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Quality of Education Predicts Performance on the Wide Range Achievement Test-4th Edition Word Reading Subtest

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Abstract

The current study examined whether self-rated education quality predicts Wide Range Achievement Test-4th Edition (WRAT-4) Word Reading subtest and neurocognitive performance, and aimed to establish this subtest's construct validity as an educational quality measure. In a community-based adult sample ($N = 106$), we tested whether education quality both increased the prediction of Word Reading scores beyond demographic variables and predicted global neurocognitive functioning after adjusting for WRAT-4. As expected, race/ethnicity and education predicted WRAT-4 reading performance. Hierarchical regression revealed that when including education quality, the amount of WRAT-4's explained variance increased significantly, with race/ethnicity and both education quality and years as significant predictors. Finally, WRAT-4 scores, but not education quality, predicted neurocognitive performance. Results support WRAT-4 Word Reading as a valid proxy measure for education quality and a key predictor of neurocognitive performance. Future research should examine these findings in larger, more diverse samples to determine their robust nature.

Keywords: Literacy; Academic achievement; Neurocognition; High schools; Multiple regression; Test validity

Educational quality is not always synonymous with educational quantity and can be impacted by numerous factors, including teacher quality, student–teacher ratio, and availability of specialized classes and resources (Rohit et al., 2007). Relying on years of education to account for group differences in neuropsychological test performance assumes that quality of education (QEd) is similar across schools and regions, which is unlikely. Measuring QEd can be challenging, particularly in retrospective studies. The “benefits” that an adult *may* or *may not* have received as a direct function of QEd during youth is obscured by a host of other factors (e.g., socioeconomic status [SES] and parental involvement) that influence the trajectory of cognitive development.

Reading Tests as a Proxy for Quality of Education

Estimating expected neuropsychological performance based on years of education alone can result in misclassification of certain demographic groups, such as African Americans (Heaton, Ryan, Grant, & Matthews, 1996; Schneider & Lichtenberg, 2011). Studies have found that proxies for QEd (i.e., reading tests) attenuate or eradicate ethnic/racial-group differences in cognitive test performance even when adjusting for other influential demographic variables (e.g., Manly, Byrd, Touradji, & Stern, 2004; Manly, Jacobs, Touradji, Small, & Stern, 2002). Consequently, it is common for neuropsychologists to rely upon reading tests to estimate received QEd, though their construct validity has not been well established.

Reading achievement has been found to correlate with QEd indicators in a meta-analysis that focused on seven school inputs: teacher education, experience, and salary, teacher–pupil ratio, per-pupil expenditure, administrative inputs, and facilities (Hedges, Laine, & Greenwald, 1994). Hence, reading tests are commonly used to measure QEd. Furthermore, as they are

performance-based tests, it is not surprising that reading tests better predict cognitive performance than standard years of education (e.g., Manly et al., 2002; Rohit et al., 2007).

No research to date has empirically tested whether self-rated QEd indeed predicts reading performance despite its widespread use as a proxy measure for QEd. We hypothesized that self-reported QEd would significantly predict reading performance on the Wide Range Achievement Test-4th Edition (WRAT-4; Wilkinson & Robertson, 2006) after controlling for race/ethnicity, SES, and years of education. We also examined the associations between QEd and WRAT-4 and neurocognitive performance and hypothesized that QEd would significantly predict and add to the explained variance of neurocognitive performance when accounting for WRAT-4 scores.

Methods

Participants

This study included a community-based sample of 106 African-American and non-Hispanic White adults (age range: 24–75 years) who participated in a larger, ongoing study on sociocultural influences on cognitive outcomes. We recruited participants using fliers posted around the campus and brochures given to volunteer-based agencies in the area, as well as word-of-mouth. Exclusion criteria included inability to provide informed consent, neurological confounds (e.g., head injury), current substance abuse, and psychotic spectrum disorders.

All research methods and procedures were approved by and compliant with the institutional review board panel. Written informed consent was obtained from all participants prior to assessment.

Measures

Demographic information. All participants completed a demographic and background questionnaire. Information collected included age, gender, race/ethnicity, years of education, and other descriptive variables.

Socioeconomic status. We included SES as a covariate in our hierarchical regression analysis, as reading skills have been shown to be correlated with SES in adulthood (e.g., Kutner et al., 2007). We measured SES using the four-factor Hollingshead Index of Social Prestige scale based on participants' and their partners' (if applicable) education and occupation (see Hollingshead, 1975 for score calculation information). Possible scores range from 8 (low) to 66 (high).

Quality of education. We used a modified version of a Quality of Education Scale (Baird, 2007) to measure participants' ratings on high school QEd. This 17-item, Likert-rating scale asks respondents to reflect on three domains of their high school QEd regarding factors more directly associated with education versus the individual (students' perceptions of and relationships with teachers, importance of testing, and availability of academic and supplemental resources). The final item asks respondents to reflect on all the questions to which they responded and provide an overall perception of their high school QEd. We used an overall QEd composite score (sum of the 17 item's ratings) for testing research hypotheses, with higher scores indicating better QEd.

Internal-consistency reliability for this scale's 17 items was good (Cronbach's $\alpha = 0.75$). Baird (2007) also found good internal-consistency reliability for the full (i.e., 59-item) version of this scale ($\alpha = 0.84$). Although this scale has not yet been subject to a thorough validation study, Baird (2007) reported preliminary evidence for its convergent validity with educational indicators and also found it to be a significant predictor of motivation for school achievement ($p < .01$). Regarding construct validity, this scale taps several of the same factors that the National Center for Education Statistics uses to measure QEd, such as schools' academic environment, classroom size and technological resources, and teachers' experience and academic skills (Mayer, Mullens, & Moore, 2000).

Wide Range Achievement Test-4th Edition Word Reading subtest. We used WRAT-4 Word Reading subtest scores (Wilkinson & Robertson, 2006) as the dependent variable for our first hypothesis. This subtest assesses examinees' abilities to accurately pronounce words of varying difficulty (i.e., common to uncommon and simple to irregular pronunciation) and was designed as a measure of academic reading skills.

Neurocognitive performance. Participants underwent a comprehensive neurocognitive battery assessing the following domains: attention/concentration and information processing speed (Wechsler Adult Intelligence Scale-4th Edition [WAIS-IV]-Coding and Symbol Search; Trail Making Test-Part A; and Stroop Interference Test-Color and Word Naming), language (Controlled Oral Word Association Test-FAS and Animal Fluency), learning and memory (Hopkins Verbal Learning Test-Revised, Total

Learning and Delayed Recall; and Brief Visuospatial Memory Test-Revised, Total and Delayed Recall), visuospatial abilities (WAIS-IV-Block Design), and executive functioning (Trail Making Test-Part B; Stroop Interference Test-Interference score; and WAIS-IV-Letter-Number Sequencing). We converted raw scores for each test into demographically corrected *T*-scores and then averaged them to create global neurocognitive performance and cognitive domain composites.

Statistical Method

We assessed the data for univariate normality (skew < 2 and kurtosis < 4 suggestive of non-normality; Kline, 2010) and outliers before examining the correlations between the key variables and evaluating for multicollinearity, with tolerance values of < 0.40 and variance inflation factor values of > 2.5 suggestive of multicollinearity (Allison, 2012). Next, we tested for racial/ethnic-group differences in self-rated QEd, WRAT-4 Word Reading, and neurocognitive performance. We then ran a two-step hierarchical linear regression in SPSS 17.0 to determine whether QEd (added in Model 2) significantly contributed to the explained variance of Word Reading scores above and beyond race/ethnicity, SES, and years of education (Model 1) based on the *p*-value of the ΔR^2 score. We examined overall significance levels for both models and the predictors' regression coefficients and associated *p*-values. Finally, in a separate two-step hierarchical linear regression model, we tested whether QEd (added in Model 2) significantly predicted neurocognitive performance beyond WRAT-4 scores, controlling for race/ethnicity and SES (Model 1).

Results

Table 1 provides demographic characteristics for the sample and descriptive statistics for the key variables. The data were normally distributed with no evidence of outliers or multicollinearity. We found significant correlations between WRAT-4 Word Reading and years of education ($r = .60, p < .01$), SES ($r = .46, p < .01$), total QEd ($r = .37, p < .01$), QEd domain scores for students' perceptions of and relationships with teachers ($r = .36, p < .01$), and global neurocognitive performance ($r = .45, p < .01$). Additionally, years of education was significantly correlated with total QEd ($r = .36, p < .01$), QEd domain scores for students' perceptions of and relationships with teachers ($r = .39, p < .01$), and SES ($r = .68, p < .01$). Total QEd ($r = .34, p < .01$) and QEd domain scores for students' perceptions of and relationships with teachers ($r = .35, p < .01$) were significantly correlated with SES. Finally, African Americans had significantly lower WRAT-4 scores ($M = 56.39, SD = 7.01$) than non-Hispanic Whites ($M = 64.76, SD = 4.78$), $t(99) = -7.21, p < .01$. There was also a trend toward significance for racial/ethnic-group differences in total QEd scores, $t(101) = -1.77, p = .08$, with lower mean scores among African Americans ($M = 62.71, SD = 14.49$) compared with non-Hispanic Whites ($M = 67.61, SD = 11.86$).

Table 2 presents the results from the hierarchical linear regression analyses. In the first step (Model 1), we regressed WRAT-4 Word Reading scores on race/ethnicity, SES, and years of education. The overall model was statistically significant, $F(3, 96) = 26.53, p < .01$, with an R^2 value of 0.45. Race/ethnicity ($\beta = .35, p < .01$) and years of education ($\beta = 0.43, p < .01$) significantly predicted Word Reading scores. In the second step (Model 2) with QEd added, the overall model remained significant, $F(4, 95) = 21.92, p < .01$. The R^2 value increased to 0.48, which was a statistically significant increase ($p = .03$). Both race/ethnicity ($\beta = 0.35, p < .01$) and years of education ($\beta = 0.39, p < .01$) remained significant, and QEd emerged as a significant predictor ($\beta = 0.18, p = .03$), with higher scores predicting better Word Reading performance.

Regarding neurocognitive performance, we found significant bivariate correlations between WRAT-4 Word Reading and global neurocognitive performance ($r = .45, p < .01$) and the cognitive domain scores (attention/concentration and information processing speed: $r = .22, p = .02$; language: $r = .22, p = .02$; learning and memory: $r = .53, p < .01$; visuospatial abilities: $r = .42, p < .01$; and executive functioning: $r = .29, p < .01$). The only significant correlation between QEd and neurocognition was for total QEd and learning and memory performance ($r = .22, p = .03$). SES was significantly correlated with global neurocognitive performance ($r = .21, p = .03$) and learning and memory ($r = .39, p < .01$), visuospatial abilities ($r = .23, p = .02$), and executive functioning ($r = .23, p = .02$). In addition, African Americans had significantly lower scores ($M = 36.29, SD = 10.11$) than non-Hispanic Whites ($M = 41.75, SD = 9.97$) on learning and memory, $t(103) = -2.69, p = .01$, and visuospatial abilities ($M = 26.67, SD = 5.46$ vs. $M = 30.97, SD = 4.74$, respectively), $t(103) = -4.10, p < .01$.

As shown in Table 2, our model predicting global neurocognitive performance from WRAT-4 scores (controlling for race/ethnicity and SES) was significant, $F(3, 96) = 9.45, p < .01$, with an R^2 value of 0.23. Only WRAT-4 Word Reading significantly predicted global neurocognitive performance ($\beta = 0.54, p < .01$). When we added total QEd in the second step, our overall model remained significant, $F(4, 95) = 7.02, p < .01$, with an R^2 value of 0.23. WRAT-4 performance remained the only significant predictor ($\beta = .54, p < .01$), and the ΔR^2 value was nonsignificant. The overall pattern of results remained the same across all cognitive domains in that QEd did not significantly predict neurocognitive test performance, whereas Word Reading did.

Table 1. Descriptive statistics of participants and key variables

Variable	Value	Valid <i>n</i>
Age (years), mean (<i>SD</i>)	53.21 (11.38)	106
Race/ethnicity, <i>n</i> (%)		106
Black/African American	67 (63.21)	
Non-Hispanic White	39 (36.79)	
Gender, <i>n</i> (%)		106
Male	70 (66.04)	
Female	36 (33.96)	
Relationship status, <i>n</i> (%)		104
Single, never married	52 (50.00)	
Currently married	9 (8.65)	
Domestic partnership	8 (7.69)	
Married, legally separated	5 (4.81)	
Divorced	22 (21.15)	
Widowed	8 (7.69)	
Education (years), mean (<i>SD</i>)	13.86 (2.25)	105
Quality of education, <i>n</i> (%)		105
Poor	5 (4.76)	
Fair	9 (8.57)	
Good	34 (32.38)	
Very good	31 (29.52)	
Excellent	20 (19.05)	
Do not know/cannot say	6 (5.72)	
Annual household income range, <i>n</i> (%)		104
<\$6,000	11 (10.58)	
\$6,000–\$11,999	32 (30.77)	
\$12,000–\$24,999	28 (26.92)	
\$25,000–\$49,999	17 (16.35)	
≥ \$50,000	16 (15.38)	
Hollingshead SES, mean (<i>SD</i>)	40.71 (11.57)	102
Hollingshead SES category, <i>n</i> (%)		102
Menial service workers	2 (1.96)	
Unskilled workers	6 (5.88)	
Machine operators and semi-skilled workers	14 (13.73)	
Skilled manual workers, craftsmen, small business owners (worth <\$25,000)	7 (6.86)	
Clerical and sales workers, small business owners (worth \$25,000–\$50,000)	25 (24.51)	
Technicians, semi-professionals, and small business owners (worth \$50,000–\$75,000)	15 (14.71)	
Minor professionals, managers, and small business owners (worth \$75,000–\$100,000)	17 (16.67)	
Administrators, lesser professionals, and business owners (worth \$100,000–\$250,000)	9 (8.82)	
Higher executives, major professionals, and business owners (worth >\$250,000)	7 (6.86)	
WRAT-4 Word Reading subtest raw score, mean (<i>SD</i>)	59.45 (7.46)	104
Global neurocognitive performance <i>T</i> -score, mean (<i>SD</i>)	44.55 (5.64)	105

Notes: SES = socioeconomic status, WRAT-4 = Wide Range Achievement Test-4th Edition.

Discussion

This study aimed to test whether the WRAT-4 Word Reading subtest can be meaningfully used as an objective measure of QEd. Despite its frequent use as a proxy measure of QEd, to our knowledge, no studies have empirically examined Word Reading's validity as a proxy variable. Results supported our hypothesis that QEd significantly predicted Word Reading scores and significantly contributed to the prediction of WRAT-4 performance beyond standard years of education, race/ethnicity, and SES. Further, overall QEd and the QED domain measuring students' perceptions of and relationships with teachers were moderately strongly correlated with WRAT-4 performance. Together, these results provide evidence for the construct validity of the WRAT-4 Word Reading subtest as a proxy variable for educational quality, which may be particularly strongly driven by teacher-related factors. Findings also support Word Reading's continued use in neuropsychological assessment, particularly when standard years of education may not reflect the actual educational experience received. Information on QEd may provide clinicians with a richer understanding of patients' educational background and assist them with more accurately interpreting neuropsychological test findings.

Table 2. Results from hierarchical linear regression models predicting WRAT-4 word reading subtest scores and global neurocognitive performance

Model	Outcome variable	<i>p</i> -value of model	<i>R</i> ² of model	Step	Predictors	β	<i>p</i> -value of β	Tolerance	Variance inflation factor
1	WRAT-4 Word Reading	<.01	0.45	1	Race/ethnicity	0.35	<.01	0.77	1.29
				1	Hollingshead SES	0.01	.93	0.53	1.88
				1	Years of education	0.43	<.01	0.52	1.94
2	WRAT-4 Word Reading	<.01	0.48	1	Race/ethnicity	0.35	<.01	0.77	1.29
				1	Hollingshead SES	−0.02	.88	0.53	1.90
				1	Years of education	0.39	<.01	0.50	2.02
				2	Quality of education	0.18	.03	0.87	1.16
1	Global neurocognitive performance	<.01	0.23	1	Race/ethnicity	−0.19	.08	0.67	1.49
				1	Hollingshead SES	0.03	.75	0.73	1.37
				1	WRAT-4 Word Reading	0.54	<.01	0.65	1.54
2	Global neurocognitive performance	<.01	0.23	1	Race/ethnicity	−0.19	.08	0.67	1.49
				1	Hollingshead SES	0.03	.75	0.73	1.37
				1	WRAT-4 Word Reading	0.54	<.01	0.60	1.67
				2	Quality of education	−0.01	.90	0.83	1.21

Notes: WRAT-4 = Wide Range Achievement Test-4th Edition; SES = socioeconomic status. ΔR^2 for the second step of the model predicting WRAT-4 Word Reading scores was 0.03 ($p = .03$). ΔR^2 for the second step of the model predicting global neurocognitive performance was 0.00 ($p = .90$).

Consistent with prior studies, WRAT-4 performance significantly predicted neuropsychological performance, though self-rated QEd did not. Our findings suggest that the WRAT-4 is more closely tied to actual cognitive processes than QEd ratings. This leads to the following question: *If reading tests better predict neuropsychological performance, are additional measures of QEd necessary?* We believe that while reading performance may measure QEd, it also measures verbal aptitude and facility with testing situations, which may explain the strong correlations between reading tests and cognitive performance. QEd may explain a certain amount of variation in verbal aptitude, however, other factors such as the home environment or parental involvement may modulate its effects on cognitive performance. This is an important issue that warrants further investigation but is beyond the scope of the current study.

Although most studies have found that WRAT-4 performance remains reasonably stable at varying test–retest intervals (e.g., Schneider & Lichtenberg, 2011), some studies have not (e.g., Johnstone & Wilhelm, 1996). Further, the WRAT-4 has been found to produce lower estimates of premorbid IQ among individuals with neurodegenerative diseases (e.g., O'Rourke et al., 2011). It could also be true that the presence of severe cognitive impairment would obscure self-rated QEd, as shown in studies of self-rating of functioning among individuals with cognitive impairment (e.g., Bowie et al., 2007; Thames et al., 2011). As with most evaluations, the rule of thumb is to gather as much data possible to make informed clinical decisions. However, in many cases (and settings), gathering comprehensive information about QEd may not be feasible, and a relatively quick, practical measure such as the WRAT-4 may be especially useful.

The current study has limitations that should be noted. Our sample was composed of Black/African-American and non-Hispanic White adults. Future research should evaluate the association between QEd and WRAT-4 Word Reading in larger, culturally and linguistically diverse samples of varying ages (i.e., children and adults) and educational attainment. Additionally, QEd was based upon self-report using a scale that has yet to be thoroughly validated. Nonetheless, participants rated QEd after responding to numerous questions tapping various domains of their high school education, thereby encouraging them to reflect more thoroughly on their QEd. Moreover, some objective QEd measures (e.g., national school rankings) have their own limitation of solely relying on average scores on standardized tests of specific subjects such as algebra and English. In contrast, the QEd scale we used also asks respondents to rate their own performance and attendance in school rather than relying on school-wide averages. Furthermore, we demonstrated good internal-consistency reliability and additional preliminary convergent validity for this scale as evidenced by its significant, relatively strong correlation with Word Reading scores, an academic performance-based measure. These limitations aside, our results add to the literature by providing evidence for the utility of WRAT-4 Word Reading as an objective measure of self-rated QEd.

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Conflict of Interest

None declared.

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