word Reading subtest alone accounted for 84.1% of the variance in WASI FSIQ when there is disturbance on both non-reading language performances (Step 1). Stepwise regression analysis excluded NART-R estimated FSIQ, Animal T Score, COWA T score, and years of education from Step 1.

Table 13

Stepwise Multiple Regression of WASI FSIQ on Intellectual Ability, Reading Ability, and Years of Education With Disturbances in Both Non-Reading Language Tasks

		R	Adjusted R Square	Standard Error of the Estimate	Percentage of Variance	Significance
Step 1	WRAT-4 Word Reading Subtest	.926	.841	7.74	84.1	.000

*Significance of Adjusted R Square tested by applying F test

Fourth Research Question

What was the influence on WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest when the severity of non-reading language disturbances increases?

An Analysis of Variance (ANOVA) was employed to understand the impact on WASI FSIQ, NART-R estimated FSIQ, and WRAT-4 Word Reading subtest across the following three levels of non-reading language disturbances: No disturbances on non-reading language tasks (i.e., None), disturbances on one of the non-reading language tasks (i.e., AN or COWA), and disturbances on both non-reading language tasks (i.e., AN and COWA). The results related to the third research question are shown in Table 14, Table 15, and Table 16.

The impact on WASI FSIQ across the three levels of non-reading language disturbances are displayed in Table 14. The results from Table 14 indicated that there is a significant difference between the WASI FSIQ without non-reading language disturbances and the WASI FSIQ with non-reading language disturbances. It is noteworthy that there are only non-significant differences between the WASI FSIQ among individuals with disturbances on one of the non-reading language tasks (i.e., AN or COWA) and disturbances on both non-reading language tasks (i.e., AN and COWA).

Table 14

ANOVA to Understand the Impact on WASI FSIQ Across Three Levels of Non-Reading Language Tasks

Dependent Variable	Non-Reading Language Disturbances (I)	Non-Reading Language Disturbances (J)	Mean Difference (I - J)	Standard Error
WASI FSIQ	None (113.38; 18.69)*	AN or COWA	18.62**	5.13
		AN and COWA	31.20**	6.47
	AN or COWA (94.76; 19.17)*	None	-18.62**	5.12
		AN and COWA	12.58	7.05
	AN and COWA (82.18; 19.40)*	None	-31.20**	6.47
		AN or COWA	-12.58	7.05

*Mean and Standard Deviation
**The mean difference is significant at the 0.05 level

The impact on NART-R estimated FSIQ across the three levels of non-reading language disturbances are displayed in Table 15. The results from Table 15 indicated that there is a significant difference between the NART-R estimated FSIQ across the three levels of non-reading language disturbances. It is noteworthy that the NART-R estimated FSIQ decreased when the severity of the non-reading language disturbances increased.

Table 15

ANOVA to Understand the Impact on NART-R Estimated FSIQ Across Three Levels of Non-Reading Language Tasks

Dependent Variable	Non-Reading Language Disturbances (I)	Non-Reading Language Disturbances (J)	Mean Difference (I - J)	Standard Error
NART-R Estimated FSIQ	None (107.14; 11.01)*	AN or COWA	7.68**	2.75
		AN and COWA	17.42**	3.46
	AN or COWA (99.46; 9.19)*	None	-7.68**	2.75
		AN and COWA	9.74**	3.78
	AN and COWA (89.72; 8.40)*	None	-17.42**	3.46
		AN or COWA	-9.74**	3.78

*Mean and Standard Deviation
**The mean difference is significant at the 0.05 level

The impact on WRAT-4 Word Reading subtest across the three levels of non-reading language disturbances are displayed in Table 16. The results from Table 16 indicate that there is a significant difference between the WRAT-R Word Reading subtest across the three levels of non-reading language disturbances. It is noteworthy that the

WRAT-4 Word Reading subtest decreased when the severity of the non-reading language disturbances increased.

Table 16

ANOVA to Understand the Impact on WRAT-4 Word Reading Across Three Levels of Non-Reading Language Tasks

Dependent Variable	Non-Reading Language Disturbances (I)	Non-Reading Language Disturbances (J)	Mean Difference (I - J)	Standard Error
WRAT-4 Word Reading Subtest	None (107.77; 18.05)*	AN or COWA	11.53**	4.66
		AN and COWA	29.04**	5.88
	AN or COWA (96.24; 16.98)*	None	-11.53**	4.66
		AN and COWA	17.51**	6.41
	AN and COWA (78.73; 14.19)*	None	-29.04**	5.88
		AN or COWA	-17.51**	6.41

*Mean and Standard Deviation
**The mean difference is significant at the 0.05 level

Discussion

The purpose of this study was to understand the impact of non-reading language performance as measured by verbal fluency tasks on the estimation of premorbid IQ among normal elderly individuals. The role of non-reading language ability, including verbal fluency, has not being studied in the context of estimating premorbid intellectual ability. The results are discussed by addressing the four research questions in order to understand the role of non-reading language ability in the estimation of premorbid intellectual ability among normal elderly individuals.

First Research Question

The first research question is as follows: What variables influenced the estimation of intellectual ability when there were no non-reading language disturbances?

The results indicated that non-reading language tasks such as Animal Naming (AN) and Controlled Oral Word Association (COWA) did not account for any variance in the estimation of premorbid intellectual ability. Among individuals with no disturbances in non-reading language tasks, the NART-R estimated FSIQ alone accounted for 83.4% of the variance in WASI FSIQ. The other variables such as the WRAT-4 Word Reading subtest, Animal Naming, COWA, and years of education did not contribute significantly to the prediction of intellectual ability. It is noteworthy that both NART-R FSIQ (107.14) and WRAT-4 Word Reading subtest (107.77) have similar average means, but the WRAT-4 did not contribute significantly to the prediction of intellectual ability. Therefore, the results suggested that the NART-R estimated FSIQ can be a better estimate of premorbid intellectual ability when there were no disturbances in non-reading language tasks. It is noteworthy that years of education did not influence the positive relationship between the NART-R estimated FSIQ and WASI FSIQ.

However, clinicians must be cautious about the possibility of underestimating intellectual ability based on NART-R performance. The current study supports the findings of the studies by Wiens, Bryan, and Crossen (1993) and Johnstone, Callahan, Kapila, and Bouman (1996) that the NART-R based FSIQ underestimated the intellectual ability of the participants. One main reason for the underestimation of intellectual ability by NART-R in the current sample can be due to its limitations in predicting a WASI FSIQ above 127.8 (Wiens, Bryan, & Crossen, 1993). In the current sample, 48.7% of the sample with no disturbances in non-reading language tasks fell within the Very Superior to Superior range. As a result, the NART-R might have underestimated the intellectual ability of the individuals within these higher FSIQ ranges.

Second Research Question

The second research question is as follows: What variables influenced the estimation of intellectual ability when there was disturbance in one of the non-reading language tasks (i.e., AN or COWA)?

With regard to the second research question, the results indicated that NART-R alone better predicted intellectual ability by accounting for 52.4% of the variance in the WASI FSIQ when there was disturbance in one of the non-reading language tasks. The other variables such as the WRAT-4 Word Reading subtest, Animal Naming, COWA, and years of education did not contribute significantly to the prediction of intellectual ability. Results also indicated that there are no differences between the average means of the WASI FSIQ (94.76), NART-R FSIQ (99.46), and NART-R Word Reading subtest (96.24). However, the NART-R FSIQ was better able to predict intellectual ability than the WRAT-4 Word Reading subtest. The current study also supports the study by Griffin, Mindt, Rankin, Ritchie, and Scott (2002) that the North American Adult Reading Test (NAART) accurately classified individuals who had a FSIQ within the Average range. The number of years of education was not found to influence the positive relationship between the NART-R estimated FSIQ and WASI FSIQ.

Third Research Question

The third research question is as follows: What variables influenced the estimation of intellectual ability when there was disturbance in both non-reading language tasks (i.e., AN and COWA)?

The results indicated that the WRAT-4 Word Reading subtest alone accounted for 84.1% of the variance in the WASI FSIQ when there were disturbances on both non-reading language tasks. The other variables such as NART-R estimated FSIQ, Animal Naming, COWA, and years of education did not contribute significantly to the prediction of intellectual ability. There were no differences between the average means of the WASI FSIQ (82.18), NART-R estimated FSIQ (89.72), and WRAT-4 Word Reading subtest (78.73). However, the WRAT-4 Word Reading subtest better estimated the intellectual ability of individuals when there were disturbances on both non-reading language tasks. The current study provides support for the study by Griffin, Mindt, Rankin, Ritchie, and Scott (2002) whereby it was concluded that the WRAT-3 Reading subtest accurately classified non-neurological subjects in the Below Average IQ range. The number of years of education was not found to influence the positive relationship between the NART-R estimated FSIQ and WASI FSIQ. It is noteworthy that the reading measures such as the NART-R and the WRAT-4 Word Reading subtest better predicted intellectual ability when there were disturbances on non-reading language tasks.

Fourth Research Question

The fourth research question is as follows: What is the influence on the WASI FSIQ, NART-R estimated FSIQ, and the WRAT-4 Word Reading subtest when the severity of non-reading language disturbances increases?

Stebbins, Gilley, Wilson, Bernard, and Fox (1990) found that non-reading language disturbances measured by the Visual Naming Test and COWA underestimated the NART-R based FSIQ among mildly demented individuals. The current study found that disturbances on non-reading language tasks reduced the intellectual ability measured by the WASI. Therefore, a lower estimate of FSIQ by the NART-R when there is language disturbance in the study by Stebbins et al. (1990) can be an accurate estimate of intellectual ability. The results of the current study support the work by Stebbins et al. in that the WASI FSIQ decreased significantly when there were disturbances on one or both of the non-reading language tasks. Similarly, the NART-R estimated FSIQ and WRAT-4 Word Reading subtest decreased when the severity of the non-reading language disturbances increased.

Limitations of the Study and Directions for Future Research

One major limitation of this study was the use of only two subtests, Vocabulary and Matrix Reasoning, of the WASI to measure FSIQ. Other cognitive abilities such as processing speed or working memory are not addressed using the WASI. Therefore, the current study highlights the importance of studying the influence of non-reading language performances with the full battery of the Wechsler Adult Intelligence Scale- Fourth Edition (WAIS-4).

The second major limitation of the study was using norms for the Animal Naming Test and Controlled Oral Word Association Test that were stratified only by age and years of education. Gladsjo et al. (1999) found that ethnicity influenced the performance on both the COWA and Animal Naming Test. Future research should include norms that are stratified by age, education, and ethnicity. In order to measure COWA, it is recommended that the FAS test be used because it has norms that are stratified based on age, education, and ethnicity.

The third limitation of this study was the arbitrary classification of disturbances on non-reading language performances. In the current study, performances in the Low Average to Very Poor range were classified as disturbances on the non-reading language tasks. On the other hand, performances in the Average to Superior range were not considered disturbances on the non-reading language tasks. This type of classification might have significantly contributed to a higher variance within each group. It is suggested that future research focus on understanding the intellectual ability within each range of non-reading language ability. For instance, the intellectual ability of individuals within Very Poor, Borderline, Low Average, Average, Above Average, Superior, and Very Superior ranges on the Animal Naming Test provides more clarity regarding the role of non-reading language tasks. This approach was not utilized in the current study due to a limited sample size in each category.

Diversity issues

The current study raises some important diversity issues that clinicians need to be aware of in order to accurately estimate premorbid intellectual ability. The first diversity issue that clinicians have to consider is individuals' quality of education. As noted by Johnson, Flicker, and Lichtenberg (2006), an estimation of intellectual ability based on reading measures such as the NART-R or WRAT-4 Word Reading subtest may underestimate the IQ of individuals with poor reading ability or with a low quality of education. As a result, non-reading language tasks may be more appropriate than reading measures when estimating premorbid intellectual ability. Furthermore, non-reading language tasks may also reduce anxiety and embarrassment than a reading-based test due to individuals' familiarity with these tasks (Brayne & Beardsall, 1990; Johnson et al., 2006).

A second diversity issue that clinicians have to consider is the influence of cultural background. Non-reading language tasks such as verbal fluency tests are applicable to individuals from different cultural backgrounds (Ardila, Ostrosky-Solis, & Bernal, 2006). Therefore, clinicians have to gather information regarding individuals' cultural backgrounds prior to administration of reading or non-reading-based measures.

References

Ardila, A., Ostrosky-Solis, F., & Bernal, B. (2006). Cognitive testing toward the future: The example of semantic verbal fluency (ANIMALS). *International Journal of Psychology, 41* (5), 324-332.

Ardila, A., Ostrosky-Solis, F., Rosselli, M., & Gomez, C. (2000). Age-related cognitive decline during normal aging: The complex effect of education. *Archives of Clinical Neuropsychology, 15* (6), 495-513.

Barona, A., Reynolds, C.R., & Chastain, R. (1984). A demographically based index of premorbid intelligence for the WAIS-R. *Journal of Consulting and Clinical Psychology*, *52* (5), 885-887.

Benton, A.L., Hamsher, K.desS., & Silven, A.B. (1983). *Multilingual Aphasia Examination* (3rd ed.). Iowa City: AJA Associates

Blair, J.R., & Spreen, O. (1989). Predicting premorbid IQ: A revision of the national adult reading test. *The Clinical Neuropsychologist*, *3* (2), 129-136.

Brayne, C., & Beardsall, L. (1990). Estimation of verbal intelligence in an elderly community: An epidemiology study using NART. *British Journal of Clinical Psychology*, *29* (2), 217-223.

Bryan, J., Luszcz, M.A., & Crawford, J.R. (1997). Verbal knowledge and speed of information processing as mediators of age differences in verbal fluency performance among older adults. *Psychology and Aging, 12* (3), 473-478.

Cooper, D., & Fraboni, M.A. (1988). Relationship between the Wechsler adult intelligence scale- revised and the wide range achievement test-revised in a sample of normal adults. *Educational and Psychological Measurement, 48* (3) 799-803.

Crawford, J.R., & Allan, K.M. (1997). Estimating premorbid WAIS-R IQ with demographic variables: Regression equations derived from a UK sample. *The Clinical Neuropsychologist, 11* (2), 192-197.

Crawford, J.R., Besson, J.A.O., Bremner, M., Ebmeier, K.P., Cochrane, R.H.B., & Kirkwood, K. (1992). Estimation of premorbid intelligence in schizophrenia. *British Journal of Psychiatry, 161*, 69-74.

Crawford, J.R., Besson, J.A.O., Parker, D.M., Sutherland, K.M., & Keen, P.L. (1987). Estimation of premorbid intellectual status in depression. *British Journal of Clinical Psychology, 26* (4), 313-314.

Crawford, J.R., Cochrane, R.H.B., Besson, J.A.O., Parker D.M., & Stewart, L.E. (1990). Premorbid IQ estimates obtained by combining the NART and demographic variables: Construct validity. *Personality and Individual Differences, 11* (2)*, 209-210.*

Crawford, J.R., Deary, I.J., Starr, J., & Whalley, L.J. (2001). The NART as an index of prior intellectual functioning: A retrospective validity study covering a 66-year interval. *Psychological Medicine: A Journal of Research in Psychiatry and the Allied Sciences, 31* (3), 451-458.

Crawford, J.R., Millar, J., & Milne, A.B. (2001). Estimating premorbid IQ from demographic variables: A comparison of a regression equation vs. clinical judgment. *British Journal of Clinical Psychology, 40* (1), 97-105.

Crawford, J.R., Moore, J.W., & Cameron, I.M. (1992). Verbal fluency: A NART-based equation for the estimation of premorbid performance. *British Journal of Clinical Psychology*, *31* (3), 327-329.

Crawford, J.R., Nelson, H.E., Blackmore, L., Cochrane, R.H.B., & Allan, K.M. (1990). Estimating premorbid intelligence by combining the NART and demographic variables: An examination of the NART standardization sample and supplementary equations. *Personality and Individual Differences, 11* (11), 1153-1157.

Crawford, J.R., Parker, D.M., & Besson, J.A.O. (1988). Estimation of premorbid intelligence in organic conditions. *British Journal of Psychiatry, 153*, 178-181.

Crawford, J.R., Stewart, L.E., Cochrane, R.H.B., Foulds, J.A., Besson, J.A.O., & Parker, D.M. (1989). Estimating premorbid IQ from demographic variables: Regression equations derived from a UK sample. *British Journal of Clinical Psychology, 28* (3), 275-278.

Crawford, J.R., Stewart, L.E., Garthwaite, P.H., Parker, D.M., & Besson, J.A.O. (1988). The relationship between demographic variables and NART performance in normal subjects. *British Journal of Clinical Psychology*, *27* (2), 181-182.

Crawford, J.R., Stewart, L.E., Parker, D.M., Besson, J.A.O., & Cochrane, R.H.B. (1989). Estimation of premorbid intelligence: Combining psychometric and demographic approaches improves predictive accuracy. *Personality and Individual Differences, 10* (7), 793-796.

Crossley, M., Arcy, C.D., & Rawson, N.S.B. (1997). Letter and category fluency in community-dwelling Canadian seniors: A comparison of normal participants to those with dementia of the Alzheimer or vascular type. *Journal of Clinical and Experimental Neuropsychology, 19* (1), 52-62.

Dawes, R.M., Faust, D., & Meehl, P.E. (2002). Clinical versus actuarial judgment. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 716-729). Cambridge, United Kingdom: Cambridge University Press.

Epker, M.O., Lacritz, L.H., & Cullum, C.M. (1999). Comparative analysis of qualitative verbal fluency performance in normal elderly and demented populations. *Journal of Clinical and Experimental Neuropsychology*, *21* (4), 425-434.

Faust, D. (1986). Research on human judgment and its application to clinical practice. *Professional Psychology: Research and Practice, 17* (5), 420-430.

Faust, D., & Nurcombe, B. (1989). Improving the accuracy of clinical judgment. *Psychiatry: Journal for the Study of Interpersonal Processes*, *52* (2), 197-208.

Gladsjo, J.A., Schuman, C.C., Evans, J.D., Peavy, G.M., Miller, S.W., & Heaton, R.K. (1999). Norms for letter and category fluency: Demographic corrections for age, education, and ethnicity. *Assessment*, *6* (2), 147-178.

Goldstein, F.C., Gary, H.E. Jr., & Levin, H.S. (1986). Assessment of the accuracy of regression equations proposed for estimating premorbid intellectual functioning on the Wechsler adult intelligence scale. *Journal of Clinical and Experimental Neuropsychology*, *8* (4), 405-412.

Gomez, R.G., & White, D.A. (2006). Using verbal fluency to detect very mild dementia of the Alzheimer's type. *Archives of Clinical Neuropsychology*, *21* (8), 771-775.

Griffin, S.L., Mindt, M.R., Rankin, E.J., Ritchie, A.J., & Scott, J.G. (2002). Estimating premorbid intelligence: Comparison of traditional and contemporary methods across the intelligence continuum. *Archives of Clinical Neuropsychology, 17* (5), 497-507.

Grober, E., & Sliwinski, M. (1991). Development and validation of a model for estimating premorbid verbal intelligence in the elderly. *Journal of Clinical and Experimental Neuropsychology*, *13* (6), 933-949.

Hart, S., Smith, C.M., & Swash, M. (1986). Assessing intellectual deterioration. *British Journal of Clinical Psychology*, *25* (2), 119-124.

Henry, J.D., & Crawford, J.R. (2004). A meta-analytic review of verbal fluency performance in patients with traumatic brain injury. *Neuropsychology, 18* (4), 621-628.

Henry, J.D., Crawford, J.R., & Phillips, L.H. (2004). Verbal fluency performance in dementia of the Alzheimer's type: a meta-analysis. *Neuropsychologia*, *42* (9), 1212-1222.

Jastak, S., & Wilkinson, G. (1984). *The wide range achievement test: Manual of instructions*. Wilmington, DE: Jastak Associates.

Johnson, A.S., Flicker, L.J., & Lichtenberg, P.A. (2006). Reading ability mediates the relationship between education and executive function tasks. *Journal of the International Neuropsychological Society, 12* (1), 64-71.

Johnstone, B., Callahan, C.D., Kapila, C.J., & Bouman, D.E. (1996). The comparability of the WRAT-R reading test and NAART as estimates of premorbid intelligence in neurologically impaired patients. *Archives of Clinical Neuropsychology, 11* (6), 513-519.

Johnstone, B., Hexum, C.L., & Ashkanazi, G. (1995). Extent of cognitive decline in traumatic brain injury based on estimates of premorbid intelligence. *Brain Injury, 9* (4), 377-384.

Johnstone, B., & Wilhelm, K.L. (1996). The longitudinal stability of the WRAT-R reading subtest: Is it an appropriate estimate of premorbid intelligence? *Journal of the International Neuropsychological Society, 2* (4), 282-285.

Jones, S., Laukka, E.J., & Backman, L. (2006). Differential verbal fluency deficits in the preclinical stages of Alzheimer's disease and vascular dementia. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior*, *42* (3), 347-355.

Kareken, D.A. (1997). Judgment pitfalls in estimating premorbid intellectual functioning. *Archives of Clinical Neuropsychology, 12* (8), 701-709.

Kareken, D.A., Gur, R.C., & Saykin, A.J. (1995). Reading on the wide range achievement test-revised and parental education as predictors of IQ: Comparison with the Barona formula. *Archives of Clinical Neuropsychology, 10* (2), 147-157.

Kareken, D.A., & Williams, J.M. (1994). Human judgment and estimation of premorbid intellectual functioning. *Psychological Assessment*, *6* (2), 83-91.

Kempler, D., Teng, E.L., Dick, M., Taussig, M., & Davis, D.S. (1998). The effects of age, education, and ethnicity on verbal fluency. *Journal of the International Neuropsychological Society, 4* (6), 531-538.

Klesges, R.C., & Troster, A.I. (1987). A review of premorbid indices of intellectual and neuropsychological functioning: What have we learned in the past five years? *The International Journal of Clinical Neuropsychology, 9* (1), 1-11.

Klesges, R.C., Wilkening, G.N., & Golden, C.J. (1981). Premorbid indices of intelligence: A review. *Clinical Neuropsychology, 3* (3), 32-39.

Larrabee, G.J., Largen, J.W., & Levin, H.S. (1985). Sensitivity of age-decline resistant (“Hold”) WAIS subtests to Alzheimer’s disease. *Journal of Clinical and Experimental Neuropsychology, 7* (5), 497-504.

Lezak, M.D., Howieson, D.B., Loring, D.W., Hannay, H.J., & Fischer, J.S. (2004). *Neuropsychological Assessment* (4th ed.). New York: Oxford University Press, Inc.

Manly, J. J., Jacobs, D. M., Touradji, P., Small, S. A., & Stern, Y. (2002). Reading level attenuates differences in neuropsychological test performance between African American and white elders. *Journal of the International Neuropsychological Society, 8* (3), 341-348.

Manly, J.J., Schupf, N., Tang, M.X., & Stern, Y. (2005). Cognitive decline and literacy among ethnically diverse elders. *Journal of Geriatric Psychiatry and Neurology, 18* (4), 213-217.

McFie, J. (1975). *Assessment of organic intellectual impairment*. New York: Academic Press, Inc.

Meehl, P.E. (1954). *Clinical and statistical prediction: A theoretical analysis and a review of the evidence.* Minneapolis: University of Minnesota Press.

Mortensen, E.L., Gade, A., & Reinisch, J.M. (1991). A critical note on Lezak's 'best performance method' in clinical neuropsychology. *Journal of Clinical and Experimental Neuropsychology, 13* (2), 361-371.

Murphy, K.J., Rich, J.B., & Troyer, A.K. (2006). Verbal fluency patterns in amnestic mild cognitive impairment are characteristics of Alzheimer's type dementia. *Journal of the International Neuropsychological Society, 12* (4), 570-574.

Nelson, H.E. (1982). *National adult reading test (NART): Test manual*. Windsor: NFER-Nelson

Nelson, H.E., & McKenna, P. (1975). The use of current reading ability in the assessment of dementia. *British Journal of Social and Clinical Psychology, 14* (3), 259-267.

Nelson, H.E., & O'Connell, A. (1978). Dementia: The estimation of premorbid intelligence levels using the new adult reading test. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior, 14* (2), 234-244.

O'Carroll, R.E., Baikie, E.M., & Whittick, J.E. (1987). Does the national adult reading test hold in dementia? *British Journal of Clinical Psychology, 26* (4), 315-316.

O'Carroll, R.E., & Gilleard, C.J. (1986). Estimation of premorbid intelligence in dementia. *British Journal of Clinical Psychology, 25* (2), 157-158.

Orme, D.R., Johnstone, B., Hanks, R., & Novack, T. (2004). The WRAT-3 reading subtest as a measure of premorbid intelligence among persons with brain injury. *Rehabilitation Psychology, 49* (3), 250-253.

Pasquier, F., Lebert, F., Grymonprez, L., & Petit, H. (1995). Verbal fluency in dementia of frontal lobe type and dementia of Alzheimer's type. *Journal of Neurology, Neurosurgery, and Psychiatry, 58* (1), 81-84.

Raskin, S.A., & Rearick, E. (1996). Verbal fluency in individuals with mild traumatic brain injury. *Neuropsychology, 10* (3), 416-422.

Ravnkilde, B., Videbech, P., Rosenberg, R., Gjedde, A & Gade, A. (2002). Putative tests of frontal lobe function: A PET- study of brain activation during stroop's test and verbal fluency. *Journal and Clinical and Experimental Neuropsychology, 24* (4), 534-547.

Russell, E.W. (1972). WAIS factor analysis with brain-damaged subjects using criterion measures. *Journal of Consulting and Clinical Psychology, 39* (1), 133-139.

Salvatierra, J., Rosselli, M., Acevedo, A., & Duara, R. (2007). Verbal fluency in bilingual Spanish/English Alzheimer's disease patients. *American Journal of Alzheimer's Disease & Other Dementias, 22* (3), 190-201.

Schinka, J.A., & Vanderploeg, R.D. (2000). Estimating premorbid level of functioning. In R.D. Vanderploeg (Ed.), *Clinician's guide to neuropsychological assessment* (pp. 39-67). Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc.

Schlosser, R., Hutchinson, M., Joseffer, S., Rusinek, H., Saarimaki, A., Stevenson, J., Dewey, S.L., & Brodie, J.D. (1998). Functional magnetic resonance imaging of human brain activity in a verbal fluency task. *Journal of Neurology, Neurosurgery, & Psychiatry, 64* (4), 492-498.

Scholtissen, B., Dijkstra, J., Reithler, J., & Leentjens, A.F.G. (2006). Verbal fluency in Parkinson's disease: Results of a 2-min fluency test. *Acta Neuropsychiatrica, 18* (1), 38-41.

Schwartz, M., & Saffran, E. (1987). *The American-NART: Replication and extension of the British findings on the persistence of word pronunciation skills in patients with dementia.* Unpublished manuscript.

Silva, C.G., Petersson, K.M., Faisca, L.,Ingvar, M., & Reis, A. (2004). The effects of literacy and education on the quantitative and qualitative aspects of semantic verbal fluency. *Journal of Clinical and Experimental Neuropsychology, 26* (2), 266-277.

Silverstein, A.B. (1987). Accuracy of estimates of premorbid intelligence based on demographic variables. *Journal of Clinical Psychology, 43* (5), 493-495.

Spruill, J., & Beck, B. (1986). Relationship between the WAIS-R and wide range achievement test-revised. *Educational and Psychological Measurement, 46* (4), 1037-1040.

Stebbins, G.T., Gilley, D.W., Wilson, R.S., Bernard, B.A., & Fox, J.H. (1990). Effects of language disturbances on premorbid estimates of IQ in mild dementia. *The Clinical Neuropsychologist, 4* (1), 64-68.

Stebbins, G.T., Wilson, R.S., Gilley, D.W., Bernard, B.A., & Fox, J.H. (1990). Use of the national adult reading test to estimate premorbid IQ in dementia. *The Clinical Neuropsychologist, 4* (1), 18-24.

Strub, R.L., & Black, F.W. (2000). *The mental status examination in neurology (4^{th} ed.).* Philadelphia: F.A. Davis Company.

Sweet, J.J., Moberg, P.J., & Tovian, S.M. (1990). Evaluation of Wechsler adult intelligence scale- Revised premorbid IQ formulas in clinical populations. *Psychological Assessment: A Journal of Consulting and Clinical Psychology, 2* (1), 41-44.

Tombaugh, T.N., Kozak, J., & Rees, L. (1999). Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. *Archives of Clinical Neuropsychology, 14* (2), 167-177.

Wechsler, D. (1958). *The measurement and appraisal of adult intelligence* (4^{th} ed.). Baltimore: The Williams & Wilkins Company.

Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence manual*. San Antonio: Harcourt Assessment, Inc.

Wedding, D. (1983). Clinical and statistical prediction in neuropsychology. *Clinical Neuropsychology, 5* (2), 49-55.

Wedding, D., & Faust, D. (1989). Clinical judgment and decision making in neuropsychology. *Archives of Clinical Neuropsychology*, *4* (3), 233-265.

Wiens, A.N., Bryan, J.E., & Crossen, J.R. (1993). Estimating WAIS-R FSIQ from the national adult reading test-revised in normal subjects. *The Clinical Neuropsychologist*, *7* (1), 70-84.

Wilkinson, G.S., & Robertson, G.J. (2006). *Wide range achievement test: Professional manual*. Florida: Psychological Assessment Resources, Inc.

Wilson, R.S., Rosenbaum, G., Brown, G., Rourke, D., Whitman, D., & Grisell, J. (1978). An index of premorbid intelligence. *Journal of Consulting and Clinical Psychology, 46* (6), 1554-1555.

Yates, A.J. (1956). The use of vocabulary in the measurement of intellectual deterioration- A review. *The Journal of Medical Science, 102,* 409-438.