HHS Public Access

Author manuscript

J Learn Disabil. Author manuscript; available in PMC 2017 July 01.

Published in final edited form as:

J Learn Disabil. 2016 July ; 49(4): 424–436. doi:10.1177/0022219414556771.

A Quantile Regression Approach to Understanding the Relations Between Morphological Awareness, Vocabulary, and Reading Comprehension in Adult Basic Education Students

Elizabeth L. Tighe and **Christopher Schatschneider**

Florida State University

Abstract

The purpose of this study was to investigate the joint and unique contributions of morphological awareness and vocabulary knowledge at five reading comprehension levels in Adult Basic Education (ABE) students. We introduce the statistical technique of multiple quantile regression, which enabled us to assess the predictive utility of morphological awareness and vocabulary knowledge at multiple points (quantiles) along the continuous distribution of reading comprehension. To demonstrate the efficacy of our multiple quantile regression analysis, we compared and contrasted our results with a traditional multiple regression analytic approach. Our results indicated that morphological awareness and vocabulary knowledge accounted for a large portion of the variance (82-95%) in reading comprehension skills across all quantiles. Morphological awareness exhibited the greatest unique predictive ability at lower levels of reading comprehension whereas vocabulary knowledge exhibited the greatest unique predictive ability at higher levels of reading comprehension. These results indicate the utility of using multiple quantile regression to assess trajectories of component skills across multiple levels of reading comprehension. The implications of our findings for ABE programs are discussed.

Keywords

Adult Basic Education; Morphological awareness; Quantile regression; Reading comprehension; Vocabulary knowledge

Several recent studies have identified morphological awareness (Tighe, 2012; Herman, Gilbert-Cote, Reilly, & Binder, 2013; Tighe & Binder, 2014; To, Tighe, & Binder, in press) and vocabulary knowledge (Tighe, 2012; Hall, Greenberg, Laures-Gore, & Pae, 2014; Mellard & Fall, 2012; Mellard, Fall, & Woods, 2010; Taylor, Greenberg, Laures-Gore, & Wise, 2012) as important component skills of reading comprehension in adults with low literacy skills. The extent to which morphological awareness and vocabulary knowledge contribute jointly and uniquely to reading comprehension has been investigated extensively with children (Kieffer & Lesaux, 2008; Ku & Anderson, 2003; Nagy, Berninger, & Abbott, 2006; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003; Singson, Mahony, & Mann, 2000); however, it has only been considered in a single study in the low literate adult

Corresponding Author: Elizabeth L. Tighe, Department of Psychology, Florida State University, 1107 W. Call St., Tallahassee, FL, 32306-4301, USA. ; Email: tighe@psy.fsu.edu

population (Tighe, 2012). The joint and unique predictive utility of these two constructs may vary as a function of reading comprehension skills (higher and lower levels); however, this has not been explored in struggling adult readers. The present study introduces multiple quantile regression analysis to examine the stability of the joint and unique contributions of morphological awareness and vocabulary knowledge across the distribution of reading comprehension skills in adults with low literacy. This statistical technique is compared and contrasted with the traditional ordinary least squares (OLS) regression approach, which allows only single estimates of the total and unique contribution of morphological and vocabulary knowledge to the prediction of reading comprehension skills.

Adults with Low Literacy Skills

The low literate adult population is heterogeneous in terms of age, ethnicity, language experience, educational background, and prevalence of learning disabilities (Lesgold & Welch-Ross, 2012). Further, Adult Basic Education (ABE) programs group adult learners into classes of multiple reading grade level equivalencies (GLEs) (i.e., a GED-level class represents adults at 9th through 12th reading GLEs). The diversity of this population, coupled with the multitude of reading skill levels represented in a single classroom, indicates that the predictive utility of component reading skills may vary across the distribution of reading comprehension (higher and lower levels). Several studies have investigated the importance of various component skills to reading comprehension in adults with low literacy; however, the majority of these studies have assumed that these skills contribute uniformly across reading comprehension levels (Hall et al., 2014; MacArthur, Konold, Glutting, & Alamprese, 2010; Mellard et al., 2010; Sabatini, Sawaki, Shore, & Scarborough, 2010; Tighe & Binder, 2014).

Four recent studies have identified subgroups of ABE students that have different profiles of reading component skills (Binder & Lee, 2012; MacArthur, Konold, Glutting, & Alamprese, 2012; Mellard, Fall, & Mark, 2009; Strucker, Yamamoto, and Kirsch, 2007). Binder and Lee (2012) identified four subgroups within pre-GED and GED level ABE classes: 1. poor decoding and poor comprehension skills; 2. good decoding and good comprehension skills; 3. good decoding and poor comprehension skills; and 4. poor decoding and good comprehension skills. MacArthur et al. (2012) reported eight reader profiles among learners at 4th through 7th GLE based on five component skills: decoding, word recognition, spelling, fluency, and comprehension. Mellard et al. (2009) distinguished seven reading subgroups from a range of GLEs (representative of all six National Reporting System levels) based on measures of phonemic decoding, word recognition, fluency, and comprehension. Finally, Strucker et al. (2007) found five latent classes of adult learners (functioning at Levels 1 to 3 on the prose literacy scale of the International Adult Literacy Survey) based on the component skills of vocabulary, decoding, spelling, and short-term memory. These studies suggest that ABE students have differential reading profiles; thus, the contribution of individual component skills may vary as a function of reading comprehension ability. The current study utilized multiple quantile regression to assess the joint and unique contributions of morphological awareness and vocabulary knowledge at five different reading comprehension percentiles (10th, 25th, 50th, 75th, and 90th) with adults enrolled in GED-level ABE classes. Based on the heterogeneity of ABE classrooms and the findings of

multiple subgroups of ABE readers, we hypothesized that the importance of our two constructs would fluctuate depending upon higher and lower levels of adults' reading comprehension skills.

Morphological Awareness in Adults with Low Literacy

Morphological awareness, broadly defined as a conscious awareness of how words are decomposed into smaller units of meaning (Carlisle, 2003), has consistently emerged as a predictor of low literate adults' reading comprehension skills even after controlling for phonological awareness (Herman et al., 2013; Tighe & Binder, 2014), decoding (To et al., in press), and vocabulary knowledge (Tighe, 2012). Tighe and Binder (2014) reported that beyond phonological awareness, morphological awareness accounted for an additional 33% of the variance in reading comprehension in adults enrolled in pre-GED and GED-level ABE classes. To et al. (in press) investigated morphological and pseudoword decoding skills in pre-GED and GED-level adult literacy students compared to skilled college readers. These researchers found that in both the less skilled and skilled reader groups, morphological awareness contributed unique variance to reading comprehension (7% and 19%, respectively). Tighe (2012) assessed the joint and unique contributions of morphological awareness and vocabulary knowledge to reading comprehension in GED-level adult literacy students. Utilizing causal indicator modeling, Tighe (2012) reported that morphological awareness and vocabulary knowledge accounted for 78% of the variance in reading comprehension. Moreover, both skills contributed uniquely. These studies reveal that morphological awareness is an important predictor of reading comprehension in this population and contributes substantial unique variance after controlling for other component skills. The current study aimed to expand the current body of literature by assessing whether the common and unique contributions of morphological awareness and vocabulary knowledge change across the distribution of reading comprehension skills in ABE students.

Vocabulary Knowledge in Adult Literacy Students

Vocabulary knowledge (both expressive and receptive) has also been identified as an important contributor to adults' reading comprehension skills (Tighe, 2012; Hall et al., 2014; Mellard & Fall, 2012; Mellard, et al., 2010). Hall et al. (2014) reported that expressive vocabulary accounted for 16% unique variance in reading comprehension over and above nonword reading, word reading, and exception word reading in adults at 3rd through 5th GLEs. Tighe (2012) found that a latent variable of expressive and receptive vocabulary accounted for 5% unique variance after controlling for morphological awareness in GED-level adults. Mellard and Fall (2012) investigated the contributions of several component skills to reading comprehension by adults' functional reading levels (beginning, intermediate, and secondary). In a model by itself, vocabulary (both expressive and receptive) was not predictive for the beginning readers; but it explained approximately 25% of the variance in intermediate readers and accounted for approximately 50% of the reading comprehension variance in the secondary readers. This study demonstrates that the contribution of vocabulary knowledge may differ by reading comprehension level with vocabulary becoming increasingly important at higher reading comprehension levels. However, subdividing the sample based on adults' functional reading levels truncates the

reading comprehension distribution and this restriction of range can lower the estimated relations. To address this issue, the current study proposes to utilize quantile regression, an analysis that considers all data points when estimating all quantiles (levels of reading comprehension).

Quantile Regression vs. Ordinary Least Squares Regression

Quantile regression, developed by Koenker and Bassett (1978), presents an alternative analytic technique to ordinary least squares (OLS) regression (also referred to as linear or multiple regression). Quantile regression is a direct extension of OLS regression; however quantile regression allows researchers to assess the relationship of a predictor(s) to an outcome at several points along the continuous distribution of the outcome variable (Koenker, 2005; Koenker & Hallock, 2001; Petscher & Logan, 2014; Petscher, Logan, & Zhou, 2013). The points represent percentiles (or quantiles) along the continuum of the outcome variable such that the 25th, 50th, and 75th percentiles correspond to the .25, .50, and .75 quantiles, respectively. For example, let's say a researcher wanted to investigate the relationship of reading comprehension (outcome measure) with morphological awareness (predictor variable). OLS regression would generate a predicted morphological awareness estimate (the slope) based on the median (.50 quantile) reading comprehension level. Quantile regression would generate multiple estimates of predicted morphological awareness scores based on specific researcher-defined points (i.e., .25, .50, .75 quantiles) along the distribution of reading comprehension. Thus, quantile regression would extend beyond OLS regression by providing separate morphological awareness estimates at each quantile of reading comprehension. This allows researchers to investigate if the contribution of this construct differs at higher versus lower levels of reading comprehension. It is important to note that quantile regression utilizes an asymmetric weighting system of data points and therefore, all data points are “weighted” based upon their distance from the researcher-specified quantile for that estimation. Consequently, quantile regression is not synonymous with fitting a separate OLS regression line at each quantile (Petscher & Logan, 2014; Petscher et al., 2013).

The utility of quantile regression has been demonstrated in recent education-based research (Catts, Petscher, Schatschneider, Bridges, & Mendoza, 2009; Logan et al., 2012; Petscher & Kim, 2011; Reeves & Lowe, 2009). For example, Reeves and Low (2009) examined the relations of several demographic predictors to 8th grade math achievement and compared the obtained estimates from OLS regression to quantile regression. The researchers reported that the magnitudes of estimates for the various demographic predictors varied across the distribution of students’ math achievement. Thus, quantile regression provided more information about the changing nature of the predictors across differing levels of math achievement as compared to OLS regression. The current study proposed to add to the existing body of literature by examining the utility of using multiple quantile regression in adults with low literacy skills. We proposed to investigate the unique contribution of morphological awareness and vocabulary knowledge at varying levels (quantiles) of adults’ reading comprehension. To effectively demonstrate multiple quantile regression, we compared the estimates obtained from multiple regression to the estimates obtained from multiple quantile regression.

Current Study

The purpose of the current study was to introduce the statistical technique of multiple quantile regression to examine the joint and unique contributions of morphological awareness and vocabulary knowledge to multiple reading comprehension levels in ABE students. To demonstrate the value of multiple quantile regression, we compared and contrasted this technique with results obtained in a multiple regression analysis. Morphological awareness and vocabulary knowledge have been identified as important predictors' of adults' reading comprehension skills (Tighe, 2012; Hall et al., 2014; Herman et al., 2013; Mellard & Fall, 2012; Mellard et al., 2010; Taylor et al., 2012; Tighe & Binder, 2014; To et al., in press); however, no research has looked at the joint and unique contributions of these skills at different levels across the continuous distribution of reading comprehension. ABE students comprise a diverse group of learners with multiple reading comprehension GLEs represented in a single classroom (Lesgold & Welch-Ross, 2012). Thus, we hypothesized that the predictive utility of our two component skills would change as a function of reading comprehension skill, particularly at the distal ends of the distribution (lowest and highest reading comprehension levels).

METHOD

Participants

The participants included 136 adults enrolled in GED preparation classes in two ABE programs in Northern Florida during the spring of 2012. It is important to note that although GED-level classes are designed for adults at 9th to 12th reading grade equivalencies (RGEs), there is usually considerable variability in the RGEs represented in these classes (Lesgold & Welch-Ross, 2012). Our sample included adults that ranged from 3rd grade to 12th grade, 9 months RGEs (M = 7.7; SD = 2.8) on the Test of Adult Basic Education (TABE) Reading subtest. Despite the range of included RGEs, our sample was normally distributed across the National Reporting System (NRS) Levels 2-6: 8.1% at Level 2 (RGEs 2.0-3.9), 22.1% at Level 3 (RGEs 4.0-5.9), 36.8% at Level 4 (RGEs 6.0-8.9), 15.4% at Level 5 (RGEs 9.0-10.9), and 16.2% at Level 6 (RGEs 11-12.9).

All of the participants were native-English speakers. The sample consisted of 51% females (n = 70) and the participants were from a range of ages (16-73; M = 24). The participants represented a range of racial backgrounds: 68% African American, 24% Caucasian, 5% Hispanic, 3% Mixed race, and .7% Asian. Approximately 71% of the sample reported being unemployed and 30% reported having a diagnosed learning difficulty. In addition, participants' educational background varied: .7% completed below a middle school level, 9% completed some middle school, 74% completed some high school, and 17% completed high school.

Participants were recruited for the study with the understanding that all information would be kept completely confidential. Additionally, participants received a five-dollar gift card as compensation for their time. Of the 136 participants, 127 completed both days of testing.

Materials

Participants completed a demographic survey addressing age, race, and educational background. Additionally, a battery of 10 tasks was administered: seven experimental morphological awareness measures, two norm-referenced vocabulary knowledge measures, and two norm-referenced reading comprehension assessments.

Morphological Awareness

Base Form Morphology (BMORPH) Task: This assessment was adapted from Carlisle (1988; 2000) and Leong (2000) and utilized in Tighe and Binder (2014). BMORPH measures participants' knowledge of morphological structure by asking participants to decompose target words in order to identify the root word. Participants were read aloud a derived target word followed by a short sentence with a blank in it. The participant was prompted to fill in the blank with the correct root word from the derived target word given. An example item was "Growth. She wanted her plant to _____."; "grow". A correct response elicited one point and an incorrect response or no response received zero points. Items were read orally to the participant to avoid decoding difficulties. In addition, the participant had the task in front of them visually to prevent placing heavy demands on working memory and listening comprehension skills. Participants were given two practice items followed by 30 test items. The Cronbach's α coefficient was .86 for the sample.

Derived Form Morphology (DMORPH) Task: This assessment was also adapted from Carlisle (1988; 2000) and Leong (2000) and utilized in Tighe and Binder (2014). DMORPH measures participants' knowledge of morphological structure by asking participants to transform root words into more complex, derived words. Participants were read aloud a root word followed by a short sentence with a blank in it. The participant was prompted to supply the correct derived form of the root word given. An example item was "Happy. Money does not buy _____."; "happiness". A correct response elicited one point and an incorrect response or no response received zero points. Items were read orally to the participant and the participant had the task available to them visually. Participants were given two practice items followed by 30 test items. The Cronbach's α coefficient was .90 for the sample.

Derivational Suffix Choice Test of Pseudowords: This assessment was adapted from Mahony (1994), Singson et al (2000), and Tighe and Binder (2014). The Derivational Suffix Choice Test assesses participants' ability to manipulate morphemes using pseudowords. Participants were read aloud a sentence with a blank followed by four possible multiple-choice answers. The participant was asked to select the correct answer choice. For example, "Our teacher taught us how to _____ long words." The answer choices included "jittling", "jittles", "jittled", and "jittle". The correct response, "jittle", received one point while an incorrect response or no response received zero points. All items were read orally to the participant and the participant had the task available to them visually. This task included a single practice item followed by 18 test items. The Cronbach's α coefficient was .85 for the sample.

Morphological Skill Task: This assessment was adapted from the Comes From Task, which is primarily used with elementary school children (Derwing, 1976; Derwing & Baker, 1979;

Mahony, 1994; Singson et al., 2000; Muse, 2005). The Morphological Skill Task was re-designed by Maag (2007) to include more challenging, low frequency items in a multiple-choice format for college students. The present study incorporated an abbreviated version of the Maag (2007) measure. This assessment measures participants' ability to distinguish morphological relatedness between derived and root words. Participants were presented both visually and orally with derived words followed by three answer choices of root words. Participants were asked to identify the correct root word of the derived word given. For example, a participant was provided with the word "noncombatant" and the three answer choices: "comb", "bat", and "combat". The correct response of "combat" received one point and an incorrect or no answer resulted in zero points. This task consisted of two practice items followed by 29 test items. The Cronbach's α coefficient was .75 for the sample.

Morphological Construction Task: This assessment was modified from Muse (2005) and Berko (1958). The Morphological Construction Task measures participants' ability to manipulate syntactic information in order to construct new pseudowords. Participants were presented both visually and orally with mini scenarios, which introduced a pseudoword and concluded with a blank. Based on the context of the scenario and the pseudoword, participants were expected to utilize their knowledge of inflected morphology to fill in the blank with the correct pseudoword. For example, "This is a musical instrument called a hux. Now we have three of them. We have three _____."; "huxes". A correct response was awarded one point and an incorrect response or no response received zero points. The measure consisted of two practice items followed by 12 test items. The Cronbach's α coefficient was .79 for the sample.

Morphological Analogy Real Word Task: This assessment was adapted from Nunes, Bryant, and Bindman (1997; 2006) and Tong et al. (2011). A analogy format of A : B :: C : D was employed in which participants were presented visually and orally with an inflected word pair (A : B) followed by the first word of the second word pair (C). Participants were expected to supply the missing word from the second word pair (D). For example, "push : pushed :: lose : _____."; "lost" (an irregular inflected change from present to past tense). A correct answer received one point and an incorrect response or no response resulted in zero points. The participant received two practice items followed by 15 test items. The Cronbach's α coefficient was .81 for the sample.

Morphological Analogy Pseudoword Task: This experimenter-created measure followed the same A : B :: C : D format as in the Real Word Task; however, the measure included pseudowords. The participant was presented both visually and orally with a pair of real words (A : B) followed by a pseudoword (C) and asked to fill in the corresponding pseudoword (D). For example, "advantage : advantageous :: stomage : _____."; "stomageous". A correct answer received one point and an incorrect response or no response received zero points. This task consisted of two practice items followed by 15 test items. The Cronbach's α coefficient was .88 for the sample.

Vocabulary Knowledge

Peabody Picture Vocabulary Test-Fourth Edition (PPVT-4): The PPVT-4 is a norm-referenced measure of receptive vocabulary (Dunn & Dunn, 2007). Participants were shown a series of four pictures and the examiner provided a word. Participants were asked to select the picture that best matched the definition of the word given. Two practice items were included to familiarize participants with the format of the measure. Testing commenced on a set of 12 items dependent upon participant age (age 13 was utilized for this sample because this is an early high-school level). During the initial testing set if more than one error occurred, testing continued with an easier set until a basal set was established. Once a basal set was determined, testing proceeded (with sets increasing in difficulty) until eight errors in a set were reached. The PPVT-4 was normed on individuals aged 3-90 and has a split-half reliability of .94.

Expressive One-Word Picture Vocabulary Test-Fourth Edition (EOWPVT-4): The EOWPVT-4 is a norm-referenced measure of expressive vocabulary (Martin & Brownell, 2011). Participants were presented with various pictures depicting objects, actions, and concepts. Participants were prompted to provide a single word to identify each picture. Testing commenced on item number 85 (age range 12 to 13 and 11 months). A basal was reached when the participant answered eight consecutive items correctly. Testing continued (with items increasing in difficulty) until a ceiling was established (six consecutive incorrect responses). The EOWPVT-4 was normed on individuals' aged 2-103 and has a median internal consistency reliability of .95.

Reading Comprehension

Test of Adult Basic Education (TABE) – Reading Subtest—The TABE is a nationally used measure in ABE programs (CTB/McGraw-Hill, 2008), which is comprised of five levels: L (literacy, GE = 0-1.9), E (easy, GE = 1.6-3.9) M (medium, GE = 3.6-6.9), D (difficult, GE = 6.6-8.9), and A (advanced, GE = 8.6-12.9). The reading subtest consists of brief passages and multiple-choice questions. The subtest includes expository and narrative texts as well as functional tests (i.e. completing a mock employment form or reading a newspaper). The questions increase in difficulty at each level. For example in the lowest level (L), participants are asked to recognize letters and sounds, identify simple vocabulary words, and match letters. At increasing difficulty levels, participants are asked to interpret graphic information, recall information, construct meaning, and make inferences from text. The internal consistency reliability ranges from .88 to .95 across the five levels.

Test of Silent Word Reading Efficiency and Comprehension (TOSREC): The TOSREC is a timed, individually administered assessment, which assess silent reading of connected text for comprehension (Wagner, Torgesen, Rashotte, & Pearson, 2010). Participants are presented with sentences and asked to circle "yes" or "no" as to the truthfulness of the sentences. Participants were allotted three minutes to read silently and respond to as many sentences as possible. This measure was normed on individuals in Grades 1-12 and has an alternate forms reliability of .88 for the Grade 9 version.

Procedure

A trained graduate student administered the 10 tasks individually to participants in two 30-minute sessions over a two-day span. Session one included BMORPH, Derivational Suffix Choice, Analogy Real Word, PPVT-4, and TOSREC. Session two included DMORPH, Construction, Morphological Skill, Analogy Pseudoword, and EOWPVT-4. The order of the sessions and the order of the tasks within sessions was counterbalanced. Tasks were presented over two-days to eliminate time sampling error. TABE Reading scores were obtained from the ABE centers; we utilized the most recently administered TABE Reading scores in our analyses. Testing took place in a quiet room at each ABE center.

RESULTS

Checking for Data Issues and Descriptive Statistics

The dataset was examined for outliers, skewness, kurtosis, and missing values. Across the 11 measures, a total of 20 univariate outliers were identified and brought to the boundaries of +/− two interquartile ranges. Examining pairwise scatterplot comparisons revealed that there were no bivariate outliers. With the exception of BMORPH, all skewness and kurtosis values fell within an acceptable range (+/− 2), indicating that these variables were normally distributed. BMORPH was leptokurtic and was transformed by reflecting it, taking the log transformation, and then reflecting it back. Finally, missing values were evaluated. A total of nine participants did not complete the second half of testing, resulting in a total of 47 missing values across the 11 variables. Because there were relatively few missing data points and no more than 7 missing values in a single variable, maximum likelihood (ML) estimation was employed.

Table 1 presents the means, standard deviations, and ranges. Correlations between measures are reported in Table 2. All measures were positively and significantly correlated (ps < .01). We utilized morphological awareness, vocabulary knowledge, and reading comprehension standardized factor scores in the multiple regression and multiple quantile regression analyses. These factor scores were computed in Version 7.0 of the Mplus statistical package by fitting a 3-factor confirmatory factor analysis (CFA) of our three constructs (Muthén & Muthén, 1998-2012). Morphological awareness consisted of 7 observed indicators, vocabulary knowledge consisted of two observed indicators, and reading comprehension consisted of two observed indicators. This model provided adequate fit to our data ($\chi^2(41) = 68.51$, $p = .005$, CFI = .967, TLI = .955, RMSEA = .070, and SRMR = .042). All factor loadings were above .66 and significant (ps < .001) across the three constructs (see Tighe & Schatschneider, in revision and Tighe, 2012 for figures). Correlations among the factor scores are provided in Table 3.

Data Analytic Strategy

First, we present the results from the multiple regression analysis and provide total R^2 and unique R^2 estimates for our two predictors, morphological awareness and vocabulary knowledge. A multiple regression analysis provides a starting point to investigate the partial effects of morphological awareness and vocabulary knowledge at the median (.50 quantile) of reading comprehension. Next, we present the results from the multiple quantile regression

analysis and compare these results with those obtained in the multiple regression analysis. We demonstrate how multiple quantile regression extends beyond the results of our multiple regression analysis by examining: 1. Unique predictor slope estimates at five reading comprehension quantiles; 2. Quantile process plots; 3. Total pseudo-R^2 values at five quantiles; and 4. Between-quantile statistical comparison tests. It is important to note that multiple quantile regression does not allow researchers to compute unique predictor pseudo-R^2 estimates at each quantile. Instead, multiple quantile regression produces a total pseudo-R^2 value for each quantile. Comparing unique pseudo-R^2 estimates between quantiles can be misleading because they are not scaled linearly across the distribution and can be interpreted differently relative to the total pseudo-R^2 value. The effects of the non-interval scaling of unique pseudo-R^2 values become magnified at higher total pseudo-R^2 values. For example, accounting for 2% unique variance when the total pseudo-R^2 is 90% is much larger than accounting for 2% unique variance when the total pseudo-R^2 is 50%. Thus, for our multiple quantile regression analysis we only report total pseudo-R^2 values at each quantile. To test for differences between quantiles, we report a between-quantile statistical comparison test (described in detail below). To give an approximate estimate of the magnitude of the unique R^2 estimates for morphological awareness and vocabulary knowledge we utilize the results from our multiple regression analysis.

Method Comparison: Multiple Regression vs. Multiple Quantile Regression

Multiple regression and multiple quantile regression analyses were computed in SAS 9.2 (SAS Institute Inc., 2012). Table 4 presents a comparison of the standardized intercept and predictor regression coefficients obtained utilizing both multiple regression and multiple quantile regression analyses. For the multiple regression analysis, reading comprehension was regressed on morphological awareness and vocabulary knowledge. This allowed us to estimate the partial effects of morphological awareness and vocabulary knowledge to reading comprehension, controlling for each other. This analysis revealed an overall significant regression equation, $F(2, 135) = 620.77$, $p < .001$, total $R^2 = .90$. In addition, both morphological awareness and vocabulary knowledge were significant unique predictors of reading comprehension ($ps < .001$, see Table 4 for intercept and slope estimates). Morphological awareness contributed 29% unique variance to reading comprehension, whereas vocabulary accounted for 5% unique variance in predicting reading comprehension. Using the test of dependent correlations, which relies on sample size and inter-correlations among the predictors and outcome variable, we determined that the unique predictor variance contributions were significantly different from each other ($t(136) = 5.53$, $p < .001$) (Meng, Rosenthal, & Rubin, 1992). Thus, morphological awareness is contributing significantly more unique variance to reading comprehension as compared with vocabulary knowledge at the median level of adults' reading comprehension skills.

Quantile regression was utilized to assess if the pattern of the partial effects of morphological awareness and vocabulary knowledge change across the distribution of reading comprehension. Reading comprehension was regressed on morphological awareness and vocabulary knowledge at five quantiles: .10, .25, .50, .75, and .90. As can be seen in Table 4, the morphological awareness and vocabulary knowledge slope estimates from the multiple regression ($\beta = .72$, $\beta = .31$, respectively) correspond to the .50 quantile slope

estimates from the multiple quantile regression (β = .72, β = .31, respectively). For morphological awareness at the .50 quantile (or for multiple regression) this can be interpreted such that for every one-unit change in morphological awareness (controlling for vocabulary knowledge), reading comprehension changes by .72 units. Similarly, for vocabulary knowledge at the .50 quantile (or for multiple regression) this can be interpreted such that for every one-unit change in vocabulary knowledge (controlling for morphological awareness), reading comprehension changes by .31 units. These slope estimates for morphological awareness and vocabulary knowledge are the only ones provided by multiple regression. However, quantile regression provides slope estimates for both constructs at the additional quantiles (or levels of reading comprehension): .10, .25, .75, and .90.

The Table 4 predictor slope estimates across the different quantiles reveal a clear pattern: the unique predictive utility of morphological awareness to reading comprehension decreases at increasing quantiles, whereas the unique predictive utility of vocabulary knowledge to reading comprehension increases at higher quantiles. In other words, morphological awareness (controlling for vocabulary knowledge) is more predictive at lower levels of adults' reading comprehension skills and vocabulary knowledge (controlling for morphological awareness) is more predictive at higher levels of adults' reading comprehension. The quantile process plots present a graphical representation of the decreasing pattern of the unique morphological awareness estimates across comprehension quantiles (Figure 1) and the increasing vocabulary knowledge estimates across comprehension quantiles (Figure 2). Moreover, these plots provide a contrast between our results obtained from the multiple regression analysis and the multiple quantile regression analysis. In Figure 1, multiple regression predicts that the unique morphological awareness slope estimate is constant at .72 whereas the multiple quantile analysis predicts fluctuations across the distribution (βs ranging from .76 at .10 quantile to .54 at the .90 quantile). Thus, multiple regression is slightly under-predicting the unique contribution of morphological awareness at lower levels of reading comprehension (.10 quantile) and over-predicting the unique contribution of morphological awareness at higher levels of reading comprehension (.90 quantile). Similarly, in Figure 2, multiple regression predicts that the unique vocabulary knowledge slope estimate is constant across the distribution of comprehension at .31 whereas multiple quantile regression predicts changes in vocabulary knowledge across the distribution (βs ranging from .24 at .10 quantile to .47 at the .90 quantile). Therefore, multiple regression is over-estimating the unique contribution of vocabulary knowledge at lower levels of reading comprehension (.10 quantile) and under-estimating the unique contribution of vocabulary knowledge at higher levels of reading comprehension (.90 quantile).

To further illustrate the utility of multiple quantile regression at estimating changes in our predictors across the continuous distribution of reading comprehension, we present total pseudo-R^2 estimates across the quantiles in Table 5. Looking at Table 5, multiple regression predicts that morphological awareness and vocabulary knowledge account for approximately 90% of the variance in reading comprehension. Multiple quantile regression estimates that these two predictors account for between 82% and 95% of the variance at different levels of reading comprehension. Thus, multiple quantile regression offers a more precise picture of the changing pattern of the joint contribution of morphological awareness and vocabulary

knowledge across the reading comprehension distribution. Although quantile regression cannot provide unique predictor pseudo-R^2 estimates, we were able to utilize the R statistical software package to calculate statistical significance tests of between-quantile slopes (R Development Core Team, 2011). These analyses compute a Wald test, providing the researcher with pseudo-F statistics, standard errors, degrees of freedom, and significance values (Koenker & Bassett, 1982; Petscher et al., 2013). The between-quantile comparison tests allowed us to investigate whether the unique quantile predictor slope estimates were statistically different from one another at varying reading comprehension quantiles. We determined that there were significant slope estimate differences between the .10 and .90 quantiles for both morphological awareness (pseudo-$F(1, 271) = 6.45$, $p = .012$) and vocabulary knowledge (pseudo-$F(1, 271) = 6.30$, $p = .013$). There were no other statistical differences observed for between-quantile comparisons for either construct. These analyses revealed that morphological awareness is significantly more related to reading comprehension at the lower end of the distribution (.10 quantile) as compared to the higher end of the distribution (.90 quantile). Vocabulary knowledge is significantly more related to reading comprehension at the higher end of the distribution (.90 quantile) as compared to the lower end of the distribution (.10 quantile).

DISCUSSION

The purpose of the current study was to examine the total and unique contributions of morphological awareness and vocabulary knowledge at five reading comprehension quantiles in adults with low literacy skills. Multiple regression analysis indicated that both morphological awareness and vocabulary knowledge were significant unique predictors at the median level of reading comprehension. In addition, morphological awareness contributed significantly more unique variance (29%) to reading comprehension than vocabulary knowledge (5%). The results from the multiple regression analysis were utilized to demonstrate how multiple quantile regression analysis provides more detail about the joint and unique predictive nature of morphological awareness and vocabulary knowledge across varying levels of reading comprehension. The results indicated that morphological awareness was the most uniquely predictive at lower levels of reading comprehension, whereas vocabulary knowledge was the most uniquely predictive at higher levels of reading comprehension. Moreover, both skills jointly accounted for substantial variance across the distribution of reading comprehension and both skills contributed uniquely at all five reading comprehension quantiles.

Morphological Awareness and Vocabulary Knowledge in Adults with Low Literacy

Concurrent with past literature, morphological awareness (Tighe, 2012; Herman et al., 2013; Tighe & Binder, 2014; To et al., in press) and vocabulary knowledge (Tighe, 2012; Hall et al., 2014; Mellard & Fall, 2012; Mellard et al., 2010; Taylor et al., 2012) emerged as significant predictors at the median level of adults' reading comprehension skills. Extending beyond the median level, morphological awareness and vocabulary knowledge were also significant unique predictors at the .10, .25, .75, and .90 quantiles of reading comprehension. Our multiple quantile regression analysis revealed patterns in the unique relationships of our predictors across the reading comprehension distribution. Morphological awareness emerged

as the more important predictor across all levels of reading comprehension (βs ranging from .76 to .54); however, the magnitude of importance decreased as reading comprehension skill increased. Vocabulary knowledge (βs ranging from .24 to .47) exhibited the opposite pattern, increasing in importance at higher levels of reading comprehension. At the highest level of reading comprehension (.90 quantile), the unique predictive utility of morphological awareness and vocabulary knowledge was similar, as evidenced by the magnitude of the predictor slope estimates (βs = .54 and .47, respectively). These findings demonstrate the utility of employing multiple quantile regression analysis: morphological awareness and vocabulary knowledge are not static at different reading comprehension levels. Instead, we determined that morphological awareness and vocabulary knowledge display inverse trajectories across the distribution of adults' reading comprehension.

Implications for ABE Programs

Consistent with ABE programs at a national level, the adults in this study represented a range of RGEs (ranging from 3rd grade through 12th grade, 9 months, with a mean of approximately 7th grade, 7 months) (Lesgold & Welch-Ross, 2012). This diversity in terms of multiple reading ability levels represented in the same classroom presents a challenge to researchers and practitioners trying to target component skills in order to improve reading comprehension. Recent studies have identified subgroups of adult learners with differential reading profiles based on the core component skills of decoding (Binder & Lee, 2012; MacArthur et al., 2012; Strucker et al., 2007), word recognition (MacArthur et al., 2012; Mellard et al., 2009), fluency (MacArthur et al., 2012; Mellard et al., 2009), spelling (MacArthur et al., 2012), and short-term memory (Strucker et al., 2007). For example, Binder and Lee (2012) detected four reader subgroups based on only two skills: reading comprehension and decoding. Members of one subgroup had particularly weak decoding skills relative to their comprehension level and members of a second subgroup had particularly weak comprehension skills relative to their decoding abilities. This suggests that whole class instruction focusing on decoding skills may not maximally benefit learners across all reading comprehension levels. Instead, learners may have dissimilar instructional needs, and therefore, may require instruction tailored to their specific weaknesses. Individualizing instruction in accordance with specific skills stands in stark contrast to current ABE practices. Currently, ABE programs utilize broad reading assessments (i.e., TABE), which do not provide explicit information and scoring on component reading skills (Greenberg, 2007). Consistent with the subgroup research, the current study found that the importance of two component skills (morphological awareness and vocabulary knowledge) varied as a function of adults' reading comprehension level. However, despite the variation in the predictive utility of these skills to reading comprehension, both of these skills remained crucial in predicting adults' reading comprehension across all quantiles. Thus, morphological awareness and vocabulary knowledge may be essential component skills to target for interventions and whole class instruction in order to improve reading comprehension in GED-level ABE classrooms.

Limitations and Future Directions

There are a few limitations that should be addressed. First, multiple quantile regression is a new tool to education- and developmental-based research and therefore, little information

exists regarding appropriate sample sizes (Petscher et al., 2013). Our sample size of 136 is small in comparison to the other recent educational studies that have employed this approach (Catts et al., 2009; Logan et al., 2012; Petscher & Kim, 2011; Reeves & Lowe, 2009). Because multiple quantile regression utilizes all data points at each quantile estimate (by asymmetrically weighting them relative to the particular quantile), a sample size of 136 may be adequate.

Second, multiple quantile regression is unable to provide unique pseudo-R^2 estimates at each quantile. This is a weakness of the approach because it limits the interpretability of the precise findings at different quantiles. At present, multiple quantile regression is equipped to show graphical trends of predictors across the distribution of an outcome variable, show slope estimate increases/decreases, test for statistical differences in slope estimates, and estimate total pseudo-R^2 values at each quantile. However, it would be beneficial to quantify exactly how much variance morphological awareness and vocabulary knowledge were uniquely contributing at various comprehension levels. Future research should consider ways to transform unique pseudo-R^2 values into a linear scale so they can be compared between quantiles.

Third, we obtained TABE Reading scores from the ABE centers and therefore, we did not have control over the administration of this assessment. Although we utilized the most recently administered TABE scores in our analyses, these scores were from a different time point than the administration of our larger battery of assessments. In addition, the TABE Reading subtest differed in format from the TOSREC measure. The TABE includes a functional literacy component and passage-level reading with multiple-choice responses. The TOSREC is a three-minute, true/false, sentence-level assessment that measures silent reading fluency and reading comprehension. For generalizability of the current findings, future research should consider examining the relations of morphological awareness and vocabulary knowledge to different types of reading comprehension measures (see Cutting & Scarborough, 2006).

Finally, our sample included only native English speaking adult literacy students. This is not representative of national ABE programs because approximately 43% of adult literacy students are non-native English speakers (Lesgold & Welch-Ross, 2012). Strucker et al. (2007) conducted a cluster analysis and reported that reading skill profiles differed based on English proficiency level. Therefore, future research should investigate whether the contributions of morphological awareness and vocabulary knowledge at various reading comprehension levels differ as a function of English proficiency status.

Conclusion

The current study highlights the joint and unique importance of morphological awareness and vocabulary knowledge across different levels of reading comprehension in adult literacy students. Across five reading quantiles, these skills were able to account for a large portion of the variance in reading comprehension (82-95%) and both skills contributed uniquely at each reading comprehension level. These findings suggest the need to incorporate morphological awareness and vocabulary knowledge into instructional practices in ABE programs to effectively promote reading comprehension skills. Future research is needed to

investigate the trajectories of other component skills across reading comprehension levels in order to build a more comprehensive understanding of the instructional needs and reading skills of this population.

References

Berko J. The child's learning of English morphology. Word. 1958; 14:150–177.

Binder KS, Lee C. Reader profiles for adults with low literacy skills: A quest to find resilient readers. Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education. 2012; 1(2): 19–30.

Carlisle JF. Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. Applied Psycholinguistics. 1988; 9:247–266.

Carlisle JF. Awareness of the structure and meaning of morphologically complex words: Impact on reading. Reading and Writing: An Interdisciplinary Journal. 2000; 12:169–190.

Carlisle JF. Morphology matters in learning to read: A commentary. Reading Psychology. 2003; 24:291–322.

Catts HW, Petscher Y, Schatschneider C, Bridges MS, Mendoza K. Floor effects associated with universal screening and their impact on the early identification of reading disabilities. Journal of Learning Disabilities. 2009; 42:163–176. [PubMed: 19098274]

CTB/McGraw-Hill. Test of Adult Basic Education (TABE). Monterey, CA: 2008.

Cutting LE, Scarborough HS. Prediction of reading comprehension: Relative contributions of word recognition, language proficiency, and other cognitive skills can depend on how comprehension is measured. Scientific Studies of Reading. 2006; 10(3):277–299.

Derwing B. Morpheme recognition and the learning of rules for derivational morphology. The Canadian Journal of Linguistics. 1976; 21:38–66.

Derwing, BL.; Baker, WJ. Recent research on the acquisition of English morphology.. In: Fletcher, P.; Garman, M., editors. Language acquisition: Studies in first language development. Cambridge University Press; New York: 1979. p. 209-223.

Dunn, LM.; Dunn, DM. Peabody Picture Vocabulary Test-Fourth Edition (PPVT 4). Pearson Assessments; Circle Pines, MN: 2007.

Greenberg, D. Tales from the field: The struggles and challenges of conducting ethical and quality research in the field of adult literacy.. In: Belzer, A., editor. Toward defining and improving quality in Adult Basic Education. Lawrence Erlbaum Associates; Mahwah, NJ: 2007. p. 53-67.

Hall R, Greenberg D, Laures-Gore J, Pae HK. The relationship between expressive vocabulary knowledge and reading skills for adult struggling readers. Journal of Research in Reading. 2014; 37(1):87–100. [PubMed: 24778459]

Herman J, Gilbert-Cote N, Reilly L, Binder KS. Literacy skill differences between adult native English and native Spanish speakers. Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education. 2013; 2(3):142–155.

Kieffer MJ, Lesaux NK. The role of derivational morphology in the reading comprehension of Spanish-speaking English language learners. Reading and Writing: An Interdisciplinary Journal. 2008; 21(8):783–804.

Koenker, R. Quantile regression. Cambridge University Press; New York: 2005.

Koenker R, Bassett G. Regression quantiles. Econometrica. 1978; 46(1):33–50.

Koenker R, Bassett G. Robust tests for heteroscedasticity based on regression quantiles. Econometrica. 1982; 50(1):43–61.

Koenker R, Hallock KF. Quantile regression. Journal of Economic Perspectives. 2001; 15:143–156.

Ku Y-M, Anderson RC. Development of morphological awareness in Chinese and English. 2003

Leong CK. Rapid processing of base and derived forms of words and grades 4, 5, and 6 children's spelling. Reading and Writing: An Interdisciplinary Journal. 2000; 12:277–302.

Lesgold, AM.; Welch-Ross, M., editors. Improving adult literacy instruction: Options for practice and research. National Academies Press; Washington, DC: 2012.

Logan JAR, Petrill SA, Hart SA, Schatschneider C, Thompson LA, Deater-Deckard K, DeThorne LS, Bartlett C. Heritability across the distribution: An application of quantile regression. 2012

Maag, L. Measuring morphological awareness in adult readers: Implications for vocabulary development. University of Florida; 2007. Unpublished dissertation

MacArthur CA, Konold TR, Glutting JJ, Alamprese JA. Reading component skills of learners in adult basic education. Journal of Learning Disabilities. 2010; 43:108–121. [PubMed: 20179306]

MacArthur CA, Konold TR, Glutting JJ, Alamprese JA. Subgroups of adult basic education learners with different profiles of reading skills. Reading and Writing: An Interdisciplinary Journal. 2012; 25:587–609.

Mahony DL. Using sensitivity to word structure to explain variance in high school and college level reading ability. Reading and Writing: An Interdisciplinary Journal. 1994; 6:19–44.

Martin, NA.; Brownell, R. Expressive One-Word Picture Vocabulary Test-Fourth Edition (EOWPT-4). Pro-Ed; Austin, TX: 2011.

Mellard DF, Fall E. Component model of reading comprehension for Adult Education participants. Learning Disabilities Quarterly. 2012; 35(1):10–23.

Mellard DF, Fall E, Mark C. Reading profiles for adults with low-literacy: Cluster analysis with power and speeded measures. Reading and Writing: An Interdisciplinary Journal. 2009; 22:975–992.

Mellard D, Fall E, Woods K. A path analysis of reading comprehension for adults with low literacy. Journal of Learning Disabilities. 2010; 43(2):154–165. [PubMed: 20179309]

Meng X-L, Rosenthal R, Rubin DB. Comparing correlated correlation coefficients. Psychological Bulletin. 1992; 111:172–175.

Muse, AE. The nature of morphological knowledge. Florida State University; 2005. Unpublished dissertation

Muthén, LK.; Muthén, BO. Mplus User's Guide. Seventh Edition. Muthén & Muthén; Los Angeles, CA: 1998-2012.

Nagy W, Berninger VW, Abbott RD. Contribution of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. Journal of Educational Psychology. 2006; 98(1):134–147.

Nagy WE, Berninger V, Abbott R, Vaughan K, Vermeulen K. Relationship of morphology and other language skills to literacy skills in at-risk second-grade readers and at-risk fourth-grade writers. Journal of Educational Psychology. 2003; 95:730–742.

Nunes T, Bryant P, Bindman M. Morphological spelling strategies: Developmental stages and processes. Developmental Psychology. 1997; 33(4):637–649. [PubMed: 9232379]

Nunes T, Bryant P, Bindman M. The effects of learning to spell on children's awareness of morphology. Reading and Writing: An Interdisciplinary Journal. 2006; 19:767–787.

Petscher Y, Kim Y-S. The utility and accuracy of oral reading fluency score types in predicting reading comprehension. Journal of School Psychology. 2011; 49:107–129. [PubMed: 21215838]

Petscher Y, Logan JAR. Quantile regression in the study of developmental sciences. Child Development. 2014; 85(3):861–881. [PubMed: 24329596]

Petscher, Y.; Logan, JAR.; Zhou, C. Extending conditional means modeling: An introduction to quantile regression.. In: Petscher, Y.; Schatschneider, C.; Compton, DL., editors. Applied quantitative analysis in the social sciences. Routledge; New York: 2013. p. 3-33.

R Development Core Team. R: A language and environment for statistical computing [Computer software]. R Foundational for Statistical Computing; Vienna, Austria: 2011. Retrieved from http://www.R-project.org

Reeves EB, Lowe J. Quantile regression: An education policy research tool. Southern Rural Sociology. 2009; 24(1):175–199.

Sabatini JP, Sawaki Y, Shore J, Scarborough H. Relationships among reading skills of adults with low literacy. Journal of Learning Disabilities. 2010; 43(2):122–138. [PubMed: 20179307]

SAS Institute Inc. Base SAS 9.2 utilities: Reference. Author; Cary, NC: 2012.

Singson M, Mahony D, Mann V. The relation between reading ability and morphological skills: Evidence from derivation suffixes. Reading and Writing. 2000; 12:219–252.

Strucker, J.; Yamamoto, K.; Kirsch, I. The relationship of component skills of reading to IALS performance: Tipping points and five classes of adult literacy learners. National Center for the Study of Adult Learning and Literacy (NCSALL); Cambridge, MA: 2007. Retrieved from http://www.ncsall.net/fileadmin/resources/research/report_29_ials.pdf

Taylor NA, Greenberg D, Laures-Gore J, Wise JC. Exploring the syntactic skills of struggling adult readers. Reading and Writing: An Interdisciplinary Journal. 2012; 25:1385–1402.

Tighe, EL. An investigation of the dimensionality of morphological and vocabulary knowledge in Adult Basic Education students. Florida State University; 2012. Unpublished masters thesis

Tighe EL, Binder KS. An investigation of morphological awareness and processing in adults with low literacy. Applied Psycholinguistics. 2014

Tighe EL, Schatschneider C. Exploring the dimensionality of morphological awareness and its relations with vocabulary knowledge in Adult Basic Education students. Reading Research Quarterly. in revision.

To NL, Tighe EL, Binder KS. Investigating morphological awareness and the processing of transparent and opaque words in adults with low literacy skills and in skilled readers. Journal of Research in Reading. in press.

Tong X, Deacon SH, Kirby JR, Cain K, Parrila R. Morphological awareness: A key to understanding poor reading comprehension in English. Journal of Educational Psychology. 2011; 103:523–534.

Wagner, RK.; Torgesen, JK.; Rashotte, CA.; Pearson, NA. The Test of Silent Reading Efficiency and Comprehension (TOSREC). Pro-Ed; Austin, TX: 2010.

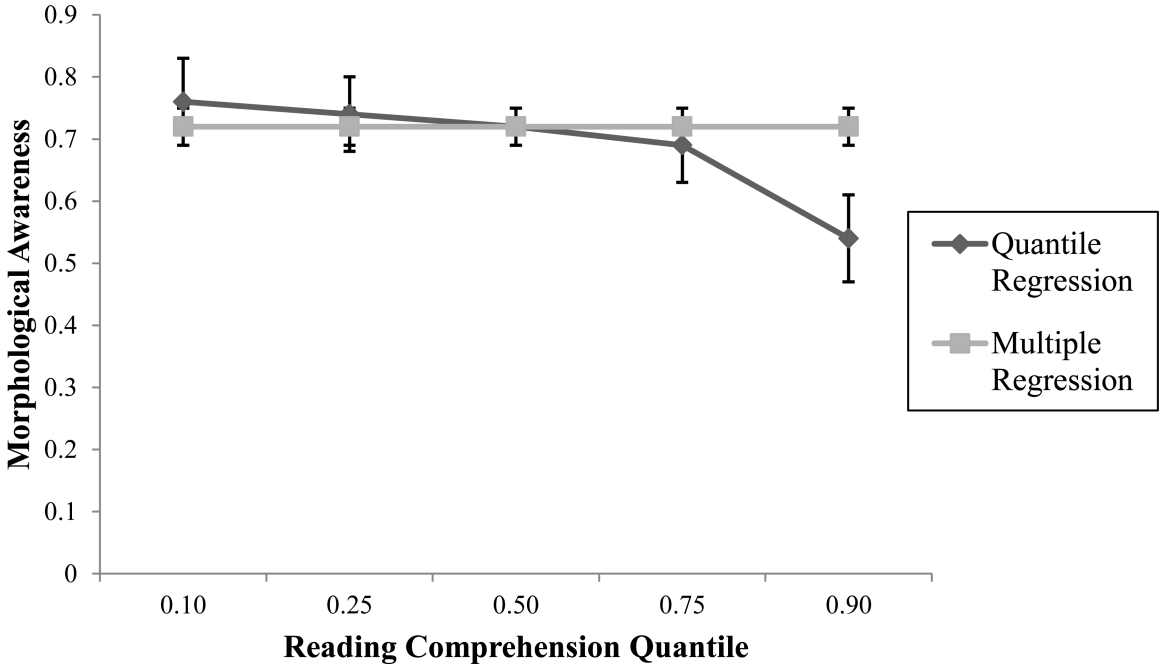

Figure 1.
Quantile Process Plot of the Unique Slope Estimates of Morphological Awareness

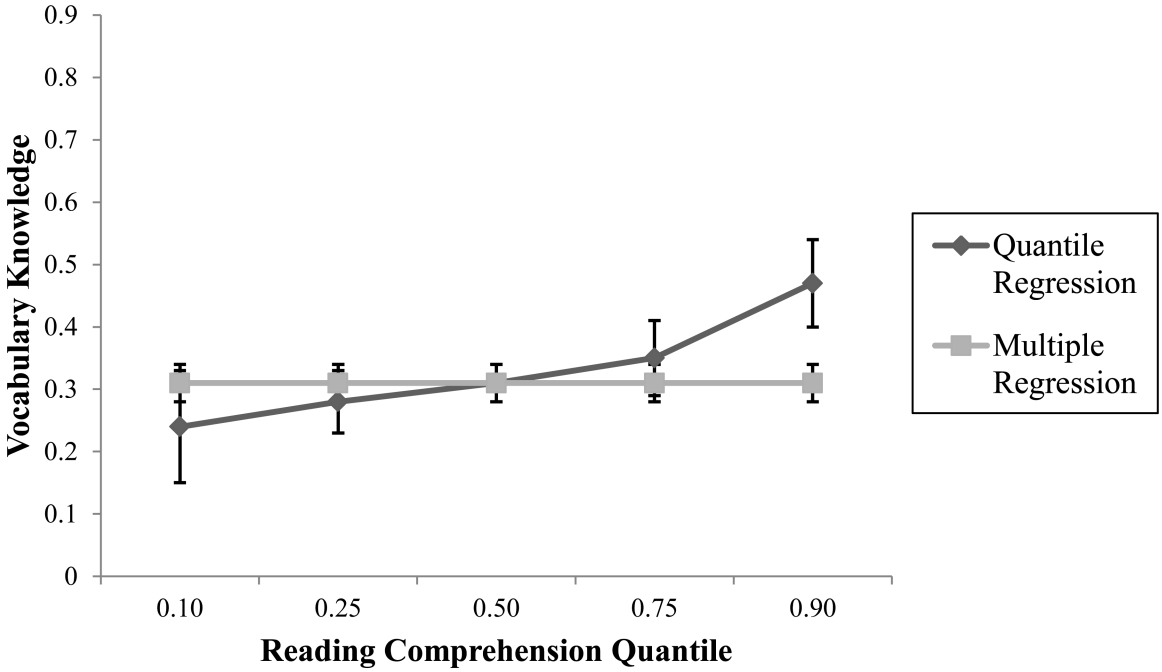

Figure 2.
Quantile Process Plot of the Unique Slope Estimates of Vocabulary Knowledge

Table 1

Descriptive Statistics for all Measures

Measure	N	M(SD)	Min/Max	Item Total
Morphological Awareness				
DMORPH	129	18.60 (6.14)	1-28	28
BMORPH	134	−.64 (.25)	−.3 – −1.34	28
Morphological Skill	129	21.74 (4.08)	11-28	29
Derivational Suffix Choice	134	11.73 (4.53)	1-18	18
Analogy Real Word	134	6.85 (3.61)	0-15	15
Analogy Pseudoword	129	8.19 (4.30)	0-15	15
Morphological Construction	129	9.25 (2.49)	4-12	12
Vocabulary Knowledge				
PPVT-4	134	81.15 (12.74)	48-117	--
EOWPVT-4	129	72.81 (14.38)	55-111	--
Reading Comprehension				
TOSREC	134	88.51 (16.61)	55-120	--
TABE-Reading	134	541.92 (53.20)	422-676	--

Note: DMORPH = Derived Form Morphology. BMORPH = Base Form Morphology. PPVT-4 = Peabody Picture Vocabulary Test- Fourth Edition. EOWPVT-4 = Expressive One-Word Picture Vocabulary Test - Fourth Edition. TOSREC = Test of Silent Word Reading Efficiency and Comprehension. TABE = Test of Adult Basic Education.

Table 2

Correlations Among all Measures

Measure	1	2	3	4	5	6	7	8	9	10	11
1. DMORPH	--	.63	.61	.63	.52	.53	.61	.52	.55	.59	.52
2. BMORPH	--	--	.55	.65	.56	.47	.48	.44	.47	.57	.43
3. MSkill	--	--	--	.55	.49	.50	.43	.36	.45	.54	.53
4. Suffix	--	--	--	--	.56	.53	.63	.33	.37	.54	.47
5. ARW	--	--	--	--	--	.48	.46	.37	.37	.43	.36
6. APW	--	--	--	--	--	--	.59	.37	.32	.47	.44
7. Construct	--	--	--	--	--	--	--	.36	.32	.53	.51
8. EOWPVT-4	--	--	--	--	--	--	--	--	.83	.53	.40
9. PPVT-4	--	--	--	--	--	--	--	--	--	.59	.48
10. TOSREC	--	--	--	--	--	--	--	--	--	--	.61
11. TABE	--	--	--	--	--	--	--	--	--	--	--

Note: N = 125. BMORPH = Base Form Morphology. DMORPH = Derived Form Morphology. MSkill = Morphological Skill Task. ARW = Analogy Real Word Task. APW = Analogy Pseudoword Task. Construct = Morphological Construction Task. . EOWPVT-4 = Expressive One-Word Picture Vocabulary Test – Fourth Edition. PPVT-4 = Peabody Picture Vocabulary Test- Fourth Edition TOSREC = Test of Silent Word Reading Efficiency and Comprehension. TABE = Test of Adult Basic Education.

All are significant at $p < .01$.

Table 3

Correlations Among Factor Scores

Factor	1	2	3
1. Morphological Awareness	--	.66	.92
2. Vocabulary Knowledge	--	--	.78
3. Reading Comprehension	--	--	--

Note: $N = 136$. All are significant at $p < .01$.

Table 4

Comparison of Multiple Regression and Multiple Quantile Regression Analyses

				95% CI			
Model	**Parameter**	**Estimate**	**SE**	**LB**	**UB**	***t*-value**	***p*-value**
Multiple OLS Regression							
	Intercept	0.00	0.03	−0.05	0.05	0.00	1.000
	Morph	0.72	0.03	0.65	0.79	20.04	<.001
	Vocab	0.31	0.03	0.24	0.38	8.66	<.001
Multiple Quantile Regression							
QR-10	Intercept	−0.41	0.05	−0.52	−0.31	−7.58	<.001
	Morph	0.76	0.07	0.63	0.89	11.62	<.001
	Vocab	0.24	0.09	0.07	0.41	2.85	0.005
QR-25	Intercept	−0.20	0.04	−0.28	−0.12	−4.99	<.001
	Morph	0.74	0.06	0.61	0.86	11.77	<.001
	Vocab	0.28	0.05	0.19	0.37	6.13	<.001
QR-50	**Intercept**	**0.03**	**0.02**	**−0.02**	**0.08**	**1.22**	**0.226**
	Morph	**0.72**	**0.03**	**0.67**	**0.79**	**24.31**	**<.001**
	Vocab	**0.31**	**0.03**	**0.25**	**0.37**	**10.35**	**<.001**
QR-75	Intercept	0.21	0.04	0.12	0.30	4.67	<.001
	Morph	0.69	0.06	0.57	0.82	10.95	<.001
	Vocab	0.35	0.06	0.23	0.46	5.99	<.001
QR-90	Intercept	0.39	0.04	0.31	0.47	9.81	<.001
	Morph	0.54	0.07	0.41	0.68	7.90	<.001
	Vocab	0.47	0.07	0.32	0.62	6.32	<.001

Note: **These are standardized estimates.** $N = 136$. CI = Confidence Interval. LB = Lower Bound. UB = Upper Bound. QR-10 = quantile regression at the .10 quantile. OLS = Ordinary Least Squares. QR-25 = quantile regression at the .25 quantile. QR-50 = quantile regression at the .50 quantile. QR-75 = quantile regression at the .75 quantile. QR-90 = quantile regression at the .90. Bold font indicates the comparison between the .50 quantile and multiple OLS regression.

Table 5

R^2 Estimates for Multiple Regression and Multiple Quantile Regression Analyses

Method	Predictor(s)	Total R^2	Unique R^2
MR	Morph Awareness	--	.29
	Vocab Knowledge	--	.05
	Morph + Vocab	.90	--
QR-10	Morph + Vocab	.82	--
QR-25	Morph + Vocab	.95	--
QR-50	Morph + Vocab	.92	--
QR-75	Morph + Vocab	.89	--
QR-90	Morph + Vocab	.87	--

Note: N = 136. MR = Multiple Regression. QR-10 = quantile regression at the .10 quantile. OLS = Ordinary Least Squares. QR-25 = quantile regression at the .25 quantile. QR-50 = quantile regression at the .50 quantile. QR-75 = quantile regression at the .75 quantile. QR-90 = quantile regression at the .90. Total R^2 estimates for all quantile regression analysis are pseudo-R^2 values.