

Using word recognition tests to estimate premorbid IQ in early dementia: Longitudinal data

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Abstract

This study examined the utility of word recognition scores for estimating actual Verbal IQ scores obtained from 1–5 years earlier. Participants were 271 persons remaining normal and 24 initially normal persons who developed cognitive impairment over longitudinal follow-up. A previously published regression equation based on education and the American modification of the National Adult Reading Test (Nelson, 1982) was used to estimate Mayo Verbal IQ. In spite of correlating well with prior obtained scores ($r = .7$) the predicted score tended to overestimate the obtained Mayo Verbal IQ. A revised equation was developed in the normal sample, which improved accuracy of prediction. Among the 24 persons who developed cognitive impairment over a 5-year span, the revised predicted scores provided reasonable estimates of initial Mayo Verbal IQ. To aid in clinical interpretation, a table of the normal frequencies of predicted Mayo Verbal IQ minus contemporaneously obtained Mayo Verbal IQ is provided. (*JINS*, 1997, 3, 528–533.)

Keywords: Dementia; Premorbid IQ; Word recognition

INTRODUCTION

Past researchers (Nelson & O'Connell, 1978; Crawford et al., 1988; Blair & Spreen, 1989; Brayne & Beardsall, 1990; Grober & Sliwinski, 1991; Sharpe & O'Carroll, 1991; Patterson et al., 1994; Johnstone & Wilhelm, 1996; Maddrey et al., 1996) have argued that word recognition performance may be relatively preserved in the early to middle phases of degenerative dementia. These researchers have shown that reading scores on The National Adult Reading Test (Nelson, 1982) or the American modification of the National Adult Reading Test (AMNART; Grober & Sliwinski, 1991) correlate highly with contemporaneous WAIS-R Verbal IQ scores in normal elderly individuals (Nelson & O'Connell, 1978; Grober & Sliwinski, 1991; Sharpe & O'Carroll, 1991). These researchers have also shown that these word recognition scores do not differ between demographically matched controls and early dementia patients. In addition, it has been observed that word recognition scores generally overestimate contemporaneous Verbal IQ in dementia patients. Investigators have reasoned that since word

recognition correlates with contemporaneous Verbal IQ score in normals and word recognition scores do not differ between demographically matched normals and early dementia patients, that reading scores accurately assess premorbid function in early dementia. It has been further suggested that discrimination between healthy older people and early dementia cases could be enhanced by combining word recognition based premorbid IQ estimates with tests of current ability (Crawford et al., 1990).

However, the above studies have been largely cross-sectional in nature and have used deductive reasoning in place of empiric data to argue for the utility of word recognition estimates of premorbid IQ. More recently, longitudinal data have been presented to enhance cross-sectional studies. Paque and Warrington (1995) followed 57 patients with degenerative dementia by obtaining serial NART reading scores and shortened versions of the WAIS-R over three assessments spanning unspecified amounts of time. They observed a modest decline in NART estimated IQs over time ($M = 5$ points) as compared to more marked declines in Performance IQ and Verbal IQ ($M = 12$ and 15 points, respectively). They also noted that most of the reading decline was attributable to a subset of dementia patients with initial Verbal IQ–Performance IQ discrepancies that favored the latter score, suggesting a degenerative dementia with

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more prominent language decline. Paque and Warrington (1995) argued that the NART is a useful predictor of premorbid intellectual functioning in persons with dementia. Their conclusion contrasts Fromm et al. (1991), who found more significant declines on NART scores in longitudinal assessment.

In many of these studies, the dependent measure (IQ score) has been derived without adequate age corrections for persons above age 74. Only Ryan and Paolo (1992) used extended age norms (Ryan et al., 1990) to calculate IQ scores in persons over age 74. Utilizing these corrections in a paradigm similar to the previously cited research (cross-sectional study of normals and neurologically impaired patients), Ryan and Paolo also found that the NART “adequately” estimated premorbid IQ.

While cross-sectional methods thus provide encouraging results, they do not directly validate the use of word recognition reading skills to estimate premorbid intellect for neurologically compromised persons. An inferential leap is still required to assume that word recognition estimates obtained from neurocognitively impaired persons accurately index their premorbid Verbal IQ scores. Direct validation requires a longitudinal design in which word-recognition-based IQ estimates obtained after the clinical diagnosis of dementia are compared to premorbidly documented IQ.

The present study had two goals. The first was to directly validate the utility of word recognition scores in predicting premorbid Verbal IQ. Longitudinal data obtained on initial cognitively normal participants in the Mayo Older Americans Normative Studies (MOANS; Ivnik et al., 1992) served as the basis for this goal of the study. We compared the prediction of premorbid IQ in persons who remained normal over longitudinal assessment to prediction with persons who developed cognitive impairment.

Second, we examined the frequency distribution of discrepancy scores between contemporaneously obtained estimates of premorbid verbal IQ (based on word recognition scores) and obtained Verbal IQ scores in normals. These are the data that are commonly available to clinicians when they

make judgments about possible verbal intellectual decline. For all groups Mayo IQ scores (Ivnik et al., 1992), which provide age based norms for persons from age 55 to 97, were used.

METHODS

Research Participants

Participants were a subset of MOANS described in previous longitudinal studies (Ivnik et al., 1995; Malec et al., 1996; Smith et al., 1996). Two groups were identified. First, the normal sample included all persons who met our previously established criteria (Ivnik et al., 1992) for normality, both at initial collection of IQ data (from 1986 to 1988), and at the time of follow-up cognitive testing (1991–1993). These criteria include (1) independent community-dwelling status; (2) the absence of active psychiatric or neurologic disorders affecting cognition; (3) the absence of psychotropic medication use in types or amounts that would affect cognition; and (4) the absence of concern regarding cognitive function on the part of the person and her or his primary care physician. This sample included 118 men and 153 women.

The second group in this study (*crossovers*) consisted of 24 persons who met the above criteria for normality when they were first tested, but who subsequently developed cognitive impairment before their second testing. There were 8 vascular cases, 5 probable Alzheimer’s disease cases (NINCDS–ADRDA criteria; McKhann et al., 1984), 7 mild cognitive impairment (Petersen et al., 1995) cases, and four other dementias (e.g., Parkinson’s) in this crossover group.

Demographic information, mean IQ scores, and reading recognition scores for both groups are listed in Table 1. As might be expected, given the association of age and onset of cognitive impairment, the crossover group was significantly older. The interval of follow-up for this group was also slightly longer. However, age-adjusted initial Mayo IQ scores and education were not different for the crossover

Table 1. Demographic, Verbal IQ and word recognition data

Variable	MOANS group <i>n</i> = 271		Crossover group <i>n</i> = 24		<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Age (Time 1)	72.2	8.7	82.3	5.3	.0001
Education	13.4	2.6	13.3	3.3	.88
Retest interval (years)	3.7	0.6	5.1	1.5	.0002
Mini Mental State score (Time 2)	28.2	1.8	23.3	5.9	.0004
Mayo Verbal IQ (Time 1)	106.8	9.7	105.6	9.4	.57
Mayo Verbal IQ (Time 2)	107.8	9.6			—
Grober & Sliwinski AMNART estimated Verbal IQ	112.6	7.7	109.2	8.8	.02
Mayo AMNART estimated Verbal IQ	106.7	6.8	104.0	8.0	.06

Note. AMNART = American Modification of the National Adult Reading Test.

group relative to the normals. As should be expected, the crossover group had a lower mean Mini-Mental State Exam (MMSE; Folstein et al., 1975) total score at follow-up. This mean score fell below the traditional MMSE screening cut-off of 24.

Procedure

Data for this study were retrospectively obtained from the MOANS database. Persons in the MOANS studies were recruited for longitudinal assessment as described in previous reports (Ivnik et al., 1995; Malec et al., 1996; Smith et al., 1996). Briefly, each person had initially been recruited following a general medical examination by their primary physician and review of their entire medical record by one of the investigators. Persons with prior histories of disorders potentially affecting cognition (e.g., head injury, substance abuse) were excluded unless it was documented in their medical record that the condition was no longer active, and the patient was without clinically apparent residuals. Persons with concern regarding their own cognitive function, or for whom their primary physician or family had concerns regarding cognitive function were also excluded from initial enrollment. Data from 295 persons who had been tested twice and had the requisite measures (Mayo Verbal IQ and AMNART) were utilized for this study. Maintenance of normal status or development of cognitive impairment was established by neuropsychologists' review of the interim medical record. Time 1 Mayo Verbal IQ scores had been calculated for all participants from standard administrations of the WAIS-R (Wechsler, 1981) at their initial (Time 1) evaluation. The normal, cognitively stable participants received readministration of the full WAIS-R at the second assessment, enabling calculation of a Time-2 Mayo Verbal IQ. All participants had the AMNART at the second exam.

RESULTS

The test-retest interval was 3.7 years ($SD = 0.6$) for the 271 cognitively normal participants and 5.1 years ($SD = 1.5$) for the 24 persons who developed cognitive impairment after their initial testing. Each group's mean (SD), age, and education are presented in Table 1, along with similar data for other independent and dependent measures.

Table 1 data reveals a slight mean increase among the normals in Mayo Verbal IQ (+1.1 points) over the test-retest interval. This change is statistically significant from zero [$t(270) = -3.4, p = .007$], but its size suggests no clinical relevance. The 24 participants who were demented at Time 2 did not receive full WAIS-Rs as part of their clinical exams (only selected subtests were readministered), so similar test-retest comparisons were not possible for them.

If Verbal IQ was not stable over time in normal people, it would be unreasonable to expect any test to be able to predict premorbid past functioning. To establish an upper limit

to what to expect for Time-2 AMNART scores' ability to predict Time-1 Mayo Verbal IQ values, the correlation between Time-1 and Time-2 Mayo Verbal IQs was computed using only the normal participants' data. This correlation was statistically significant ($r = .70, p < .01$). Next, Grober and Sliwinski's regression equation [1991; predicted Verbal IQ = $118.56 - (\text{AMNART errors} \times 0.88) + (\text{Education} \times 0.56)$] was applied to all Time-2 AMNART scores to obtain Grober-and-Sliwinski-estimated Time-1 Mayo Verbal IQs. This correlation ($r = .70$) shows that the Grober and Sliwinski equation is a strong estimator of premorbid Verbal IQ.

Using data from the normal participants, discrepancy scores were computed by subtracting Time-1 actual Mayo Verbal IQ from Grober-and-Sliwinski-estimated Time-1 Mayo Verbal IQs. These discrepancy scores show that the Grober and Sliwinski equation significantly [$t(270) = -13.8; p < .001$] overestimates actual Time-1 Mayo Verbal IQs by an average of 5.9 points ($SD = 7$). This discrepancy may arise from the fact that the Grober and Sliwinski equation was developed based on conventionally normed WAIS-R Verbal IQ values but here was applied to Mayo Verbal IQ.

To reduce this overestimation, a new regression equation (i.e., the Mayo estimated Verbal IQ equation) was computed from the cognitively normal participants' Time-2 AMNART scores to estimate Time-1 Mayo Verbal IQs. This linear regression model, which used the same independent variables as the Grober and Sliwinski model, was significant [$F(2,268) = 129.9, p < .001$], with an adjusted R -squared of .49. The Mayo estimate equation (which has a standard error of estimate of 6.9), for predicting premorbid Mayo Verbal IQ is Mayo AMNART Predicted Verbal IQ = $106.3 - (\text{AMNART errors} \times 0.70) + (\text{Education} \times 0.83)$.

The correlation between the Mayo AMNART predicted and actual Time-1 Verbal IQs was .70. This was identical to the correlation obtained between the Grober and Sliwinski estimated Time-1 Mayo Verbal IQs. This was expected since both the Grober and Sliwinski and the Mayo estimation equations are linear transformations of the same data (i.e., AMNART errors and patient education levels).

In those rare instances where premorbid intelligence has been documented, the predictions being studied are irrelevant. However, it is usually the case that practicing clinicians only have contemporaneous AMNART and Verbal IQ data available for making diagnostic decisions. It would be clinically useful, therefore, to know how common the following difference scores occur among cognitively normal older persons: (1) Grober-and-Sliwinski-estimated premorbid (i.e., Time-1) Verbal IQ minus obtained Time-2 Mayo Verbal IQ; and (2) Mayo-estimated premorbid Verbal IQ minus obtained Time-2 Mayo Verbal IQ values. For these analyses, only data from the 271 persons who were cognitively normal are relevant. To obtain this base-rate information, the above mentioned differences were computed, and are presented in Table 2 for both the Grober and Sliwinski and Mayo equations.

Table 2. Percentages of normals with estimated premorbid Verbal IQ minus current Verbal IQ discrepancy scores of varying magnitudes

Discrepancy score	Magnitude of discrepancy				
	≥5	≥8	≥10	≥15	≥20
Mayo-estimated premorbid Verbal IQ – obtained Mayo Verbal IQ	19%	9%	6%	2%	.4%
Grober & Sliwinski AMNART-estimated premorbid Verbal IQ – obtained Mayo Verbal IQ	47%	31%	21%	8%	2%

Note. AMNART = American Modification of the National Adult Reading Test. All scores obtained at Time-2 evaluation. Table lists the frequency of the directional discrepancy where estimated Mayo Verbal IQ exceeds obtained Mayo Verbal IQ.

Finally, we cross-validated the correlations between predicted Mayo Verbal IQ and obtained Time-1 Mayo Verbal IQ in the sample of recently demented subjects. Again, as different linear transformations of the same data, the Grober and Sliwinski and Mayo AMNART equations were not different in their correlations with obtained premorbid Mayo Verbal IQ ($r = .84$ and $.85$, respectively, differences due to rounding error only, $p < .001$). In the recently cognitively impaired patients, the Grober and Sliwinski estimate of Mayo Verbal IQ predictions overestimated Time-1 VIQs by 3.6 points, which was significant [$t(23) = 3.4, p = .0025$]. The Mayo equation underestimated Time-1 VIQs by 1.6 points. This value is not significantly different from zero [$t(23) = -1.6, p = .11$]. Grober and Sliwinski estimated Verbal IQ and Mayo Estimated Verbal IQ scores are plotted against obtained Time-1 Mayo Verbal IQ in Figure 1.

DISCUSSION

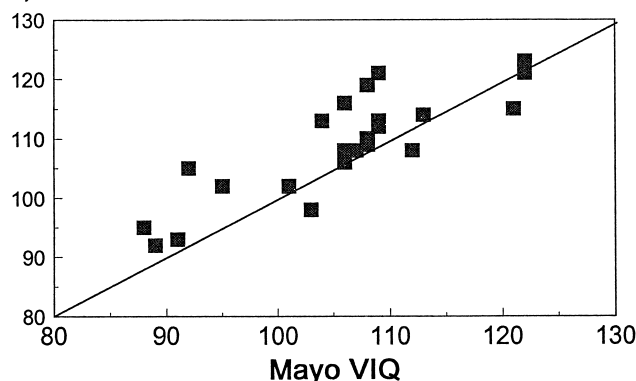
This study directly tested the hypothesis that a word recognition reading measure can be used to estimate premorbid IQ. The results generally support this hypothesis. Word recognition scores were found to strongly correlate with previously obtained Mayo Verbal IQ scores in normals. More importantly, in a sample of persons with the recent onset of cognitive impairment, word recognition reading scores provided excellent estimation of Mayo Verbal IQs that had been obtained on average 5 years earlier, while these people were still presumably unimpaired. These findings thereby validate the results from the normal sample.

This study supports and extends prior work (Nelson & O’Connell, 1978; Crawford et al., 1988; Blair & Spreen, 1989; Brayne & Beardsall, 1990; Grober & Sliwinski, 1991; Sharpe & O’Carroll, 1991; Paque & Warrington, 1995) indicating that word recognition scores closely estimate the premorbid status of persons with early dementia, and it provides a strong empirical basis for this practice. However, certain limitations of this approach must be acknowledged. As alluded to in the introduction, word-recognition-based estimates of premorbid IQ may be less accurate in dementia patients with early or prominent language dysfunction (Paque & Warrington, 1995). Moreover, Taylor et al. (1996) have shown that estimates of Verbal IQ themselves decline over

longitudinal follow-up of dementia patients based on slowly declining AMNART scores. They suggest that corrections are necessary based on degree of cognitive decline.

This study also found that simply adopting the Grober and Sliwinski AMNART (1991) formula to estimate prior Mayo Verbal IQs in both normals and cognitively compromised persons leads to overestimation. Such overestimation could lead to interpretations of cognitive decline in persons who are not actually declining. Thus, a Mayo re-

a) Grober and Sliwinski estimated VIQ



b) Mayo Estimated VIQ

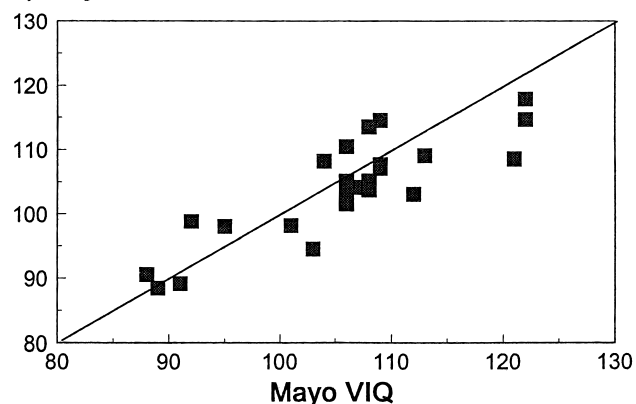


Fig. 1. Initial Mayo Verbal IQ scores of the crossover group ($n = 24$) with (a) Grober and Sliwinski AMNART-estimated Verbal IQ scores; (b) Mayo estimated Verbal IQ scores. Note that the identity line, i.e., perfect prediction, is plotted, not the regression line.

gression equation based on AMNART was developed. It appears to provide a more conservative estimate of premorbid Mayo Verbal IQ. It should be kept in mind that the Mayo regression equation is intended to estimate Verbal IQ derived using the Mayo norms (Ivnik et al., 1992). Comparison of Mayo estimated Verbal IQ to conventional WAIS-R IQ scores may be misleading, and should be avoided. Moreover, it should be reemphasized that the MOANS sample from which the Mayo estimation equation was derived is restricted in its geographic, socioeconomic, racial, and cultural composition. The validity of the methods described herein for comparing an individual's estimated and obtained Mayo Verbal IQ scores may depend heavily on the extent to which the individual is comparable to the demographics of the MOANS sample.

Attempting to estimate true premorbid IQ may be misleading. For example, recent research (Snowdon et al., 1995; Reiman et al., 1996) has suggested that there may be physiological and functional anomalies in some presymptomatic dementia cases many years before they are detected and diagnosed. Thus, even the Time-1 Verbal IQs obtained in cognitively impaired participants in this study may not be truly premorbid. However, in many clinical situations the goal is not to establish true premorbid function, but to decide if Verbal IQ has declined. Group data regarding the correlation of word recognition scores with premorbid scores are only partially informative for this purpose. For example, what does the .84 correlation noted in this study's cognitive impairment sample tell us about a person who presents with memory difficulties and a current Verbal IQ score that is 9 points below estimated premorbid IQ? A first consideration should be whether or not a 9-point change in Verbal IQ is uncommon in normal persons. Ivnik et al.'s (1995) work on the longitudinal stability of IQ indices in normals is informative in this regard. If this degree of change is uncommon, then a second consideration is the clinical significance of the discrepancy between concurrently measured word recognition estimates and Verbal IQ scores. Table 2 addresses this latter question, and lists the frequency of estimated Verbal-IQ-obtained Verbal IQ discrepancies of various magnitudes in our large normal sample. Note that Table 2 lists only the frequency of the directional discrepancy where estimated Mayo Verbal IQ exceeds obtained Mayo Verbal IQ. This directional discrepancy is presumed to be the score of greatest interest, since scores in this direction could suggest significant decline in Mayo Verbal IQ.

This table suggests that when using our Mayo estimation formula, current Verbal IQ falls 8 or more points below estimated Verbal IQ in less than 10% of normals. As discrepancy scores move above 10 points, it is increasingly unlikely that they are the result of normal variation. Thus our data suggests the difference of 9 points in the above case is uncommon and potentially "abnormal." When Grober-Sliwinski estimates are used, a larger discrepancy is required, because their equation overestimates past Mayo Verbal IQ. Nevertheless, Table 2 provides a good basis to recommend the word recognition method, because it en-

ables a clearer interpretation of the significance of word recognition-Verbal IQ discrepancies in any given individual. Additional research is needed to determine whether this method has comparable utility in other (e.g., head injured, epileptic) populations.

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