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BRIEF COMMUNICATION

The use of word-reading to estimate "premorbid" ability in cognitive domains other than intelligence

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Abstract

Diagnostic neuropsychological assessment requires the clinician to estimate a patient's premorbid abilities. Word reading tests, such as the National Adult Reading Test–Revised (NART–R), provide reasonably accurate estimates of premorbid IQ, but their capacity to benchmark other premorbid cognitive abilities remains unclear. In this extension of an earlier report, we administered the NART–R, an abbreviated Wechsler Adult Intelligence Scale (WAIS–R or WAIS–III), and 26 other cognitive measures to 322 reasonably healthy adults. While NART–R performance correlated robustly ($rs \geq .72$) with concurrent Verbal and Full Scale IQ, its correlation with all other cognitive measures was significantly lower. Thus, while it is appealing to use word reading as a proxy for premorbid functioning in other cognitive domains, the NART–R has limited utility for this because it does not predict current performance on other cognitive tests as well as it predicts IQ in healthy adults. (*JINS*, 2005, *11*, 784–787.)

Keywords: Premorbid IQ, Intelligence, Psychological tests, Neuropsychology, National Adult Reading Test–Revised, NART–R

INTRODUCTION

Determining the presence of cognitive decline is an essential element of clinical inference in neuropsychology. The absence of premorbid test results forces the clinician to estimate an individual's premorbid ability in most cases. The NART–R (Blair & Spreen, 1989) and other word-reading tests are used to estimate premorbid intelligence because word-reading correlates highly with IQ in healthy adults and is *relatively* resistant to decline in patients with various brain disorders (Bright et al., 2002; Graves et al., 1999; Johnstone et al., 1996). Perhaps because the need is so pressing, there is a tendency to generalize the usefulness of the NART–R to other domains. However, while the NART–R can provide good estimates of premorbid IQ, whether it can estimate premorbid memory, executive functioning, and other abilities with equal accuracy is unclear. Word-reading correlates significantly with verbal fluency, attention, and memory (Crawford et al., 1992, 1998; O'Carroll et al., 1994), but it does not account for significant variance in Performance IQ, word list learning, or average impairment ratings beyond that explained by demographic variables in healthy adults (Gladsjo et al., 1999). In an earlier report we found that below average, average, and above average IQ groups (defined by either WAIS–R or NART–R scores) differed on most other cognitive tests administered (Diaz-Asper et al., 2004). However, we did not compare the NART–R's predictive accuracy for these other neuropsychological tests to its predictive accuracy for IQ. Here we aim to determine whether the NART–R correlates as highly with concurrent performance on memory and other cognitive abilities as it does with IQ in healthy adults (i.e., persons who are in a "premorbid" state). If so, this would support using the NART–R to estimate premorbid ability across cognitive domains in patients with brain disorders. If not, it would underscore the need to continue searching for accurate markers of premorbid ability in domains other than intelligence.

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METHODS

Participants and Procedure

As described previously (Diaz-Asper et al., 2004), we recruited participants from the Baltimore, Maryland area primarily via random-digit dialing or calling randomly selected telephone numbers from the residential directory for the Aging, Brain Imaging and Cognition study at Johns Hopkins University (ABC–JHU). A second sample was recruited through the Hartford Hospital Olin Neuropsychiatry Research Center by calling randomly selected numbers from the residential directory for Hartford, Connecticut (ABC–NRC). Each participant received a medical and psychiatric assessment that included neuropsychological testing. Of 377 persons assessed, 55 (14.6%) reported, or were found to have, a history of dementia, stroke, multiple sclerosis, Parkinson's disease, current drug or alcohol dependence, schizophrenia, or traumatic brain injury with >1 hr loss of consciousness, or scored below 25/30 on the Mini-Mental State Examination (MMSE; Folstein et al., 1975) and were excluded from further analysis. This left 322 participants who ranged from 18 to 92 ($M \pm SD = 53 \pm 18$) years of age. The sample included 182 women and 140 men who completed 14.1 ± 3.1 years of education. Most (255) were non-Hispanic White; the rest included persons of African American (59) or "other" (7) racial/ethnic background. The participants produced a mean ($\pm$ SD) Full Scale IQ of 106.2 ± 14.6, and a NART–R estimated IQ of 104.6 ± 10.3. This study was approved by the Johns Hopkins University and Hartford Hospital Institutional Review Boards, and all participants gave written informed consent to participate.

Cognitive Measures

In addition to the NART–R, each participant completed Ward's (1990) seven-subtest version of the Wechsler Adult Intelligence Scale–Revised or WAIS–R (Wechsler, 1981) for ABC–JHU or the WAIS–III (Wechsler, 1997) for ABC-NRC. Another 26 cognitive variables were derived from 14 neuropsychological tests, which are referenced in Diaz-Asper et al. (2004). These included times to complete the Grooved Pegboard Test (GPT) with each hand, total correct on the Brief Test of Attention, times to complete Parts A and B of the Trail Making Test, hit reaction time and discrimination (d') on Conners' Continuous Performance Test (CPT), total number correct on a 30-item version of the Boston Naming Test, total acceptable words reported in consecutive 1-minute trials of letter (S and P) and category (Animals and Supermarket Items) Word Fluency, number of acceptable designs produced on the Design Fluency Test, deviation scores on the Cognitive Estimation Test, categories achieved and perseverative errors on Nelson's (1976) modified Wisconsin Card Sorting Test (mWCST), number correct on the Facial Recognition Test, copy score for the Rey Complex Figure Test (Rey CFT), total items recalled over three learning trials, total correct on delayed recall, and recognition discrimination for the Hopkins Verbal Learning Test–Revised (HVLT–R) and Brief Visuospatial Memory Test–Revised (BVMT–R), and immediate and delayed recall from the Logical Memory and Visual Reproduction subtests of the Wechsler Memory Scale–Revised (WMS–R).

Data Analyses

Because WAIS–R IQ scores are age-corrected, we age-corrected the other 26 cognitive test scores by regressing each on age and saving the standardized residuals. We then computed Pearson r (Spearman ρ for variables whose skewness or kurtosis exceeded an absolute value of 1.0) correlations between the NART–R, Verbal and Full Scale IQ scores, and remaining 26 neuropsychological variables. Because the WAIS–R and WAIS–III IQ scores did not differ after controlling for sex, race, and years of education ($ps > .33$), we pooled these scores across test forms. We next conducted a series of t tests for dependent correlations (Bruning & Kintz, 1987) to test whether the correlation between the NART–R and each cognitive measure differed significantly from the correlation between the NART–R and either Verbal or Full Scale IQ scores. Finally, we transformed the age-corrected scores for the 26 neuropsychological variables into standardized form (i.e., with $M \pm SD = 100 \pm 15$), and regressed each of these on NART–R performance in order to compare the resulting standard errors of NART–R estimates (SE_{Est}) with the standard error of NART–R estimated Full Scale IQ scores.

RESULTS

As expected, NART–R premorbid IQ estimates correlated highly with both Verbal and Full Scale IQ, accounting for 57% and 52% of the variance, respectively. As shown in Table 1, NART–R scores also correlated significantly with 24 of the 26 other neuropsychological measures. However, a series of t tests for the difference between dependent correlations revealed that the correlations between the NART–R and every other cognitive measure were significantly smaller ($p < .001$) than the correlations between the NART–R and Verbal and Full Scale IQ scores. This was true regardless of whether Pearson or Spearman correlations were used for the analysis.

Also as shown in Table 1, the standard error of NART–R estimated WAIS–R Full Scale IQ scores (SE_{Est}) was 10.1 points. Because ± 2 standard errors of the estimate define the 95% confidence interval, actual prorated Full Scale IQ scores can be expected to fall within ± 19.8 points (i.e., 1.96×10.1) of those predicted by the NART–R in about 95% of healthy individuals. Prediction accuracy increases with reductions in the SE_{Est} and confidence intervals. Since the 95% confidence interval for predicted performance on any standardized test based on chance alone would be ± 29.4 points (i.e., $\pm 1.96 \times SD$), the NART–R appears to substantially improve estimates of WAIS–R/WAIS–III Verbal and Full Scale IQ scores in healthy adults. In contrast, the SE_{Est}

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Table 1. Pearson r (or Spearman ρ) correlation of the NART–R with age-corrected scores on each cognitive test, standard errors of the estimates of NART–R predicted performances on the same measures, and standard scores corresponding to 5th percentile of NART–R predicted minus actual scores for each cognitive test variable

Test/variable	Correlation[1]	$p <$	SE_{Est}	5th %ile[2]
Verbal IQ (prorated)[3]	$r = .755$	.0001	9.4	13.4
Full Scale IQ (prorated)[3]	$r = .724$	.0001	10.1	15.4
GPT Dominant Hand	$\rho = -.286$	.0001	12.9	26.7
GPT Nondominant Hand	$\rho = -.276$	.0001	13.6	24.5
Trail Making Test, Part A	$\rho = -.237$	.0001	14.6	35.3
Trail Making Test, Part B	$\rho = -.528$	.0001	12.1	25.5
Brief Test of Attention	$r = .319$	.0001	14.2	31.5
mWCST Categories	$\rho = .311$	.0001	14.3	37.8
mWCST Perseverative Errors	$\rho = -.259$	.0001	14.5	33.4
Cognitive Estimation Test	$r = -.500$	.0001	13.0	27.1
CPT Hit Reaction Time	$r = .071$	n.s.	15.0	33.1
CPT Discrimination (d')	$r = .061$	n.s.	15.0	39.8
Boston Naming Test	$\rho = .384$	.0001	13.0	28.7
Word Fluency (Letters)	$r = .481$	.0001	13.1	25.7
Word Fluency (Category)	$r = .386$	.0001	13.8	29.0
Design Fluency Test	$r = .403$	.0001	13.7	27.4
Benton Facial Recognition	$r = .284$	.0001	14.4	30.3
Rey CFT (Copy)	$\rho = .328$	.0001	14.2	31.6
HVLT–R Learning	$r = .356$	.0001	14.0	31.6
HVLT–R Delay	$\rho = .349$	.0001	14.2	35.5
HVLT–R Recognition	$\rho = .142$	.05	14.4	33.0
BVMT–R Learning	$r = .318$	.0001	14.2	31.5
BVMT–R Delay	$r = .300$	.0001	14.3	31.1
BVMT–R Recognition	$\rho = .119$	.05	15.0	39.6
WMS–R Logical Memory I	$r = .419$	.0001	13.6	29.7
WMS–R Logical Memory II	$r = .422$	.0001	13.6	28.3
WMS–R Visual Reproduction I	$r = .343$	.0001	14.1	33.5
WMS–R Visual Reproduction II	$r = .258$	.0001	14.5	33.8

[1]Spearman rank order correlations were used for cognitive measures whose distributions were characterized by skewness or kurtosis >1.0; Pearson product-moment correlations were used for all others. [2]Difference between NART–R estimated Full Scale IQ and each standardized test score that included the 5% of participants with the largest discrepancies. [3]Prorated using Ward's (1990) seven-subtest short form of the WAIS–R or WAIS–III.

for NART–R predicted performance on every other test was >12.8 points. Finally, because the age-corrected distributions of many neuropsychological variables showed substantial departure from normality, we examined cumulative frequency distributions for the differences between each age-corrected standardized test score and NART–R estimated IQs. We then identified the standard score difference that defined the lowest 5% of participants for each measure. For example, as shown in the final column of Table 1, only 5% of subjects produced Full Scale IQ scores that fell more than 15.4 points below their NART–R estimate.

DISCUSSION

Three main findings emerged from this study. First, like others, we found that NART–R word reading test performance correlated robustly with concurrent Verbal and Full Scale IQ scores in healthy adults. Although the correlation between NART–R and FSIQ scores was nearly identical to that reported by Blair and Spreen (1989), these investigators obtained a smaller SE_{Est} (7.6 points) than was found in the present study (10.1 points). One possible explanation of this difference is that our study participants were more heterogeneous in terms of age, racial/ethnic background, years of education, and IQ. Another is that Blair and Spreen used the full WAIS–R, whereas we used a short form. Given that the 95% confidence interval for NART–R estimates of FSIQ in our study was ±19.8 points, one could argue that the NART–R provides little improvement over demographic estimates of FSIQ, which yield a 95% confidence interval of ±23.8 points (Barona et al., 1984). However, only 5% of our participants produced Full Scale IQ scores that fell more than 15 points below their NART–R estimated IQ.

The second major finding was that correlations between performance on the NART–R and 24 of 26 other neuropsy-

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chological variables significantly exceeded zero. This both confirms and extends previous reports that the NART–R can provide information about "premorbid" abilities in domains other than IQ (Crawford et al., 1992, 1998; O'Carroll et al., 1994). It is consistent with the finding that healthy adults grouped by NART–R scores into below average, average, and above–average groups differ on most other cognitive measures (Diaz-Asper et al., 2004). In the present study, NART–R scores correlated most strongly with performance on Trails B, Cognitive Estimation, letter Word Fluency, WMS–R Logical Memory, and the Design Fluency tests, accounting for 16 to 28% of their variance.

The third finding of this study was that the correlation between the NART–R and every other neuropsychological measure was significantly smaller than correlations between the NART–R and WAIS–R/WAIS–III prorated Verbal and Full Scale IQ scores. Given that the mean of all 26 correlations was .31, the NART–R accounted for only about 10% of the variance, on average, in performance on neuropsychological measures other than IQ, and two measures (CPT hit RT and d') did not correlate significantly with NART–R performance at all. Use of the NART–R to estimate age-corrected performances on the 26 cognitive measures yielded standard errors of 12.9 to 15.0 points. After transforming the cognitive measures to standard scores, these corresponded to 95% confidence intervals of ± 25.3 to ± 29.4 points across the 26 measures. Given that the 95% confidence interval for a predictor whose correlation with IQ is zero also would be 29.4 points (since 95% of cases are likely to fall within the interval of 100 ± 1.96 *SD*s), the finding that all 26 of the 95% confidence intervals exceeded 25 points suggests that the NART–R is a relatively weak predictor of current functioning in domains other than IQ. In fact, on every single neuropsychological measure, at least 5% of healthy adults produced standard scores that fell more than 24 points below their own NART–R estimated IQ score.

Several investigators have highlighted the need to develop ability-specific predictors of premorbid ability for clinical use (Crawford, 2004; Franzen et al., 1997; O'Carroll et al., 1994). Such predictors would be particularly useful since tests of memory, executive functioning, psychomotor speed, attention, and other cognitive abilities often are more sensitive than IQ tests to acquired cerebral dysfunction. Although the NART–R can be used as a benchmark against which to compare a patient's performance on other cognitive measures, the present data suggest that reliance on the NART–R alone has limited utility for this purpose since it does not predict current performance on other neuropsychological measures as well as it predicts IQ in healthy adults.

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