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# Evaluating Child-Based Reading Constructs and Assessments with Struggling Adult Readers

Alice Owens Nanda

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## ACCEPTANCE

This dissertation, EVALUATING CHILD-BASED READING CONSTRUCTS AND ASSESSMENTS WITH STRUGGLING ADULT READERS, by ALICE OWENS NANDA, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

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Alice Owens Nanda

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## ABSTRACT

### EVALUATING CHILD-BASED READING CONSTRUCTS AND ASSESSMENTS WITH STRUGGLING ADULT READERS

by  
Alice Owens Nanda

Due to the paucity of research on struggling adult readers, researchers rely on child-based reading constructs and measures when investigating the reading skills of adults struggling with reading. The purpose of the two studies in this investigation was to evaluate the appropriateness of using child-based reading constructs and assessments with adults reading between the third- and fifth-grade levels. The first study examined whether measurement constructs behind reading-related tests for struggling adult readers are similar to what is known about measurement constructs for children. The sample included 371 adults, including 218 native English speakers and 153 English speakers of other languages. Using measures of skills and subskills, confirmatory factor analyses were conducted to test three theoretical measurement models of reading: an achievement model of reading skills, a core deficit model of reading subskills, and an integrated model containing achievement and deficit variables. Although the findings present the best measurement models, the contribution of this study is the description of difficulties encountered when applying child-based assumptions to developing measurement models for struggling adult readers. The second study examined the usefulness of the Comprehensive Test of Phonological Processing (CTOPP) Elision and Blending Words subtests (Wagner, Torgesen, & Rashotte, 1999) with struggling adult readers.

The sample included 254 adults, including 207 native English speakers and 47 native Spanish speakers. Overall performance, subtest reliability, and subtest validity were evaluated for the participants. Analyses included comparisons of struggling adult readers to the CTOPP norm group as well as comparisons within the struggling adult readers by demographic characteristics of age, gender, special-education status, and native language. Compared to the norm group, struggling adult readers exhibited lower overall performance as well as lower subtest reliability and validity. Regardless of demographic grouping, subtest validity was low for struggling adult readers. Overall performance and subtest reliability differed for struggling adult readers depending on demographic grouping, particularly age and native language. This study raises concerns about the appropriateness of administering and interpreting Elision and Blending Words subtests with struggling adult readers. In conclusion, both studies caution the use of child-based reading constructs and assessments with struggling adult readers.



EVALUATING CHILD-BASED READING CONSTRUCTS AND ASSESSMENTS  
WITH STRUGGLING ADULT READERS

by  
Alice Owens Nanda

A Dissertation

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in  
Educational Psychology  
in  
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in  
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## ABBREVIATIONS

BNT	Boston Naming Test
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CTOPP	Comprehensive Test of Phonological Processing
ESOL	English Speakers of Other Languages
GORT-3	Gray Oral Reading Test – Third Edition
GORT-4	Gray Oral Reading Test – Fourth Edition
NES	Native English Speakers
NFI	Normed Fit Index
PIAT-R	Peabody Individual Achievement Test – Revised
PPVT-III	Peabody Picture Vocabulary Test – Third Edition
RAN	Rapid Automatic Naming
RMSEA	Root Mean Square Error of Approximation
TOWRE	Test of Word Reading Efficiency
WJ-III	Woodcock-Johnson III: Tests of Achievement
WRAT-3	Wide Range Achievement Test – Third Edition
WRMT-R	Woodcock Reading Mastery Test – Revised

CHAPTER 1

MODELING CHILD-BASED THEORETICAL READING CONSTRUCTS

WITH STRUGGLING ADULT READERS

Introduction

As indicated by the 2003 National Assessment of Adult Literacy, 43% of adults in the United States have difficulty reading materials encountered in their houses, neighborhoods, and workplaces (Kutner et al., 2007). There is a paucity of research on struggling adult readers, and therefore researchers interested in investigating the reading skills and processes of struggling adult readers rely on the extensive literature describing children's reading development (e.g., Greenberg, Ehri, & Perin, 1997; Kruidenier, 2002). The appropriateness of this reliance has not been tested, and therefore, the purpose of this study is to evaluate child-based measurement models of reading constructs with struggling adult readers. Such an evaluation will help elucidate reading skills and subskills, their interrelationships, and their measures for this specific group of struggling readers. Three measurement models are investigated: a reading achievement skill model, a reading subskill based model referred to as the core deficit model, and an integrated model of both reading achievement skills and reading subskills. Reading achievement skills including word reading, nonword reading, reading fluency, and reading comprehension are important areas of reading performance. Reading subskills, or underlying processes, including phonological awareness, rapid automatic naming (RAN),

and oral vocabulary are subskills that impact overall reading performance but do not involve actual reading.

This study used confirmatory factor analysis (CFA) to test child-based theoretical measurement models of reading constructs with struggling adult readers. Measurement models, as tested with CFA, specify the number of factors (or constructs), reveal how the factors correlate, and show how the indicators (or observed variables) relate to the factors. Based on theory, these models are specified apriori and then tested for fit. When a tested model meets fit criteria, it is an indication that the observed variables are measuring constructs as specified in the model. Measurement model assessment is a crucial data analysis step prior to developing causal models, especially for populations for which there is so little research that it is impossible to know if the measures used actually form constructs as might be expected. One such population is that of struggling adult readers. The current limited research in the area of adult literacy is based on previously conducted reading research with children. Measurement modeling of critical reading skills and subskills for struggling adult readers will therefore help determine if reading skills and subskills and their associated measures form constructs as they commonly do with children. Findings from this type of research will help indicate whether the reliance adult literacy researchers place upon child-based reading development theory is appropriate.

#### *Reading Achievement Measurement Model*

Children's reading literature indicates that reading achievement skills such as word reading, nonword reading, reading fluency, and reading comprehension are

important components of reading (National Institute for Child Health and Human Development, 2000). There is limited research on these achievement constructs with struggling adult readers. Researchers comparing struggling adult readers to children often use word reading to match participants from the two groups (e.g., Greenberg et al. 1997; Read & Ruyter, 1985; Thompkins & Binder, 2003). The fact that the adults are reading at levels comparable to children highlights the deficits these adults have in word reading. However, compared to children with similar word-reading levels, adult readers have a relative strength in orthographic skills such as sight word reading (Greenberg et al.; Thompkins & Binder).

Despite the relative strength in sight word reading, many adults struggling with reading have significant deficits in nonword reading. Comparisons of adults and children matched on word-reading levels reveal that the adults perform worse than the children on nonword reading (Greenberg et al., 1997). Greenberg and colleagues hypothesized that the poor nonword-reading skills of struggling adult readers resemble those of children with reading disabilities. In fact, many struggling adult readers with deficits in nonword reading report having a learning disability (Strucker, Yamamoto, & Kirsch, 2007).

Reading fluency also seems to be problematic for struggling adult readers (Winn, Skinner, Oliver, Hale, & Ziegler, 2006). Mudd (1987) compared struggling adult readers to two groups of reading age matched children. One group of children included skilled readers whose actual age was less than or equal to their reading age while the other group of children included less skilled readers whose actual age was at least two months greater

than their reading age. Mudd found that the struggling adults read faster than the less skilled children but slower than the more skilled children.

Reading comprehension also poses a problem for adults struggling with reading. In fact, struggling adult readers have difficulty on a variety of reading comprehension tasks that resemble real-world uses of literacy (Kutner, Greenberg, & Baer, 2006). Chall (1994) hypothesized that adults struggling with reading comprehension may simply lack the basic skills such as word reading, nonword reading, and reading fluency necessary to read at a level required for comprehension.

Reading achievement skills including word reading, nonword reading, reading fluency, and reading comprehension are vital to overall reading performance. However, there is limited research on these reading achievement constructs for struggling adult readers. One purpose of this study is to analyze how a measurement model with constructs of word reading, nonword reading, reading fluency, and reading comprehension and their associated observed measures fits for struggling adult readers.

#### *Core Deficit Measurement Model*

There is some evidence that struggling adult readers have deficits in the same reading subskills that differentiate children struggling with reading: phonological awareness, RAN, and oral vocabulary. For example, researchers comparing struggling adult readers to typically developing children matched on reading age found that the struggling adults possessed poorer phonological skills (Greenberg et al., 1997; Thompkins & Binder, 2003). Read and Ruyter's (1985) work proposed that the phonological skills of struggling adults are similar to those of children with reading



disabilities. Similar to phonological skills, RAN also appears to be a deficit for struggling adult readers. In a study investigating the naming speed of adults who were good and poor readers, Sabatini (2002) found that compared to the good readers, adults reading at lower levels had slower naming rates.

Prior to 1980, researchers generally thought that adults struggling with reading would not necessarily have deficits in oral language because these adults had accumulated a lifetime of oral language experiences (Hoffman, 1978). Since 1980, some research has emerged indicating that struggling adult readers are actually weak in oral language skills. For example, Greenberg and colleagues (1997) found very low receptive vocabulary skills for adults reading from the third- through fifth-grade levels with age-based norms placing the adults at the first percentile rank. They also found that the adults reading at the third- and fourth-grade levels exhibited better vocabulary skills than reading-level-matched children. However, the vocabulary advantage for the adults disappeared when comparing the adults and children reading at the fifth-grade level. Greenberg and colleagues hypothesized that vocabulary growth at fifth grade and beyond may be greatly influenced by reading experiences; so, adults lacking reading skills may have deficits in vocabulary.

While we have some evidence that struggling adult readers, like children struggling with reading, perform poorly on phonological awareness, RAN, and vocabulary tasks, we do not know whether tasks measuring these core deficit skills form constructs like they do with children. This uncertainty of modeling constructs based on children's reading theory with struggling adult readers leads to the second purpose of this

research: to determine how the core deficit measurement model with constructs of phonological awareness, RAN, and oral vocabulary and their associated measures fits for struggling adult readers.

### *Integrated Measurement Model*

The achievement model of reading skills and the core deficit model of reading subskills each include different tasks important to overall reading. However, reading researchers indicate that reading skills and subskills work together in integrated models of reading (Adams, 1990; Vellutino, Tunmer, Jaccard, & Chen, 2007). Prior to testing causal pathways in integrated models, a measurement model must first be verified. What remains unknown and will be addressed with the third purpose is how such an integrated measurement model including assessments of reading skills from the achievement model and reading subskills from the core deficit model fits for struggling adult readers.

### *Nonnative English Speaking Adults Struggling with Reading*

The heterogeneity of struggling adult readers complicates the investigation of their reading skills and subskills. In the United States, the population of adults struggling with reading consists of both native English speakers (NES) as well as English Speakers of Other Languages (ESOL) (Kutner et al., 2007). Therefore, studies on struggling adult readers should include an examination of the possible differences between NES and ESOL participants.

There are many gaps in the research on struggling adult readers who are ESOL (Kruidenier, 2002). The limited research that has been conducted with this special population indicates that when comparing struggling adult readers who are ESOL and

NES, ESOL readers have different profiles of relative strengths and weaknesses (Strucker et al., 2007). Unlike NES readers, the ESOL group tends to have a relative strength in decoding (Chall, 1994; Strucker et al.). This relative strength in decoding is highlighted by research investigating the errors in word recognition of NES and ESOL struggling adult readers matched on nonword reading. Even though the two groups exhibited the same decoding skills, the ESOL readers relied more on their decoding skills for word reading as evidenced by their abundance of phonetically plausible incorrect responses (Davidson & Strucker, 2002).

Despite relative strengths in decoding, ESOL struggling adult readers have extensive difficulties with reading and tend to be overrepresented in the lowest ranks of comprehension skills (Kutner et al., 2007). Their comprehension difficulties may be due to their limited experience with English and their resulting poor English vocabularies. Specifically, their limited vocabularies may hinder their overall reading ability even when they do not have significant problems with decoding (Chall, 1994; Strucker et al., 2007).

### *Summary and Research Questions*

While there are many gaps in the research literature on struggling adult readers, some research indicates that struggling adult readers perform poorly on achievement skills of word reading (Greenberg et al., 1997), nonword reading (Greenberg et al.), reading fluency (Mudd, 1987), and reading comprehension (Kutner et al., 2007), with particularly poor performance on nonword reading. Furthermore, research indicates that struggling adult readers, like children struggling with reading, also have difficulties in the

core deficit subskills of phonological awareness (Greenberg et al.), RAN (Sabatini, 2002), and oral vocabulary (Greenberg et al.).

The study of struggling adult readers is complicated by the prevalence of ESOL readers. The ESOL group compared to the NES group tends to have different profiles of strengths and weaknesses including a relative strength in decoding and large deficits in oral vocabulary and comprehension (Strucker et al., 2007). What remains unknown is whether the tasks commonly used to assess constructs from the achievement, core deficit, and integrated measurement models will measure these constructs for NES and ESOL struggling adult readers.

Because of the lack of research on struggling adult readers, adult literacy researchers rely, perhaps inappropriately, on constructs and measures based on children's reading research. The purpose of this study was to examine measurement models of constructs behind tests of reading skills and subskills for struggling adult readers to determine whether the constructs prevalent in children's reading research are evident in struggling adult readers. This research used confirmatory factor analyses to test three child-based measurement models of reading constructs with adults reading between the third- and fifth-grade levels. The models include: 1) an achievement measurement model with constructs of word reading, nonword reading, reading fluency, and reading comprehension and their associated assessments; 2) a core deficit measurement model with constructs of phonological awareness, RAN, and oral vocabulary and their associated assessments; and 3) an integrated measurement model combining the

constructs and assessments from the achievement and core deficit models. For each of the three measurement models, the following questions were investigated:

1. How does the measurement model fit for NES struggling adult readers?
2. How does the measurement model fit for ESOL struggling adult readers?
3. Is the measurement model different for struggling adult readers who are ESOL compared to those who are NES?

Based on reading research with children, one might expect these measurement models to fit as they include constructs commonly studied with children. However, due to the lack of research in adult literacy, it is unknown how these measurement models will fit.

## Method

### *Participants*

This study utilized reading assessment data from 371 struggling adult readers ages 16 and older who attended adult literacy programs. The participants included 218 NES and 153 ESOL individuals who were recruited from adult literacy programs in a large southeastern city and volunteered to partake in a study investigating the effectiveness of various instructional strategies (Appendix A). To participate in this larger study, participants were screened and invited to take part if they possessed word-reading skills from the third- through the fifth-grade levels as measured by the Letter-Word Identification subtest of the Woodcock-Johnson III: Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001). Appendix B includes demographic

characteristics of the participants. These characteristics are representative of the adult literacy programs from which the participants were recruited.

### *Measures*

Each measure was selected based on its psychometric properties and the age range of intended examinees. While each test has excellent psychometric properties for its norm group, none of the norm groups included samples of struggling adult readers. Because it is unclear whether standard scores are appropriate for struggling adult readers and because some assessments do not have standard scores for all ages included in this investigation, raw scores were used for all the analyses, unless otherwise specified.

For the achievement model, data were analyzed on the following assessments:

*Word reading.* To assess word-reading skills, two different tests were administered: the WJ-III Letter-Word Identification subtest and the Adams and Huggins' (1985) Sight Word Reading Test. The WJ-III Letter-Word Identification was normed on people ages 2 to 80+ with reliability of .94. This subtest requires examinees to read lists of words that gradually increase in difficulty. The Adams and Huggins' Sight Word Reading Test is an unstandardized test assessing the ability of examinees to read words with atypical spellings.

*Word reading and reading fluency.* The Sight Word Efficiency subtest of the Test of Word Reading Efficiency (TOWRE; Torgesen & Wagner, 1999) was administered. This subtest was normed on people ages 6 through 24 with reliability of .93. In this assessment, examinees read as many words as they can in 45 seconds from a list of words that continually increases in difficulty.

*Nonword reading.* To assess nonword-reading skills, the WJ-III Word Attack subtest was administered (Woodcock et al., 2001). WJ-III Word Attack was normed on people ages 4 to 80+ with reliability of .87. For the first few items, examinees evaluate basic sound-symbol correspondences. For the rest of the items, examinees read aloud progressively more difficult nonwords.

*Nonword reading and reading fluency.* The Phonemic Decoding Efficiency subtest of the TOWRE (Torgesen & Wagner, 1999) was administered. This subtest was normed on people ages 6 through 24 with reliability of .94. In this assessment, examinees read as many nonwords as they can in 45 seconds from a list of nonwords that continually increases in difficulty.

*Reading fluency.* To assess reading fluency two different tests were administered: the WJ-III Reading Fluency subtest (Woodcock et al., 2001) which was normed on people ages 6 to 80+ with reliability of .90 and the Gray Oral Reading Test – Fourth Edition (GORT-4; Weiderholt & Bryant, 2001) which was normed on people ages 6 through 18 with reliability of .93. In the WJ-III Reading Fluency subtest, examinees silently read as many statements as they can in three minutes, decide while reading if each statement is true or false, and mark their decision in their test booklets. In the GORT-4, examinees read stories aloud and the examiner marks errors, times the reading, and converts the errors and times into fluency scores.

*Reading comprehension.* Two measures assessing reading comprehension were used: the WJ-III Passage Comprehension subtest (Woodcock et al., 2001) which was normed on people ages 2 to 80+ with reliability of .88 and the GORT-4 (Weiderholt &

Bryant, 2001) which was normed on people ages 6 through 18 with reliability of .97. The WJ-III Passage Comprehension subtest is a cloze reading comprehension procedure in which the examinee reads a passage silently and supplies a word to fill in the blank in the passage. The GORT-4 includes increasingly difficult passages each with five multiple choice comprehension questions. Examinees read a story aloud, listen and follow along while comprehension questions and answer options are read to them, and select answer options.

For the core deficit model, data were analyzed on the following assessments:

*Phonological awareness.* The Elision and Blending Words subtests of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) were used to assess phonological awareness. The Elision subtest was normed on people ages 5 to 24 with reliability of .89. This subtest assesses the ability to manipulate sounds in words. The examinee listens to an orally presented word, says the word, listens to an orally presented sound in that word, removes that sound from the word, and says the resulting word. The Blending Words subtest was normed on people ages 5 to 24 with reliability of .84. This subtest assesses the ability to combine sounds to form words. The examinee listens to orally presented individual sounds in a word, combines those sounds, and says the resulting word. CTOPP Elision for the NES group (but not for the ESOL group) had questionable normality with skewness of 1.33 and kurtosis of 6.01. A square root transformation of CTOPP Elision reduced the skewness to .04 and reduced the kurtosis to 2.98. Therefore, the square root transformed CTOPP



Elision variable was used for analysis for the NES group, but the original raw CTOPP Elision score was used in analyses for the ESOL group.

*Rapid automatic naming (RAN).* The Rapid Letter Naming and Rapid Color Naming subtests of the CTOPP (Wagner et al., 1999) were used to evaluate RAN. Each subtest was normed on people ages 5 to 24 with reliabilities of .82 for each one. In each subtest, examinees name the targets (lowercase letters in Rapid Letter Naming and colored squares in Rapid Color Naming) as fast as they can while being timed. The CTOPP Rapid Letter Naming and CTOPP Rapid Color Naming times were converted to rate scores by taking the inverse of the raw time scores. Rate scores are advantageous because a higher rate score indicates better performance.

*Oral vocabulary.* To assess receptive vocabulary, the Peabody Picture Vocabulary Test – Third Edition (PPVT-III; Dunn & Dunn, 1998) was administered. The PPVT-III was normed on people ages 2 to 90+ with reliability of .95. In the PPVT-III, the examinee looks at a template with four pictures, listens to the word presented orally by the examiner, and chooses the picture that best represents the word. To assess expressive vocabulary, the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 2001) was administered. In this unstandardized assessment, the examinee orally labels individually presented drawings. If the examinee does not know or answers incorrectly, the examiner provides cues including a stimulus cue which states information about the item in the picture and then a phonemic cue stating the beginning sound of the target response. The raw score used for this study was the total number correct which includes items answered correctly with initial presentation or with the stimulus cue.

### *Procedure*

The tests were individually administered by trained graduate research assistants in the following order: PPVT-III, BNT, WJ-III Reading Fluency, WJ-III Passage Comprehension, WJ-III Word Attack, GORT-4 Fluency and Comprehension, TOWRE Sight Word Efficiency, TOWRE Phonemic Decoding Efficiency, Adams and Huggins Sight Word Reading Test, CTOPP Elision, CTOPP Blending Words, CTOPP Rapid Letter Naming, and CTOPP Rapid Color Naming. Test order was based on the authors' previous testing experience with this population. For example, tests with pictures were administered first, a balance of task duration and demand was attempted for change of pace while testing, and examinee fatigue was considered. Testing was completed in one session lasting one and half to two hours with frequent breaks.

### *Results*

The means, standard deviations, and reliabilities for each assessment for the NES and ESOL groups are shown in Appendix C. To assess reliability, coefficient alphas (Cronbach, 1951) were computed for all nontimed subtests with available item-by-item data. For other tests, test-retest reliability, for which there was approximately a four-month delay between test and retest, was provided. In addition, Appendix C presents the statistical results of one-way ANOVAs comparing NES and ESOL groups for each subtest. Based on effect sizes greater than 0.20, the NES group performed better on the PPVT-III, BNT, WJ-III Passage Comprehension subtest, and Sight Word Reading Test while the ESOL group performed better on the TOWRE Phonemic Decoding Efficiency subtest.

To further explore the performance of struggling adult readers on the assessments, standard scores were computed for each norm-based test. Appendix D shows the standard scores for each assessment using norms at the participants' actual ages when available. For the tests that did not have norms for the ages of the participants in this investigation, the norms for age 18 were used to identify standard scores instead.

Correlation coefficients were computed separately for all assessments for the NES and ESOL groups. As seen in Appendix E, correlations were low with only 15% and 14% of correlations larger than .50 for the NES and ESOL groups, respectively. Fisher z transformations (Fisher, 1921) were computed to test the differences between the correlation coefficients for the two groups. Out of 105 correlation coefficients, 10 were larger for the NES group and 23 were larger for the ESOL group at the .05 level.

The primary purpose of the study was to test three child-based theoretical models of reading with struggling adult readers. The main data analysis included confirmatory factor analysis (CFA) in LISREL 8.72 (Joreskog & Sorbom, 2005) of the achievement model, the core deficit model, and the integrated model with adults reading from the third- through fifth-grade level who are NES or ESOL readers. Good model fit was determined with RMSEA values below 0.05, and NFI and CFI values above 0.95 (MacCallum, Browne, & Sugawara, 1996).

In completing the confirmatory factor analyses, the hypothesized models were evaluated first. The resulting models were inspected for theoretically-justifiable areas of improvement. In cases where the resulting models had low factor loadings, the variables with the low loadings were removed from their associated factors and allowed to load

elsewhere. In cases where there were very high factor correlations, models with the factors combined were considered. In addition, the modification indices were reviewed for each model to see if adding variables to other factors or including error covariances would be appropriate. In testing the hypothesized models and modifying them as described above, many problems were encountered including matrices that were not positive definite, negative error variances, poor overall fit, and models not working for both the NES and ESOL groups. Matrices that are not positive definite contain a set of values that are not possible resulting in eigenvalues that are zero or negative. With zero or negative eigenvalues, certain mathematical operations cannot be performed and solutions are indeterminable. Negative error variances, or Heywood cases, are problematic because they are impossible values. The best fitting models are presented below.

#### *Achievement Measurement Model*

The achievement models included variables assessing word reading, nonword reading, reading fluency, and reading comprehension.

*NES participants.* Appendix F presents the factor loadings, interfactor correlations, and error variances for the best fitting CFA model of achievement variables for the NES participants. The model shows the observed variables in rectangles and the latent factors in ovals with straight and curved lines and their associated values as estimated solutions. The observed variables have straight lines with arrows pointing at them from two directions. The arrows coming from the factors with associated factor loadings indicate the extent to which the factor contributes to performance on the

variable. The straight lines and associated values going to the observed variables from the left are error variances. The curved lines with arrows on each end and their corresponding values are estimated correlations between factors. The model in Appendix F had good fit as indicated by the  $\chi^2(11, n = 218) = 14.93, p = .19$ , RMSEA = .04, NFI = .99, and CFI = .99.

*ESOL participants.* Appendix G presents the factor loadings, interfactor correlations, and error variances for the best fitting CFA model of achievement variables for the ESOL participants. Model fit statistics included  $\chi^2(19, n = 153) = 29.23, p = .06$ , RMSEA = .06, NFI = .97, and CFI = .99.

*Differences between NES and ESOL participants.* To address the question whether the CFA models would fit differently for NES and ESOL participants, the best fitting achievement model for the NES group shown in Appendix F also was tested for the ESOL group. This model converged for the ESOL group, but TOWRE Sight Word Efficiency had standardized loadings greater than one and an accompanying negative error variance. The best fitting ESOL achievement model presented in Appendix G was also assessed for the NES group. For the NES participants, the model pictured in Appendix G had negative error variance on the WJ-III Passage Comprehension variable. Without the model fitting for both groups, a multigroup CFA could not be completed.

#### *Core Deficit Measurement Model*

The core deficit model included variables measuring phonological awareness, RAN, and oral vocabulary.

*NES participants.* The confirmatory factor analyses of the core deficit model with NES participants did not converge and the preliminary solution provided to help identify problems revealed a theta-delta matrix that was not positive definite along with negative error variances for BNT and CTOPP Rapid Color Naming rate. Other CFA models of the core deficit variables were attempted for the NES group including one- and two-factor models, but similar problems were encountered with these models. A one-factor CFA model in which all six variables loaded onto one factor and the three pairs of variables had correlated error variances did converge but was not acceptable. The PPVT and CTOPP Rapid Letter Naming rate error variances approached one while the corresponding loadings were close to zero.

*ESOL participants.* For the ESOL group, the hypothesized core deficit model converged and met criteria for good fit. Appendix H shows the core deficit model for the ESOL participants and the associated fit statistics.

*Differences between NES and ESOL participants.* Because no model fit for the NES participants, the question of whether the core deficit model fits differently for NES and ESOL readers cannot be addressed using multigroup CFA.

#### *Integrated Measurement Model*

The integrated model included constructs and associated measures from both the achievement and core deficit models.

*NES participants.* A best fitting integrated model for NES participants was identified with factors of vocabulary, comprehension, word reading, speed, decoding, and phonological awareness ( $\chi^2(66, n = 218) = 80.57, p = .11, RMSEA = .03, NFI = .97$ , and

CFI = .99). Appendix I presents the factor loadings, interfactor correlations, and error variances for this best fitting integrated CFA model for the NES participants.

*ESOL participants.* A best fitting integrated model for the ESOL group, as seen in Appendix J, was identified with factors of vocabulary, comprehension, word reading, speed, decoding, and phonological awareness ( $\chi^2(68, n = 153) = 94.85, p = .02$ , RMSEA = .05, NFI = .95, and CFI = .98).

*Differences between NES and ESOL participants.* To address the question whether the CFA models would fit differently for NES and ESOL readers, the CFA models would have to fit for each group independently. The best fitting integrated model for the NES group shown in Appendix I did not converge for the ESOL group. In addition, the best fitting integrated model for the ESOL group presented in Appendix J did not meet fit criteria for the NES group. Because of the difficulty obtaining good fitting CFA models for both groups with all the variables, multi-group CFA was not completed.

## Discussion

Due to a lack of research on struggling adult readers, adult literacy researchers have relied, perhaps inappropriately, on reading research with children. The purpose of this study was to examine measurement models of constructs behind tests of reading skills and subskills for struggling adult readers to determine whether the constructs prevalent in children's reading research are evident in struggling adult readers. Confirmatory factor analyses were conducted to test three child-based theoretical models of reading: an achievement model of word reading, nonword reading, reading fluency,

and reading comprehension; a core-deficit model of vocabulary, naming speed, and phonological awareness; and a third model containing both achievement model and core deficit model variables. Overall, there was difficulty fitting the measurement models for the struggling adult readers. Following brief interpretations of the three models for NES and ESOL participants, a discussion ensues as to why these models were so problematic.

Since the achievement measurement model included tests commonly used in both reading research and practice to measure word reading, nonword reading, reading fluency, and reading comprehension it is surprising that there was difficulty fitting this model for struggling adult readers. The achievement model was problematic for the NES participants and after testing numerous alternatives, a best fitting 5-factor CFA model with numerous double loadings was identified, as seen in Appendix F. This model renames the nonword reading factor as decoding because WJ-III Letter-Word Identification loaded with the nonword reading tasks. Also, fluency split into two factors, connected-text fluency and word-reading fluency, rather than being a single fluency construct.

For the ESOL group, both the initially hypothesized achievement model and the best fitting model for the NES group were problematic. After modifications to the initial four-factor model, a best fitting ESOL achievement model was identified as seen in Appendix G. This model was simpler than was the best fitting NES achievement model as this ESOL model did not separate word and text fluency and did not include many double loadings, even though some could be theoretically justified. The only double loading included for both groups was WJ-III Reading Fluency on both fluency and



comprehension. This test required examinees to read sentences silently and decide if each sentence was true or false. While determining if the sentences were true or false was not intended to be difficult, it did require language and comprehension skills. Caution should be taken in using this test as a primary measure of fluency for struggling adult readers as results may be confounded by comprehension skills.

The core deficit measurement model was based on research with children who were struggling with reading and since some have hypothesized that struggling adult readers are similar to children struggling with reading (Greenberg et al., 1997) it was assumed that this model would fit for struggling adult readers. Specifically, one could argue that some of the NES struggling child readers, on whom the model was based, grow up to be NES struggling adult readers. Unexpectedly, in this study the core deficit model was problematic for the NES group with estimated matrices that were not positive definite, negative error variances, and overall poor fit. However, it fit beautifully for the ESOL group as seen in Appendix H.

The integrated measurement model combining the core deficit and achievement constructs did not work initially for either group. For the NES group, the hypothesized model had estimated matrices that were not positive definite. Modifications including allowing all timed measures to load on a speed factor resulted in a best fitting six-factor integrated model for the NES participants as seen in Appendix I. The speed factor positively related to the reading, decoding, and phonological awareness factors. This indicates that general processing speed may be a critical component in many timed tasks of reading skills and subskills and that this component relates to reading skills and

subskills. This supports the findings of Sabatini (2002) indicating that both domain-general and domain-specific processing speed tasks related to reading level for struggling adult readers.

For the ESOL participants, numerous problems were encountered when trying to fit the initial integrated model and the best fitting integrated model for the NES group. A model combining the best fitting core deficit and achievement models for the ESOL participants was evaluated but did not meet criteria for good fit. Instead, a six-factor model as seen in Appendix J fit best for the ESOL group. In this model, CTOPP Rapid Color Naming loaded on speed and vocabulary factors. While expected to be a good speed measure, this subtest may also assess vocabulary in the form of color names.

While the main structure of the integrated models remained similar for the NES and ESOL groups, differences were primarily seen in double loadings. This implies that the major structure of the measures is similar between groups, but that there are nuances for the assessments when using them with struggling adult readers. The WJ-III Reading Fluency subtest functioned differently for the groups as it loaded on speed, reading, and comprehension factors for the NES group and on speed and vocabulary factors for the ESOL group. Group differences are further highlighted with the WJ-III Passage Comprehension loadings. Specifically, WJ-III Passage Comprehension had a single strong loading on comprehension for the ESOL group but had a double loading on comprehension and word reading for the NES group. This supports the conclusions of Strucker et al. (2007) that poor word-reading skills may limit the performance of NES readers on comprehension tasks.

Overall, there was great difficulty in obtaining models with good fit. Prevalent problems included matrices that were not positive definite, negative error variances, poor overall fit, and models not working for both NES and ESOL participants. There are many possible explanations for these types of problems including lack of normality in the measures, poor reliability of the measures, lack of variability in the measures, low correlations between measures, and possible real differences between NES and ESOL participants who struggle with reading. Each of these possible reasons was explored.

Lack of normality is one factor that could result in issues with model convergence in CFA, particularly when samples are not especially large. Results revealed adequate normality overall with an exception for CTOPP Elision for the NES participants. It is possible that the nonnormality of the CTOPP Elision distribution, even after transformation, hindered convergence of the core deficit model and the integrated model for the NES group.

Perhaps analysis difficulties occurred because the tests involved were not reliable for the participants. None of the tests were developed for or specifically normed with struggling adult readers. In fact, some tests such as the CTOPP and GORT-4 were not even intended for people 25 or older. However, the reliability coefficients for the participants presented in Appendix C were quite high for both groups with all alpha values exceeding .75 except those for WJ-III Letter-Word Identification. Lower reliabilities were expected for this subtest due to the restriction of range created by its use in participant selection. Some of the test-retest reliabilities were low as might be expected due to the four-month stretch between testing sessions. In particular, the test-retest

reliability of the GORT-4 Fluency and Comprehension subtests were low and may hinder convergence of the achievement and integrated models. Future research should evaluate each measure to explore its appropriateness for struggling adult readers. In addition, test designers should include additional norm subgroups of struggling adult readers so researchers and practitioners can choose tests most appropriate for their specific sample.

Lack of variability in measures can be problematic for model convergence and fit. It is possible that the sample selection criteria for this study resulted in a restriction of range in test scores leading to low variability. When reviewing the means and standard deviations of each test as seen in Appendix C, there is a lack of variability on the WJ-III Letter-Word Identification subtest. This is not surprising since only participants with grade equivalent scores from the third- through fifth-grade levels were invited to participate. This lack of variability for the WJ-III Letter-Word Identification subtest likely impacted the variability of other measures, although other measures had larger standard deviations relative to their means than did WJ-III Letter-Word Identification. It is possible that the restriction of range based on participant selection impacted model convergence and fit for all models but particularly for the achievement and integrated models that contained WJ-III Letter-Word Identification.

Low correlations between variables could also lead to problems with model convergence and fit. In this study, the magnitudes of the correlations for both groups were low overall. The low correlations could represent true low relationships between the tests for struggling adult readers or could be a result of the restriction of range in scores created with participant selection. Greenberg et al. (1997) reported lower correlations

between reading measures for struggling adult readers than for children when all participants were reading from the third- through fifth-grade levels on word identification. Because the low correlations were not seen for the children, Greenberg et al. hypothesized that low correlations between reading measures for struggling adult readers may be evidence of their lack of integration of skills and subskills needed for reading. It is possible that participants in this study also struggle with reading due to lack of skill and subskill integration. Regardless of cause, the low correlations for the participants in this study may result in poor model convergence and fit.

A possible explanation for difficulties with model fit for both groups on the same model may be due to real differences between the NES and ESOL participants.

Preliminary analyses describing the performance of NES and ESOL struggling adult readers reveal that the NES participants perform better than the ESOL participants on oral vocabulary tests, a reading comprehension test, and a sight word reading test but perform worse than the ESOL group on nonword-reading fluency. These results are consistent with the findings of Strucker et al. (2007) which indicate that the two groups have different patterns of strengths and weaknesses with ESOL readers weak in vocabulary and comprehension and strong in decoding and the NES readers very weak in decoding.

When comparing the correlations between the tests for the NES and ESOL readers in this study there were striking differences. Thirty-one percent of all correlations were different between the two groups. The NES group had higher correlations among speeded tasks and had higher correlations for nonword-reading tasks with other

assessments. The ESOL group had higher correlations for vocabulary and comprehension tasks with other assessments. Overall, it appears that measures in this study interrelate differently for the NES and ESOL participants and that this will impact the fitting of identical measurement models to both groups.

The differences between NES and ESOL participants could be due to the origination of reading problems. The NES group may have a high prevalence of learning disabilities preventing their reading development while the ESOL group may have a language barrier hindering their reading. It is also possible that the differences were simply due to differences in language levels and not due to true differences in the measures and their associated constructs for the groups as the ESOL group had lower receptive and expressive oral vocabulary than the NES group. Although hard to do, researchers may want to match NES and ESOL participants on language skills to investigate if language level accounts for some group differences. However, by doing this a researcher may obtain results related to statistical limitations due to the restriction of range instead of actual differences. A Monte Carlo modeling of a fuller distribution for each group is one way for researchers to address this issue. In addition, teasing out the differences between groups might be easier if researchers include reading and language tests in the native language of the ESOL participants.

Several limitations of this study should be noted. The study did not include several variables that might also be interesting in these models such as listening comprehension and working memory as those were not administered to the sample. In addition, the participant selection criteria restricted the range of performance to a point

that may have impacted variability in the sample. Furthermore, the criteria only included word reading and perhaps should have included a language threshold for the ESOL participants.

In conclusion, this study found that fitting child-based theoretical measurement models to struggling adult readers is very challenging. While there were minor problems with test normality, reliability, and variability, low correlations were pervasive and may have hindered model convergence and fit. In addition, it is possible that there are true differences in models for NES and ESOL struggling adult readers. Although this paper presents the best models found with the reading skill variables, the reading subskill variables, and a combination of both skill and subskill variables, the major finding is the difficulty in fitting measurement models of constructs from children's research with struggling adult readers. Results from this study depict the care that needs to be taken when applying assumptions based on research of children's reading development to struggling adult readers. More research specifically focused on struggling adult readers is needed. This need is crucial in order to advance our understanding of the difficulties 43% of adults have with reading (Kutner et al., 2007). This understanding can help to lead to implications for adult literacy instruction so that this percentage can be decreased.

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## CHAPTER 2

### RELIABILITY AND VALIDITY OF THE CTOPP ELISION AND BLENDING WORDS SUBTESTS FOR STRUGGLING ADULT READERS

#### Introduction

Adults who struggle with reading tend to have extreme difficulties with phonological tasks (Greenberg, Ehri, & Perin, 1997). Unfortunately, there are no tests of phonological awareness specifically normed on and intended for struggling adult readers. Instead, researchers must rely on phonological assessments developed on and intended for children and young adults. The purpose of this study is to investigate the usefulness of two such phonological awareness subtests from the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) for a group of adults reading from the third- through fifth-grade levels.

#### *Phonological Awareness*

Phonological awareness involves hearing, isolating, and manipulating individual sounds, or phonemes, in spoken language (Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997). In an alphabetic language system, the ability to distinguish and manipulate phonemes is helpful for linking phonemes to their corresponding graphemes, which in turn facilitates reading (National Institute of Child Health and Human Development, 2000). Phonological awareness seems to be a stable construct contributing to reading and predicting reading growth in children even after accounting for previous reading levels

(Torgesen et al.; Wagner et al., 1997). In addition, deficits in phonological awareness are frequently identified in children struggling with reading (Wolf & Bowers, 1999).

While there is a plethora of research on the contribution of phonological awareness to reading in children, there is much less research regarding phonological awareness in adults reading at children's levels. The limited research does indicate that phonological awareness predicts reading acquisition in adults (Durgunoglu & Oney, 2002). The research also indicates that struggling adult readers, like children struggling with reading, have deficits in phonological awareness (Read & Ruyter, 1985). Greenberg and her colleagues (1997) compared adults reading from the third- through fifth-grade levels to children reading from the third- through fifth-grade levels and found that the adults' phonological awareness skills were worse than the children's. Despite this evidence that struggling adult readers have poor phonological skills, much is still unknown. For example, struggling adult readers are a heterogeneous group varying on many demographic characteristics. They range in age from young adult to elderly, include both males and females, have various experiences in special education and general education classes, and have diverse native language backgrounds (Kutner, Greenberg, & Baer, 2006). The limited research on phonological awareness of struggling adult readers has not considered how these various demographic characteristics impact phonological awareness.

#### *The Comprehensive Test of Phonological Processing (CTOPP)*

One common test used to assess phonological awareness is the CTOPP (Wagner et al., 1999). This test is designed for and normed on individuals ages 5 through 24.

Despite the fact that the test is not intended for or normed on adults older than 24, the CTOPP is commonly used by adult literacy researchers and is a recommended assessment for adult literacy educators (Thinkfinity Literacy Network, n.d.).

The CTOPP is an individually administered norm-referenced test of phonological processing skills including phonological awareness, phonological memory, and rapid naming as problems in these areas are common in struggling readers (Wagner et al., 1999). According to the CTOPP Examiner's Manual, the intended use of the CTOPP is to identify people who would benefit from instructional support in the various phonological processing areas. The CTOPP was normed on 1,656 people from 30 states ranging in age from 5 through 24 years old. The Examiner's Manual reports that the normative sample is comparable to the United States population in terms of geographic region, gender, race, rural or urban residence, ethnicity, family income, parent education, and disability status (Wagner et al.).

This study focuses on the phonological subtests which comprise the CTOPP Phonological Awareness composite for ages 7 through 24: Elision and Blending Words. Elision is a 20-item subtest where the examinee listens to an orally presented word, says the word, listens to an orally presented sound in that word, removes that sound from the word, and says the resulting word. Feedback, including confirmation of correct responses or correction of incorrect responses, is provided for the practice items as well as the first five test items. Following the practice items, testing begins with the first item and continues until the examinee misses three items in a row or completes the last item in the subtest. As testing proceeds, the items get more difficult as the size of the segments to be

removed becomes smaller and the linguistic complexity increases. The beginning items require the removal of a whole word from a compound word. Later items require removal of smaller parts such as syllables and onset and rime units. The remaining items require the removal of individual phonemes in rime units and consonant clusters. The raw score is the total number of correct responses.

Blending Words is a 20-item subtest assessing the ability to combine sounds to form words. The examinee listens to orally presented individual sounds in a word, combines those sounds, and says the resulting word. Feedback, including confirmation of correct responses or correction of incorrect responses, is provided for the practice items as well as the first three test items. Following the practice items, testing begins with the first item and continues with progressively more difficult items until the examinee misses three items in a row or completes the last item in the subtest. Easier items require examinees to blend two or three sounds while harder items include more sounds and have increased linguistic complexity. The raw score is the total number of correct responses.

The CTOPP Examiner's Manual provides evidence of test reliability and validity for the norm group. For evidence of acceptable reliability, the Examiner's Manual reports internal consistency estimates of Cronbach's (1951) coefficient alpha and test-retest reliability correlations. The internal consistency reliability estimates are provided for various demographic subgroups of the normative sample. For evidence of acceptable test validity, the Examiner's Manual reports content-description validity, including item difficulty and discrimination estimates, and criterion-prediction validity. For criterion-prediction validity, the CTOPP Examiner's Manual presents relationships of Elision and

Blending Words to other tests of word reading, nonword reading, spelling, reading fluency, and reading comprehension.

The purpose of this investigation is to study the usefulness of the CTOPP Elision and Blending Words subtests, in assessing the phonological awareness of struggling adult readers. Specifically, this paper aims to examine the following:

1. How does this study's group of struggling adult readers ages 18-24 compare to the CTOPP norm group on overall performance, subtest reliability, and subtest validity for Elision and Blending Words?
2. Are there differences in overall performance, subtest reliability, and subtest validity of CTOPP Elision and Blending Words for struggling adult readers based on their age, gender, special-education status, and native language?

This study is an exploratory one. However, emerging research indicates that there are measurement issues when administering child-based reading tests with struggling adult readers (Greenberg, Pae, Morris, Calhoon, & Nanda, in press). Therefore, it is expected that the measurement characteristics of the CTOPP Elision and Blending Words subtests will be different for the struggling adult readers than for the CTOPP norm group. It is also expected that findings may differ based on participant demographic characteristics.



## Method

### *Participants*

Participants included 254 struggling readers who were recruited from adult literacy programs in a southeastern city (Appendix A). Participants were screened and invited to take part if they possessed word-reading skills from the third- through the fifth-grade levels as measured by the Letter-Word Identification subtest of the Woodcock-Johnson III: Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001). The participants for this study included 207 native English speakers and 47 native Spanish speakers. The native English speakers included participants between the ages of 18 and 72. All the native Spanish speakers were born outside of the United States, reported Spanish as the language spoken in their childhood home, and did not live in the United States prior to age 13. They were born in seven different countries in Central America and South America with 74.47% born in Mexico. Since the analyses in this study included comparisons of age groups and there were not enough native Spanish speakers in the youngest and oldest age groups, only native Spanish speaking participants in the middle age group ranging from 25 through 46 were included in this study.

Of the 254 participants in this investigation, 104 native English speakers and 35 native Spanish speakers had two testing points, with an average of 16.82 ( $SD = 3.48$ ) weeks between testing points. This group of 139 comprised the sample used for test-retest reliabilities as well as predictive validity analyses. Appendix K includes demographic characteristics of the participants at initial testing and at retesting by age and native language.

### *Measures*

In addition to the CTOPP Elision and Blending Words subtests described in detail above, the following assessments were used in this study. Because none of these tests were specifically designed for or standardized on struggling adult readers, raw scores were used for analyses.

*Test of Word Reading Efficiency* (TOWRE; Torgesen & Wagner, 1999). The Sight Word Efficiency and Phonemic Decoding Efficiency subtests were administered. In the Sight Word Efficiency subtest, examinees read as many words as they can in 45 seconds from a list of words that continually increases in difficulty. In the Phonemic Decoding Efficiency subtest, examinees read as many nonwords as they can in 45 seconds from a list of nonwords that continually increases in difficulty.

*Woodcock-Johnson III: Tests of Achievement* (WJ-III; Woodcock et al., 2001). The Letter-Word Identification and Word Attack subtests were administered. In the Letter-Word Identification subtest, examinees read lists of real words that gradually increase in difficulty. In the Word Attack subtest, examinees read progressively more difficult nonwords.

*Gray Oral Reading Tests – Fourth Edition* (GORT-4; Weiderholt & Bryant, 2001). Examinees read stories aloud and the examiner marks errors, times the reading, and converts the times and errors into Rate and Accuracy scores. Following the oral reading of each passage, examinees listen and follow along while comprehension questions and answer options are read to them, and then they select answer options. The correct responses to these questions comprise the Comprehension score.

*Peabody Individual Achievement Test-Revised* (PIAT-R; Frederick & Markwardt, 1997). The Spelling subtest was administered. In this subtest, examinees choose a correctly spelled word from four options that are provided.

*Demographic Survey.* In this researcher-developed survey, the examinees listen to questions read aloud to them and respond orally. The survey items inquire about age, gender, place of birth, native language, number of years of education, and whether or not the individual attended any special-education classes while in school.

#### *Procedure*

Trained examiners individually administered assessments in the following order: WJ-III Letter-Word Identification, PIAT-R Spelling, WJ-III Word Attack, Demographic Survey, GORT-4, TOWRE Sight Word Efficiency, TOWRE Phonemic Decoding Efficiency, CTOPP Elision, and CTOPP Blending Words. Responses to the Demographic Survey were used to classify participants by age, gender, special-education status, and native language. Because it is difficult to compare education from various countries and because special education might mean something different for the native Spanish speakers, only special-education status data for the native English speakers was evaluated in this study. After 16.82 weeks, on average, testing was completed again with participants who could be contacted and agreed to be retested.

#### Results

##### *Research Question 1:*

*How do the struggling readers ages 18-24 compare to the CTOPP norm group on overall performance, subtest reliability, and subtest validity for Elision and Blending Words?*

Because the CTOPP was normed with individuals through age 24, this question aimed to compare how struggling adult readers in the age range of the CTOPP norm group compared to that norm group. In order to compare the struggling adult readers to those in the CTOPP norm group, the 18-24 year old struggling readers in this study were compared to the 18-24 year olds in the norm group. However, some validity analyses in the CTOPP Examiner's Manual were completed with broader age groups so comparisons of the 18-24 year old struggling readers with the broader age groups represented in the Examiner's Manual were made for those concurrent and predictive validity analyses.

*Overall performance.* In the CTOPP norm group, the 18-24 year olds had mean raw scores of 18 and 16 respectively for Elision and Blending Words. Appendix L and Appendix M summarize the performance of the struggling readers on CTOPP Elision and Blending Words, respectively. The performance of the struggling adult readers in this study fell much below those adults in the norm group. The 18-24 year old struggling readers, on average, answered less than half as many items correctly than did the norm group with one study participant not answering any Blending Words items correctly. The standard scores for the 18-24 year old struggling readers based on norms for 18-24 year olds fell over two standard deviations below the mean for Elision and almost two standard deviations below the mean for Blending Words. In addition, mean raw scores corresponded to grade equivalencies of kindergarten through early second grade.

*Reliability.* For reliability estimates, the CTOPP Examiner's Manual reports internal consistency estimates of Cronbach's (1951) coefficient alpha and test-retest reliability correlations. Appendix N shows those estimates for the CTOPP norm group as

well as for the struggling adult readers. A direct comparison of the 18-24 year olds in the norm group and in this study showed adequate alpha values for both Elision and Blending Words with the norm groups' values larger than those of the struggling readers from this study.

Test-retest reliability estimates for the norm group were based on testing sessions within two weeks of each other while test-retest sessions for the 18-24 year old struggling readers spanned 16.82 weeks, on average. These test-retest reliability estimates for the struggling readers were lower than those for the norm group and also lower than desired with values falling below .70 for both subtests, with a particularly low test-retest reliability estimate of .45 for the 18-24 year old struggling readers on Blending Words.

*Validity.* The CTOPP Examiner's Manual provides evidence of test validity including content-description validity and criterion-prediction validity. In addition to the descriptions of the logic behind the test design, content-description validity includes the item level analyses of item discrimination and item difficulty. The Examiner's Manual presents the median discrimination and difficulty scores for items with variance for each subtest by age group. For item discrimination, or how well an item differentiates examinees with varying skill levels, a Pearson item score and total score correlation was employed. Higher values indicate the item helps distinguish those who do well on the task from those who do poorly on the task. Values below .15 indicate low item discrimination. Median item discrimination scores for the 18-24 year olds in the norm group were .64 for Elision and .51 for Blending Words. Item difficulty values are the proportion of participants who get each item correct. Easier items have higher item

difficulty values while harder items have lower item difficulty values. Test makers aim for items to have higher difficulty values at the beginning of the test with a steady progression to lower difficulty values until the end of the test. The median item difficulty values for the 18-24 year olds in the norm group were .89 for Elision and .74 for Blending Words indicating that the items from both subtests were relatively easy for that group.

The Elision and Blending Words item discrimination and difficulty values and medians for items with variance for 18-24 year old struggling readers from this study are presented in Appendix O. The median item discrimination scores in Appendix O were lower for the struggling readers than for the norm group for both tests, but the medians still represented acceptable discrimination values. Further evaluation of the Elision item discrimination scores revealed low estimates of .15 or less for some items at the beginning and end of the test. All Blending Words items had discrimination values of at least .15 for the 18-24 year old struggling readers.

The item difficulty median values in Appendix O for the 18-24 year old struggling readers were much lower than those described above for the 18-24 year olds in the norm group indicating that the test items were hard for the struggling adult readers. When looking at the progression of difficulty values for the 18-24 year old struggling readers on Elision, items six and eight broke the desired trend as their difficulty values were higher than those of preceding items. In addition, the desired gradual decrease in difficulty values was violated at the ninth item where there was a large decrease in difficulty values. Elision difficulty values from the ninth item through the end of the test

remained low. The progression of difficulty values for the Blending Words items for 18-24 year old struggling readers showed that a slightly different item order would allow for a smoother difficulty progression. Specifically, the progression of item difficulty values indicated the third item fit better earlier in the test, the fifth item fit better later in the test, the thirteenth and fourteenth items fit better earlier in the test, and the fifteenth item fit better later in the test.

In addition to analyses of item statistics for validity, the CTOPP Examiner's Manual also included estimates of criterion-prediction validity. These included partial correlations, controlling for age, between the CTOPP and other reading-based tests. These tests included the TOWRE (Torgesen & Wagner, 1999) subtests of Sight Word Efficiency and Phonemic Decoding Efficiency, the Woodcock Reading Mastery Tests-Revised (WRMT-R; Woodcock, 1987) subtests of Word Attack and Word Identification, the Gray Oral Reading Test-Third Edition (GORT-3; Weiderholt & Bryant, 1992) subtests of Accuracy, Rate, and Comprehension, and the Wide Range Achievement Test-Third Edition (WRAT-3; Wilkinson, 1995) Spelling subtest.

Validity estimates for the 18-24 year old struggling readers were completed with similar tests including TOWRE (Torgesen & Wagner, 1999) Sight Word Efficiency and Phonemic Decoding Efficiency, WJ-III (Woodcock et al., 2001) Word Attack and Word Identification, GORT-4 (Weiderholt & Bryant, 2001) Accuracy, Rate, and Comprehension, and PIAT-R (Frederick & Markwardt, 1997) Spelling. Appendix P describes the raw scores and standard scores of the 18-24 year old struggling readers on

each of these assessments. Appendix Q presents the validity estimates for the CTOPP norm group and the 18-24 year old struggling readers.

Fisher z transformations were used to compare the validity estimates between the CTOPP norm group and the 18-24 year old struggling readers. Alpha levels of .01 were used for these analyses due to the large number of tests completed. For Elision concurrent validity, the estimates for the struggling readers were significantly lower than those for the CTOPP norm group for all subtests except GORT Comprehension. For Blending Words concurrent validity, the estimates for struggling readers were significantly lower than the norm group for TOWRE Sight Word Efficiency, TOWRE Phonemic Decoding Efficiency, GORT Rate, and Spelling. Because the validity estimates were low overall, scatterplots were completed showing the relationships between CTOPP Elision and Blending Words and the two other phonological tests, TOWRE Phonemic and WJ-III Word Attack. Appendix R includes these four scatterplots depicting the lack of strong relationships between the variables. The predictive validity estimates did not differ between the CTOPP norm group and the 18-24 year old struggling readers at the .01 level for either Elision or Blending Words.

*Research Question 2:*

*Are there differences in overall performance, subtest reliability, and subtest validity of CTOPP Elision and Blending Words for struggling adult readers based on their age, gender, special-education status, and native language?*

Age, gender, and special-education status comparisons were completed with only native English speakers. The comparisons on native language included the native Spanish



speakers. Results were divided into separate sections below for each demographic characteristic.

*Are there differences in overall performance, subtest reliability, and subtest validity of CTOPP Elision and Blending Words for struggling adult readers based on their age?*

For analysis, the struggling readers were divided into three age categories, 18-24, 25-46, and 47-72. The first age group was chosen because it fell within the age range of the CTOPP norm group. The other two age groups were created with a median split of the participants ages 25 and older.

*Overall performance.* Appendix L and Appendix M summarize the performance of the struggling adult readers by age group on CTOPP Elision and Blending Words, respectively. Because CTOPP standard scoring only goes through age 24, the standard scores for the older participants were determined using the norms for the 18-24 year olds. ANOVAs used to compare raw scores for the three age groups revealed significant differences for Elision,  $F(2, 204) = 23.14, p < .001, \eta_p^2 = .18$  and for Blending Words,  $F(2, 204) = 21.13, p < .001, \eta_p^2 = .17$ . Tukey post hoc comparisons showed that for both Elision and Blending Words the 18-24 year olds scored significantly higher than both other groups while the 47-72 year olds scored significantly lower than both other groups. Furthermore, the number of participants not able to answer any items correctly on the tests increased with age. For Elision, no participants obtained raw scores of zero in the 18-24 and 25-46 year old groups but two participants ages 47-72 did not answer any Elision items correctly. For Blending Words, one participant in the 18-24 year old group,

6 participants in the 25-46 year old group, and 8 participants in the 47-72 year old group obtained raw scores of zero.

*Reliability.* Appendix N shows the internal consistency and test-retest reliability estimates by age for Elision and Blending Words. For Elision, alpha values decreased as age group increased, with the alphas for the two older groups falling below .70. For Blending Words, the alpha values all exceeded .70 with the highest estimate for the 24-46 year olds. All test-retest reliability estimates for Elision fell below .70. For Blending Words, the test-retest reliability estimate for the 25-46 year olds exceeded .70 but the estimates for the other two age groups did not, with the estimate for the 18-24 year olds falling below .50.

*Validity.* Appendix O shows the item discrimination and difficulty values by age group for both Elision and Blending Words. Elision item discrimination scores revealed some age group differences. Specifically, the items at the beginning of the test did not discriminate well for the younger participants while the items at the end of the test did not discriminate well for the older participants as revealed by items with discrimination below .15. For Blending Words, discrimination values were adequate for all age groups at the beginning of the test, but were low for the older age groups at the end of the test.

Examination of the Elision and Blending Words item difficulty values by age group revealed difficulty values decreased as age increased for most items. It also showed difficulty values decreased more rapidly for the older participants. Further examination of the progression of difficulty values on Elision identified trends common to all age groups. Specifically, item six had higher difficulty values than the items preceding it, item seven

had lower difficulty values than the item following it, and difficulty values dropped much lower at item nine and remained low for the remainder of the test. For Blending Words, there were also trends in item difficulty for all ages such that rearranging items 5, 6, and 7, moving item 13 earlier in the test, and moving item 15 later in the test smoothed the difficulty progression.

Concurrent and predictive validity estimates for Elision and Blending Words by age group are shown in Appendix S. The validity estimates were low regardless of age. Fisher z transformations comparing the validity estimates for the age groups revealed only one significant difference at the .01 level. The Elision concurrent validity estimate with WJ-III Word Attack was significantly larger for the 25-46 year olds than for the 47-72 year olds.

*Are there differences in overall performance, subtest reliability, and subtest validity of CTOPP Elision and Blending Words for struggling adult readers based on their gender?*

*Overall performance.* Appendix L and Appendix M summarize the performance of the struggling adult readers by gender on CTOPP Elision and Blending Words, respectively. The scores were low overall for both genders, but ANOVAs used to compare raw scores by gender were not significant for Elision,  $F(1, 205) = 1.15, p = .29, \eta_p^2 = .01$ , or for Blending Words,  $F(1, 205) = .83, p = .36, \eta_p^2 = .004$ .

*Reliability.* Appendix N shows the internal consistency and test-retest reliability estimates by gender for Elision and Blending Words. Alpha values for both genders and both subtests exceeded .70. The test-retest reliability estimates were above .70 for males

on Elision and for females on Blending Words. Overall, reliability estimates were larger for males on Elision and larger for females on Blending Words.

*Validity.* Appendix T shows the item discrimination and difficulty values by gender for Elision and Blending Words. Elision item discrimination scores revealed that the beginning items did not discriminate as well for males as for females as evidenced by discrimination values less than .15 for males. For Blending Words, discrimination was adequate for females throughout the test, but was low for higher numbered items for males.

The progression of item difficulty across gender groups for Elision indicated that item six should be moved earlier in the test and item seven moved later in the test. Furthermore, there was a drop in item difficulty values at item nine and difficulty values remained low for all items following item nine. For Blending Words, there were trends in item difficulty for both genders such that the first item should be later in the test and the seventh and thirteenth items should be earlier in the test for smoother difficulty progression.

Concurrent and predictive validity for Elision and Blending Words by gender are shown in Appendix U. The validity estimates were low overall, but Fisher z comparisons between males and females revealed no significant differences at the .01 level.

*Are there differences in overall performance, subtest reliability, and subtest validity of CTOPP Elision and Blending Words for struggling adult readers based on their special-education status?*

*Overall performance.* Appendix L and Appendix M summarize the performance of the struggling adult readers by special-education status on CTOPP Elision and Blending Words, respectively. The scores were low overall for both groups with no differences between groups for Elision as shown by an ANOVA,  $F(1, 201) = .23, p = .63, \eta_p^2 = .001$ . For Blending Words, ANOVA results showed differences between groups with the special-education group scoring higher than the regular-education group,  $F(1, 201) = 6.76, p < .01, \eta_p^2 = .03$ . On Blending Words, the regular-education group had 12 participants with raw scores of zero while the special-education group had 3 participants with raw scores of zero.

*Reliability.* Appendix N shows the internal consistency and test-retest reliability estimates by special-education status for Elision and Blending Words. Alpha values exceeded .70 for the regular-education group on Elision and both groups on Blending Words. The test-retest reliability estimates were above .70 for both groups for Elision, but not for Blending Words. Overall, reliability estimates were larger for the regular-education than for the special-education group.

*Validity.* Appendix V shows the item discrimination and difficulty values by special-education status for Elision and Blending Words. Elision item discrimination scores revealed some differences in that the items at the beginning and end of the test did not discriminate as well for the special-education group as for the regular-education group as evidenced by discrimination values less than .15. For Blending Words, discrimination was adequate for the regular-education group throughout the test, but low for higher numbered items for the special-education group.

Elision item difficulty progression would be smoother for both regular- and special-education groups with item six moved earlier in the test and item seven moved later in the test. In addition, there was a drop in difficulty values at item nine and difficulty values remained low for all items following nine. For Blending Words, there were also trends in item difficulty for both groups such that the first item should be later in the test and the seventh and thirteenth items should be earlier in the test for smoother difficulty progression. For Blending Words there were also differences in difficulty between groups. The beginning items had higher item difficulty values for the special-education group than for the regular-education group but the later items had higher item difficulty values for the regular-education group than for the special-education group.

Concurrent and predictive validity estimates for Elision and Blending Words by special-education status are shown in Appendix W. Concurrent and predictive validity estimates were low for both groups, but Fisher z comparisons between the regular and special-education groups only showed one significant difference at the .01 level. Blending Words predictive validity with GORT Rate was higher for the regular-education group than for the special-education group.

*Are there differences in overall performance, subtest reliability, and subtest validity of CTOPP Elision and Blending Words for struggling adult readers based on their native language?*

To answer this question, comparisons were made between native English speaking participants ages 25-46 and native Spanish speaking participants ages 25-46.

*Overall performance.* Appendix L and Appendix M summarize the performance of the struggling adult readers ages 25-46 who are native English speakers and those who are native Spanish speakers on CTOPP Elision and Blending Words, respectively. ANOVAs used to compare raw scores for the two native language groups revealed that the native Spanish speakers scored significantly higher than the native English speakers on Elision,  $F(1, 112) = 4.79, p = .03, \eta_p^2 = .04$ , and Blending Words,  $F(1, 112) = 7.07, p < .01, \eta_p^2 = .06$ . On Elision, the native English speakers did not have any raw scores of zero, but their maximum score was 13 while the native Spanish speakers had six raw scores of zero, but also had higher scores including one perfect score of 20. On Blending Words, the range of scores was the same between the two groups, but the native English speakers had six raw scores of zero while the native Spanish speakers had two raw scores of zero.

*Reliability.* Appendix N shows the internal consistency and test-retest reliability estimates by native language for 25-46 year olds for Elision and Blending Words. Alpha values exceeded .70 for both groups but the alphas for the native Spanish speakers were higher than those of the native English speakers for both subtests. All test-retest reliability estimates were below .70 for both groups but were higher for the native English speakers than for the native Spanish speakers.

*Validity.* Appendix X shows the item discrimination and difficulty values by native language for Elision and Blending Words. Elision item discrimination scores revealed some differences in that the items at the beginning and end of the test did not discriminate as well for the native English speakers as for the native Spanish speakers as

evidenced by discrimination values less than .15 for only the native English speakers. For Blending Words, discrimination was higher for items at the beginning of the test for native English speakers than for native Spanish speakers.

For both native language groups, Elision item difficulty decreased at item nine and remained low for all items after nine. However, there were also differences in Elision item difficulty for the two groups. For native English speakers, smoother item difficulty progression would be obtained if the sixth and eleventh items were moved up in the test. For native Spanish speakers, item 13 should be moved up in the test for smoother difficulty progression. In addition, the difficulty values for native English speakers were higher at the beginning of the test, but lower at the end of the test than for native Spanish speakers. For Blending Words, there were also trends in item difficulty for both native language groups such that the first item should be later in the test, items five through seven should be reversed, and the thirteenth item should be earlier in the test for a smoother difficulty progression. For Blending Words there were also differences in difficulty between groups in that difficulty progression would be smoother with item 16 earlier in the test for the native Spanish speakers.

Concurrent and predictive validity estimates for Elision and Blending Words by native language are shown in Appendix Y. Concurrent and predictive validity estimates were low for both groups and Fisher z comparisons revealed no significant differences at the .01 level between native English and Spanish speakers.

## Discussion

Due to a dearth of assessments specifically designed with and intended for



struggling adult readers, researchers and practitioners rely on measures commonly used with children to assess skills such as phonological awareness (Thinkfinity Literacy Network, n.d.). This paper examines the usefulness of the CTOPP phonological awareness subtests, Elision and Blending Words, with adults recognizing words from the third- through fifth-grade level.

Comparisons of 18-24 year old struggling readers from this study to the norm group reveal differences in overall performance, subtest reliability, and subtest validity. Overall performance is considerably lower for the struggling readers than for same-aged members of the norm group. This poor performance is not surprising in light of previous research indicating that struggling adult readers have deficits in phonological awareness (Greenberg et al., 1997; Read & Ruyter, 1985). Reliability estimates, particularly test-retest reliability, are lower for the struggling readers. It is possible that these differences may be attributed to differences in length of time between test-retest sessions as the CTOPP norm group completed test and retest within 2 weeks while the struggling adults completed test and retest after approximately 17 weeks. In addition, validity estimates are quite different between the 18-24 years olds from the norm group and from this study. The majority of concurrent validity estimates are significantly lower for the struggling readers than for the norm group. Although the predictive validity estimates are not significantly different between groups, the values for the struggling adult readers are lower than might be expected.

Age impacts performance on Elision and Blending Words such that the 18-24 year olds performed better than the 25-46 and 47-72 year olds while the 47-72 year old

group performed worse than both other groups. Using the 18-24 year old standard scores, even the very highest performers in the oldest group have standard scores falling two or more standard deviations below the mean. The age differences are further seen in the item discrimination and difficulty estimates such that the test items are easier for the younger participants. Further age differences are reported in reliability with internal consistency reliability estimates decreasing with age for Elision.

The results regarding age leave many questions for researchers and practitioners regarding why older participants are different than younger ones on phonological awareness tasks. It is possible that the older participants are further removed from school and may not be as familiar with these types of tasks. Struggling adult readers tend to depend on orthographic skills more than on phonological skills in their reading, leaving phonological skills unpracticed in their everyday lives (Greenberg, Ehri, & Perin, 2002). It is also possible that the age groups represent cohorts of students receiving different types of reading instruction with the younger participants receiving more phonological training. Future research examining the phonological skills of expert adult readers of varying ages would offer insight into the age effect found in this study.

In the struggling adult reader sample, gender differences are not prevalent for the CTOPP Elision and Blending Words subtests. The overall performance for males and females is similar while reliability and validity only vary slightly between groups. Test-retest reliability is low for Elision for females and for Blending Words for males. The concurrent and predictive validity estimates are comparable for males and females, but there are slight trends in item discrimination with Elision items at the beginning of the

test not discriminating as well for males as for females. For Blending Words, discrimination is adequate for females throughout the test, but not good for higher numbered items for males. Given the small sample size for males it will be beneficial to see if similar results are replicated with larger and more balanced gender samples of struggling adult readers.

Regular- and special-education groups in this study do not differ on performance on Elision; however, on Blending Words the special-education group outperforms the regular-education group. It is possible the special-education group received more blending instruction during their childhood reading instruction. Investigation of item difficulty for Blending Words shows that the beginning items of the test were easier for the special-education group but that the end items were easier for the regular-education group. Group differences also can be seen in the reliability estimates with slightly better estimates for both Elision and Blending Words for the regular-education group. Caution should be used in interpreting these results, however, because this study determined special-education status based on a self-report survey question. Inclusion of educational records to determine special-education status will be valuable for future investigations.

Despite the differences highlighted above between various groups of readers, there are many consistencies among the native English speaking struggling adult readers, regardless of age, gender, and special-education status. First of all, the struggling readers in this study perform poorly on both Elision and Blending Words. This low performance as evidenced by low mean raw scores is consistent with past research on struggling adult readers (Greenberg et al., 1997). In the current study, the struggling adults read between

the third- and fifth-grade levels on a word-reading task but their Elision and Blending Words mean raw scores correspond to grade equivalencies lower than third grade. This supports the findings of Greenberg and colleagues that struggling adult readers perform worse on phonological tasks than do children reading words at the same level as the adults. An easier phonological task such as the CTOPP Sound Matching subtest (Wagner et al., 1999) intended to measure phonological awareness of five and six year olds might be administered in the future to the struggling adult readers to better describe their skills. This test includes pictures that would appeal to young children, however, and might be perceived as demeaning if completed with adults.

In this study, low reliability, particularly test-retest, is seen for both Elision and Blending Words for the struggling adult readers regardless of age, gender, and special-education status. The test and retest spanned about 17 weeks, on average, for these participants. The long time between testing may contribute to lower than desired levels for test-retest reliability. If possible, test-retest reliability should be further examined with adults following a more standard two week time span.

The item difficulty values presented as part of the validity analyses in this study consistently indicate that changes in item order are needed to have a smooth progression of Elision and Blending Words items from easiest to most difficult, regardless of age, gender, and special-education status. Specifically, Elision item six is easier than some preceding items and item seven is harder than some later items. Item six and the preceding items require the removal of the consonant sound at the beginning of single-syllable words. One possibility explaining the ease of item six is that the feedback

provided with the first five items continues helping the adults improve their performance. However, this is an unlikely explanation given that results show item five is not easier than item four for this sample. Another possibility is that other characteristics such as the specific sound pattern or word familiarity impact item difficulty for struggling adult readers. According to difficulty values, item seven is more difficult than item eight for the participants. Item seven is the first item requiring the removal of a single phoneme at the end of a word. It is possible that the slight change in task confused examinees on first presentation but that some adjusted and were able to answer the similarly constructed item eight correctly. In order to better understand the difficulty of Elision items, item order could be altered and the test administered to more participants to see if the changes improve the difficulty progression.

In addition to item order, CTOPP Elision item nine consistently creates problems in difficulty progression for the struggling adults, regardless of age, gender, and special-education status, as the test appears to become much more difficult with this item. Item nine is the first item asking participants to remove a middle sound from a word instead of a first or last sound. This task requires not only removing the sound as in the previous items, but also joining together the remaining sounds to determine the answer. It is possible that the adults have the ability to complete this item but did not understand the task requirement. Perhaps including a few practice items requiring removal of a middle sound could help them better understand how to complete item nine. The CTOPP Examiner's Manual does not include the difficulty values for each item so it is unclear if the norm group faced similar challenges with item nine. Further research could provide

sample items similar to item nine with feedback to see if that indeed aids performance.

For Blending Words there was also some item reordering that would improve difficulty progression, regardless of age, gender, and special-education status. Specifically, item 1 is harder than some items following it, while items 7 and 13 are easier than some of the items preceding them. The first item requires the blending of two syllables of a word. This is the same type of requirement as in the second and third items, so it is unclear why the first item is the most difficult of the three. Perhaps the feedback provided on the first item helps the participants such that they do better on the second and third items because they have the benefit of the additional feedback. The seventh item requires blending two phonemes into a single-syllable word, but it is not apparent why this item is easier than the two preceding items also requiring blending of two phonemes into single-syllable words. Item 13 requires blending four phonemes from a single-syllable word. It might be easier than the preceding item requiring the blending of five phonemes, but it is not clear why it would be easier than item 11 which only requires the blending of three phonemes. Further research could be completed investigating how characteristics such as sound pattern and word familiarity are associated with Blending Words item difficulty for struggling adult readers. The CTOPP Examiner's Manual does not provide the item difficulty values for each item and age group so it is unknown if similar reordering would be appropriate for some age groups in the normative sample.

Results show low concurrent and predictive validity estimates for the struggling adult readers, regardless of age, gender, and special-education status, for both Elision and Blending Words. We cannot determine, however, whether these concurrent and

predictive validity estimates are low due to lack of validity of the CTOPP subtests or of the tests used in the validity analyses as none of the tests were normed with or intended specifically for struggling adult readers. In fact, only the WJ-III Letter-Word Identification and Word Attack subtests included people over age 24 in their normative sample. Few studies have investigated the use of various reading-related assessments with struggling adult readers and those limited findings provide initial evidence of validity issues for the assessments. One such study identifies validity problems of the GORT for struggling adult readers (Greenberg et al., in press) and advises readers to use caution in using and interpreting child-based assessments with struggling adult readers.

Comparisons between the 25-46 year old native English speakers and native Spanish speakers reveal numerous group differences. Native language impacts overall performance with the native Spanish speakers outperforming the native English speakers on both Elision and Blending Words. This is not surprising as past research indicates that nonnative English speakers who struggle with reading tend to have a relative strength in phonological tasks (Strucker, Yamamoto, & Kirsch, 2007). In addition to the group differences in overall performance, there are also Elision and Blending Words reliability differences with excellent internal consistency estimates and poor test-retest estimates for the native Spanish speakers. While concurrent and predictive validity estimates are comparable between groups, there are differences in item discrimination and difficulty patterns for the groups. In considering these group differences it may be pertinent that the native Spanish speakers were born outside of the United States, spoke Spanish at home as children, and were all age 13 or older when coming to the United States. There is also

considerable variance in their education level as seen in Appendix K such that some only obtained a third-grade education while others earned advanced degrees. Spanish is more phonetically based than English, so phonological skills could have been emphasized in their early education in their home countries. It would be helpful for future researchers to include reading and language measures in Spanish to see how those variables impact phonological awareness in English. In addition it might be valuable to collect more specific information about the educational histories of the native Spanish speakers to determine if both their Spanish and English reading skills are commensurate with the amount of education they have completed in each respective language.

In conclusion, this study finds that struggling adult readers perform poorly on the CTOPP phonological awareness subtests, Elision and Blending Words, and that these subtests do not have desired levels of reliability and validity with this population. However, this study is limited by its sample size and composition and further research with larger samples would be beneficial. The limited sample size in this study results in unbalanced gender groups and limited age groupings. A second limitation of this study is that of participant selection. The participants all volunteered to take part in the study and then only those who could be contacted and agreed to complete additional testing were included in the test-retest reliability and predictive validity portion. Participants completing the additional testing may be different from those not retested. Furthermore, the long time lapse between test and retest may negatively impact the test-retest reliability estimates. Future researchers should reevaluate these estimates for struggling adult readers over a more traditional two week time span.



Although some of the reliability and validity concerns can be explained by study characteristics such as time between test and retest and questions of possible lack of validity of other reading-related assessments, this study raises enough uncertainty regarding the appropriateness of CTOPP Elision and Blending Words for struggling adult readers to question their use with this population. Because these subtests are some of the most common measures of phonological awareness for children they have been identified as good measures to use with struggling adult readers. However, other simpler measures of phonological awareness may be helpful for better assessing the phonological awareness of struggling adult readers. Future research should focus on filling a much needed gap by designing reading-related assessments specifically for and with struggling adult readers.

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## APPENDIXES

### APPENDIX A

#### *Larger Study Funding Source*

This paper represents part of a larger study on *Reading Instruction for Low Literate Adults*, a project funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development, the National Institute for Literacy, and the US. Department of Education, grant # 1 R01 HD43801-01.

## APPENDIX B

*Frequencies and Descriptive Statistics for Demographic Characteristics of the NES (n = 218) and ESOL (n = 153) Participants*

Sample characteristics		English speaking status	
		NES	ESOL
Gender frequencies	Male	62	65
	Female	156	88
Race frequencies	Black	202	46
	Hispanic	3	59
	Asian	0	39
	White	10	9
	Other/mixed	3	0
Word-reading level frequencies	3 <sup>rd</sup> grade	95	49
	4 <sup>th</sup> grade	74	48
	5 <sup>th</sup> grade	49	56
Age descriptives	Range	16 - 72	16 - 62
	Mean	34.89	31.45
	Standard deviation	15.70	10.61
Years of education descriptives	Range	5 - 14	0 - 21
	Mean	10.08	11.67
	Standard deviation	1.55	3.89

# APPENDIX C

*Means, Standard Deviations, and Reliability Estimates for Tests for NES (n = 218) and ESOL Participants (n = 153), and Test Statistics for NES and ESOL Mean Test Score Comparisons*

Measures	English speaking status				NES and ESOL differences		
	NES		ESOL		F		Effect size
	M	SD	reliability	M	SD	reliability	
PPVT	134.06	18.01	.95 <sup>d</sup>	94.07	31.99	.98 <sup>d</sup>	.39
BNT	35.78	7.27	.89 <sup>d</sup>	19.31	8.84	.92 <sup>d</sup>	.51
WJ Passage Comprehension	25.97	4.19	.77 <sup>d</sup>	19.20	3.85	.79 <sup>d</sup>	.41
GORT Comprehension	24.76	9.73	.58 <sup>e</sup>	19.78	9.48	.55 <sup>e</sup>	.06
WJ Letter-Word Identification	49.41	4.46 <sup>c</sup>	.75 <sup>d</sup>	50.94	4.59 <sup>c</sup>	.69 <sup>d</sup>	.03
Sight Word Reading Test	28.57	7.51	.87 <sup>d</sup>	20.88	7.19	.86 <sup>d</sup>	.21
TOWRE Sight Word	64.06	11.32	.84 <sup>e</sup>	62.41	10.99	.75 <sup>e</sup>	.01
WJ Reading Fluency	38.45	9.47	.82 <sup>e</sup>	31.54	9.93	.83 <sup>e</sup>	.11
GORT Fluency	43.88	12.86	.65 <sup>e</sup>	38.22	11.93	.74 <sup>e</sup>	.05
CTOPP Letter Naming Rate <sup>a</sup>	.032	.008	.83 <sup>e</sup>	.031	.007	.72 <sup>e</sup>	.01
CTOPP Color Naming Rate <sup>a</sup>	.020	.005	.79 <sup>e</sup>	.017	.004	.77 <sup>e</sup>	.07
TOWRE Phonemic Decoding	16.81	10.71	.79 <sup>e</sup>	32.50	11.03	.77 <sup>e</sup>	.34
WJ Word Attack	12.56	6.17	.89 <sup>d</sup>	17.72	5.78	.83 <sup>d</sup>	.15
CTOPP Elision	6.25	2.47	.80 <sup>d</sup>	7.17	4.61	.92 <sup>d</sup>	.02
CTOPP Elision Square Root <sup>b</sup>	2.65	0.46	na	2.73	0.84	na	.00
CTOPP Blending Words	5.53	3.05	.84 <sup>d</sup>	7.29	4.32	.88 <sup>d</sup>	.05

*Note.* PPVT = Peabody Picture Vocabulary Test – Third Edition; BNT = Boston Naming Test; WJ = Woodcock Johnson-III; Tests of Achievement; TOWRE = Test of Word Reading Efficiency; GORT = Gray Oral Reading Tests – Fourth Edition; CTOPP = Comprehensive Test of Phonological Processing; na = not applicable.

<sup>a</sup>Rate score is the inverse of the raw time score. This transformation results in higher scores that indicate better performance.

<sup>b</sup>The transformation is the square root of the sum of the CTOPP Elision raw score and 1. This transformation improves normality for the NES participants.

<sup>c</sup>Range is limited on this test as all participants read from the third- through fifth-grade level according to this assessment.

<sup>d</sup>Reliability coefficient computed was Cronbach's alpha.

<sup>e</sup>Reliability coefficient was test-retest for 108 NES participants and 88 ESOL participants with approximately 4 months between testing points.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

# APPENDIX D

Standard Score Means, Standard Deviations, and Minimum and Maximum Values for Tests for NES ( $n = 218$ ) and ESOL Participants ( $n = 153$ )

Measures	English speaking status							
	NES				ESOL			
	<i>M</i>	<i>SD</i>	min.	max.	<i>M</i>	<i>SD</i>	min.	max.
PPVT <sup>ac</sup>	72.64	9.72	40	94	51.14	15.13	40	87
WJ Passage Comprehension <sup>ac</sup>	76.42	11.66	28	95	66.64	12.74	21	91
GORT Comprehension <sup>bd</sup>	3.80	1.52	1	8	3.10	1.42	1	7
WJ Letter-Word Identification <sup>ac</sup>	75.56	8.68	52	89	77.40	8.18	55	89
TOWRE Sight Word <sup>ad</sup>	72.33	7.55	50	92	71.27	7.17	50	86
WJ Reading Fluency <sup>ac</sup>	79.07	6.38	63	100	76.32	6.57	58	90
GORT Fluency <sup>bd</sup>	1.28	0.63	1	4	1.09	0.35	1	3
CTOPP Rapid Letter Naming <sup>bd</sup>	6.20	2.95	1	14	5.50	2.85	1	15
CTOPP Rapid Color Naming <sup>bd</sup>	6.45	2.65	1	18	5.10	2.35	1	10
TOWRE Phonemic Decoding <sup>ad</sup>	61.12	11.19	50	96	76.93	9.78	50	100
WJ Word Attack <sup>ac</sup>	73.77	11.03	20	97	81.47	10.72	33	98
CTOPP Elision <sup>bd</sup>	2.82	1.42	1	10	3.50	2.48	1	12
CTOPP Blending Words <sup>bd</sup>	3.36	1.92	1	11	4.48	2.74	1	12

Note. PPVT = Peabody Picture Vocabulary Test – Third Edition; WJ = Woodcock Johnson-III; Tests of Achievement;

TOWRE = Test of Word Reading Efficiency; GORT = Gray Oral Reading Tests – Fourth Edition; CTOPP = Comprehensive

Test of Phonological Processing.

<sup>a</sup>Assessment has a standard score mean of 100 and standard deviation of 15 in the norm group.

<sup>b</sup>Assessment has a standard score mean of 10 and standard deviation of 3 in the norm group.

<sup>c</sup>Standard score computed based on norms for the actual age of the participant.

<sup>d</sup>Standard score computed based on norms for 18 year olds due to lack of norms at participants' actual ages.



# APPENDIX E

Correlation Coefficients for Tests for NES Participants ( $n = 218$ ) Below the Diagonal and ESOL Participants ( $n = 153$ ) Above the Diagonal

	1	2	3	4	5	6	7	8	9	10	11	12	13	14 <sup>c</sup>	15 <sup>d</sup>	16
1. PPVT	—	.72	.51	.39	.25	.32	.25 <sup>b</sup>	.48 <sup>b</sup>	.16 <sup>b</sup>	.10 <sup>b</sup>	.28 <sup>b</sup>	.15 <sup>b</sup>	.03	.25 <sup>b</sup>	.24	.25 <sup>b</sup>
2. BNT	.76	—	.59 <sup>b</sup>	.49	.28	.34	.22 <sup>b</sup>	.46 <sup>b</sup>	.26 <sup>b</sup>	.17 <sup>b</sup>	.28 <sup>b</sup>	.05	.03	.23	.25	.13
3. WJ Passage Comp.	.39	.42	—	.60 <sup>b</sup>	.30	.43	.28	.54	.42 <sup>b</sup>	.20	.32 <sup>b</sup>	.05	.11	.26	.27	.18
4. GORT Comp.	.37	.38	.34	—	.13	.30 <sup>b</sup>	.24 <sup>b</sup>	.46 <sup>b</sup>	.35 <sup>b</sup>	.16	.22 <sup>b</sup>	.01	.04	.21	.23	.18
5. WJ Letter-Word Id.	.17	.22	.31	.08	—	.48	.36	.38	.45	.16	.15	.43	.39	.29	.27	.16
6. Sight Word Reading	.19	.18	.31	.02	.52	—	.52	.40	.56	.26	.20	.51 <sup>b</sup>	.44	.30	.26	.09
7. TOWRE Sight Word	-.06	-.03	.26	-.01	.57 <sup>a</sup>	.53	—	.51	.65	.41	.36	.61	.26	.33	.32	.11
8. WJ Reading Fluency	.05	.11	.37	.17	.41	.41	.68 <sup>a</sup>	—	.54	.26	.45	.36	.20	.42	.46 <sup>b</sup>	.13
9. GORT Fluency	-.08	-.05	.23	-.01	.44	.48	.63	.56	—	.35	.30	.51	.43	.27	.26	.15
10. CTOPP Letter Rate	-.13	-.12	.12	.01	.18	.10	.59 <sup>a</sup>	.52 <sup>a</sup>	.41	—	.31	.13	.10	.12	.17	.00
11. CTOPP Color Rate	-.12	-.01	.11	.01	.19	.07	.39	.43	.36	.53 <sup>a</sup>	—	.24	.14	.28	.28	.15
12. TOWRE Phonemic	-.20	-.06	.19	-.08	.52	.32	.60	.43	.49	.35 <sup>a</sup>	.27	—	.58	.37	.32	.17
13. WJ Word Attack	-.11	.03	.27	.01	.59 <sup>a</sup>	.34	.46 <sup>a</sup>	.39	.44	.16	.24	.73 <sup>a</sup>	—	.34	.31	.23
14. CTOPP Elision <sup>c</sup>	.04	.18	.23	.18	.31	.13	.21	.28	.17	.05	.18	.37	.53 <sup>a</sup>	—	.97	.32
15. Elision Square Root <sup>d</sup>	.04	.20	.24	.19	.31	.12	.20	.27	.16	.06	.17	.39	.52 <sup>a</sup>	.98	—	.30
16. CTOPP Blending	.03	.20	.12	.10	.17	-.04	.07	.13	.01	.05	.10	.24	.37	.44	.45	—

Note. PPVT = Peabody Picture Vocabulary Test – Third Edition; BNT = Boston Naming Test; WJ = Woodcock Johnson-III: Tests of Achievement; TOWRE = Test of Word Reading Efficiency; GORT = Gray Oral Reading Tests – Fourth Edition; CTOPP = Comprehensive Test of Phonological Processing. CTOPP Letter Rate is the inverse of CTOPP Rapid Letter Naming Time. CTOPP Color Rate is the inverse of CTOPP Rapid Color Naming Time. CTOPP Elision Square Root is used for NES and CTOPP Elision is used for ESOL participants.

<sup>a</sup>Correlation for NES is significantly larger than that for ESOL participants ( $\alpha = .05$ ).

<sup>b</sup>Correlation for ESOL participants is significantly larger than that for NES ( $\alpha = .05$ ).

<sup>c</sup>CTOPP Elision raw scores are used for ESOL participants.

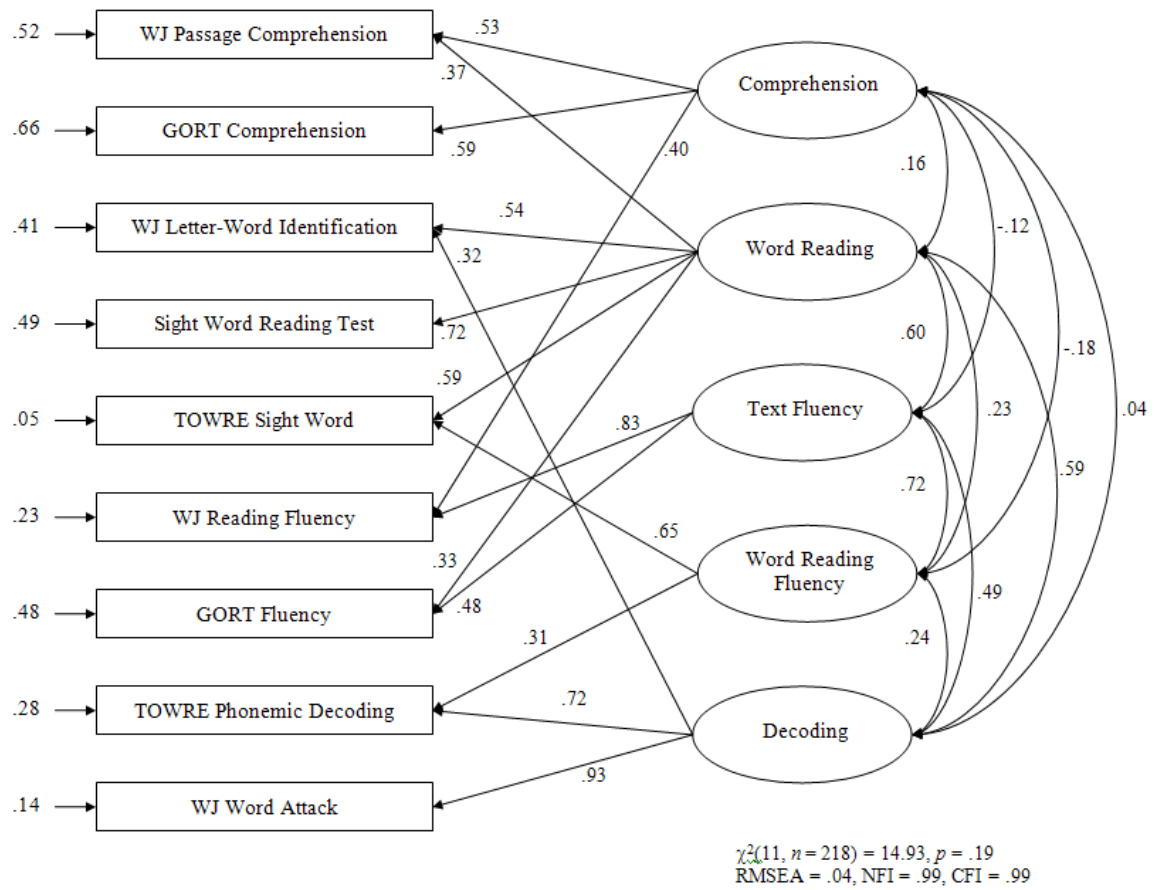
<sup>d</sup>CTOPP Elision raw scores with a square root transformation are used for NES to improve the normality of the variable for the group.

NES correlations  $> .134$  are significant at the .05 level and NES correlations  $> .176$  are significant at the .01 level.

ESOL correlations  $> .161$  are significant at the .05 level and ESOL correlations  $> .220$  are significant at the .01 level.

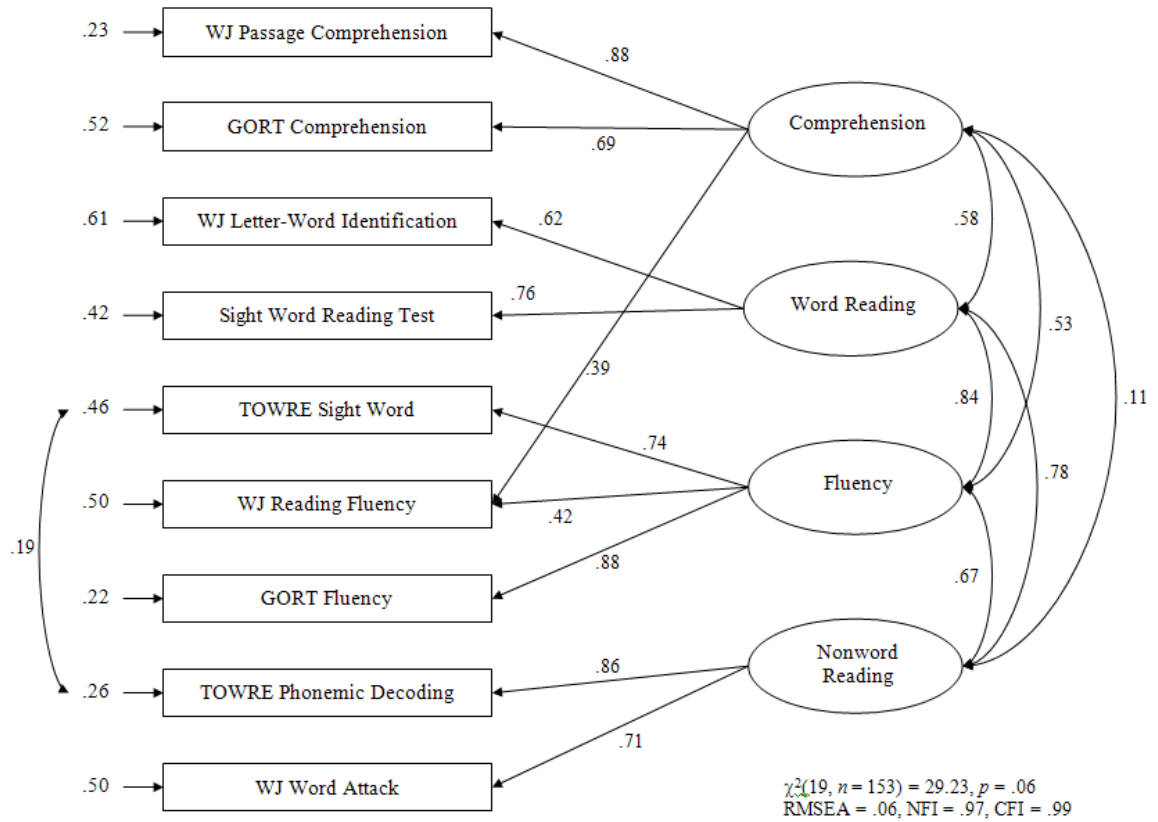
## APPENDIX F

### *CFA results for the achievement model for NES participants*



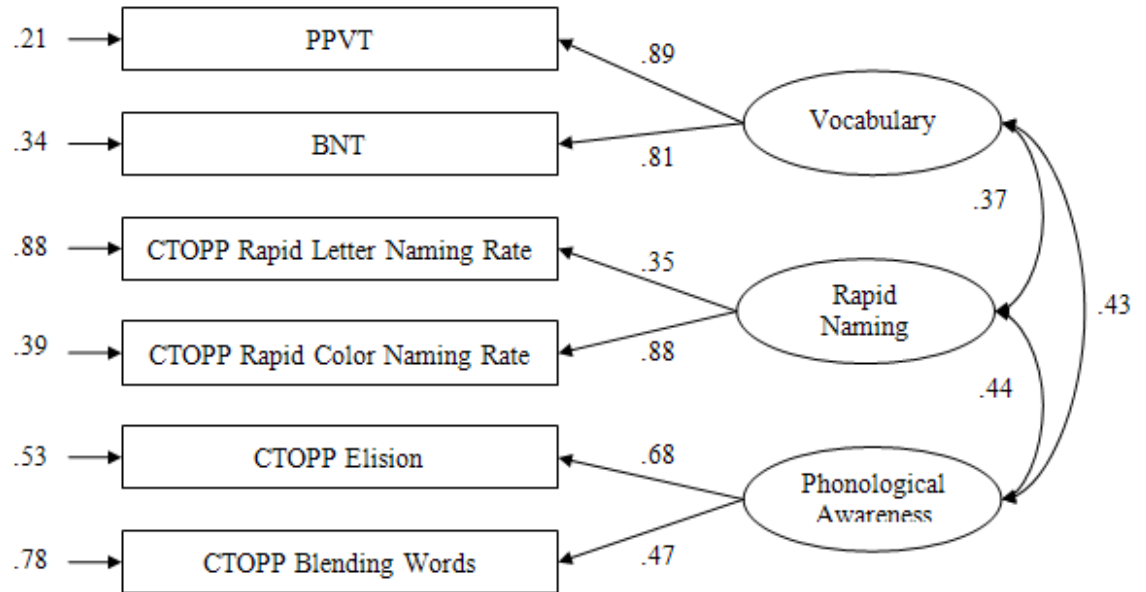
## APPENDIX G

### *CFA results for the achievement model for ESOL participants*



## APPENDIX H

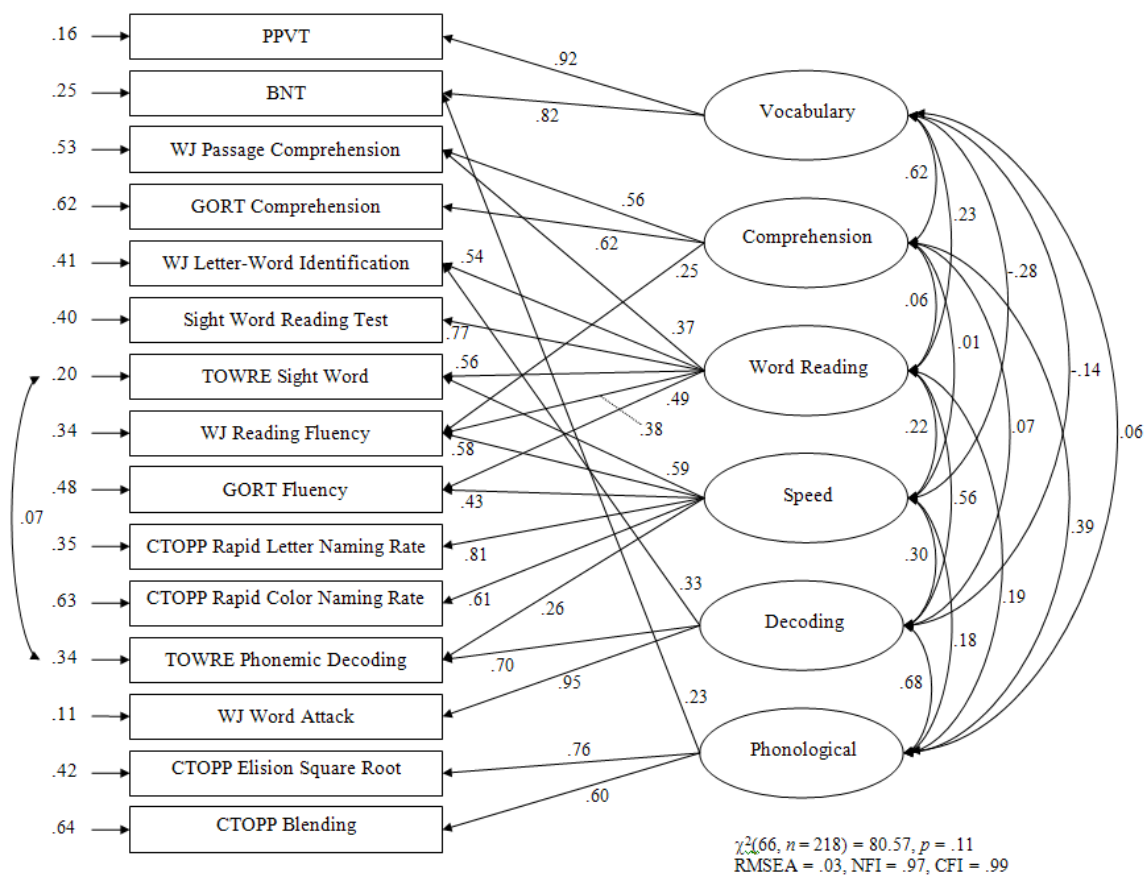
*CFA results for the core deficit model for ESOL participants*



$\chi^2(6, n = 153) = 7.13, p = .31$   
 RMSEA = .04, NFI = .96, CFI = .99

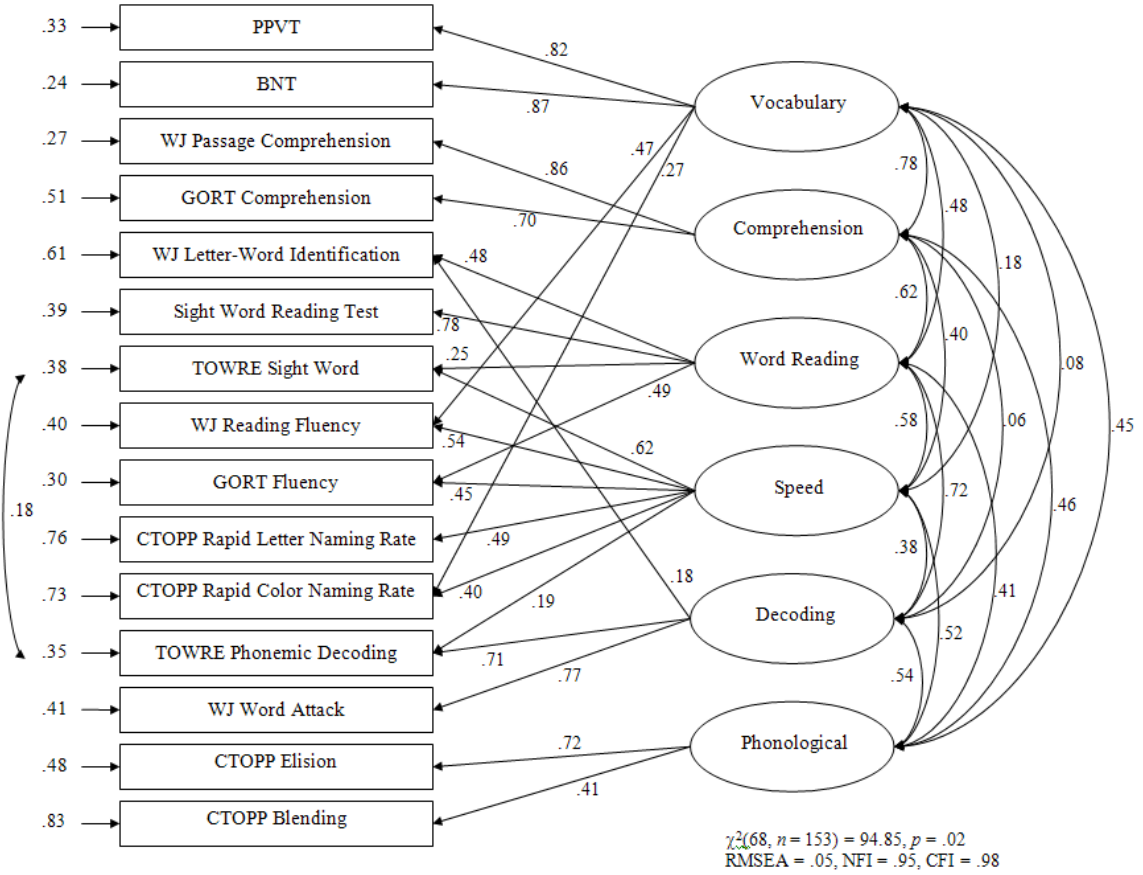
## APPENDIX I

*CFA results for the integrated model for NES participants*



## APPENDIX J

### *CFA results for the integrated model for ESOL participants*



# APPENDIX K

*Demographic Characteristics of Participants at Pretest (n = 254) and Posttest (n = 139) by Native Language and Age*

Sample characteristics	Pretest						Posttest					
	English			Spanish			English			Spanish		
	18-24	25-46	47-72	18-24	25-46	47-72	18-24	25-46	47-72	18-24	25-46	47-72
Gender frequencies												
Male	23	13	13	13	13	13	9	4	9	10	10	10
Female	49	54	55	34	34	34	20	25	37	25	25	25
Race frequencies												
Black	67	65	63	0	0	0	27	28	43	0	0	0
Hispanic	1	0	0	47	47	47	1	0	0	35	35	35
Other	4	2	5	0	0	0	1	1	3	0	0	0
Years of education descriptives												
Range	6-14	5-14	7-14	3-19	3-19	3-19	6-12	5-12	7-12	3-19	3-19	3-19
Mean	10.54	9.90	10.15	13.00	13.00	13.00	10.21	9.76	10.04	13.00	13.00	13.00
SD	1.34	1.71	1.63	3.55	3.55	3.55	1.47	1.99	1.60	3.95	3.95	3.95
Special education frequencies												
No	45	41	53	NA	NA	NA	19	17	34	NA	NA	NA
Yes	27	24	13	NA	NA	NA	10	11	10	NA	NA	NA

*Note.* NA = not applicable. Special-education status was not considered for the native Spanish speakers

## APPENDIX L

### *Performance on CTOPP Elision for Subgroups of Struggling Adult Readers*

Participant groups		Raw score			Standard score <sup>a</sup>			
		N	Range	Mean	SD	Range	Mean	SD
Native English speakers								
Ages 18-24	72	3-18	7.28	2.15	1-10	3.42	1.23	2.0
Ages 25-46	67	2-13	6.25	1.89	1-6	2.84	1.07	1.7
Ages 47-72	68	0-9	5.00	1.88	1-4	2.09	1.02	1.2
Females	158	0-14	6.11	2.09	1-7	2.75	1.15	1.7
Males	49	3-18	6.49	2.46	1-10	2.94	1.49	1.7
Regular ed.	139	0-18	6.12	2.30	1-10	2.74	1.30	1.7
Special ed.	64	2-14	6.28	1.95	1-7	2.87	1.11	1.7
Native Spanish speakers								
Ages 25-46	47	0-20	7.66	4.75	1-12	3.79	2.28	2.0

*Note.* GE = Grade Equivalent associated with the average raw score.

<sup>a</sup>The CTOPP does not provide standard scores for individuals above the age of 18.

Therefore the standard scores in this table are based on the norms for 18-24 year olds.

Standard scores for the norm group have a mean of 10 and a standard deviation of 3.



## APPENDIX M

### *Performance on CTOPP Blending Words for Subgroups of Struggling Adult Readers*

Participant groups		Raw score			Standard score <sup>a</sup>			
		Range	Mean	SD	Range	Mean	SD	GE
Native English speakers								
Ages 18-24	72	0-16	6.81	2.69	1-10	4.10	1.76	1.2
Ages 25-46	67	0-17	5.48	3.00	1-11	3.34	1.90	1.0
Ages 47-72	68	0-9	3.93	2.08	1-8	2.37	1.42	k.2
Females	158	0-17	5.33	2.92	1-11	3.23	1.87	1.0
Males	49	0-12	5.76	2.70	1-7	3.47	1.77	1.0
Regular ed.	139	0-16	5.01	2.82	1-10	2.96	1.77	1.0
Special ed.	64	0-14	6.08	2.50	1-8	3.81	1.65	1.2
Native Spanish speakers								
Ages 25-46	47	0-17	7.17	3.78	1-11	4.38	2.46	1.4

*Note.* GE = Grade Equivalent associated with the average raw score.

<sup>a</sup>The CTOPP does not provide standard scores for individuals above the age of 18.

Therefore the standard scores in this table are based on the norms for 18-24 year olds.

Standard scores for the norm group have a mean of 10 and a standard deviation of 3.

*CTOPP Elision and Blending Words Reliability Coefficients for the CTOPP Norm Group and this Study's Struggling Adult Readers*

Group	Elision reliability			Blending Words reliability		
	Internal consistency		Test-retest <sup>a</sup>	Internal consistency		Test-retest <sup>a</sup>
	N	$\alpha$	N $r$	N	$\alpha$	N $r$
CTOPP norm group						
Ages 18-24	112	.87	29 .77	112	.84	29 .71
Struggling adult readers						
Native English speakers						
Ages 18-24	72	.77	29 .63	72	.78	29 .45
Ages 25-46	67	.69	28 .53	67	.83	29 .77
Ages 47-72	68	.65	46 .57	68	.73	46 .58
Females	158	.72	81 .57	158	.83	82 .75
Males	49	.81	22 .84	49	.79	22 .61
Regular education	139	.77	69 .70	139	.82	70 .76
Special education	64	.69	31 .54	64	.76	31 .67
Native Spanish speakers						
Ages 25-46	47	.90	35 .49	47	.85	35 .41

*Note.* CTOPP norm group data from the CTOPP Examiner's Manual (Wagner, Torgesen, & Rashotte, 1999).

<sup>a</sup>Test and retest for the norm group were within 2 weeks of each other while test and retest for struggling adult readers spanned 16.82 weeks, on average.

## APPENDIX N

# APPENDIX O

*CTOPP Elision and Blending Words Item Discrimination and Difficulty Values for Struggling Adult Readers who are Native English Speakers Ages 18-24 (n = 72), 25-46 (n = 67), and 47-72 (n = 68)*

Item	Elision						Blending Words					
	Discrimination			Difficulty			Discrimination			Difficulty		
	18-24	25-46	47-72	18-24	25-46	47-72	18-24	25-46	47-72	18-24	25-46	47-72
1	.00	-.05	.39	1.00	.99	.97	.34	.42	.59	.96	.85	.81
2	-.02	.00	.39	.97	1.00	.97	.17	.43	.63	.96	.90	.87
3	.20	.20	.31	.93	.91	.87	.26	.51	.66	.99	.91	.84
4	.00	.37	.43	.92	.73	.47	.32	.50	.55	.88	.81	.62
5	.18	.47	.36	.88	.76	.51	.48	.48	.39	.60	.34	.19
6	.20	.52	.41	.93	.88	.62	.37	.44	.34	.64	.37	.09
7	.26	.43	.49	.58	.39	.26	.42	.59	.31	.63	.46	.24
8	.37	.48	.44	.63	.43	.29	.28	.54	.43	.36	.33	.19
9	.58	.22	.20	.06	.03	.01	.27	.46	.20	.15	.16	.06
10	.61	.18	.20	.07	.01	.01	.48	.46	.25	.15	.10	.01
11	.55	.40	.00	.07	.06	.00	.41	.36	.00	.10	.03	.00
12	.64	.39	.00	.07	.01	.00	.48	.19	.00	.04	.01	.00
13	.63	.00	.00	.04	.00	.00	.62	.49	.25	.17	.06	.01
14	.47	.39	.00	.03	.01	.00	.41	.55	.00	.08	.04	.00
15	.52	.00	.00	.03	.00	.00	.28	.00	.00	.01	.00	.00
16	.65	.00	.00	.03	.00	.00	.40	.44	.00	.03	.01	.00
17	.32	.39	.00	.01	.01	.00	.40	.52	.00	.03	.03	.00
18	.56	.39	.00	.01	.01	.00	.37	.52	.00	.01	.03	.00
19	.65	.00	.00	.03	.00	.00	.37	.00	.00	.01	.00	.00
20	.00	.00	.00	.00	.00	.00	.37	.44	.00	.01	.01	.00
Median <sup>a</sup>	.49	.39	.39	.07	.22	.49	.37	.47	.39	.15	.13	.19

<sup>a</sup>Median computed for items that have variance.

# APPENDIX P

*Raw Score and Standard Score Performance of 18-24 Year Old Struggling Readers on Reading Related Tests*

Test	N	Raw score		Standard score	
		Range	Mean	Range	Mean
TOWRE Sight Word <sup>a</sup>	72	30-91	64.42	12.30	72.68
TOWRE Phonemic <sup>a</sup>	72	1-53	20.01	10.71	65.44
WJ Word Attack <sup>b</sup>	72	3-27	14.90	5.78	69.14
WJ Word Identification <sup>b</sup>	72	42-57	49.40	4.51	65.92
GORT Accuracy <sup>c</sup>	71	5-37	19.72	8.13	2.38
GORT Rate <sup>c</sup>	71	11-36	25.62	6.23	3.59
GORT Comprehension <sup>c</sup>	69	8-47	25.90	8.93	4.00
PIAT Spelling <sup>a</sup>	72	39-97	71.68	11.82	82.07

*Note.* TOWRE = Test of Word Reading Efficiency; WJ = Woodcock Johnson-III: Tests of Achievement; GORT = Gray Oral Reading Test – Fourth Edition; PIAT = Peabody Individual Achievement Test – Revised.

<sup>a</sup>Standard scores based on age 18 and have a norm group mean of 100 and standard deviation of 15.

<sup>b</sup>Standard scores based on actual age of participant and have a norm group mean of 100 and standard deviation of 15.

<sup>c</sup>Standard scores based on age 18 and have a norm group mean of 10 and standard deviation of 3.

*CTOPP Elision and Blending Words Concurrent and Predictive Validity Coefficients from the CTOPP Examiner's Manual and for Struggling Adult Readers Ages 18-24 (n = 72)*

Tests	Elision				Blending Words			
	Concurrent		Predictive		Concurrent		Predictive	
	CTOPP norm	Struggling adults	CTOPP norm	Struggling adults	CTOPP norm	Struggling adults	CTOPP norm	Struggling adults
TOWRE Sight Word <sup>a</sup>	.53	.13	—	.27	.34	-.09	—	.07
TOWRE Phonemic <sup>a</sup>	.47	.09	—	.09	.27	-.05	—	.04
Word Attack <sup>b</sup>	.74	.29	.72	.47	.32	.03	.42	.11
Word Identification <sup>b</sup>	.53	.14	.68	.31	.16	-.01	.43	.00
GORT Accuracy <sup>b</sup>	.48	.01	.60	.11	.15	-.06	.37	-.16
GORT Rate <sup>b</sup>	.39	.04	.46	.11	.21	-.22	.27	.04
GORT Comprehension <sup>b</sup>	.40	.18	.64	.25	.02	.09	.48	-.07
Spelling <sup>b</sup>	.62	.21	.59	.20	.29	-.06	.33	.08

*Note.* Coefficients are partial correlations controlling for age. CTOPP norm group data from the CTOPP Examiner's Manual (Wagner, Torgesen, & Rashotte, 1999). TOWRE = Test of Word Reading Efficiency; GORT = Gray Oral Reading Tests. Word Attack and Word Identification are from the Woodcock Reading Mastery Test-Revised for the CTOPP group and from the Woodcock Johnson-III: Tests of Achievement for the struggling adult readers. Spelling is from the Wide Range Achievement Test-3 for the CTOPP group and from the Peabody Individual Achievement Test-Revised for the struggling adult readers.

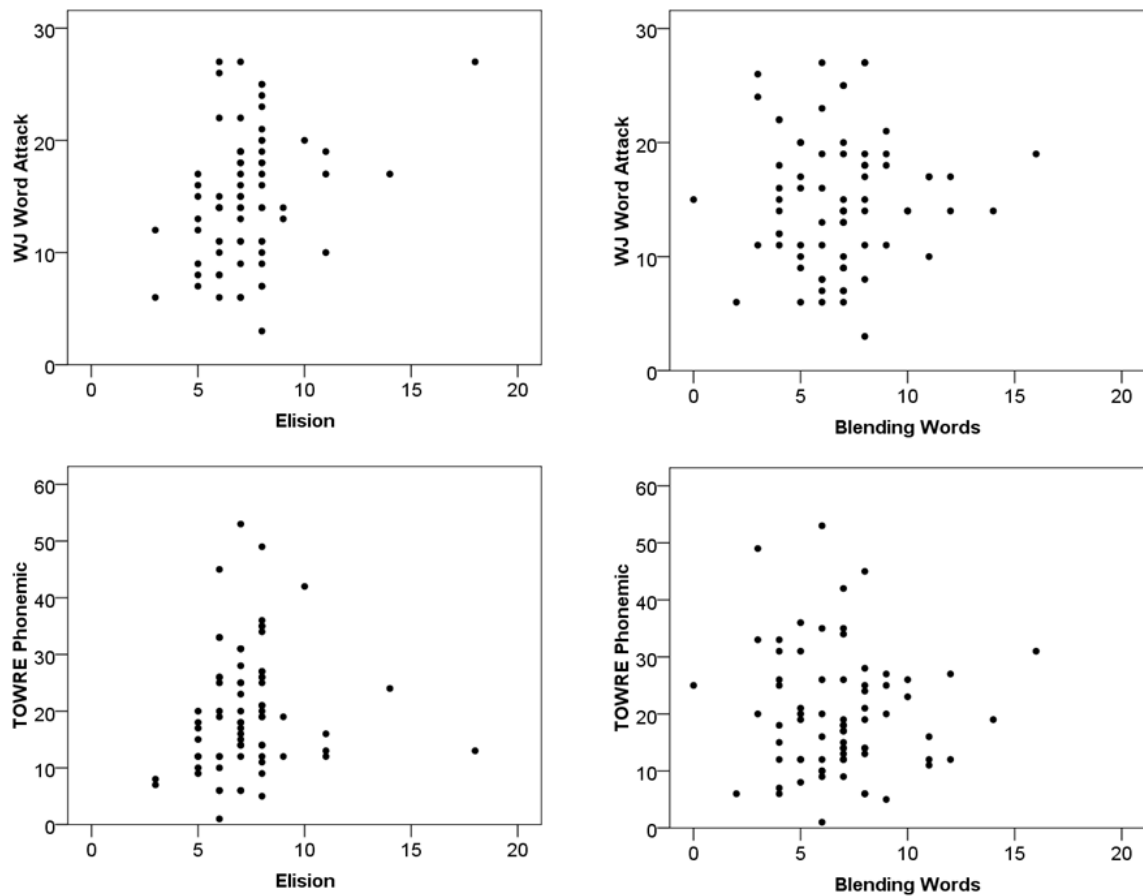
<sup>a</sup>Concurrent validity calculations completed on the 1352 people ages 7-24 in the CTOPP norm group. No predictive validity estimates were provided in the CTOPP Examiner's Manual. Predictive validity estimates computed for the struggling adult readers from test points spanning 3.87 months, on average.

<sup>b</sup>Concurrent and predictive validity calculations completed on 73 people with learning disabilities ranging from kindergarten through twelfth grade with test points spanning 6 months for the CTOPP group and on struggling adult readers from this study with test points spanning 3.87 months, on average.

## APPENDIX Q

## APPENDIX R

*Scatterplots show the relationship between raw scores on CTOPP Elision and Blending Words and two other phonological tasks, WJ-III Word Attack and TOWRE Phonemic Decoding Efficiency, for 18-24 year old struggling readers.*



# APPENDIX S

*CTOPP Elision and Blending Words Concurrent and Predictive Validity Coefficients for Struggling Adult Readers who are Native English Speakers Ages 18-24 (n = 72), 25-46 (n = 67), and 47-72 (n = 68)*

Test	Elision						Blending Words					
	Concurrent			Predictive			Concurrent			Predictive		
	18-24	25-46	47-72	18-24	25-46	47-72	18-24	25-46	47-72	18-24	25-46	47-72
TOWRE Sight	.13	.11	.06	.27	.26	.24	-.09	.00	-.05	.07	-.01	.01
TOWRE Phonemic	.09	.34	.23	.09	.26	.34	-.05	.15	.10	.04	.14	.27
WJ Word Attack	.29	.62	.18	.47	.58	.35	.03	.34	.23	.11	.44	.35
WJ Word Id.	.14	.41	.15	.31	.36	.10	-.01	.09	.17	.00	.25	.30
GORT Accuracy	.01	.24	-.09	.11	.36	.19	-.06	-.10	-.07	-.16	.26	.13
GORT Rate	.04	.01	-.07	.11	.00	.11	-.22	-.20	-.09	.04	-.30	.11
GORT Comp.	.18	.30	.15	.25	.09	.10	.09	.16	.20	-.07	.10	.28
PIAT Spelling	.21	-.06	-.05	.20	.07	-.04	-.06	-.14	.01	.08	-.12	-.24

*Note.* Coefficients are partial correlations controlling for age. TOWRE = Test of Word Reading Efficiency; WJ = Woodcock Johnson-III; Tests of Achievement; GORT = Gray Oral Reading Test – Fourth Edition; PIAT = Peabody Individual Achievement Test – Revised.

# APPENDIX T

*Item Discrimination and Difficulty Values for CTOPP Elision and Blending Words for Female (n = 158) and Male (n = 49) Struggling Adult Readers*

Item	Elision				Blending Words			
	Discrimination		Difficulty		Discrimination		Difficulty	
	Female	Male	Female	Male	Female	Male	Female	Male
1	.28	-.03	.99	.98	.44	.51	.87	.88
2	.15	.00	.97	1.00	.39	.48	.90	.94
3	.30	.05	.89	.96	.49	.48	.91	.94
4	.44	.21	.69	.78	.46	.57	.75	.84
5	.44	.33	.71	.76	.51	.60	.36	.45
6	.45	.40	.80	.84	.47	.60	.36	.41
7	.42	.51	.42	.39	.53	.51	.42	.51
8	.48	.51	.46	.43	.46	.34	.30	.29
9	.29	.55	.03	.06	.31	.45	.11	.16
10	.33	.55	.03	.06	.53	.27	.08	.12
11	.32	.62	.04	.06	.38	.36	.04	.06
12	.39	.63	.03	.04	.38	.00	.03	.00
13	.30	.65	.01	.02	.56	.45	.08	.10
14	.24	.65	.01	.02	.47	.30	.04	.04
15	.00	.63	.00	.04	.21	.00	.01	.00
16	.27	.65	.01	.02	.42	.00	.02	.00
17	.35	.00	.01	.00	.44	.29	.02	.02
18	.23	.65	.01	.02	.44	.00	.02	.00
19	.27	.65	.01	.02	.27	.00	.01	.00
20	.00	.00	.00	.00	.40	.00	.01	.00
Median <sup>a</sup>	.31	.55	.03	.06	.44	.47	.08	.35

<sup>a</sup>Median computed for items that have variance.



# APPENDIX U

*CTOPP Elision and Blending Words Concurrent and Predictive Validity Coefficients for Female (n = 158) and Male (n = 49) Struggling Adult Readers*

Tests	Elision				Blending Words			
	Concurrent		Predictive		Concurrent		Predictive	
	Female	Male	Female	Male	Female	Male	Female	Male
TOWRE Sight Word	.10	.21	.23	.42	.03	-.08	.01	-.01
TOWRE Phonemic	.20	.52	.12	.45	.20	.08	.27	.13
WJ Word Attack	.28	.46	.30	.61	.27	.01	.35	.18
WJ Word Identification	.30	.31	.29	.31	.15	.02	.21	.04
GORT Accuracy	.07	.08	.23	.24	-.05	-.28	.00	.02
GORT Rate	.01	.21	-.01	.35	-.12	-.13	-.12	-.01
GORT Comprehension	.21	-.07	.16	-.04	.02	.12	-.03	.24
PIAT Spelling	.12	.22	.14	.31	-.02	-.11	-.06	-.18

*Note.* Coefficients are partial correlations controlling for age. TOWRE = Test of Word Reading Efficiency; WJ = Woodcock Johnson-III: Tests of Achievement; GORT = Gray Oral Reading Test – Fourth Edition; PIAT = Peabody Individual Achievement Test – Revised.

# APPENDIX V

*Item Discrimination and Difficulty Values for CTOPP Elision and Blending Words for Struggling Adult Readers who Attended Regular Education (n = 139) and Special Education (n = 64)*

Item	Elision				Blending Words			
	Discrimination		Difficulty		Discrimination		Difficulty	
	Regular	Special	Regular	Special	Regular	Special	Regular	Special
1	.27	-.05	.99	.98	.47	.42	.85	.92
2	.18	-.05	.98	.98	.44	.36	.90	.92
3	.23	.32	.91	.88	.51	.48	.89	.95
4	.46	.17	.68	.75	.49	.47	.69	.92
5	.44	.31	.69	.77	.54	.49	.35	.42
6	.49	.27	.77	.89	.53	.42	.33	.45
7	.50	.33	.43	.39	.57	.42	.38	.56
8	.47	.52	.45	.42	.42	.41	.24	.38
9	.35	.50	.02	.05	.31	.32	.10	.14
10	.39	.51	.02	.06	.44	.43	.05	.17
11	.48	.25	.06	.02	.30	.37	.04	.05
12	.48	.45	.04	.02	.33	.41	.01	.03
13	.41	.51	.01	.03	.52	.48	.06	.13
14	.44	.00	.02	.00	.49	.10	.05	.02
15	.40	.00	.01	.00	.00	.36	.00	.02
16	.41	.45	.01	.02	.35	.00	.01	.00
17	.22	.45	.01	.02	.41	.00	.02	.00
18	.45	.00	.01	.00	.37	.00	.01	.00
19	.41	.45	.01	.02	.31	.00	.01	.00
20	.00	.00	.00	.00	.31	.00	.01	.00
Median <sup>a</sup>	.41	.39	.04	.23	.44	.42	.06	.38

<sup>a</sup>Median computed for items that have variance.

# APPENDIX W

*CTOPP Elision and Blending Words Concurrent and Predictive Validity Coefficients for Struggling Adult Readers who Attended Regular Education (n = 139) and Special Education (n = 64)*

Tests	Elision				Blending Words			
	Concurrent		Predictive		Concurrent		Predictive	
	Regular	Special	Regular	Special	Regular	Special	Regular	Special
TOWRE Sight Word	.11	.14	.30	.07	.02	-.02	.15	-.21
TOWRE Phonemic	.23	.17	.24	.02	.11	.02	.24	-.03
WJ Word Attack	.35	.38	.50	.31	.20	.12	.37	.30
WJ Word Identification	.23	.22	.27	.07	.11	.03	.17	.16
GORT Accuracy	.10	-.01	.26	.06	.00	-.11	.16	-.08
GORT Rate	.01	-.01	.16	-.22	-.05	-.26	.15	-.41
GORT Comprehension	.19	.25	.07	.18	.18	.14	.10	.27
PIAT Spelling	.04	.02	.06	.00	.03	-.14	-.11	-.05

*Note.* Coefficients are partial correlations controlling for age. TOWRE = Test of Word Reading Efficiency; WJ = Woodcock Johnson-III; Tests of Achievement; GORT = Gray Oral Reading Test – Fourth Edition; PIAT = Peabody Individual Achievement Test – Revised.

# APPENDIX X

*Item Discrimination and Difficulty Values for CTOPP Elision and Blending Words for Struggling Adult Readers ages 25-46 who are Native English (n = 67) and Native Spanish (n = 47) Speakers*

Item	Elision				Blending Words			
	Discrimination		Difficulty		Discrimination		Difficulty	
	English	Spanish	English	Spanish	English	Spanish	English	Spanish
1	-.05	.49	.99	.72	.42	.13	.85	.87
2	.00	.49	1.00	.83	.43	.37	.90	.94
3	.20	.45	.91	.68	.51	.35	.91	.89
4	.37	.53	.73	.72	.50	.21	.81	.70
5	.47	.50	.76	.77	.48	.52	.34	.43
6	.52	.56	.88	.70	.44	.55	.37	.57
7	.43	.57	.39	.70	.59	.49	.46	.57
8	.48	.49	.43	.66	.54	.58	.33	.45
9	.22	.51	.03	.21	.46	.43	.16	.34
10	.18	.41	.01	.21	.46	.69	.10	.32
11	.40	.64	.06	.21	.36	.66	.03	.28
12	.39	.61	.01	.17	.19	.59	.01	.21
13	.00	.70	.00	.23	.49	.55	.06	.26
14	.39	.54	.01	.15	.55	.52	.04	.15
15	.00	.66	.00	.17	.00	.23	.00	.02
16	.00	.64	.00	.17	.44	.59	.01	.13
17	.39	.69	.01	.15	.52	.00	.03	.00
18	.39	.53	.01	.09	.52	.00	.03	.00
19	.00	.55	.00	.09	.00	.35	.00	.02
20	.00	.36	.00	.02	.44	.35	.01	.02
Median <sup>a</sup>	.39	.53	.22	.21	.47	.51	.13	.33

<sup>a</sup>Median computed for items that have variance.

*CTOPP Elision and Blending Words Concurrent and Predictive Validity Coefficients for Struggling Adult Readers Ages 25-46 who are Native English (n = 67) and Native Spanish (n = 47) Speakers*

Tests	Elision				Blending Words			
	Concurrent		Predictive		Concurrent		Predictive	
	English	Spanish	English	Spanish	English	Spanish	English	Spanish
TOWRE Sight Word	.11	.14	.26	.30	.00	.25	-.01	-.12
TOWRE Phonemic	.34	.30	.26	.12	.15	.08	.14	.11
WJ Word Attack	.62	.27	.58	.33	.34	.01	.44	.03
WJ Word Identification	.41	.46	.36	.31	.09	.19	.25	.09
GORT Accuracy	.24	.28	.36	.37	-.10	.00	.26	-.14
GORT Rate	.01	.11	.00	.07	-.20	.15	-.30	-.24
GORT Comprehension	.30	.16	.09	.14	.16	.05	.10	.04
PIAT Spelling	-.06	.32	.07	.32	-.14	.09	-.12	-.15

*Note.* Coefficients are partial correlations controlling for age. TOWRE = Test of Word Reading Efficiency; WJ = Woodcock Johnson-III; Tests of Achievement; GORT = Gray Oral Reading Test – Fourth Edition; PIAT = Peabody Individual Achievement Test – Revised.

## APPENDIX Y