EXAMINING LANGUAGE AND LITERACY PROFILES OF ADOLESCENT STRUGGLING READERS

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ABSTRACT

Joy Elizabeth Diamond: Examining Language and Literacy Profiles of Adolescent Struggling Readers
(Under the direction of Karen Erickson)

As societal demands for literacy increase, many adolescents continue to exhibit weak reading skills, but little is known about the language and literacy profiles of adolescent struggling readers. The purpose of this study was to identify language- and literacy- related profiles of adolescents who struggle with reading. Participants between the ages of 11 and 15 (N=105) were assessed using measures of phonological awareness, morphological awareness, orthographic awareness, listening comprehension, word reading, and vocabulary. Examination of mean scores for participants in this study indicated overall average abilities across the assessment battery, but the individual profiles indicated clear strengths and weaknesses with some median scores within factors falling well below average.

Exploratory factor analysis indicated three clear factors that were labeled: word identification, language, and phonological awareness. After factor analysis, hierarchical agglomerative cluster analysis was completed based on the factor scores. The Partitioning Around Medoids (PAM) algorithm was used to partition the data set into groups. Results of the cluster analysis indicated that four clusters best represented the sample. Each of the four clusters exhibited different profiles of strengths and weaknesses regarding the median scores on each factor and observed scores of each of the language and literacy measures. The four-cluster solution converged with solutions created through k-means partitioning, as well as analyses

using silhouette width and model-based approaches. The four-cluster solution was theoretically sound and provided information that was clinically valid.

The results of the factor analysis and cluster analysis for this data indicated that the language and literacy skills of adolescent struggling readers are best characterized as four heterogeneous groups with varied profiles of strengths and weaknesses regarding word identification, phonological awareness, and language. The four-cluster solution portrayed interpretable profiles from an educational and theoretical perspective. Results of this study suggested the need to examine the reading skills of adolescent struggling readers in a more sophisticated, detailed manner in order to inform subsequent instructional decisions.

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CHAPTER 1: INTRODUCTION

Introduction

Learning to read is a critically important skill in modern society and is foundational for academic and career success. With fewer blue-collar jobs and more service-related and information-based jobs, employment increasingly requires the use of computers and the Internet, which place large demands on individuals' literacy skills (Snow, 2002). Additionally, most new jobs require post-secondary education and many jobs that were previously held by individuals without college degrees have been automated or outsourced (Wise, 2009). Success in modern society also requires critical literacy skills, including the ability to understand complex information from different sources. Unfortunately, as societal demands for literacy are increasing, many students are failing to become proficient readers (National Center for Educational Statistics [NCES], 2013). In fact, adolescents in the United States exhibit extremely weak literacy skills in international comparisons with other developed nations (NCES, 2014). Difficulty in becoming a proficient reader is especially alarming for adolescents because they have minimal time left in school before they enter the work force. Though the statistics regarding the number of adolescents who struggle to read are abundant (e.g., see reports from Alliance for Excellent Education, 2014; National Center for Educational Statistics, 2014), little is known about the characteristics of these struggling readers. Yet, understanding the characteristics of adolescent struggling readers is critical in order to develop and provide effective interventions.

Adolescent Struggling Readers

The term adolescent refers broadly to students in fourth through twelfth grades (Kamil, 2003). Like elementary students, adolescents may struggle in reading due to word level decoding difficulties or reading comprehension difficulties or a combination of both (Snow & Biancarosa, 2003). Though some struggling students may be diagnosed with dyslexia, a specific weakness in word reading that is strongly associated with poor phonological abilities (Stanovich, 1996), many adolescents are undiagnosed with a specific disability, but exhibit reading difficulties. This may be due to the fact that literacy development beyond fourth grade is considered more challenging than in earlier elementary years, as text becomes more complex and adolescents are expected to comprehend text across multiple disciplines. These changes mean that readers who had success in the early grades may struggle with reading in adolescence due to the increased complexity of the words, text structures, and comprehension tasks they encounter. For this study, adolescent struggling readers were defined as students who exhibited weaknesses in any area of reading, including (but not limited to) reading comprehension, word reading, fluency, vocabulary, or phonological awareness.

In recent years, the quantity of research focused on adolescent reading has increased considerably, but there continues to remain a shortage of research specifically focused on characteristics of adolescent struggling readers. Research regarding the characteristics of younger struggling readers has led to improved interventions that help to place elementary students in the U.S. near the top in international comparisons (National Assessment of Educational Progress [NAEP], 2013), but as a result of the lack of similar information regarding adolescent struggling readers, the reading skills of adolescent students have remained stagnant and near the bottom in international comparisons. Though the 2013 NAEP reading scores of

adolescents improved from 2011, 64% of students in eighth grade continue to perform at or below basic levels in reading, which means these students have only partial mastery of the expected skills. Biancarosa and Snow (2004) note that one of the most commonly cited reasons that students drop out of high school at a rate of thousands each day is that students simply do not have the literacy skills to keep up with the high school curriculum, which has become increasingly complex. Though the United States has experienced an improvement in the percentage of adolescents at or below basic levels in reading over the past few years (NAEP, 2013), the continued high percentage of students who exhibit no more than partial mastery of expected reading skills combined with increasing literacy demands of modern society, indicates a significant need to improve our understanding of adolescent struggling readers so that appropriate curriculums or interventions can be developed.

Components of Successful Reading

The language and literacy skills that correlate with success in reading are similar for early elementary and adolescent readers, but the influence of the variables appears to change as text becomes more complex (Carlisle, 2000; Kirby, Parrila, & Pfeiffer, 2003). Both word identification and language comprehension skills are required for successful reading with comprehension (Gough & Tunmer, 1986). Word identification is required to decode text into language and language comprehension is required to assign meaning to the text. Metalinguistic skills underpin word identification. It is well established that the metalinguistic skill of phonological awareness is important for young readers when learning to decode (Bus & van IJzendoorn, 1999), but it may be less important in adolescence (Deacon & Kirby, 2004). Moreover, recent evidence indicates that the metalinguistic skills of morphological awareness and orthographic awareness are important skills for young readers as well as adolescent readers

in learning to decode and comprehend text (Nagy, Berninger, & Abbott, 2006; Richards et al., 2006)

Word identification. The influence of word identification skills to reading outcomes appears to change with age. Specifically, the ability to decode pseudo-words has less of an impact on reading comprehension in adolescence than with younger students (Savage, 2006). The terms *word identification, word recognition,* and *decoding,* are often used interchangeably and refer to reading of both pseudo- and real-words. Pseudo-word reading refers to reading nonsense words that conform to the orthographic and phonological structure of English (e.g., *trisp, gospen, sloam*). Word identification skills are related to reading comprehension for both child (Leach, Scarborough, & Rescorla, 2003) and adolescent readers (Dennis, 2013; Hock et al., 2009); however, proficient word identification skills in the early elementary grades are quite different than proficient word reading skills in adolescence. For students in the early elementary grades, proficient word reading ability is marked by the ability to decode novel, single-syllable words and decode other more common one- and two-syllable words, but proficient real-word reading in adolescence is marked by the ability to read complex, multi-syllabic novel words. Therefore early good real-word readers may struggle with reading comprehension in adolescence due to the increased difficulty of decoding multi-syllabic words.

One critical difference between the word identification skills of early elementary and adolescent readers appears to be the influence of pseudo-word reading skills. At the elementary level, there is a predictive relationship between the ability to read pseudo-words (a measure of phonological decoding) and word identification (Vanderwood, Linklater, & Healy, 2008) and reading comprehension skills (Lesaux & Kieffer, 2010; Savage, 2006). Importantly, the association between pseudo-word reading and real-word reading in adolescence appears to be

less direct (Savage, 2006) and a significant proportion of adolescent struggling readers continue to exhibit word identification difficulties (Buly & Valencia, 2002; Dennis, 2013; Hock et al., 2009).

Metalinguistic skills. Phonological awareness, morphological awareness and orthographic awareness are metalinguistic skills that have been shown to directly influence word reading in both early elementary and adolescent readers (Berninger, Abbott, Nagy, & Carlisle, 2010). Phonological awareness refers to the ability to manipulate the sound structure of language, including the understanding that sentences are made of words, words are made of syllables, and syllables are made of sounds. The specific knowledge of sounds in words is called phoneme awareness and is a part of overall phonological awareness (Wagner, Torgesen, & Rashotte, 1994). Researchers have found that poor phoneme awareness is associated with poor real-word reading and poor pseudo-word reading at all ages, but is less predictive of word reading in adolescence than during the early elementary years (Apel, Wilson-Fowler, Brimo, & Perrin, 2011; Badian, 2001; Wagner et al., 1994).

Morphological awareness refers to the understanding that words can be made of smaller components that hold meaning, called *morphemes*, and that different words can share morphemes (e.g., *pre*view, *pre*dict, *pre*heat). Morphological awareness includes knowledge of base words, inflections, and derivations (Carlisle, 1996; Wolter, Wood, & D'Zatko, 2009). For adolescent readers, morphological awareness is highly correlated with overall word reading ability (Carlisle & Stone, 2005) and predictive of ability to decode morphologically complex words (Goodwin & Gilbert, 2013). In fact, it has been reported that by fifth grade students' reading is better predicted by their morphological skills than by their phonological skills (Mann & Singson, 2003). Additionally, morphological awareness is strongly correlated with vocabulary

and reading comprehension (Carlisle, 2000), and the importance of morphological awareness to reading development increases with age (Kuo & Anderson, 2006),

Orthographic awareness is the implicit understanding of permissible letter patterns and the stored mental graphemic representations of specific written words (Apel, 2011). Orthographic awareness accounts for significant variance in word reading for students in first through third grade (Cunningham, Perry, & Stanovich, 2001), and orthographic awareness measures in preschool have been found to be more predictive of later reading than phonological awareness measures in preschool (Badian, 1994). Importantly, older struggling readers often exhibit weak orthographic awareness (Badian, 2001; Hultquist, 1997).

Phonological awareness, morphological awareness, and orthographic awareness skills and their relationship to reading have been studied extensively for early elementary students, but only recently with adolescents. It appears that these correlations change from early childhood to adolescence. Phonological awareness is strongly related to decoding in early elementary (Hogan, Catts, & Little, 2005), especially to decoding of pseudo-words, but the importance of phonological awareness to decoding seems to decrease as words become morphologically complex and orthographic and morphological awareness skills improve. It has been reported that metalinguistic and linguistic skills contribute simultaneously to success in beginning readers (Apel et al., 2011), but similar studies have not been conducted with adolescent readers.

Language comprehension. In addition to metalinguistic skills and word reading, language comprehension abilities are related to reading success in elementary-aged children and adolescents. Oral language comprehension, linguistic comprehension, and listening comprehension are used in the literature to describe the ability to derive meaning from spoken words (Catts, Adlof, & Weismer, 2006). Each of these forms of oral language comprehension

allows listeners to understand written language, and each is required to derive meaning from print in reading comprehension. Longitudinal studies have indicated that preschool students with language comprehension difficulties are more likely to have reading comprehension difficulties in later years (Snowling, Bishop, & Stothard, 2000). Moreover, retrospective studies have suggested that adolescents who struggle with reading, exhibited early (often unidentified) difficulties with listening comprehension (Leach et al., 2003).

Receptive vocabulary is a critical component of language comprehension. Most children enter school with vocabulary and grammar knowledge that exceeds what is needed to understand early reading materials (Catts et al., 2006); however, as text and word reading demands become more complex, receptive vocabulary skills begin to have a greater impact on reading comprehension and word reading (Bhattacharya & Ehri, 2004). Thus, adolescents with weak reading skills may exhibit language comprehension difficulties, including weak vocabulary, and these difficulties are often evident in measures of listening comprehension.

Reading Profiles of Adolescents

Two known studies examined foundational skill profiles of adolescents with weak reading comprehension (i.e., Buly & Valencia, 2002; Dennis, 2013). Both studies identified that struggling adolescent readers performed poorly on measures related to meaning, rate, and decoding. In fact, performance on these measures accounted for nearly 78% of the total variance in performance on a standardized reading comprehension measure (Buly & Valencia, 2002). These studies indicated that adolescent struggling readers are not a homogeneous group, but exhibit varying profiles of strengths and weaknesses regarding their word identification, fluency, and comprehension. Though no known study has examined adolescent struggling reader profiles and response to different interventions, a study that looked at the reading profiles of early

elementary students indicated that students with different reading profiles responded differently to interventions (Berninger et al., 2002), thus suggesting the importance of identifying the profiles of strengths and weaknesses for adolescent struggling readers so that interventions that will effectively target areas of need can be implemented.

Statement of Problem

It is clear that word identification, metalinguistic, and language comprehension skills are essential for proficient reading with comprehension in the early elementary grades and in adolescence, but we do not understand how these factors, and particularly the underlying metalinguistic skills, cluster and interact in adolescents who exhibit poor reading comprehension. The recent research on metalinguistic skills indicates the importance of including these measures in studies of adolescent readers. This study was designed to determine if adolescent struggling readers exhibit distinguishing patterns of strengths and weaknesses in their word reading, meta-linguistic, and language comprehension skills.

Understanding the factors responsible for reading difficulties and defining how these factors relate to each other is required in order to properly identify, diagnose and treat adolescent struggling readers. The need to provide adolescents with differentiated literacy instruction specific to their individual needs is supported by a position statement on adolescent literacy from the International Reading Association (2012). The current investigation adds to our collective understanding of adolescent struggling readers so that the demand for differentiated instruction can be met, and is the first known study to examine the relationship of metalinguistic skills, word reading, and language comprehension for adolescent readers with poor reading skills.

The major research question guiding this study was: What are the language and literacy profiles of adolescents with weak reading skills? To further understand the language and literacy

profiles of adolescents with weak reading skills, three sub questions were addressed: (a) What are the underlying latent variables that are reflected in the observed variables? (b) What reading strengths and weaknesses are present for each identified profile? and (c) On which variables do the groups differ? Exploratory factor analysis procedures were used to identify the underlying latent variables. Hierarchical agglomerative cluster analysis procedures were used in order to identify homogeneous groups that distinctly differed from other groups. Post-hoc analyses were used to determine which variables defined each cluster. These findings were then interpreted to explain how different profiles could be used to inform interventions.

CHAPTER 2: LITERATURE REVIEW

The connections between word reading, metalinguistic skills, language comprehension, and reading success have been widely studied in early elementary school-aged populations (e.g., Garcia & Cain, 2014; Kendeou, van den Broek, White, & Lynch, 2009) and more recently with adolescents (Barth, Catts, & Anthony, 2009; Goodwin & Gilbert, 2013). Furthermore, theoretical models have postulated the connection between these skills and reading success (Perfetti, 2007; Richards et al., 2006). Understanding the existing literature about each of these areas is important to understanding why they have been selected in the current investigation. This chapter will: (a) describe the theoretical underpinning of the study; (b) examine the literature on word identification; (c) summarize research on metalinguistic skills and their connection to reading; (d) explain the connection between oral language comprehension and reading success; and (e) summarize what we know about adolescent reading profiles.

Theoretical Underpinning

This research is based on the simple view of reading (Gough & Tunmer, 1986) as well as recent theories that consider metalinguistic skills as foundational to reading (see e.g., Berninger et al., 2006; C. Perfetti, 2007). The simple view asserts that both decoding and language comprehension skills are required for successful reading with comprehension (Gough & Tunmer, 1986). In original works regarding the simple view, the term decoding was narrowly defined as only pseudo-word reading, but later it was expanded to include real word reading in addition to pseudo-word reading (Hoover & Gough, 1990). According to this simple view of reading, decoding is an essential component of successful reading, but is not sufficient on its

own because print must be translated into language in order to comprehend text. Gough and Tunmer explained reading as the product of decoding and linguistic comprehension; and therefore, if a child is unable to decode, there is no reading even if linguistic comprehension is strong. The reverse is also true. Strong word reading skills in the absence of linguistic comprehension precludes successful reading with comprehension: both word reading and linguistic comprehension skills are required for long term reading success.

The lexical quality hypothesis (LQH) (Perfetti, 2007) and triple word form theory (TWF) (Berninger et al., 2006) focus on the component skills necessary for successful decoding, and each has proposed that metalinguistic skills are essential for solid decoding skills to develop. The LQH proposes that successful word identification relies on the efficiency of one's strengths and skills in orthography, phonology, morpho-syntax, and meaning as well as the ability to bind these constituents successfully. According to the LQH, weaknesses in any of these sub lexical elements negatively affect both word reading and reading comprehension.

Consistent with the LQH, the TWF proposes that when children learn to read, they must attend to multiple linguistic areas (i.e., the orthographic, phonological, and morphological word forms and their parts), and they must coordinate this knowledge to successfully and efficiently read words (Berninger et al., 2006). TWF theory posits that phonological, orthographic, and morphological word forms and their parts contribute to learning to read and spell words. Support for this theory was exhibited through structural equation modeling that showed phonological, orthographic, and morphological skills exhibited unique paths to the accuracy of word reading and reading comprehension (Berninger et al., 2006). While simpler word forms tended to emphasize the connection between orthography and pronunciation, there appeared to be a stronger underlying link between orthography and meaning in complex, multisyllabic words.

Additional evidence for the simultaneous contribution of metalinguistic skills to real and pseudo-word reading was demonstrated for fourth-, sixth-, and eighth-grade students (Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009). Multiple regression analyses indicated that all three metalinguistic skills contributed uniquely to real word reading (73%) and pseudo-word reading (40%) and did not change over time. Furthermore, brain-imaging studies have found distinct brain "signatures" for the phonological, morphological, and orthographic word forms and crossover effects of these metalinguistic skills that supports the interrelationships among these metalinguistic word forms. Specifically, brain scans indicated changes in both phoneme and morphological mapping for students who received either phonological or morphological treatments (Richards et al., 2006).

TWF theory also posits that adolescent readers' needs are different than those of early elementary readers. Nagy et al. (2003) claimed that adolescent readers focused less on the grapheme-phoneme correspondences and more on the grapheme-morpheme correspondences in order to efficiently decode complex multisyllabic words. Furthermore, the three word forms contributed uniquely to several word-level or text-level reading outcomes (Berninger et al., 2006). Likewise, in an article that reviewed the historical trends in adolescent literacy, Jacobs (2008) argued that the needs of adolescent readers were different than those of primary students.

Consistent with TWF theory and the LQH, the current study considers metalinguistic skills as important variables in overall reading success. However, because the current investigation is grounded in the simple view of reading, it was understood that lexical processes alone are not sufficient for comprehension (Cain & Oakhill, 2006), and language comprehension and word reading skills were included in the analyses. The results reported herein help to clarify

the language and literacy profiles of adolescent struggling readers relative to the simple view. In the following sections, the literature regarding each of the component skills will be reviewed.

Word Identification

According to the simple view of reading (Gough & Tunmer, 1986), decoding is one of two variables that directly affect reading comprehension. A large body of research supports this strong relationship, but the decoding skills required for successful reading comprehension change as students progress from early elementary age to adolescence. The words encountered in text for beginning readers are often single syllable words with a close spelling-to-sound relationship. Thus, successful decoding of early text requires attention to individual letters and their corresponding sounds and then more broadly to spelling patterns. On the other hand, adolescents must learn to read and understand large numbers of new, multisyllabic words across domains (Archer, Gleason, & Vachon, 2003). The multisyllabic words adolescents encounter are more complex in comparison to early elementary because many of the word forms are new, occur at a much lower frequency, are more domain-specific (Beck, McKeown, & Kucan, 2008), and have less obvious spelling-to-sound relationships. Consequently as text becomes more complex, students must also attend to the morphological structure of words and complex syllable patterns (Green, 2008) in order to decode multisyllabic words across domains.

As the decoding demands change from childhood to adolescence, the relationship between decoding skills and reading comprehension also appears to change, especially regarding measures of pseudo-word reading. Results of pseudo-word reading tasks indicate a less direct relationship to real word reading and reading comprehension for adolescents than for early elementary aged students. Pseudo-word reading refers to reading nonsense words that conform to the orthographic and phonological structure of English (e.g., *trisp, gospen, sloam*.) In order to

correctly read pseudo-words, one must apply spelling-to-sound rules or use analogies to decode the words (Hogan et al., 2005). As such, a pseudo-word reading task is thought to provide information on a participants' ability to read novel words while controlling for possible exposure to the word in the past. Though adolescent struggling readers exhibit more difficulty decoding pseudo-words than their non-struggling peers (Elbro & Jensen, 2005), this difficulty is not necessarily reflected in the reading comprehension skills of adolescents. In fact, it has been shown that strong pseudo-word reading does not necessarily predict strong reading performance and weak pseudo-word reading does not necessarily predict weak reading performance in adolescents (Lesaux & Kieffer, 2010; Savage, 2006).

Savage (2006) noted that many adolescents with weak pseudo-word reading exhibit solid reading comprehension. He surmised that adolescents with weak pseudo-word reading skills were compensating for these difficulties in a way that early elementary students were not (Savage, 2006). Lesaux and Kiefer (2010) suggest that a minority of students who struggle with reading comprehension also struggle with pseudo- word reading. In fact, they revealed that nearly 80% of their sample of sixth graders who struggled with reading comprehension exhibited strengths in pseudo-word reading skills. Paris (2005) argued that this inconsistency in pseudo-word reading and reading comprehension for adolescents was due to the non-normal distribution of pseudo-word reading skills for older students. He claimed that pseudo-word reading was a skill mastered in childhood and thus its use to predict reading was problematic, especially as students aged. Despite these complications, pseudo-word reading measures continue to provide insight into a students' ability to purely decode words either relying on letter-to-sound relationships or analogy strategies, and studies continue to demonstrate that pseudo-word reading

measures are as effective at predicting reading comprehension as real-word reading measures (Savage, 2006).

Real-word reading tasks offer another way to view word identification. Typically, assessments of real-word reading require reading lists of frequently occurring words of increasing difficulty and/or reading exception words (i.e., real words that do not conform to phonics rules words, such as *yacht*). The ability to read real words becomes more predictive of overall reading ability with age, especially for students making expected progress in reading (Scarborough, 1998). One study of adolescent struggling readers (Compton, 2002) demonstrated that the students who were better at reading exception words did better on overall word reading, than the group who did better on pseudo-word reading.

Though the relationship between decoding and reading comprehension appears to change in adolescence, solid decoding skills continue to be necessary for reading success. Unfortunately, a significant proportion of adolescents' reading problems can be explained by poor word decoding. For example, in a study of adolescent struggling readers, Dennis (2013) found that nearly one third of the total variance in weak standardized reading scores was accounted for by weak decoding. Similarly, Buly and Valencia (2002) demonstrated that 40% of fourth graders who struggled with reading comprehension also struggled with decoding; and Hock et al. (2009) found that 87% of adolescents with weak reading comprehension struggled with decoding.

Given the increasingly complex decoding demands placed on adolescent readers and the fact that decoding difficulties are consistently revealed in studies of adolescent struggling readers, measures of decoding are instrumental in understanding the reading profiles of struggling readers. Importantly, decoding ability is directly related to several underlying

metalinguistic factors including phonological sensitivity, morphological awareness, and orthographic awareness. Each has a unique relationship with reading ability across the school-aged years. As such, each may be found to have a differential role in the profiles of struggling adolescent readers. Recently, research has focused on these underlying metalinguistic factors and their affect on decoding.

Metalinguistic Components of Reading

Mounting evidence indicates that phonological awareness, morphological awareness, and orthographic awareness are underlying metalinguistic skills that affect word identification and reading comprehension. These metalinguistic skills exhibit a predictable course of development that begins in early elementary and continues through adolescence. However, struggling readers exhibit weaker metalinguistic skills than non-struggling readers.

Phonological awareness. Phonological processing is an umbrella term that includes phonological awareness, phonological memory and phonological retrieval tasks (i.e., rapid naming) (Wagner et al., 1994). As one component of phonological processing, phonological awareness refers to the auditory analysis and synthesis of words and syllables, as well as sounds (phoneme awareness) (Stahl & Murray, 1994). Confirmatory factor analysis indicates that rhyme, word, syllable, and phoneme awareness are all part of the same one-factor model that measures a single underlying phonological ability called phonological sensitivity (Anthony, Lonigan, Driscoll, Phillips, & Burgess, 2003; Pufpaff, 2009). The one construct finding indicates that overall phonological sensitivity rather than a specific level of phonological awareness is important for acquiring subsequent literacy skills. However, phoneme awareness is more closely related to decoding skills than word and syllable-level phonological awareness (Ehri, Nunes,

Stahl, & Willows, 2001), and is a better predictor of adolescent reading (Adlof, Catts, & Lee, 2010) than word and syllable level phonological awareness skills (Badian, 2001).

The development of phonological awareness follows a predictable pattern that should be well established before adolescence (Pufpaff, 2009). Longitudinal studies and growth curve analyses indicate that most growth in phonological awareness skills occurs before grade three, and syllable and rime awareness are stable by grade three (Berninger et al., 2010). However, the age of stable attainment of phoneme awareness, the most difficult phonological awareness task, is less clear. It appears that the skill of counting phonemes typically develops by the end of first grade (Pufpaff, 2009), but phoneme deletion abilities continue to be varied in third grade (Berninger et al., 2010). Though some phoneme awareness skills are not fully mastered by third grade, the developmental progression suggests that with typical development the attainment of phonological awareness skills should be well established before adolescence (Anthony & Francis, 2005).

Phonological awareness is a necessary skill for early reading success and is predictive of adolescent reading achievement (Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004). In fact, phoneme deletion skills measured in kindergarten were one of the most important predictors of eighth grade reading outcomes (Adlof et al., 2010). Additionally, phoneme awareness contributed uniquely to real word reading and pseudo-word reading of fourth, sixth, and eighth grade students (Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003; Roman et al., 2009). Similarly, Schiff et al. (2011) observed that for adolescent struggling readers, phoneme awareness skills measured in seventh grade predicted their reading comprehension skills.

It is hypothesized that this strong connection between phoneme awareness and reading success is due to the fact that knowledge of phonemes underpins the learning of phonics (Torgesen, 2002) as well as orthographic word representations (Ehri, 1998) that are essential for learning to decode fluently. Though phoneme awareness is necessary for early reading success and should be well established before adolescence, many adolescent struggling readers exhibit persistent weaknesses in this area (Fawcett & Nicolson, 1995).

Phonological sensitivity in adolescents. There is evidence that weaknesses in phonological awareness persist into adolescence, even as word recognition improves. In fact the attained level of phonological awareness for adolescent struggling readers rarely matches non-struggling readers' abilities (Bruck, 1992; Fawcett & Nicolson, 1995). Bruck (1992) examined the phonological awareness skills of adolescent struggling readers as compared to age- and reading-level matched peers. Results indicated that the adolescent struggling readers made more errors on all phonological awareness tasks (i.e., syllable and phoneme level) than their age matched and reading-level matched peers. The results of this study suggested that many adolescent struggling readers show little development of phoneme awareness as a function of age or reading level and some never attain age-appropriate levels of phonological awareness. Fawcett and Nicholson (1995) replicated the previous findings in a similar study of struggling readers ages 8, 13, and 17. Whether compared by age or reading level, the struggling readers performed worse on the phonological awareness tasks than the non-struggling readers.

Longitudinal and brain-imaging studies provide additional support for the persistence of phonological awareness differences in adolescent struggling readers. For example, Shaywitz et al. (1999) demonstrated that performance on phonological processing measures distinguished struggling readers from non-struggling readers in grades 9 through 12. Furthermore, the results

of fMRIs comparing adolescent struggling readers to non-impaired readers on phonological processing showed that the adolescent struggling readers exhibited reduced activation relative to non-impaired controls in left-hemisphere reading-related regions (Landi, Mencl, Frost, Sandak, & Pugh, 2010).

In summary, phonological awareness skills are critical for early reading success and non-struggling readers typically develop these skills before adolescence. Like pseudo-word decoding, phonological awareness skills are considered constrained skills that are mastered in childhood with short growth curves (Berninger et al., 2010). However, many adolescent struggling readers continue to exhibit weak phoneme awareness skills, despite improvements in decoding and overall reading ability. Adolescents appear to develop compensation strategies to counteract weaknesses in these areas. Thus, some argue against their use for prediction of later reading (e.g., Paris, 2005). Nonetheless, the strong relationship between phoneme awareness and decoding in early reading and the persistent difficulties of these skills in some adolescent struggling readers, suggest that measures of phoneme awareness may help define clinically relevant subgroups of adolescent struggling readers.

Morphological awareness. Like phonological awareness, morphological awareness is a set of metalinguistic skills that develops in a predictable manner and is linked to reading success beginning in early reading development. Morphological awareness differs from phonological awareness in that it refers to the understanding that words can be composed of smaller units of meaning, called morphemes, rather than sounds. Included in morphological awareness is knowledge of the concepts of base words and affixes and the ability to manipulate morphemes and employ word formation rules (Kuo & Anderson, 2006). Morphological awareness is especially important to readers in decoding morphologically complex words and

comprehending text. Morphological awareness and phonological awareness skills are highly correlated (Nagy et al., 2006), but morphological awareness skills have been shown to uniquely contribute to word reading and reading comprehension above and beyond phonological awareness. As with phonological awareness, adolescent struggling readers exhibit weaker morphological awareness than non-struggling readers and have difficulty reading morphologically complex words (Mann & Singson, 2003).

Morphological awareness develops in a predictable sequence that starts before formal schooling (Kuo & Anderson, 2006) and continues through high school (Nagy et al., 2006) with the understanding and use of inflectional morphemes preceding the understanding and use of derivational morphemes. Inflectional morphemes refer to morphemes that mark the grammatical function of a word stem without altering the meaning or part of speech of the stem (e.g., *jump**ed***, *jump**ing***, *jump**s***). Derivational morphemes change the part of speech or meaning of a base morpheme (e.g., *adap**tion***, *adapt**able***) (Kuo & Anderson, 2006). Though acquisition of major inflectional rules is generally not completed until early elementary, preschool children demonstrate some knowledge of inflectional morphemes and first graders are capable of generating morphologically related words and applying morphological knowledge in their spelling in the absence of explicit instruction in morphological awareness (Wolter et al., 2009). In contrast, derivational morphological awareness typically begins to develop in third or fourth grade and involves a longer developmental course. This later development is often attributed to the lower frequency of derivational suffixes in oral language when compared to inflectional suffixes (Berninger et al., 2010; Kuo & Anderson, 2006).

Morphological awareness supports word reading as early as elementary school. As reported by Carlisle and Stone (2005), second and third grade students read multi-syllabic words

containing two morphemes (e.g., *shady*) more easily than reading words of similar length and structure with only one morpheme (e.g., *lady*). Moreover, across grade levels derived words with phonologically stable pronunciations are read with higher speed and accuracy than derived words that exhibit a change in base word pronunciation with the addition of an affix (Carlisle & Stone, 2005).

Morphological awareness skills predict unique variance in word reading and reading comprehension for beginning readers through adolescence (Apel, et al., 2011; Foorman, Petscher, & Bishop, 2012; Goodwin & Gilbert, 2013); however, it appears that this relationship strengthens with age. Mann and Singson (2003) demonstrated that by fifth grade, the best predictor of decoding morphologically complex words was morphological awareness, not phonological awareness. Furthermore, Singson, Mahony, and Mann (2000) concluded that as grade level increases, the contribution of phonological awareness skills to word reading decreases but the contribution of morphological awareness to word reading increases. Moreover, morphological awareness uniquely contributes to reading comprehension for fourth through ninth grade students above the contribution of vocabulary (Nagy et al., 2006) and prior reading comprehension skills in grades three through ten (Foorman et al., 2012).

Morphological awareness and struggling adolescent readers. Though there is growing evidence of the significance of morphological awareness in decoding and reading comprehension for typical readers, there are few studies that have examined this relationship for adolescent struggling readers. However, Casalis, Cole, and Sopo, (2004) found that morphological awareness is weaker in struggling adolescent readers compared to their non-struggling peers. In this study, struggling readers performed below the chronological age control group as well reading age matched control group on all morphological awareness tasks. It also

appears that struggling adolescent readers have less difficulty reading words with a semantically transparent morphological structure (e.g., *sunburn*) than words that are semantically opaque (e.g., *window*) (Elbro & Arnbak, 1996).

Interestingly, Elbro and Arnbak (1996) conducted a follow-up study to the latter study and found that, although struggling readers exhibited weak morphological awareness, many used morphemes rather than the syllable structure to support their word reading. In this study, the researchers devised a computer-driven system that displayed text either one word at a time, one morpheme at a time, or one syllable at a time. The study participants were able to advance or reverse the computer screen to show the next (or previous) unit in order to decode the passage. The participants were asked to read 90 short texts that were approximately one sentence in length. Each participant decoded texts in all three-presentation modes (word, syllable, morpheme), and their reading efficiency (i.e., words read correctly per minute) was calculated. The results showed that struggling adolescent readers read the words presented in a morpheme-by-morpheme context faster than those presented in a syllable-by-syllable context. The authors proposed that perhaps struggling adolescent readers rely more on morphemes to compensate for persistent weaknesses in phonological awareness, which is typically employed to decode words that are truncated at the syllable level. Thus the results of these three studies indicate that struggling adolescent readers exhibit overall weak morphological awareness skills, but appear to use morphemes rather than syllable structure to support their word reading.

Adolescent struggling readers exhibit morphological awareness weaknesses and these skills are predictive of reading comprehension for adolescent struggling readers (Schiff, Schwartz-Nahshon, & Nagar, 2011). Schiff et al. (2011) measured the phonological awareness, morphological awareness, word reading, and reading comprehension skills of seventh grade

students with and without reading disabilities and found that, though different patterns of relationships emerged, morphological awareness skills uniquely predicted reading comprehension for both groups. The results of a step-wise hierarchical regression analysis in this study indicated that morphological awareness skills uniquely contributed to reading comprehension after phonological awareness and word reading skills were considered. In contrast, the same step-wise regression indicated that morphological awareness did not uniquely contribute to reading comprehension for seventh grade students with reading disabilities. However, when morphological awareness was entered before phonological awareness in the regression equation, morphological awareness contributed significantly to the prediction of reading comprehension for these students with reading disabilities. Thus is appears that the interrelationship between phonological awareness and morphological awareness for students with reading difficulties affects the unique contribution of these skills to reading comprehension for students with reading disabilities, but both morphological awareness and phonological awareness uniquely contribute to reading comprehension.

In summary, morphological awareness skills continue to develop into adolescence, but struggling readers exhibit weaker morphological awareness skills than non-struggling readers. Moreover, morphological awareness is predictive of reading comprehension through adolescence for both non-struggling readers and students with reading disabilities. Due to the relationship between morphological awareness, word identification, and reading comprehension for elementary students and the persistent weaknesses of morphological awareness evidenced in adolescent struggling readers, efforts to determine profiles of strengths and weaknesses among adolescent struggling readers should include measures of morphological awareness.

Orthographic awareness. Orthographic awareness is an umbrella term that refers to an individuals' implicit or explicit attention to the lexical representation of letter patterns in specific words and sub lexical understanding of permissible letter patterns in a given written language. Examples of orthographic knowledge include understanding of the patterns that operate within a language's orthography (e.g., *jr* is not a legal letter combination in English), knowledge of positional and contextual constraints on the use of letters (e.g., *tch* does not appear at the beginning of words in English), and the stored mental representations of specific written words (i.e., recognition of the correct spelling for real words) (Apel, et. al, 2011). Assessment of orthographic awareness skills is conducted using real-word and pseudo-word tasks that typically involve a forced choice activity in which a participant chooses which real or pseudo-word is a legal representation of letter patterns in English. For example, to evaluate the orthographic awareness or stored mental representation of words, a real word task may require the participant to identify the correct spelling for *train* (*train* vs. *trane*). Similarly, a pseudo-word task, assessing sub lexical knowledge regarding permissible letter patterns, may ask the participant to identify the option that most resembles a real word (e.g., *tilk* vs. *tilv*).

Like the metalinguistic skills of phonological awareness and morphological awareness, orthographic awareness has been connected to reading success (Cunningham et al., 2001; Georgiou, Parrila, & Papadopoulos, 2008). However, the direction of the relationship is unclear (Deacon, Commissaire, Chen, & Pasquarella, 2012), and the tasks used to measure orthographic awareness have not been consistent in the literature. Thus it is difficult to draw general conclusions. Additionally, studies that have utilized regression statistics to predict literacy growth rarely separate orthographic awareness tasks, which makes it challenging to determine which specific orthographic awareness task best predicts later literacy ability (Apel et al., 2011).

However, Cunningham, Perry, and Stanovich (2001) conducted a principal components analysis of six orthographic processing tasks, including three letter string tasks that assessed sub lexical knowledge of orthographic rules, two lexical forced choice tasks that assessed stored mental representations of words, and one spelling task in which participants chose the correct spelling of a word given four alternative choices. The results of this principal components analysis indicated that one component including all six tasks best represented the data and accounted for over 60% of the variance in the orthographic processing tasks. Despite the use of inconsistent orthographic awareness measures, studies are beginning to reveal that orthographic awareness follows a course of development and is important to the development of word reading and perhaps reading comprehension (e.g., Badian, 1994; Berninger et al., 2010; Georgiou et al., 2008).

There is evidence that orthographic awareness begins developing as early as kindergarten (Cassar & Treiman, 1997) and is not directly dependent on decoding ability (Cunningham et al., 2001). Cassar and Treiman (1997) conducted three studies with students from kindergarten through college age to investigate the development of sub lexical orthographic knowledge regarding allowable consonant and vowel doubling. The findings showed that orthographic knowledge played a role in early spelling even when invented spelling was encouraged. The researchers demonstrated that as early as kindergarten, children showed some knowledge of the allowable positions of doubled consonants and double vowel constraints (e.g., *geed* vs. *gaad*). Moreover, as early as second grade, sub lexical orthographic awareness (knowledge of orthographic rules and patterns) and word recognition are related for typically developing readers (Apel et al., 2011).

The relationship between orthographic awareness and reading has been demonstrated in several studies, but the direction of the relationship and the association with reading comprehension is debatable. Several studies have indicated a predictive relationship between orthographic processing and later word reading. In fact measures of orthographic processing skills in preschool have been shown to be predictive of later word reading and reading comprehension (Badian, 2001), and measures of orthographic processing skills in second grade predicted unique variance in word reading in third grade, after controlling for phonological awareness and earlier measures of pseudo-word reading (Cunningham et al., 2001). Similarly, Roman et al. (2009) found that orthographic awareness was the strongest predictor of real word reading for fourth, sixth, and eighth grade students. However, a longitudinal study of first through third grade students indicated that orthographic awareness did not contribute to real word reading after controlling for age, vocabulary, non-verbal reasoning, phonological awareness and earlier word reading (Deacon, Benere, & Castles, 2012). This same study found a relationship between orthographic awareness and reading in the opposite direction: early word reading predicted later orthographic awareness skills. Moreover, a recent study examining the concurrent relationship between orthographic awareness and reading skills failed to find a significant correlation between orthographic awareness and reading comprehension for typically developing readers in second and third grade (Apel et al., 2011). Thus, it appears that orthographic awareness is related to word reading, but the direction of the relationship is unclear, and its relationship with reading comprehension is equivocal. Regardless of the direction of the relationship, there are observable differences between skilled readers and struggling readers' orthographic awareness skills (Bekebrede, van der Leij, & Share, 2007; Compton, 2002).

Orthographic awareness and struggling readers. A few studies have examined the orthographic awareness skills of adolescent struggling readers compared to non-struggling, age-matched readers and younger, reading-level matched students. In general these studies have indicated that struggling readers exhibit weaker overall orthographic awareness skills. Two studies demonstrated that students who struggled to read pseudo-words exhibited weak orthographic processing (Castles & Coltheart, 1993; Compton, 2002), and Hultquist (1997) found that the struggling readers displayed greater difficulty than age-matched and reading-level matched students on nearly all of the orthographic awareness measures. Similarly, Bekebrede et al. (2007) found that adolescent struggling readers exhibited weak orthographic awareness skills that independently contributed to reading outcomes. The disparity continues with college-age readers. Highly skilled college-age readers exhibited quality orthographic word representations, whereas less skilled readers exhibited more disconnect between orthography and word reading (Perfetti, 2007). Overall results consistently indicate that struggling readers exhibit weaker orthographic awareness skills than non-struggling readers, which is consistent with the lexical quality hypothesis that emphasized the importance of quality orthographic representations to efficient word reading (Perfetti, 2007).

The development of orthographic awareness begins in early elementary and is closely tied to print exposure (Stanovich & West, 1989) and reading experience (Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). In fact, print exposure explained variance in orthographic processing independent of phonological processing for young adults (Stanovich & West, 1989). It is believed that the aspect of print exposure that builds orthographic awareness is the requirement to repeatedly decode novel words (Rayner et al., 2001). Unfortunately, struggling readers require more decoding attempts before they recognize the orthographic

patterns (Ehri & Saltmarsh, 1995). Given that orthographic awareness is acquired through successful decoding and print exposure, it is not surprising that adolescent struggling readers would have weaker orthographic awareness skills than non-struggling readers. What is surprising is the fact that there are differences within groups of struggling readers regarding their orthographic knowledge that is not related purely to reading experience (e.g., Perfetti & Hart, 2002). As such, efforts to determine profiles of adolescent struggling readers should include measures of orthographic knowledge to define clinically relevant subgroups.

Summary of Decoding and Metalinguistic Factors

In summary, adolescent struggling readers exhibit persistent difficulties in word reading and the metalinguistic skills that support word reading. These difficulties ultimately affect reading comprehension. The metalinguistic skill of phonological awareness is critical to beginning reading success, but exhibits a short growth curve and demonstrates a weaker relationship to word identification than morphological awareness for adolescent readers. Morphological awareness has a longer growth curve than phonological awareness and exhibits a solid relationship to word reading and reading comprehension for adolescents. Orthographic awareness is related to print exposure and successful attempts at decoding. Because adolescent struggling readers exhibit persistent weaknesses in these metalinguistic skills, it is important to examine how measures of these skills help to define subgroups and determine profiles of strengths and weaknesses among adolescent struggling readers. However, lexical processes alone are not enough for solid reading comprehension. Language comprehension is a necessary component for reading comprehension and cannot be ignored in any efforts to identify profiles of adolescent struggling readers.

Language Comprehension

According to the simple view (Gough & Tunmer, 1986), reading is the product of decoding and linguistic comprehension. Linguistic comprehension skills allow the reader to understand print once the individual words have been decoded. Poor linguistic comprehension skills in the presence of good decoding will result in poor reading comprehension. In other words, poor reading comprehension can arise from general language comprehension problems even when word decoding appears to be adequate (Perfetti, Landi, & Oakhill, 2005). It is therefore important to consider linguistic comprehension skills as an essential element of reading whether investigating the skills of elementary school-aged or adolescent readers.

Likewise, oral receptive vocabulary skills are strongly correlated to both real-word reading and reading comprehension throughout development (Stahl, 2003). The relationship between vocabulary development and reading is likely reciprocal with non-struggling readers developing the majority of their receptive vocabulary knowledge through wide, independent reading; unfortunately, struggling readers tend to read less and thus have fewer opportunities to build their receptive vocabulary through reading (Nagy & Anderson, 1984). The research on linguistic comprehension, typically assessed through written language listening comprehension tasks in the domain of reading, and oral receptive vocabulary consistently indicate that they are important components of reading success for readers of all ages.

Listening comprehension. Longitudinal studies have helped to establish the connection between oral linguistic comprehension, listening comprehension, and reading comprehension. For example, Snowling et al. (2000) found that preschool children with language impairments are more likely to be identified as dyslexic at age 15 and exhibit weaker performance on tests of reading, spelling, and reading comprehension than children who are not

identified as language impaired in preschool. Additionally, many of the children who are identified with language impairments in preschool develop basic decoding skills in early elementary, but exhibit a decline in their word recognition skills in later elementary. Snowling et al. (2000) concluded that children with a history of language impairment remain at risk for reading problems, even if they start with good decoding skills, due to the significant contributions of linguistic skills including syntactic, semantic, and pragmatic language skills to the development of solid reading comprehension.

Further evidence that early language comprehension difficulties affect later reading comprehension was established in the following two retrospective studies. The first study confirmed the importance of measuring listening comprehension early as an indicator of later reading difficulties (Leach et al., 2003). In this study, Leach et al. examined the early reading profiles of struggling readers who were not identified until fourth grade (i.e., late-identified). Most of these late-identified students exhibited reading comprehension difficulties and weak listening comprehension in fourth grade. A very low percentage of these late-identified students exhibited reading comprehension difficulties in early elementary when early-identified students were exhibiting word-level difficulties. Thus, the late-identified students either developed reading difficulties after early elementary, or listening comprehension, a critical component in the identification of reading comprehension difficulties, was not administered in early elementary. Given that late identified students exhibited weaknesses in listening comprehension and reading comprehension, it appears that listening comprehension is an important measure to include in reading assessments. The second retrospective study demonstrated that eighth grade students who were identified as poor comprehenders, with good decoding skills, exhibited weaker vocabulary, grammatical understanding, inferential skills, and listening comprehension in

kindergarten than students making expected progress (Catts et al., 2006). Moreover, the listening comprehension scores for the poor comprehenders in eighth grade were also low in second and fourth grades indicating the importance of listening comprehension to reading comprehension across the grade levels.

Finally, a comparative study of poor comprehenders (students whose reading comprehension was more than 12 months lower than their chronological age and word reading accuracy) to good comprehenders (children whose reading comprehension was better than their word reading accuracy) demonstrated that poor comprehenders exhibited weaker listening comprehension (Cain & Oakhill, 2006). Thus, evidence from longitudinal, retrospective, and comparative studies indicate that struggling readers exhibit early language comprehension difficulties that are persistent. Furthermore, these studies support the importance of oral language comprehension measures for identifying reading difficulties and classifying groups of adolescent struggling readers.

Vocabulary. In addition to listening comprehension, oral vocabulary is an important component of reading success that is not completely accounted for by general language comprehension measures with adolescent readers (Braze, Tabor, & Shankweiler, 2007). In a comprehensive study, Braze et al. (2007) administered measures of phonological awareness, decoding, verbal working memory, listening comprehension, reading comprehension, word knowledge, and experience with print to 16-24 year old struggling readers. Results indicated that weaknesses in vocabulary knowledge affected oral language understanding, as well as decoding. Moreover, vocabulary skills contributed to reading comprehension independently of listening comprehension and decoding. This finding supports the lexical quality hypothesis that posits skilled reading depends on high-quality lexical representations, which include robust knowledge

of semantic relationships among words (Perfetti, 2007). Thus vocabulary affects both decoding and language comprehension and contributes unique variance to reading comprehension above decoding and language comprehension.

Like orthographic awareness, experience with print is a reliable predictor of vocabulary knowledge (Stanovich, West, & Harrison, 1995), and learning vocabulary is essential to becoming an independent learner (Snow, 2010). Unfortunately, struggling readers often have weaker vocabulary skills than non-struggling readers and fewer successful experiences with print, which results in fewer opportunities to strengthen their vocabulary skills (Hock et al., 2009). Because language comprehension and oral vocabulary skills are often weak within adolescent struggling readers and vocabulary independently contributes to reading comprehension, it is important that vocabulary skills are evaluated and used to define reading profiles.

What Do We Know about the Profiles of Adolescent Struggling Readers?

Two known studies have examined the reading profiles of adolescent struggling readers. In 2002, Buly and Valencia examined the reading profiles of 108 fourth grade students who scored below proficient on the state reading exam. Participants were administered measures of phonemic awareness, pseudo-word reading, real word reading, reading comprehension, and vocabulary. Though mean scores were generally weak for all measures, factor analysis and cluster analyses indicated different profiles of relative strengths and weaknesses. Results of the factor analysis indicated that three factors emerged that accounted for 78% of the variance in state reading exam scores. They named the three factors: word identification, fluency, and meaning. The word identification factor included measures of real and pseudo-word decoding. The fluency factor included reading rate in context and reading expression. The meaning factor

included reading comprehension and vocabulary measures. Following the factor analysis, a cluster analysis was completed using the three factors. Results of the cluster analysis indicated six profiles. Cluster 1 was named automatic word callers (18%) and included students who were relatively stronger in word identification and fluency than meaning. These students read quickly and accurately, but not for meaning. Cluster 2 was named struggling word callers (15%) and was similar to cluster 1 but these students exhibited more difficulty in word identification. Cluster 3 was named word stumblers (18%) and these students exhibited relative strengths with meaning, but had word identification weaknesses. Cluster 4 was named slow and steady comprehenders (24%) and these students exhibited weak reading fluency, but solid word identification and meaning. Cluster 5 was named slow word callers (17%) and these students exhibited weak fluency and meaning. Cluster 6 was named disabled readers (9%) and these students exhibited weak scores in all three factors, with especially weak word identification.

In a similar investigation, Dennis (2013) conducted a multivariate correlational study of 94 middle school students, who were mostly from minority backgrounds and poor families and met criteria for below proficient on the state standards-based assessment. Similar to Buly and Valencia (2002), the participants were assessed on phonemic awareness, phonics, decoding, fluency, spelling, vocabulary, and reading comprehension. Results of exploratory factor analysis indicated that the same three factors identified by Buly and Valencia- word identification, fluency, and meaning- accounted for 74.8% of the total variance in the students' performance on the standards based test. A follow-up cluster analysis revealed four clusters of struggling readers that she labeled: slow and steady comprehenders, slow word callers, automatic word callers, and struggling word callers. Interestingly, Dennis noted that the majority of these middle school students who scored below proficient on the state exams demonstrated mastery of word reading,

but required additional instructional support developing fluency, vocabulary, and comprehension.

The information gleaned from the latter two studies provided evidence that adolescent struggling readers are not a homogeneous group. Though overall, the students exhibited generally weak scores on all of the measures, each of the clusters exhibited different profiles of strengths and weaknesses. However, these studies did not include measures of morphological awareness, orthographic awareness, or listening comprehension: skills that are critical components to success in reading as described above. Given evidence that metalinguistic skills are increasingly important to word reading in adolescence and listening comprehension is a measure that can identify struggling readers in the absence of word reading difficulties, it is important that a study examining the reading profiles of adolescent readers include these measures.

Summary of Literature Review

In summary, word reading and language comprehension skills are critical components of reading in adolescence. In line with the triple word form theory (Richards et al., 2006) and lexical quality hypothesis (Perfetti, 2007), phonological awareness, morphological awareness, and orthographic awareness are principal metalinguistic skills that underpin word reading in adolescence and are related to reading comprehension. Struggling adolescent readers exhibit weaker skills in word reading, language comprehension, and metalinguistic skills, but evidence suggests that struggling adolescent readers are not a homogeneous group. While some adolescent struggling readers can be characterized by their overall weak component skills, most are best characterized by their profiles of strengths and weaknesses.

Two studies examined the profiles of adolescent struggling readers related to the component skills of word reading, reading comprehension, and fluency. However, the critical foundational components of listening comprehension, morphological awareness, and orthographic awareness were not included in these studies. The inclusion of a listening comprehension measure is important to identify struggling readers who exhibit solid word reading and metalinguistic skills. Similarly, measures of metalinguistic skills are necessary due to increasing evidence of their relationship to word reading for adolescent readers. Thus a more complete understanding of the strengths and weaknesses of adolescent struggling readers can be gleaned from a study that includes measures of word reading, metalinguistic skills, and language comprehension.

CHAPTER 3: METHODS

The purpose of this descriptive multivariate study was to better understand the factors related to adolescent struggling readers and identify homogeneous groups of students that share similar profiles of strengths and weaknesses across reading and language-related measures. Understanding the factors related to adolescent struggling reading and the profiles of these students is required in order to improve our understanding of the nature of adolescent struggling readers so that we can properly identify, diagnose and remediate the challenges these students face.

The research questions guiding this study were:

1. What are the language and literacy profiles of adolescent struggling readers?
2. What are the underlying latent variables that are reflected in the observed variables?
3. What reading strengths and weaknesses are present for each identified profile?
4. On which variables do the groups differ?

To answer the research questions, factor analysis procedures were conducted to identify latent variables. Then, hierarchical agglomerative cluster analysis procedures were used in order to identify groups that shared similar characteristics with the intention of minimizing within cluster variation and maximizing between cluster variations. Post-hoc analyses were conducted to identify the meanings of the clusters and determine how they might be used to inform interventions as well as to identify variables on which the clusters differed.

Participants & Setting

In this study, adolescent struggling readers were defined as students who exhibited weaknesses in any area of reading, including (but not limited to) reading comprehension, word reading, fluency, vocabulary, or phonological awareness. Participants in this study were identified as struggling readers based on a combination of teacher opinion, classroom assessments, and/or standardized assessments. Previous studies have indicated that teacher judgment of reading difficulties exhibit high levels of agreement with individual standardized measures (Hoge & Coladarci, 1989) and teacher rating of reading problems is a significant predictor of reading difficulties (Speece et al., 2010). Furthermore, studies have indicated little to no correlation between labeled-performance on state standardized assessments of reading and reading profiles (see Leach, Scarborough, & Rescorla, 2003; Rupp & Lesaux, 2006). Thus for this study, teachers and administrators identified adolescent struggling readers and no specific assessment guidelines were given for choosing these students.

Participation criteria included an age range of 11 years 0 months to 14 years 11 months and a score between 70 and 130 on the Peabody Picture Vocabulary Test – 4 (PPVT-4, Dunn & Dunn, 2007). A total of 108 participants were recruited and screened for participation in this study. Of the 108, three students were excluded from participation because they scored below 70 on the PPVT-4. The final 105 students were from three different schools in the central Piedmont region of North Carolina. One school was a small, independent, privately funded middle school for boys who come from low-income families. In this school, 80% of the families qualified for the free or reduced price lunch. A second school was a public middle school with 47% of students eligible for free or reduced price lunch and 44% of the student population performing below grade level on recent end-of-grade reading tests. The third school was a tuition free,

public charter-school serving adolescents in a non-traditional school setting. Recent end-of-grade reading tests indicated that 68% of the students in this school performed below grade level in the English II proficiency assessment.

Rules of thumb for sample sizes required for exploratory factor analysis indicate that at least 100 participants are necessary with a total sample size of at least five times the number of variables. Thus this study meets both criteria with 105 participants and nearly 10 times the number of participants per variable. For cluster analysis the sample size must be sufficiently large to represent all relevant groups, and the findings suggest the sample was sufficient.

Procedures

After receiving consent from parents and assent from participants, a battery of 11 assessments measuring language and literacy skills were administered to participating students. The complete battery required approximately 60 to 90 minutes of testing and was administered in two or three separate sessions. All of the assessments were administered individually in a quiet setting within the school and the test order was randomized across participants.

The principal investigator and graduate students in speech-language pathology, who were trained by the principal investigator, administered all assessments. Training included detailed information of test administration and hands-on practice. Fidelity checklists were used during the training and during observations of test administration (see example in Appendix A) to ensure all assessments were administered with maximum fidelity. All assessments were scored by at least one assessor with all scores double-checked by the principal investigator.

Measures

All participants were administered 11 assessments that measured language comprehension, metalinguistic skills, and real and pseudo-word reading. These 11 assessments

were chosen based on theory and research outlined in chapter two. Each is described in detail below.

Language comprehension. To measure listening comprehension, the Understanding Spoken Paragraphs subtest of the Clinical Evaluation of Language Fundamentals-Fifth Edition (CELF-5; Semel, Wiig, Secord, 2013) was administered. The CELF-5 is an individually administered, standardized test for students' ages 5 to 21 years. The Understanding Spoken Paragraphs subtest is designed to evaluate the student's ability to create meaning from oral narratives and text, as well as answer questions about the content and use critical thinking. Students are presented with a few short stories read aloud to them and then asked questions related to the story. The reported reliability for this subtest is 0.85.

The Peabody Picture Vocabulary Test – 4 (PPVT-4, Dunn & Dunn, 2007) is an assessment of oral receptive single-word vocabulary. This assessment requires the participant to identify the picture that represents a spoken word. Reliability and validity coefficients for the PPVT-4 are reported at .90 and above.

Metalinguistic skills. Growing evidence indicates the importance of metalinguistic skills to reading achievement throughout adolescence. Metalinguistic skills require awareness of linguistic components of language. This ability to think about language appears to directly affect reading skills. As such, several measures of metalinguistic skills were included in the battery. Each is described below.

Phonological awareness. Three subtests from The Comprehensive Test of Phonological Processing-Second Edition (CTOPP-2; Torgesen, Rashotte, Pearson, 2013*)* were administered: Elision, Blending Words, and Phoneme Isolation. The Elision subtest measures the ability to remove phonological segments from spoken words to form other words. The

Blending Words subtest measures the ability to synthesize sounds to form words, and the Phoneme Isolation subtest measures the ability to isolate individual sounds within words.

The CTOPP-2 is a norm-referenced assessment measure with reported internal consistency coefficients for all of the subtests used exceeding 0.80. The selected subtests exhibited concurrent validity with the Test of Phonological Awareness (Robertson & Salter, 2007), Dynamic Indicators of Basic Early Literacy Skills (initial sound fluency and phoneme segmentation fluency) (Kaminski & Good, 2008), and Lindamood Auditory Conceptualization Test-3 (Lindamood & Lindamood, 2004) ranging from 0.64-0.78. The CTOPP-2 was normed on over 1900 students in six states. Thirty-eight percent of the norming population was between the ages of 12 and 17.

Morphological awareness. The Word Derivations subtest from the Test of Adolescent and Adult Language (TOAL 4, Hammill, Brown, Larsen, Wiederholt, 2007) was administered as a measure of morphological awareness. This is an assessment of an individual's ability to formulate a derived word form that taps an individuals' awareness of both the meaning and function of affixes. For example, given the base word *farm* and the sentence, *My uncle is a* _____, the participant must provide the derived word *farmer*. The TOAL 4 was normed on 1,671 individuals in 35 states. Concurrent validity with the WISC III Verbal measure is reported to be 0.83.

Orthographic awareness. The Word Choice subtest from the Test of Orthographic Competence (TOC, Mather, Roberts, Hammill, Allen, 2008) is a lexical assessment that measures mental graphemic representations, which reflect memories of specific words through a word choice activity (Apel, 2011). For this subtest the examiner says a word and the participant looks at three possible spelling choices (e.g., *sitty, sitee, city*). The participant then circles what

he or she thinks is the correct spelling of the word. This is an untimed measure that was administered individually. The TOC was normed on over 1400 students in 27 states. Nearly 50 percent of the norming population was between the ages of 12 and 17.

An experimenter-adapted Sub Lexical Orthographic Awareness Task was also administered (see Appendix B). This task was originally adapted from Cunningham, Perry, and Stanovich's (2001) Pseudo-word Pairs measure and Cassar and Treiman's (1997) word lists. This task requires the participant to identify legal spelling patterns in English words by circling the word from a pair (e.g., *noop*, *niip*) that most resembles a real word. The principal investigator of the current study adapted the task in order to shorten the overall length from 60 word pairs to 38. Decisions regarding the removal of non-word pairs were based on the number of times the pattern had been included in the task with a goal of including two assessments of each pattern. Cronbach's alpha (0.69) for the adapted version of the Sub Lexical Orthographic Awareness Task was computed using the responses for the 105 participants in the current study. The alpha falls at the high-end of the acceptable range for internal consistency reliability for measures such as this (Kline, 2000).

Word identification. The Phonemic Decoding Efficiency and Sight Word Efficiency subtests from the Test of Word Reading Efficiency, 2nd Edition (TOWRE-2, Torgesen, Wagner, & Rashotte, 2012*)* were administered. The Phonemic Decoding Efficiency is an individually administered assessment that requires timed oral reading of a list of pseudo-words (e.g., *plog*). The Sight Word Efficiency subtest is an individually administered assessment that requires timed oral reading of a list of single real words. The TOWRE-2 is a norm-referenced assessment that was normed with over 1700 students in 12 states. Approximately half of the norming population was between the ages of 12 and 16. The average alternate forms reliability coefficients (content

sampling) for the subtests exceed .90. The average test–retest (time sampling) coefficients for the same form exceed .90. The average test–retest (time sampling) coefficients for different forms of the subtests are .87.

The Slosson Oral Reading Test Revised (SORT-R3, Slosson, 1990) is a norm-referenced assessment of word recognition. This test consists of words selected from a variety of reading lists and textbooks for each grade level without reference to their phonemic characteristics. Students are asked to read progressively harder lists of words. This test was nationally normed on over 1300 people including approximately 600 students ages 10 through 18. Spearman-Brown split half reliability and KR21 were both reported at 0.98. Concurrent validity with Woodcock Johnson Letter-Word Identification (Woodcock, McGrew & Mather, 2001) and Peabody Individual Achievement Test (Markwardt, 1989) reading recognition was 0.90.

Data Analyses

Prior to each analysis, the characteristics of the data set were evaluated to determine whether assumptions were met. The following is a description of each analysis conducted to answer each research question.

In order to identify the underlying latent variables for research question one, a factor analysis was conducted using scaled data. The factor analysis derived a set of underlying latent variables that accounted for the covariances between the observed variables. In order to identify the language and literacy profiles of adolescents with weak reading skills, cluster analysis procedures were conducted to empirically describe the skill profiles of these adolescent struggling readers. The goal of cluster analysis is to create a collection of cases such that the cases within a group were similar to one another and different from the cases in other groups (Gore, 2000). Thus clusters should exhibit high internal homogeneity and high external

heterogeneity (i.e., objects within clusters should be close, but the clusters should be far apart). After reducing the 11 variables to three factors, the clusters were derived by hierarchical agglomerative clustering procedures using the scores on each factor for each observation. As applied in this study, the hierarchical agglomerative clustering procedure began with every case (i.e., participant factor scores) representing an individual cluster and at each step the two most similar clusters were combined until the last two clusters were combined into a single cluster with all students. Then, pairs of cases that are most similar were combined with existing similar clusters. This iterative process continues until the last step when there is only one cluster. In the current study, similarity between cases was determined through Euclidean distances. Ward's Method was used as the clustering algorithm to assign cases to clusters. Ward's method minimizes the total within cluster variance by choosing pairs of cases to add to a cluster that lead to the lowest increase in total within-cluster variance after the pairs are added. Ward's method then chooses which pair of clusters to combine by merging the pair of clusters that minimizes the sum of square errors, or sum of squared deviations from the cluster mean, across all clusters (Gore, 2000). Thus, at each step the pair of clusters with minimum between cluster variance was merged. Once the number of clusters was determined, they were evaluated for stability using different clustering procedures on the same data. Additionally, the grouping results were evaluated regarding how the results aligned with theory and whether the results matched expectations.

To answer research questions three and four regarding the strengths and weaknesses of each profile and the variables on which the groups differed, the hierarchical agglomerative clustering procedure was followed by a partitioning method that improved the accuracy and interpretability of the clusters. The Partitioning Around Medoids (PAM) algorithm was used to

partition the data set into groups. The PAM algorithm finds the median case in each cluster with the goal of minimizing the average dissimilarity of objects to their closest selected object (Tibshirani, 2013). The cluster medoids were then examined to distinguish characteristics of each cluster's profile and identify substantial differences between clusters. Finally, the means for each variable for the final cluster solution were evaluated to determine on which variables the groups differed.

CHAPTER 4: RESULTS

The purpose of this study was to better identify and understand the reading and language-related profiles of strengths and weaknesses among adolescents who struggle to read. Understanding the factors responsible for reading difficulties and defining how these factors relate to each other will improve our understanding of appropriate approaches to identification and remediation of reading problems among adolescent struggling readers. The research questions addressed in this study were:

1. What are the language and literacy profiles of adolescent struggling readers?
2. What are the underlying latent variables that are reflected in the observed variables?
3. What reading strengths and weaknesses are present for each identified profile?
4. On which variables do the groups differ significantly?

Descriptive Statistics

Prior to addressing the four research questions, it was important to understand the sample of students who participated in the study. The total number of cases analyzed was 105. There were 42 (40%) females and 63 (60%) males in the sample. Of the 105 cases, 59 (56%) identified their race as White, 16 (15%) as Black or African American, 21 (20%) as Hispanic, 5 (5%) as Mixed, and 4 (4%) as Not Specified. The chronological age ranged from 11 years, 0 months to 14 years, 11 months with the mean age of 12 years, 8 months.

Descriptive statistics for the language and literacy measures are provided in Table 4.1. The raw score means and score ranges are provided for all measures, as well as norm-referenced scores where applicable. The Understanding Spoken Paragraphs subtest (celfusp) of the Clinical

Evaluation of Language Fundamentals-5th Edition (CELF-5, Semel, Wiig, Secord, 2013) has a mean norm referenced score of 10 (SD=3). The Peabody Picture Vocabulary Test-4th edition (ppvt) (PPVT, Dunn & Dunn, 2007) has a mean of 100 (SD=15). The three subtests of the Comprehensive Test of Phonological Processing-2nd edition (C-TOPP, Torgesen, Rashotte, Pearson, 2013): Elision (ctoppel), Blending Words (ctoppbw), and Phoneme Isolation (ctopppi), have a subtest mean of 10 (SD=3). The Word Derivations subtest (toalwd) from the Test of Adolescent and Adult Language 4 (TOAL-4, Hammill, Brown, Larsen, Wiederholt, 2007) has a mean standard score of 10 (SD=3). The TOAL-4 is norm-referenced for ages 12-24 thus mean norm-referenced scores are provided for the participants who were at least 12 years old (n=81). The Word Choice subtest (tocwc) from the Test of Orthographic Competence (TOC, Mather, Roberts, Hammill, Allen, 2008) has a norm-referenced score mean of 10 (SD=3) and is normed on participants ages 13-17, thus mean norm-referenced scores are provided for the participants who were at least 13 years old (n=43). Raw score data is reported for the experimenter-adapted Sub Lexical Orthographic Awareness Task (sublex). The Phonemic Decoding Efficiency (towrepde) and Sight Word Efficiency subtests (towresw) from the Test of Word Reading Efficiency-2nd edition (TOWRE-2, Torgesen, Wagner, & Rashotte, 2012) have a mean of 100 (SD=15). The Slosson Oral Reading Test-R3 (sort) (SORT, Slosson, 1990) has a mean of 100 (SD=16).

As demonstrated by the descriptive statistics in Table 4.1, the mean scores for all subtests were within the average range, but the individual scores ranged from well below average to well above average for all measures.

Table 4. 1 Variable Means, Standard Deviations, and Ranges
(Standard Deviations in Parentheses; N=105 except as noted)

Assessment	Raw Score Mean	Raw Score Range	Norm-referenced Score Mean	Norm-referenced Score Range
celfusp	12.58 (3.90)	2-20	8.04(2.75)	2-16
ppvt	167.24 (13.11)	134-202	96.34(10.45)	71-130
ctoppel	24.13 (6.04)	11-33	7.71(2.80)	2-14
ctoppbw	22.70 (4.41)	9-29	8.59(3.08)	1-14
ctopppi	21.47 (5.84)	0-30	7.24(2.44)	1-13
toalwd	8.54 (3.42)	2-20	[a]8.11(2.00)	4-13
tocwc	6.79 (4.59)	1-21	[b]8.65(1.95)	6-14
sublex	34.39 (2.94)	23-38	NA	NA
towrepde	32.75 (12.10)	2-58	87.92(13.67)	55-121
towresw	66.92 (12.42)	18-92	87.54(11.63)	55-119
sort	152.18 (31.32)	26-192	96.41(12.59)	51-112

Note. celfusp =CELF-5 Understanding Spoken Paragraphs; ppvt =PPVT; ctoppel = CTOPP-2 Elision; ctoppbw =CTOPP-2 Blending Words; ctopppi =CTOPP-2 Phoneme Isolation; toalwd =TOAL Word Derivation; tocwc =TOC Word Choice; sublex =Sub Lexical Orthographic Awareness Task; towresw =TOWRE-2 Sight Word; towrepde =TOWRE-2 Phonemic Decoding; sort =SORT-R3.
[a] n=81. Norm-referenced scores were available for ages 12 and above. [b] n=43. Norm-referenced scores were available for ages 13 and above.

Latent Variables Underlying Observed Variables

In order to address the first research question regarding the profiles of adolescent struggling readers, a series of analyses and decisions were made to address the second research question, *What are the underlying latent variables reflected in the observed variables?* Before determining the underlying latent variables, assumptions regarding correlations, sample size, and outliers were examined to determine whether the required factor analysis procedures were appropriate for the data. First, the correlation matrix (Table 4.2) was surveyed to confirm that the variables were intercorrelated, but not correlated too highly. Too many low correlations indicate orthogonal variables that are not suitable for factoring and high correlations may indicate extreme multicollinearity or singularity (Thompson, 2004). Examination of the correlation matrix showed that more than half of the correlations exceeded r =.30 and the highest

correlation was r =.75, Additionally, Bartlett's test was significant (χ^2=433, p<0.000) indicating that the correlation matrix was not an identity matrix (Tabachnick & Fidell, 2006). Thus there were no concerns with the variables being orthogonal or exhibiting extreme multicollinearity. Moreover, numerous pairs of correlations were significant which is necessary when conducting a factor analysis.

Second, the sample size was considered for adequacy. The sample size of 105 met the criterion of 10 participants per variable (Koostra, 2004). Additionally the Kaiser-Meyer-Olkin measure of sampling adequacy was calculated for the variables. The Kaiser-Myer-Olkin scores for all variables ranged from .71 to .84 with a mean of .79. This indicated good sampling adequacy for factor analysis (Field & Miles, 2012).

Third, univariate and multivariate data were examined for outliers. No univariate outliers were identified. Using Mahalanobis distance measures, two multivariate outliers were identified. However, a comparison of the descriptive statistics with and without the outliers indicated no meaningful difference in the means or correlations with the outliers removed. Moreover, the factor analysis solutions were not affected when the outliers were removed. Thus, the decision was made to keep the two cases in the data set.

Finally, the distributions were examined for departures from normality; however, assumptions regarding the distributions of variables are not in force given that the factor analysis was used descriptively to summarize the relationships in a large set of observed variables and create hypotheses (Tabachnick & Fidell, 2006). The results of skewness and kurtosis calculations are provided in Appendix C (Table C1). Because the results indicated skewed univariate distributions and departures from normality, Spearman correlations were conducted

(see Table 4.2). This approach to correlation was selected because it is more robust with skewed distributions than other approaches (Tabachnick & Fidell, 2006).

Results of the Factor Analysis

After determining that the variable measurements met the assumptions, factor analysis procedures were conducted in order to identify the underlying latent variables (Kootstra, 2004). All raw scores were standardized so that measures with large variances did not affect the factor analysis solution. Table 4.3 contains the eigenvalues for the set of variables as determined through a principal components analysis on the data matrix. The eigenvalues represent the amount of variation explained by a factor and are the first step in determining the number of factors that provide the best solution in the factor analysis (Field & Miles, 2012). Based on eigenvalues greater than one, it appears that there are three factors; however, there are other criteria to consider.

A second criterion is the scree plot that graphs each eigenvalue against the factor with which it is associated. Figure 4.1 shows the scree plot for the factor analysis. The point of inflexion is where the slope of the line changes considerably, indicating the amount of variation explained by the subsequent factor is far less than the previous factor (Field & Miles, 2012), and one rule of thumb is to keep the number of factors before the point of inflexion (Kootstra, 2004). Examination of the scree plot indicates points of inflexion at two, three, and four factors.

Table 4. 2 Spearman correlations among language and literacy measures (N=105)

	toalwd	tocwc	sublex	ctoppel	ctoppbw	ctopppi	towresw	towrepde	sort	ppvt	celfusp
toalwd	–	.315**	.235*	.270**	.287**	.178	.284**	.348**	.434**	.563**	.307**
tocwc		–	.382**	.210*	.059	.075	.399**	.400**	.534**	.286**	.241*
sublex			–	.275**	.062	-.005	.302**	.308**	.353**	.126	-.004
ctoppel				–	.412**	.377**	.198*	.456**	.383**	.328**	.162
ctoppbw					–	.531**	.085	.285**	.426**	.405**	.207*
ctopppi						–	-.025	.173	.213*	.253**	.237*
towresw							–	.664**	.531**	.255**	.276**
towrepde								–	.753**	.220*	.116
Sort									–	.396**	.191
Ppvt										–	.477**
celfusp											–

* p < .05. ** p < .01.

Table 4. 3 Eigenvalues

Factor	Eigenvalue	Proportion of Variance	Cumulative Proportion
1	4.3919148	0.3993	0.3993
2	1.5412003	0.1401	0.5394
3	1.2899551	0.1173	0.6566
4	0.8349713	0.07591	0.73255
5	0.6660988	0.06055	0.79310
6	0.6152428	0.05593	0.84903
7	0.5502278	0.05002	0.89906
8	0.4372464	0.03975	0.93881
9	0.3470570	0.03155	0.97036
10	0.1887400	0.01716	0.98751
11	0.1373458	0.01249	1.0000

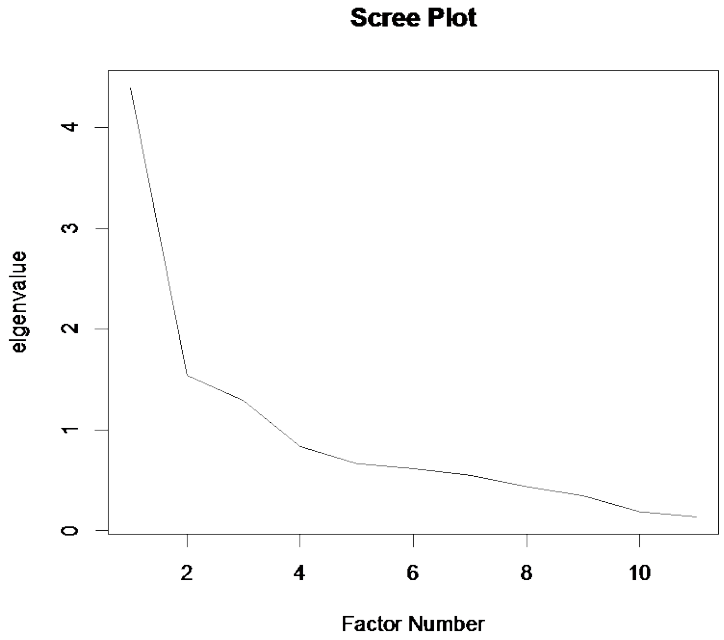

Figure 4.1 Scree Plot of Eigenvalues

A third criterion for determining the number of factors to extract is a parallel analysis. Horn's technique for numerically and graphically evaluating the components or factors retained in the exploratory factor analysis was applied. Horn's method contrasts eigenvalues produced through exploratory factor analysis on a number of random data sets of uncorrelated variables with the same number of variables and observations as the observational data set to produce

eigenvalues for factors that are adjusted for the sample error-induced inflation (Field & Miles, 2012). Components with adjusted eigenvalues greater than one are retained. The results of the parallel analysis shown in Table 4.4 and Figure 4.2 indicate a three-factor model. The scree plot in Figure 4.2 of the parallel analysis indicates that at four factors, the eigenvalues of the factor analysis on the actual data (FA Actual Data) are less than the eigenvalues of simulated data (FA Simulated Data), thus supporting the three-factor solution.

Table 4. 4 Parallel Analysis Using Horn's Technique

Component	Adjusted Eigenvalue	Unadjusted Eigenvalue	Estimated Bias
1	3.834965	4.391914	0.556949
2	1.153450	1.541200	0.387749
3	1.027431	1.289955	0.262523

Note. Only components with eigenvalues greater the one are displayed in a parallel analysis.

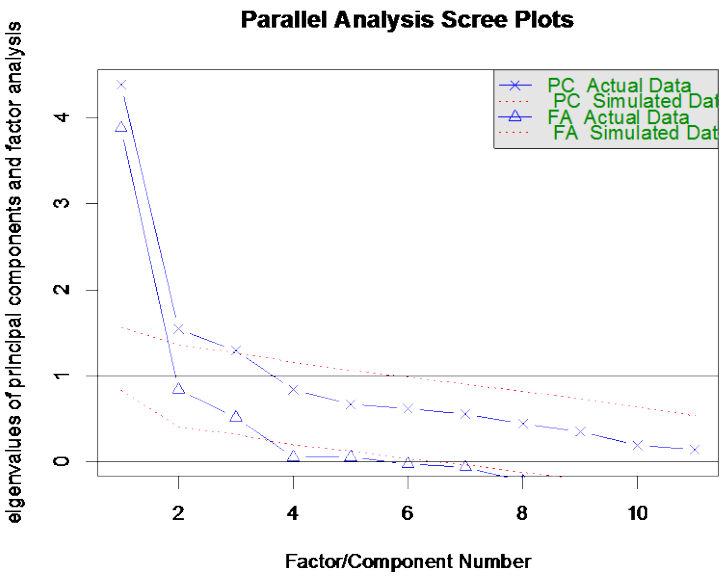

Figure 4. 2 Parallel Analysis Scree Plot

Finally, to confirm that the three-factor extraction was the most parsimonious solution, two, three, and four factor solutions were analyzed to calculate the loadings of the variables on each factor. Due to expected correlations between the factors, the factor solutions were

obliquely rotated and only variables with a loading of .4 or above were considered in each factor (Field & Miles, 2012). The two-factor solution accounted for 43 percent of the variance and exhibited an intercorrelation of .61. With this solution, measures of real word and pseudo-word reading and orthographic awareness loaded onto factor one. The second factor in this two-factor solution could be explained as language and included the measures of oral language, morphological awareness, and phonological awareness (see Appendix C, Table C2 and Figure C1). Though the two-factor solution provided a reasonable explanation of the data, the distinction between the two factors was not unexpected or new. The fact that these two sets of variables explain overall reading difficulties has been known for years and is best captured in the simple view of reading (Gough & Tunmer, 1986). This information is useful, but does not help to identify clinically relevant language and literacy profiles for struggling readers. As such, a three-factor solution was explored. This information is diagrammed in Figure 4.3 and the loadings are provided in Table 4.5.

The three-factor solution offered the best fit to the data with item loadings above .40, no cross loadings, and no factors with fewer than three variables (Costello & Osborne, 2003). The three-factor solution accounted for 53% of the variance. The first factor contained the same real- and pseudo-word reading and orthographic awareness measures as the first factor in the two-factor solution and can be explained as word identification. This first factor accounted for 27% of the total variance. The second factor contained all of the phonological awareness measures and accounted for 12% of the total variance. The third factor included the oral language measures and metalinguistic measure of morphological awareness. This factor accounted for 14% of the total variance. Factors 1 and 3 (i.e., word identification and language) exhibited a correlation of r=.56. Factors 1 and 2 (i.e., word identification and phonological awareness)

exhibited a correlation of r=.40, and factors 2 and 3 (i.e., phonological awareness and language) exhibited a correlation of r=.43. Figure 4.3 shows a diagram of the three-factor solution. The numbers on the branches indicate the loadings that were greater than .4 for the variables on each factor.

Finally, the four-factor solution (see Appendix C Table C3 and Figure C2) was examined in an effort to explain the variance of the remaining variables. This solution accounted for 55% of the total variance. The first factor contained the same variables as the two- and three- factor solutions and can be explained as word identification. The second factor contained all of the phonological awareness measures (like the three factor solution). Only one variable loaded on the third factor: celfusp, which measured listening comprehension. This measure of language was distinct from the measures on the fourth factor, which included the ppvt and toalwd. Different from the celfusp, these two measures examined oral receptive vocabulary and morphological awareness, respectively. This solution was not deemed the most parsimonious because it did not explain much more total variance and only one variable loaded on the third factor, a variable that is highly correlated with the variables on the fourth factor.

In summary, exploratory factor analysis indicated three clear factors that accounted for 53% of the variance. These factors were labeled: word identification, language, and phonological awareness. The word identification factor included the speeded real- word and pseudo- word reading measures (towresw, towrepde), non-speeded real word reading (sort), and sub lexical and lexical orthographic awareness tests (sublex, tocwc) and accounted for 27% of the total variance. The language factor included the measures of oral vocabulary (ppvt), listening comprehension (celfusp) and morphological awareness (toalwd) and accounted for 14% of the total variance. The phonological awareness factor included the three subtests of the CTOPP-2

(ctoppel, ctoppbw, ctopppi) and accounted for 12% of the total variance. The similarity in variance accounted for between Factors 2 and 3 indicates that variables loading on these two factors are equally related to adolescent struggling readers. These three factors are supported in extensive literature on reading difficulties.

Table 4. 5 Factor Loadings and Communalities (h2) for Exploratory Factor Analysis with Promax Rotation: Three Factor Solution

Variable	Component 1	Component 2	Component 3	Communality (h2)
Towresw	**.86**	-.14	.04	.72
towrepde	**.87**	.16	-.15	.75
Sort	**.86**	.16	.05	.90
Tocwc	**.41**	-.28	.24	.28
Sublex	**.62**	-.09	-.06	.32
Ctoppel	.34	**.41**	.02	.39
Ctoppbw	-.04	**.84**	.09	.74
Ctopppi	.10	**.49**	.09	.33
Toalwd	.12	.02	**.56**	.41
Ppvt	-.02	.10	**.88**	.82
Celfusp	-.14	.01	**.59**	.29
proportion variance	.27	.12	.14	
cumulative variance	.27	.39	.53	

Note: Factor loadings > .40 are in boldface. towresw =TOWRE-2 Sight Word; towrepde =TOWRE-2 Phonemic Decoding; sort =SORT-R3; tocwc =TOC Word Choice; sublex =Sub Lexical Orthographic Awareness Task; ctoppel = CTOPP-2 Elision; ctoppbw =CTOPP-2 Blending Words; ctopppi =CTOPP-2 Phoneme Isolation; Toalwd =TOAL Word Derivation; ppvt =PPVT; celfusp =CELF-5 Understanding Spoken Paragraphs

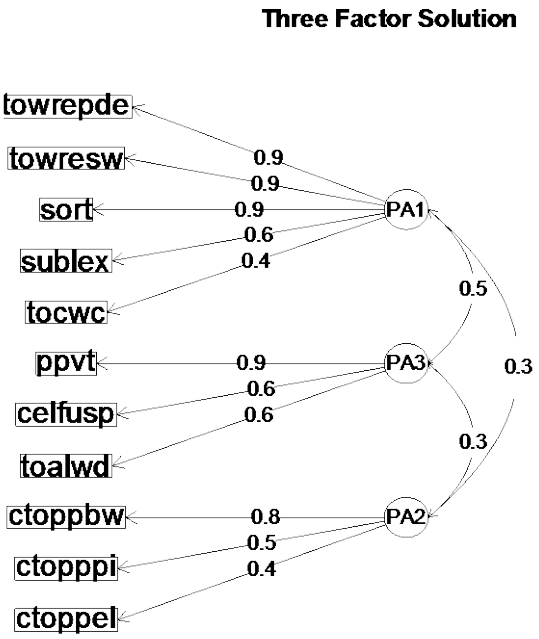

Figure 4. 3 Diagram of the Three-Factor Model

Note. PA1 =component 1; PA2 = component 2; PA3 = component 3. The numbers on the branches are the rounded loadings. The numbers connecting the components represent a factor loading built into the cut score.

The Language and Literacy Profiles of Adolescent Struggling Readers

After determining the three-factor solution was the best solution, and naming the three factors as word identification, phonological awareness, and language, a cluster analysis was performed to address the first research question, *What are the language and literacy profiles of adolescent struggling readers?* Cluster analysis is a way of grouping cases of data based on similarities of responses to several variables (Gore, 2000). In the current study, new variables were created from the factor scores for each observation. The factor scores were used to derive the clusters.

The assumptions for cluster analysis are similar to those for factor analysis and departures from normality are not a concern for cluster analysis. However, it is important that the variables chosen for cluster analysis are supported by research and theory and that the sample

size is sufficiently large to represent all relevant groups. The language and literacy variables measured in this study were supported by extensive research on adolescent readers and the sample size was sufficiently large.

Results of the cluster analysis. The first step in a cluster analysis is to derive the clusters. Hierarchical agglomerative clustering was completed using Euclidean distance measures to define closeness of cases and Ward's Method as the algorithm for clustering. Euclidean distance is the geometric distance between two cases: the smaller the distance, the more similar the cases (Gore, 2000). After measuring the similarity between cases, the cases are grouped based on their similarity coefficients. Initially, each case was treated as its own cluster, and then cases were merged based on Ward's Method for grouping. Ward's method assigns cases into clusters such that the variance within a cluster is minimized; therefore, cases are selected to enter the cluster if its inclusion in the cluster produces the least increase in error.

After deriving the clusters, the second step is to evaluate the number of clusters. There are several quantitative and qualitative methods to identify the number of clusters derived from hierarchical clustering methods. One method is to visually examine the dendrogram: a diagram that depicts the arrangement of the clusters produced by hierarchical clustering. Figure 4.4 depicts the dendrogram for this data. The dendrogram helps to visually identify the number of clusters and a common practice is to cut the tree at a height where there is greater space between two consecutive nodes (i.e., the horizontal line adjoining the clusters) (Drout & Smith, 2014). The dendrogram appears to indicate four, five or six clusters. Figures C3-C5 in Appendix C demonstrate different cut points for the dendrogram.

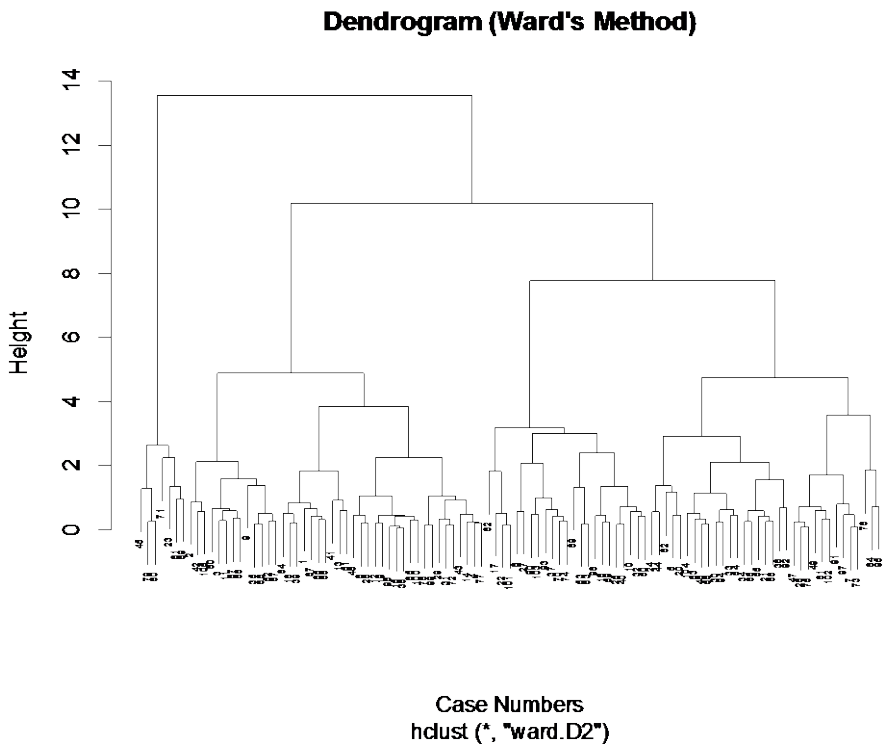

Figure 4. 4 Tree diagram of Hierarchical Agglomerative Clustering (Ward's Method)

Another way to determine the number of clusters is to examine the within group sums of squares scree plot (Field & Miles, 2012). The point of inflexion on the scree plot is an indication of the number of clusters. Figure 4.5 depicts the within group sums of squares scree plot and indicates points of inflexion at clusters two, three, and four. Additionally, a model-based approach, using maximum likelihood estimation and Bayes criteria to identify the most likely model and number of clusters, indicated that four clusters was the most parsimonious number of clusters for this data. Finally, a two-cluster solution was considered optimal based on average silhouette width (0.36), but the four-cluster solution was the next best choice with an average silhouette width of (0.29). In summary, quantitative analysis appears to indicate that two through four clusters best represent the data. Thus these sets of clusters were interpreted to determine the solution with the strongest theoretical foundation.

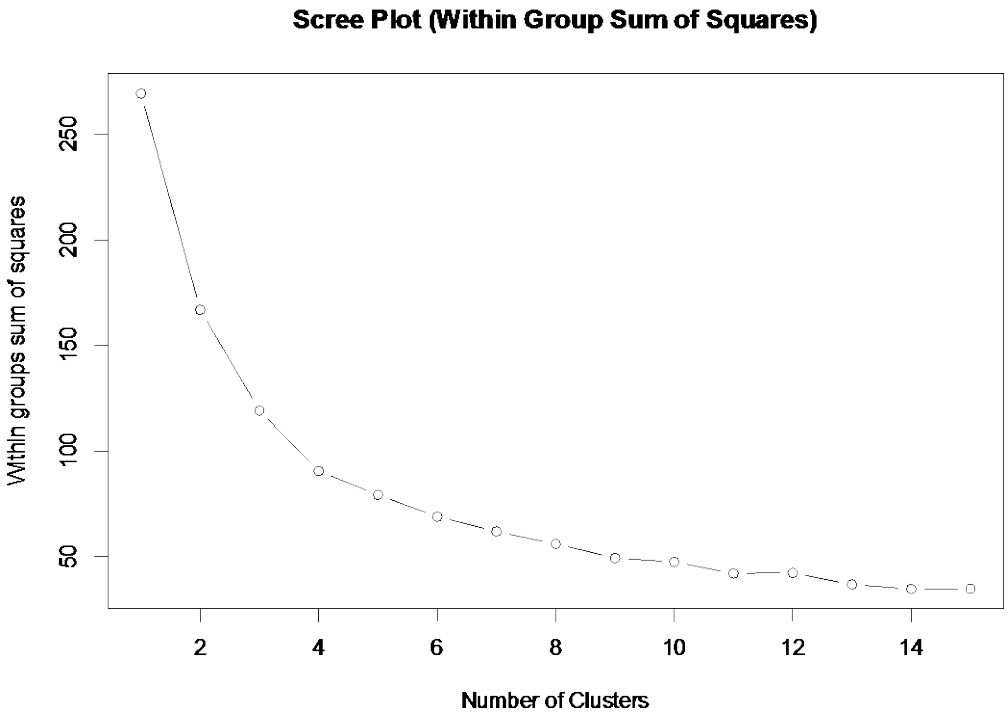

Figure 4. 5 Plot of Within-cluster Sum of Squares

To interpret the clusters, the medoid case for cluster solutions 2, 3, 4, and 5 were examined. The two-cluster solution divided the data into one cluster that could be described as exhibiting solid skills on all three factors (n=70) and one group that could be described as weak skills on all three factors (n=35) (see Table C4 in Appendix C). This two-cluster solution does not provide enough detail to truly distinguish the strengths and weaknesses of the students. The three-cluster solution medoid factor scores (Table C5 in Appendix C) break the group that was fairly solid on all three factor scores into two subgroups: one that continues to exhibit fairly solid scores on all factors (n=38) and one that exhibits weak language skills relative to their phonological awareness scores (n=42), and the third group is similar to the two-cluster solution and exhibits overall weak scores on all factors (n=25).

The four-cluster solution was theoretically sound and provided information that was clinically valid. Table 4.6 provides the factor scores for the medoid cases for the four-cluster

solution. This solution further breaks down the overall weak cluster from solutions two and three into a small group (n=7) that exhibits extremely weak scores on all factors and a second group (n=17) that exhibits relatively weak scores on all factors, but significantly weak phonological awareness. This four-cluster solution converged with solutions created through k-means partitioning and the hierarchical agglomerative clustering demonstrated in the dendrogram, as well as analyses using silhouette width and model based approaches.

Table 4.6 Factor Scores for Medoid Cases in Each Cluster

	Cluster 1 n=43 (41%)	Cluster 2 n=38 (36%)	Cluster 3 n=17 (16%)	Cluster 4 n=7 (7%)
Factor 1: Word Identification	.089	.434	-.227	-2.81
Factor 2: Phonological Awareness	.172	.665	-1.33	-1.04
Factor 3: Language	-.300	.806	-.581	-2.33

Though the four-cluster solution appeared to be the most parsimonious solution, the five-cluster solution scores were also evaluated. This solution (Table C6 in Appendix C) further broke down the cluster that included cases that were solid on all factors into one that continued to exhibit solid skills on all factors (n= 29) and one that exhibited solid word identification and language, but relatively weak phonological awareness (n=16). This solution did not offer additional information regarding clinical relevance, because evidence indicates that many adolescents exhibit persistent phonological awareness difficulties even as word recognition improves, and they rarely attain the level of phonological awareness of their non-struggling peers (Bruck, 1992; Fawcett & Nicolson, 1995). Furthermore, evidence suggests that reading skills do not improve as a result of phonological awareness intervention in adolescence (Kamil et al., 2008). Thus it appears the language and literacy profiles of the adolescent struggling readers in this study are best described using four clusters. Figures 4.6 and 4.7 depict a three-dimensional image of the four-cluster solution from two viewpoints.

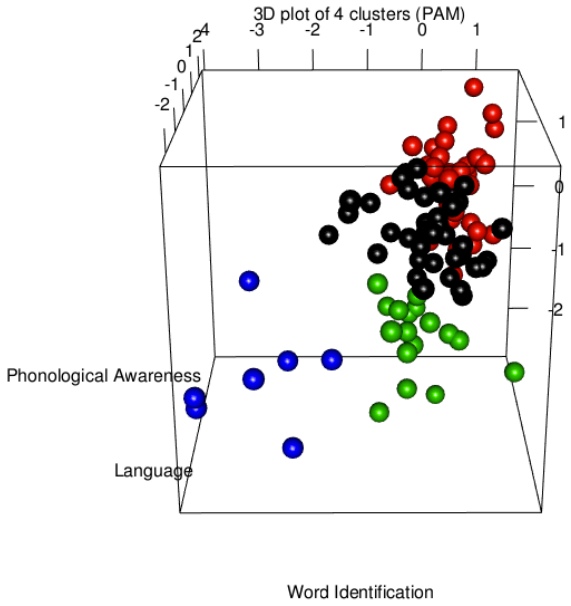

Figure 4. 6 Three-dimensional Image of the Four Clusters

Note. Cluster 1 is represented in black; cluster 2 is red; cluster 3 is green; cluster 4 is blue

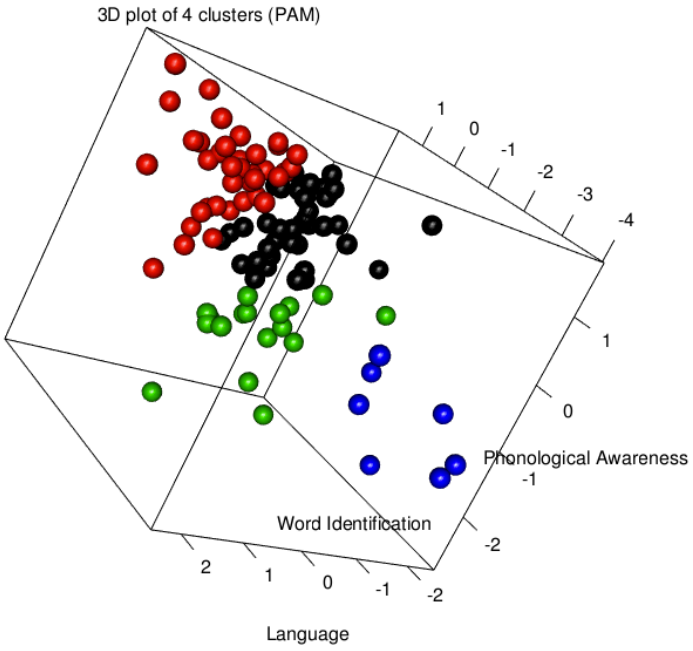

Figure 4.7 Three-dimensional Image of the Four Clusters

Note. Cluster 1 is represented in black; cluster 2 is red; cluster 3 is green; cluster 4 is blue

Relative Strengths and Weaknesses within Groups of Struggling Readers

The four-cluster solution indicates distinct profiles of strengths and weaknesses. These distinct profiles were examined further to address the third research question, *What reading strengths and weaknesses are identified for each profile?* The largest cluster represents 41% of the participants and appears to characterize students with weak language skills relative to word identification and phonological awareness. The next largest cluster represents 36% of the participants and is comprised of students with solid scores on all factors and relative strengths in the language factor within their own profiles. The third cluster represents 16% of the sample population and is characterized by students with relatively weak word identification and language skills, but very weak phonological awareness skills. The smallest cluster represents less than 7% of the sample and is characterized by considerably weak scores on all factors.

Differences Across Groups

In addition to examining the medoid factor scores in order to identify the relative strengths and weaknesses of the cases within each of the four clusters, the variable medians were examined for all cases in each cluster to address the fourth research question, *On what variables do groups differ significantly?* Table 4.7 presents the median standard scores by variable for the cases in each cluster. The median variable scores replicate the cluster strengths and weaknesses. The medians for variables in Cluster 1 (weak language relative to phonological awareness and word identification) are weakest on the toalwd and celfusp. The medians for variables in cluster 2 are all strong. The cases in this cluster exhibited the highest medians for all measures with the exception of the orthographic awareness measure, tocwc. The medians for variables in cluster 3 were all weak with very weak medians for phonological awareness. These students exhibited similar median scores on the language measures as cluster 1, but also exhibited significantly

weak phonological awareness median scores. The medians for word identification measures in cluster 3 were similar to those in cluster 1, with the exception of the tocwc measure. Thus it appears that these students in cluster 3 have compensated for weak phonological awareness skills with strong orthographic awareness skills. The medians for variables in cluster 4 are very weak for all variables. The median phonological awareness scores were similar to the medians for cluster 3, but the students in cluster 4 also had very weak median scores for orthographic awareness, real- and pseudo-word reading, morphological awareness, and listening comprehension. The medians for receptive oral vocabulary for Cluster 4 suggest it is a relative strength for the students in the cluster, but not in comparison to the other clusters.

Table 4. 7 Group Medians by Variables *(standard scores except where noted)*

Factor	Variable	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Factor 1 Word Identification	Towresw	87	92	85	61
	Towrepde	89	94	84	58
	Sort	98	105	91	60
	Tocwc	8	8	11	6
	sublex[a]	35	36	36	30
Factor 2 Phonological Awareness	Ctoppel	9	9	5	4
	Ctoppbw	8	11	4	5
	Ctopppi	7	8	5	4
Factor 3 Language	Toalwd	7	10	7	6
	Ppvt	93	106	92	80
	Celfusp	7	10	7	5

Note. Medians scores are reported because PAM computes the median cases. However, means were also calculated and the results were the same.
[a]The Sub Lexical task was an experimenter designed measure and thus does not have standard scores.

The final step in cluster analysis is cluster validation to provide evidence of the cluster stability. To accomplish this, the k-means partitioning solutions were compared to the results from the PAM method. The cases in each cluster were compared to identify the percentage of cases that were clustered the same in both methods. The two-cluster solution indicated a 94% overlap in cases per cluster, but the two clusters do not provide us with clinically relevant

information, and the two clusters partitioned through k-mean and PAM were quite different than the dendrogram specified (see Appendix, Figure C3). The three-cluster and five-cluster solutions only provided 69% and 62% convergence of cases respectively and also indicated weak convergence with the dendrogram cuts (see Appendix, Figures C4 and C5). However, 88% of the cases were placed in the same clusters for the four-cluster solutions using k-means and the PAM partitioning methods, and this solution converged with the dendrogram cut for four clusters. Figures 4.8 and 4.9 depict the cases in the four clusters for the both partitioning methods. Figure 4.10 depicts the dendrogram with cuts for four clusters and the cases highlighted for the four-cluster solution using the PAM method. These figures illustrate the stability of the four-cluster solution.

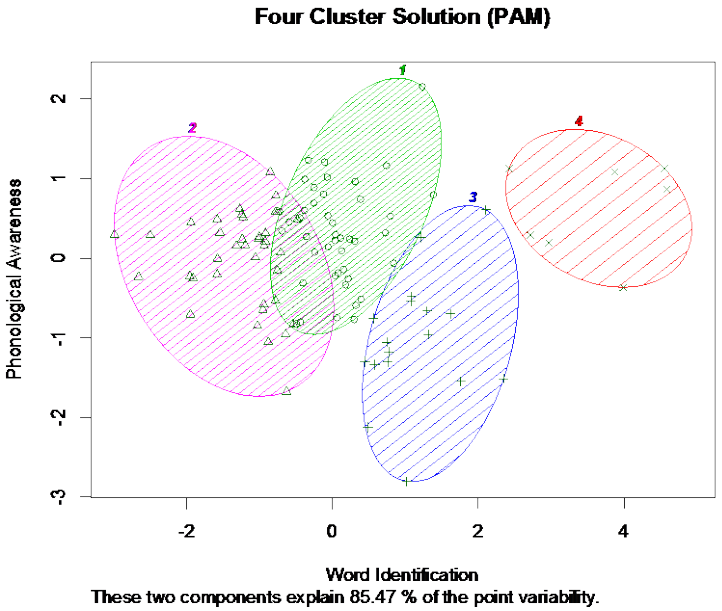

Figure 4. 8 Two-dimensional Plot of the Four-cluster Solution (PAM)

Note. It appears that the clusters overlap, because of the two-dimensional nature of this plot. The z-axis for the language factor is not shown in this plot, but if the third-dimension could be added it would show that the factors separate from one another along that factor.

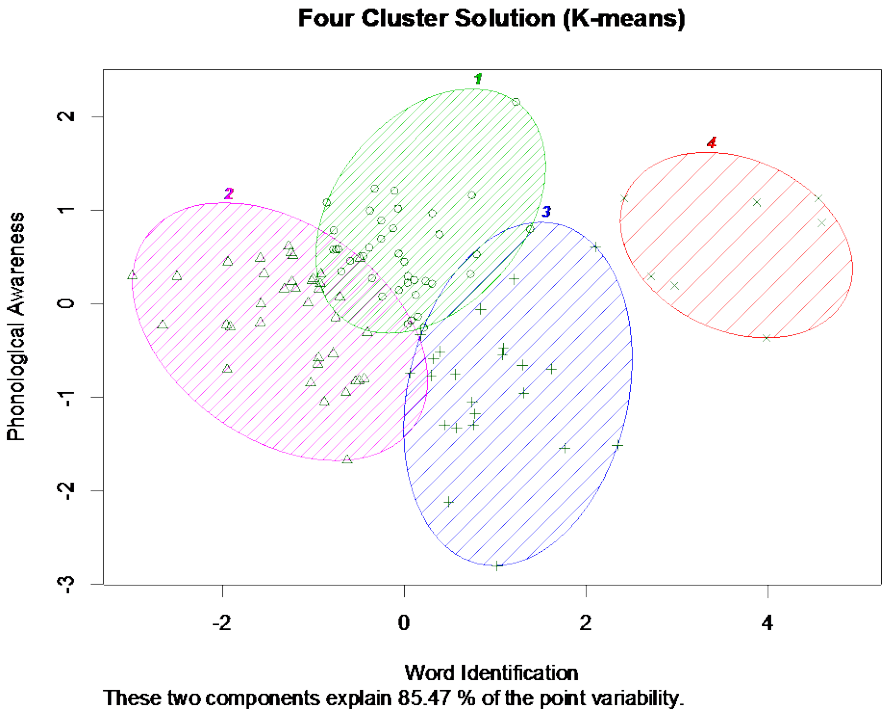

Figure 4. 9 Two-dimensional Plot of the Four-cluster Solution (k-means)

Note. It appears that the clusters overlap, because of the two-dimensional nature of this plot. The z-axis for the language factor is not shown in this plot, but if the third-dimension could be added it would show that the factors separate from one another along that factor.

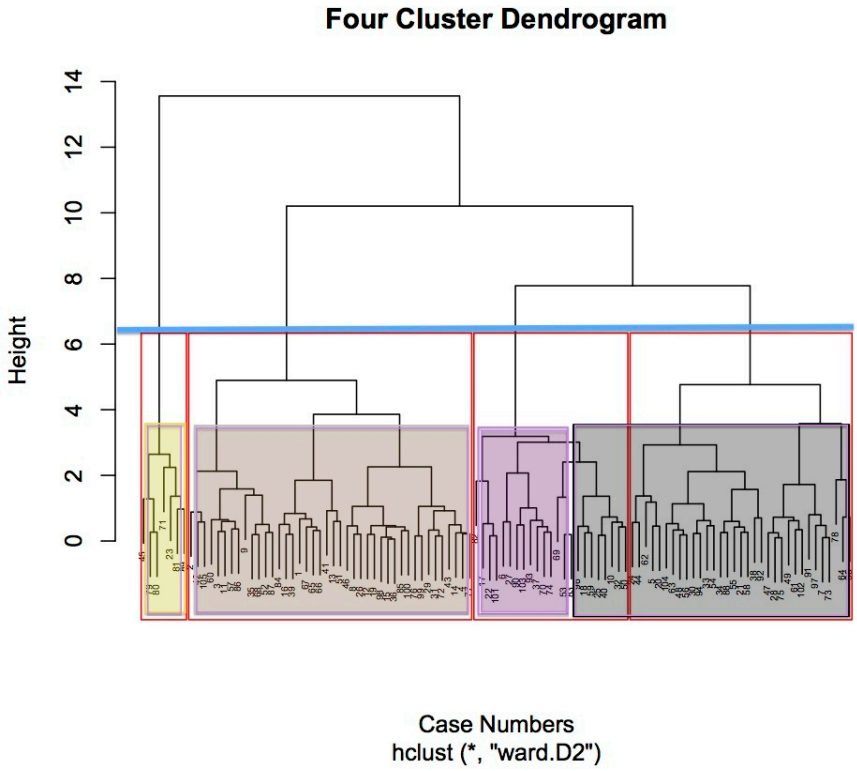

Figure 4. 10 Dendrogram Exhibiting Four-cluster Solution

Note. The cut height is indicated by the blue line for the four clusters on the dendrogram. The shaded rectangles represent the four clusters based on PAM partitioning.

Summary

The results of the factor analysis and cluster analysis for this data indicated that the language and literacy skills of adolescent struggling readers are best characterized as four heterogeneous groups with varied profiles of strengths and weaknesses regarding word identification, phonological awareness, and language. A hierarchical cluster analysis using Ward's method produced four clusters with notable differences between variables. The four-cluster solution portrayed interpretable profiles from an educational and theoretical perspective, and examination of the scores on assessments within each cluster provide important, actionable information that can guide instructional decisions and program development.

CHAPTER 5: DISCUSSION

The purpose of this study was to identify language- and literacy-related profiles of adolescents who struggle with reading. The results of this study indicated that adolescents who struggle with reading are not a homogeneous group. Examination of mean scores for participants in this study indicated overall average abilities across a battery of measures of language, metalinguistic, and reading skills, but the individual profiles indicated clear strengths and weaknesses with some median scores within factors falling well below average. The language and literacy variables in this study were best described by three factors named word identification, phonological awareness, and language. Four clusters based on the scores for these factors best represented the sample. Each of the four clusters exhibited different profiles of strengths and weaknesses regarding the median scores on each factor and observed scores of each of the language and literacy measures. This study confirms the need to examine adolescent struggling reading in a more sophisticated, detailed manner. Recognition of clusters of students that exhibit similar strengths and weaknesses will help to understand the complexities of their needs and thus deliver appropriate interventions. A one-size-fits-all intervention program for adolescent struggling readers is likely to fail for many students who exhibit a profile that is disparate from the profile for which the intervention was designed (Berninger et al., 2002).

Cluster Evaluations and Implications for Instruction

This study identified three factors that described the eleven language and literacy variable measures that were assessed directly. The word identification factor included the measures of real and pseudo-word reading and orthographic awareness. The phonological awareness factor

included the three measures of phonological awareness. The language factor included the measures of oral receptive vocabulary, listening comprehension, and morphological awareness.

Cluster 1: Weak language relative to phonological awareness and word identification. In this study, the students in cluster 1 exhibited weak language relative to their phonological awareness and word identification scores. Within the language factor, they were especially weak on listening comprehension and morphological awareness. The students in this cluster represented a profile of students with weak language comprehension in spite of good decoding. According to the simple view of reading (Gough & Tunmer, 1986), these students will likely struggle with reading comprehension because they are struggling with language comprehension which is one of two critical components of reading. Additionally, the relatively weak morphological awareness skills may affect their overall word reading ability (Carlisle & Stone, 2005), especially when decoding morphologically complex words in more complex texts (Goodwin & Gilbert, 2013). It is quite possible that the students in this cluster exhibited early language difficulties that were not identified (Snowling et al., 2000).

Interventions for students with weak language skills relative to phonological awareness and word identification like those in cluster 1 should focus on improving language comprehension both with text-based listening- and reading-based tasks. Instruction should be explicit (Biancarosa & Snow, 2006) and use evidence-based comprehension strategies (e.g., see Edmonds et al., 2009). These evidence-based approaches include instruction in higher-level thinking about text that should be emphasized to develop critical thinking skills (Carnegie, 2010), and tasks such as critiquing texts, making comparisons between points of view, and synthesizing information, which can help to develop critical thinking skills whether presented

through listening to text or reading text (Carnegie, 2010). Additionally, specific language structures, like inferences, should be explicitly taught (Perfetti et al., 2005).

Cluster 2: Strong on all factors. Students in cluster 2 exhibited overall solid scores on all factors in comparison to the other clusters. However, analysis of the variable median scores indicated relative strengths on the language and phonological awareness variables, but relative weaknesses with orthographic awareness and word identification on timed reading tasks. It is possible that these students were identified as struggling readers by their teachers based on oral reading fluency measures, which require them to read text with speed and accuracy. Additionally, it is possible that students in this cluster exhibit difficulties with reading comprehension despite solid listening comprehension skills because of reading-related skills other than decoding and language comprehension such as the print processing beyond word identification skills described by Cunningham (1993). Listening comprehension is a measure of written language comprehension, but reading comprehension differs from listening comprehension because reading also requires decoding words and processing print. Furthermore, some students in cluster 2 may have been identified as struggling readers based on skills unrelated to reading and language, such as gender (Shaywitz, et al., 1990) or English language learner status (Fletcher & Navarrete, 2003).

Based on relative weaknesses with orthographic awareness and word identification on timed reading tasks, the students in cluster 2 would likely benefit from utilizing their solid language skills to improve their word identification. Recommended strategies include utilizing morphological awareness and focusing on grapheme-morpheme correspondences rather than grapheme-phoneme correspondences to decode multi-syllabic words (Nagy et al., 2003). Importantly, these word-reading strategies should be addressed concurrently with reading

comprehension tasks, like those suggested for students in cluster 1, to ensure the new skills are applied to reading as intended.

Cluster 3: Very weak phonological awareness with relatively weak word identification and language. Students in cluster 3 exhibited very weak phonological awareness skills, with relatively weak word identification and language. However, these students exhibited strong orthographic awareness skills. It appears that the strong orthographic awareness skills positively affected their word reading in spite of weak phonological awareness skills (Roman et al., 2009). The relatively weak word identification skills may indicate that the students in this cluster are struggling to decode the more complex words in adolescent text. Though the students in this cluster exhibited weak phonological awareness skills, remediation of these skills may not be warranted, due to the strong orthographic awareness skills and lack of evidence for benefits of phonological awareness intervention in adolescence (Kamil et al., 2008).

Intervention for students in this group should focus on utilizing their orthographic awareness strengths to improve real-word reading. Like students in cluster 2, it is recommended that word reading strategies focus on grapheme-morpheme correspondences rather than grapheme-phoneme correspondences to decode multi-syllabic words. Taking a morpheme-based approach that includes additional morphological awareness activities (see Pacheco & Goodwin, 2013) has the added benefit of helping to improve vocabulary while addressing word identification skills. Because students in cluster 3 exhibit weaknesses in word identification and language, age-level text will likely be challenging both in reading and listening tasks. Thus, it is recommended that text used to teach reading comprehension and listening comprehension be carefully matched to the student's reading and listening levels respectively.

Cluster 4: Very weak across word identification, phonological awareness, and language. The students in cluster 4, representing less than seven percent of the total sample, were characterized as exhibiting very weak skills across all factors and variables. Students in cluster 4 exhibited specific weakness in word reading associated with poor phonological abilities, despite relative strengths in oral vocabulary. Limited research is available regarding effective reading interventions for adolescent students with profiles similar to the students in cluster 4. However, Vaughn et. al (2012) demonstrated that intensive, small group interventions focused on phonics, word reading, fluency, vocabulary, and comprehension effectively improved reading comprehension for middle school students who had been weak responders to previous reading interventions. Moreover, studies with upper elementary struggling readers indicated that interventions focused on multiple reading components were more effective than interventions that focused on only one reading component (Wanzek et al. 2010). Thus, students in cluster 4 may benefit from intensive, explicit instruction with trained teachers who understand persistent reading difficulties.

Summary of Cluster Descriptions

The four clusters represented a range of strengths and weaknesses. Each of the profiles represented by the clusters is associated with different implications for intervention. While some interventions required substantial focus on improving language comprehension, others required specific word reading strategies or a combination of the two. Understanding these general profiles supports the creation of profile-specific intervention programs and packages rather than general intervention packages that address the needs of only a portion of adolescent struggling readers.

Importance of Language

The results of this study highlighted the large percentage of adolescent struggling readers who exhibited language comprehension difficulties and underscored the importance of language comprehension measures for identifying struggling readers. Nearly 64% of this sample of adolescent struggling readers demonstrated weaknesses in language. This finding is similar to the findings of Buly and Valencia (2002) who found that 58% of the fourth grade struggling readers in their study exhibited weaknesses in language and meaning. Likewise, Hock (2009) found that 61% of the eighth and ninth graders in their study exhibited weak vocabulary, fluency, and comprehension. A large portion of the students in this study exhibited language comprehension difficulties that seemed to supersede difficulties in phonological awareness and word identification. It is likely that weaknesses in language comprehension were present in early elementary school years, but may have been unidentified. Retrospective studies indicate that adolescents with poor comprehension exhibit early language difficulties in grammatical understanding, listening comprehension and inferential skills, but the magnitude of the differences in reading comprehension skills was less pronounced in earlier school years so it was harder to detect (Catts et al., 2006). The inclusion of language comprehension measures in assessments to identify struggling readers is critical to identifying these students early. Moreover, it is important to include text-based comprehension activities and higher-order language activities in reading instruction and general language interventions for school-aged students.

Importance of Metalinguistic Skills

Due to extensive research on the importance of phonological awareness to early reading and more recent research on the increasing importance of morphological awareness and

orthographic awareness to later decoding, measures of these metalinguistic skills were included in this study. These metalinguistic skills were important variables in differentiating among the profiles of the adolescent struggling readers in this study. Orthographic awareness measures loaded onto the factor that contained real- and pseudo- word reading measures. The morphological awareness measure loaded onto the factor with listening comprehension and oral vocabulary. And the three phonological awareness measures formed one factor. All three metalinguistic skills contributed to the profiles for each cluster.

Phonological awareness. In the current study, the three measures of phonological awareness loaded onto one factor that was separate from word identification and language and accounted for 12% of the total variance for the three factors. Students in clusters 3 and 4, representing a combined 23% of the sample, exhibited considerably weak phonological awareness skills. However, the students in cluster 3 exhibited concurrently strong orthographic awareness skills and low average word identification despite the considerably low phonological awareness skills. In contrast, the students in cluster 4 exhibited weak orthographic awareness skills and weak word identification in addition to their weak phonological awareness skills. Thus the effect of the weak phonological awareness skills on the students' word identification varied between the two clusters. For students in cluster 3, intervention for phonological awareness is not warranted because these students developed strong orthographic awareness skills either to compensate for or as a result of the persistent phonological weaknesses that are characteristically noted in some adolescent struggling readers (Bruck, 1992; Fawcett & Nicolson, 1995). Moreover, phonological awareness interventions with adolescent struggling readers have not been found to effectively improve word reading (Bhat et al., 2003). Thus, the students in cluster 3 will likely benefit from using their relatively strong orthographic awareness skills to

decode multisyllabic words utilizing a syllable or morpheme-based intervention approach. On the other hand, students in cluster 4 would likely benefit from interventions that include multiple reading components, including structural analysis of multi-syllabic words for word identification (Bhattacharya & Ehri, 2004) and reading comprehension strategies (e.g., see Edmonds et al., 2009; IRA, 2001).

Morphological awareness. Unlike phonological awareness skills, morphological awareness skills continue to develop well into adolescence (Nagy et al., 2006) and have an increasing role in decoding and reading comprehension beyond early elementary school years (Mann & Singson, 2003). Morphological awareness skills are highly associated with success in decoding morphologically complex words (Goodwin & Gilbert, 2013) and reading comprehension (Carlisle, 2000). In the current study, one measure of morphological awareness was administered. The morphological awareness assessment loaded with oral receptive vocabulary and listening comprehension onto the language factor, but was also significantly correlated with the word reading measures. Students in clusters 1 and 3 scored low average on the morphological awareness measure. These students also exhibited low average word identification and language comprehension. Students in cluster 4 exhibited below average morphological awareness scores and below average word identification and language comprehension. Thus, students in clusters 1, 3, and 4 would likely benefit from strengthening morphological awareness skills, specifically focused both on the connection between morphemes and word identification and the connection between morphemes and vocabulary.

Orthographic awareness. Like morphological awareness, orthographic awareness skills continue to develop into adolescence (Berninger et al., 2010) and are correlated with decoding and reading comprehension (Cunningham, et. al, 2001; Roman et al., 2009). The

current study used two measures of orthographic awareness: a norm-referenced, lexical task that examined orthographic awareness in real words and an experimenter-adapted, sub lexical task that examined orthographic awareness in pseudo-words. These two measures loaded onto the word identification factor with real and pseudo-word reading measures. Both tasks correlated significantly with word reading, but not phonological awareness. The lexical task assessed knowledge of rare spelling patterns in real words. The median scores on the lexical task were low average for two clusters, below average for one cluster and high average for one cluster. The sub lexical measure was an experimenter-adapted measure with a total of 38 items that assessed common spelling patterns. With the exception of cluster 4, the students performed well on this measure. Thus it appears that adolescent struggling readers in this sample exhibited stronger orthographic awareness for common spelling patterns, as measured by the sub lexical assessment, than rare orthographic patterns in real words.

Across the clusters, orthographic awareness was the strongest skill while morphological awareness was low average or below average in three of the four clusters and phonological awareness was very low in two of the clusters. All three metalinguistic skills contributed to the understanding of the strengths and weaknesses of the adolescent struggling readers in this sample. The scores differed between clusters, which helped to distinguish the profiles of strengths and weaknesses for each cluster.

Importance of Word Identification

In this study, the word identification factor accounted for half of the total variance across the three factors. This is similar to the finding by Dennis (2013) that nearly one third of the total variance in weak standardized reading scores was accounted for by weak decoding. Similarly, Buly and Valencia (2002) demonstrated that 40% of fourth graders who struggled with reading

comprehension also struggled with decoding. The median factor scores for word identification differed across the clusters, with cluster 4 factor scores indicating extremely weak word identification. Though the median standard scores for students in cluster 2 were within average, the scores on the timed reading task for this group were relatively weak. The median pseudo-word reading score for students in cluster 3 was below average, but difficulty in pseudo-word reading for adolescent struggling readers is not necessarily associated with weak reading comprehension skills in adolescents (Lesaux & Kieffer, 2010; Savage, 2006). The students in cluster 3 seemed to compensate for weak phonological awareness and pseudo-word reading skills with high average orthographic awareness skills (Savage, 2006). It is important that word reading difficulties are addressed in classroom instruction or interventions and should consist of decoding multi-syllabic novel words across content areas (Archer et al., 2003). Many of the struggling adolescent readers in this sample would benefit from instruction that used a structural analysis approach focused on the associations of metalinguistic skills to decode multi-syllabic words (Nagy et al., 2006).

In summary, the factors of word identification, phonological awareness, and language explained 54% of the variance in this sample of adolescent struggling readers. These factors measured foundational skills for reading and scores varied across clusters, but not all aspects of reading were assessed. Some of the unexplained variance may be due to difficulties with higher order language and cognitive skills required for reading comprehension. For example, verbal working memory, inferential skills, comprehension monitoring, and integration of information have all been found to be weak in some students with poor comprehension (Cain & Oakhill, 2006) but were not assessed in this study. Additionally, reading fluency is known to be well correlated with overall reading skills (Fuchs, Fuchs, Hosp, & Jenkins, 2001). Thus measures of

fluency in meaningful text and higher-order language skills, like inferencing, may have explained more variance in the sample. However, the foundational skills that were measured provided good information on the strengths and weaknesses of these students.

Similarities and Differences to other Studies of Adolescent Struggling Readers

The current study extends our knowledge regarding the profiles of strengths and weaknesses among adolescent struggling readers. This study indicated that 64% of the struggling readers exhibited a language weakness. This percentage is similar to those reported by Buly and Valencia (2002) and Hock (2009). Additionally, seven percent of the students in this study exhibited extremely weak skills on all factors, which is similar to the nine percent reported by Buly and Valencia. However, there are several differences between the current study and previous studies examining the profiles of adolescent struggling readers. First, the current study did not specifically target urban, minority, and low SES students. Second, the students in this study were not chosen based only on scores of standardized assessments, but were also considered struggling readers based on teacher recommendations. As a single group, the students in this study exhibited mean language and literacy scores within average. Thus, it appears that the overall skill level of the students in this study were stronger than other similar studies; however, the distinct clusters that emerged suggest that the average mean scores were the result of students scoring relatively high and low on different measures. Third, the current study used two measures that examined word identification on a timed task, but these measures formed a factor with other word identification measures and orthographic awareness. Additional measures of reading fluency for connected text were not included in this study. Previous studies examining the reading profiles of adolescent struggling readers included several measures of reading rate in connected text and these measures formed a factor that they labeled fluency. The

fluency factor accounted for approximately 11 percent of the variance in previous studies (e.g., Dennis, 2013). Had a similar measure been included in the current study, it is possible another factor may have been identified and/or other clusters may have emerged. Finally, the current study included measures of metalinguistic skills that proved to be helpful in differentiating the profiles. In fact, the phonological awareness measures loaded onto one factor and accounted for 12 percent of the total variance.

Limitations

The conclusions to this study are restricted to the sample collected due to limitations inherent in factor analysis and cluster analysis procedures, as well as sampling procedures and the selection of measures. Though measures of sampling adequacy indicated a large enough sample, exploratory factor analysis is a large sample procedure with some researchers recommending at least 300 participants and at least a 20:1 ratio between number of participants and variables (Comrey & Lee, 1992). Furthermore, results of exploratory factor analysis are more generalizable if the distributions are normally distributed. Thus, a larger sample with more normally distributed variables is desirable.

There were also limitations related to the cluster analysis. For example, different criterion for measuring distances and merging clusters may give different clustering results. Additionally, dropping cases will change the clusters. This study tried to account for these limitations by seeking convergent validity on the four-cluster solution and use of factor scores to create the clusters rather than creating clusters directly from variable scores. Finally, the use of partitioning around medoids method rather than partitioning via k-means offered a more robust solution (Tibshirani, 2013). Nonetheless, replication of these findings is needed before generalizing the results.

Future Directions

This study identified four distinct profiles that distinguish among adolescent struggling readers, and it provided new information regarding the importance of metalinguistic skills in the profiles of struggling adolescent readers. To generalize the results of this study, it will be important to replicate the findings with a separate, and potentially larger, group of adolescents. Additionally, techniques like latent class analysis procedures might prove useful in assignment of new members to groups identified.

The assessment battery for this study was lengthy and involved subtests from a variety of test batteries. This is impractical for a classroom teacher to replicate. Thus there is a need to develop and refine assessment tools that identify the appropriate profile for adolescent struggling readers in a shorter time and in a more cost-effective manner. Furthermore, teachers need professional development to gain knowledge regarding the characteristics of adolescent struggling readers, how to connect assessment results to instruction, and how to deliver effective intervention strategies for students with different reading profiles. Specifically, teachers need support to understand the connection between language difficulties and reading and how to improve language comprehension skills of their students who are struggling in this area. Additionally, teachers need to understand how the interrelationships among phonological, orthographic, and morphological awareness can be used to improve word identification (Abbott & Berninger, 1999). Teachers who understand how to develop their students' language skills and word identification will improve the reading achievement of their students.

Additional research and development is required to create and evaluate the effectiveness of intervention packages that address the needs of the four profiles of struggling readers identified in the current investigation. As described above, the extant literature provides some

guidance regarding appropriate, evidence-based approaches, but those approaches have not been combined and evaluated in the ways they are described above.

Conclusion

The results of this study extend our knowledge of characteristics of adolescent struggling readers. Assessing students with measures that provide detailed patterns of strengths and weaknesses in reading can yield educationally relevant information that teachers can use for instruction. This study certainly produced actionable information regarding the profiles of participants. These results indicated that most students struggled primarily with language and secondarily with word identification, but to different degrees across profiles and with varying strengths and weaknesses regarding metalinguistic skills. This study also confirmed that it is critical that assessments of reading contain language comprehension measures in order to identify students who may struggle with reading comprehension despite solid word identification skills. We are just beginning to understand the complexities of adolescent struggling readers, but distinct profiles of strengths and weaknesses are evident such that instruction must be differentiated based on the collective group needs.

APPENDIX A: FIDELITY CHECKLIST

General Administration

	Y/N
Gives general reinforcing comments without giving away correct/incorrect responses	
Record form is hidden from the student	
Keeps the student's interest	
Knows the tests well	
Keeps examinee at ease and on task	
Knows start rules/ basal rules/ stop rules/ ceiling rules	
Comments	

PPVT

	Y/N
Correct test set- up (score form hidden behind picture easel)	
Training Items administered correctly • set up the easel to the training items- **Training Page B** o Pointed to each of the four pictures, and said, **Look at the pictures on this page. Put your finger on the picture that shows *crying*.** If correct, say, Good! If incorrect or no response, drop back to training page A… o **Put your finger on *washing*** o **Now we'll do some more. You can point to the picture or say the number.**	
Begins test at correct set for student's age	
Administers complete sets before moving to next set	
Establishes basal set correctly (tests backwards in complete sets until there are one (1) or zero (0) errors in a set)	
Tests forward to ceiling set (eight or more errors in a set)	
Uses only acceptable prompts (Put your finger on [word], Show me [word], Point to [word], Find [word], Where is [word], What number is [word])	
Scoring- circles student response in record form; slashes 'E' for errors and calculates number of errors per set	
Comments	

TOWRE-2

	Y/N
Subtest 1: Sight Word Efficiency	
• Gives standardized directions	
• Administers practice list	
• Begins timer when student says first word on the test list	
• Times for 45 seconds	
• Draws a line under last word read in 45 seconds	
• Marks record form for incorrect words	
Subtest 2: Phonemic Decoding Efficiency	
• Gives standardized directions	
• Administers practice list	
• Begins timer when student says first word on the test list	
• Times for 45 seconds	
• Draws a line under last word read in 45 seconds	
• Marks record form for incorrect words	
• Knows correct pronunciation of words	
Comments	

CTOPP 2

	Y/N
Subtest 1: Elision	
• Uses standardized directions	
• Gives correct/incorrect feedback through item 14	
• Discontinues testing when examinee misses 3 items in a row	
• Scores 1 and 0s for correct/incorrect responses	
Subtest 2: Blending Words	
• Gives standardized directions then plays track 1	
• Gives correct/incorrect feedback as noted in record form	
• Pauses after playing each track for student to answer	
• Discontinues testing when examinee misses 3 items in a row	
Subtest 3: Phoneme Isolation	
• Uses standardized directions	
• Gives correct/incorrect feedback as stated in record booklet	
• Discontinues testing when examinee misses 3 items in a row	
• Scores 1 and 0s for correct/incorrect responses	
Comments	

TOAL- Word Derivations

	Y/N
Gives directions as stated in record form	
Discontinues testing when examinee misses 3 items in a row	
Scores 1 for correct and 0 for incorrect	
Comments	

TOC- Word Choice

	Y/N
Gives standardized directions	
Says words clearly	
Has student circle answers	
Discontinues testing when student misses three of five consecutive items	
Scores a 1 for correct and 0 for incorrect	
Comments	

SORT

	Y/N
Gives directions: **I want to see how many of these words you can read. Please begin here and read each word aloud as carefully as you can. When you come to a difficult word, do the best you can and if you can't read it, say 'pass' and go on to the next word.**	
Tests backwards by complete lists until student reads a list with zero (0) errors	
Tests forward by complete list until student is unable to read ANY of the 20 words on the list	
Scoring- Adds up all words read correctly for each list	
Comments	

CELF 5- Understanding Spoken Paragraphs

	Y/N
Trial Paragraph	
• Begins with trial paragraph (The Movies) for ages 11-21	
• Says, **listen carefully to what I am going to read to you. Afterward, I will ask you some questions about what I read.**	
• Reads the title of the trial paragraph	
• Reads the trial paragraph at a conversational level	
• Reads associated questions in Record Form	
Test Paragraphs	
• Reads the age- appropriate test paragraph (11-12 or 13-14 or 15-21)	
• Says, **Now listen carefully to the next paragraph. I can read it only one time. Remember, I will ask you questions about it.**	
• Reads title of paragraph first	
• Reads test paragraph at conversations level and rate	
• Reads associated questions	
• Scores a 1 for correct response and 0 for incorrect response	
Comments	

Sub Lexical Choice Task

	Y/N
Says, **for this activity, I will show you two words. You will not recognize either word because they are not real words. Based on what you know about how words are spelled, circle the word that looks most like a real word.**	
Practice Item	
• Says, **look at the two words next to the first star. You don't need to read them. Just show me, which of those words looks most like a real word** • **DOES NOT SAY THE WORDS**	
• Gives corrective feedback	
Test Items	
• Says, **Now, I want you to do the same thing for the other items. For each pair of words, look at the words and circle the word that looks most like a real word.**	
• Scores a 1 for correct and 0 for incorrect	
Comments	

APPENDIX B: SUB LEXICAL ASSESSMENT

Nonlexical choice task
Student Form

* zeg zzeg

1.	abbe	akke	20.	miggle	miggel
2.	ttunos	tunoss	21.	ddaled	dalled
3.	earp	rp	22.	tebif	tebiff
4.	viss	viww	23.	ckak	kak
5.	foll	ffol	24.	kadder	kaddr
6.	latt	llat	25.	pringk	prink
7.	sek	seck	26.	sckap	skap
8.	yyatuf	yatuff	27.	sloo	slaa
9.	noop	niip	28.	crid	krid
10.	tible	tibl	29.	muun	meen
11.	ckug	cug	30.	gignl	gignal
12.	datch	dach	31.	pirst	prst
13.	kr	ker	32.	cappel	capple
14.	langk	lank	33.	rach	ratch
15.	pibble	pibbel	34.	duddl	duddle
16.	chacke	chake	35.	angk	ank
17.	krasp	crasp	36.	wosill	wwosil
18.	jaat	jeet	37.	haak	heek
19.	sutter	suttr	38.	zuck	zuk

APPENDIX C: TABLES AND FIGURES

Table C1

Skewness and kurtosis values for each variable (N=105)

Variable	Skewness	St. Error	Ratio	Kurtosis	St. error	Ratio
toalwd	1.164	0.236	4.932	1.418	0.467	3.036
tocwc	1.650		6.992	1.874		4.013
sublex	-1.531		-6.488	3.403		7.287
ctoppel	-0.529		2.242	-1.010		-2.163
ctoppbw	-0.805		-3.411	0.041		0.088
ctopppi	-1.419		-6.013	2.224		4.762
towresw	-1.516		-6.424	4.281		9.167
towrepde	-0.548		-2.322	-0.022		-0.047
sort	-2.144		-9.085	5.327		11.407
ppvt	-0.144		-0.610	0.383		0.820
celfusp	-0.721		-3.055	0.346		0.741

Note. towresw =TOWRE-2 Sight Word; towrepde =TOWRE-2 Phonemic Decoding; sort =SORT-R3; tocwc =TOC Word Choice; sublex =Sub Lexical Orthographic Awareness Task; ctoppel = CTOPP-2 Elision; ctoppbw =CTOPP-2 Blending Words; ctopppi =CTOPP-2 Phoneme Isolation; toalwd =TOAL Word Derivation; ppvt =PPVT; celfusp =CELF-5 Understanding Spoken Paragraphs

Table C2

Factor Loadings and Communalities (h2) for Exploratory Factor Analysis with Promax Rotation: Two Factor Solution

Variable	Component 1	Component 2	Communality (h2)
Towresw	**.88**	-.05	.73
Towrepde	**.78**	.09	.69
Sort	**.80**	.24	.89
Tocwc	**.45**	-.03	.19
Sublex	**.61**	-.10	.33
Ctoppel	.24	**.42**	.34
Ctoppbw	-.10	**.70**	.43
Ctopppi	.00	**.54**	.29
Toalwd	.17	**.46**	.32
Ppvt	.09	**.69**	.55
Celfusp	-.07	**.46**	.18
proportion variance	.25	.18	
cumulative variance	.25	.43	

Note: Factor loadings > .40 are in boldface. Toalwd =TOAL Word Derivation; tocwc =TOC Word Choice; sublex =Sub Lexical Orthographic Awareness Task; ctoppel = CTOPP-2 Elision; ctoppbw =CTOPP-2 Blending Words; ctopppi =CTOPP-2 Phoneme Isolation; towresw =TOWRE-2 Sight Word; towrepde =TOWRE-2 Phonemic Decoding; sort =SORT-R3; ppvt =PPVT; celfusp =CELF-5 Understanding Spoken Paragraphs

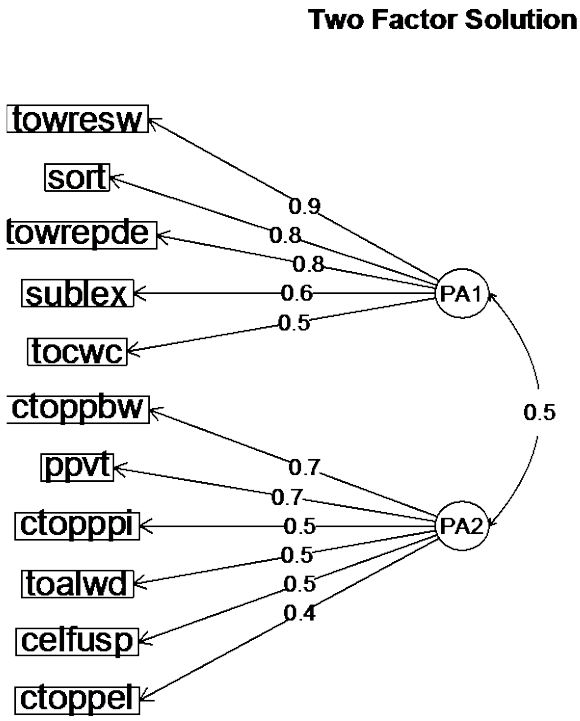

Figure C 1 Diagram of two-factor solution

Note. PA1 =component 1; PA2 =component 2. The numbers on the branches are the rounded loadings. The numbers connecting the components represent a factor loading built into the cut score.

Table C3

Factor Loadings and Communalities (h2) for Exploratory Factor Analysis with Promax Rotation: Four Factor Solution

Variable	Component 1	Component 2	Component 3	Component 4	Communality (h2)
Tocwcrs	**.47**	-.26	.24	.04	.31
Nonlexrs	**.60**	-.08	-.10	.02	.32
Towreswrs	**.89**	-.12	.08	-.03	.73
Towrepders	**.83**	.15	-.17	-.01	.75
Sortrs	**.85**	.18	.01	.03	.90
Ctoppelrs	.31	**.42**	-.09	.10	.40
Ctoppbwrs	-.06	**.79**	-.04	.14	.67
Ctopppirs	.15	**.61**	.27	-.19	.47
Toalwdrs	.05	-.02	.02	**.68**	.50
Ppvtrs	-.03	.10	.21	**.77**	.79
Celfusprs	.08	.05	**.62**	.20	.50
proportion variance	.26	.12	.06	.11	
cumulative variance	.26	.38	.44	.55	

Note: Factor loadings > .40 are in boldface. Toalwd =TOAL Word Derivation; tocwc =TOC Word Choice; sublex =Sub Lexical Orthographic Awareness Task; ctoppel = CTOPP-2 Elision; ctoppbw =CTOPP-2 Blending Words; ctopppi =CTOPP-2 Phoneme Isolation; towresw =TOWRE-2 Sight Word; towrepde =TOWRE-2 Phonemic Decoding; sort =SORT-R3; ppvt =PPVT; celfusp =CELF-5 Understanding Spoken Paragraphs

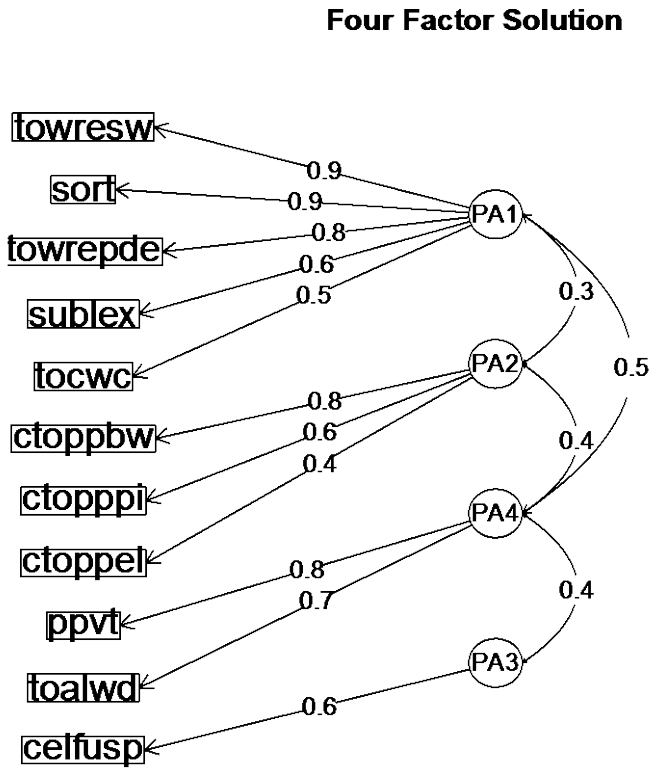

Figure C 2. Diagram of four-factor solution
Note. PA1 =component 1; PA2 =component 2; PA3 =component 3; PA4 =component 4. The numbers on the branches are the rounded loadings. The numbers connecting the components represent a factor loading built into the cut score.

Table C4

Medoid Scores for Two-Cluster Solution (PAM)

	Cluster 1 n=70	Cluster 2 n=35
Factor 1: Word Identification	.390	-.478
Factor 2: Phonological Awareness	.390	-.881
Factor 3: Language	.357	-.408

Table C5

Medoid Scores for Three-Cluster Solution (PAM)

	Cluster 1 n=38	Cluster 2 n=42	Cluster 3 n=25
Factor 1: Word Identification	.434	.089	-.341
Factor 2: Phonological Awareness	.665	.172	-1.09
Factor 3: Language	.806	-.300	-.665

Table C6

Medoid Scores for Five-Cluster Solution (PAM)

	Cluster 1 n=29	Cluster 2 n=32	Cluster 3 n=21	Cluster 4 n=16	Cluster 5 n=7
Factor 1: Word Identification	.434	.151	-.478	.646	-2.81
Factor 2: Phonological Awareness	.665	.468	-.881	-.386	-1.04
Factor 3: Language	.806	-.476	-.408	.415	-2.33

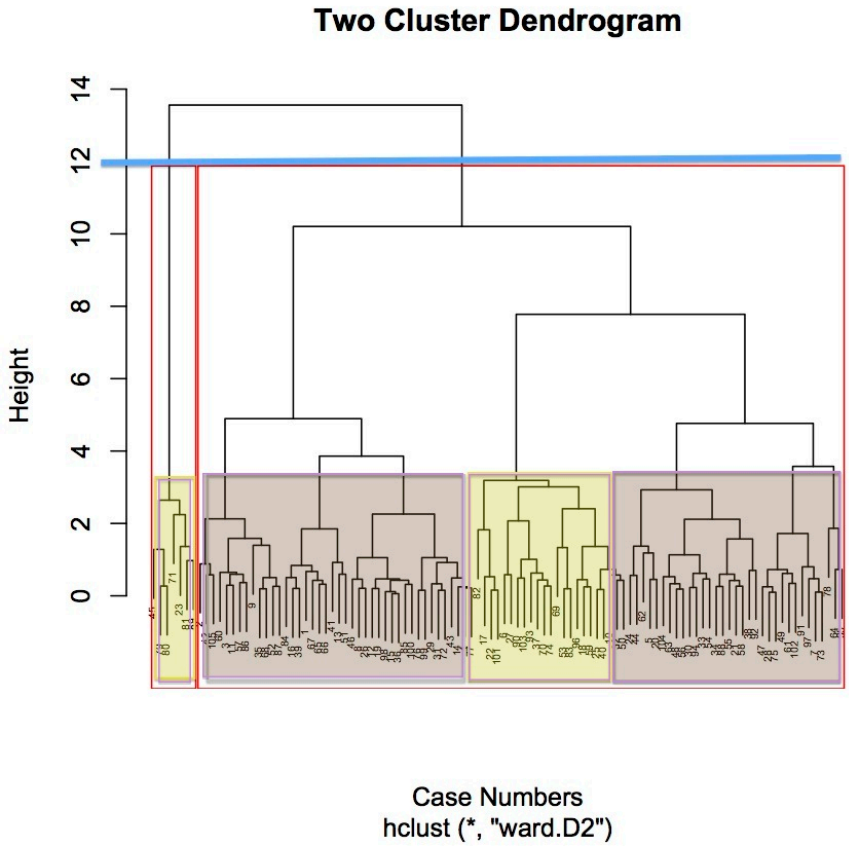

Figure C 3. Dendrogram exhibiting two clusters

Note. The cut height is indicated by the blue line for the two clusters on the dendrogram. The shaded rectangles represent the two clusters based on PAM partitioning.

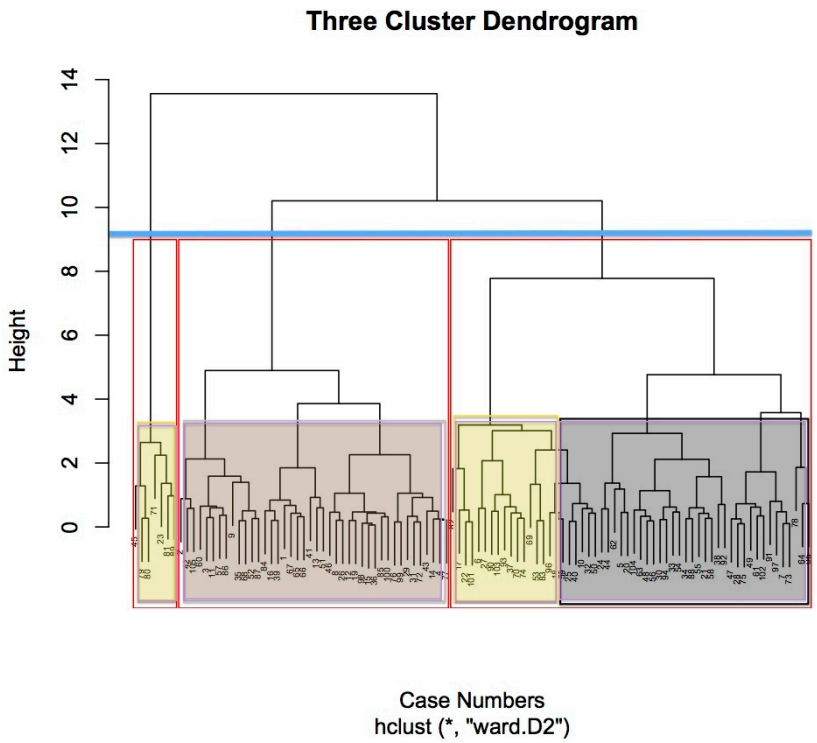

Figure C 4. Dendrogram exhibiting three clusters

Note. The cut height is indicated by the blue line for the three clusters on the dendrogram. The shaded rectangles represent the three clusters based on PAM partitioning.

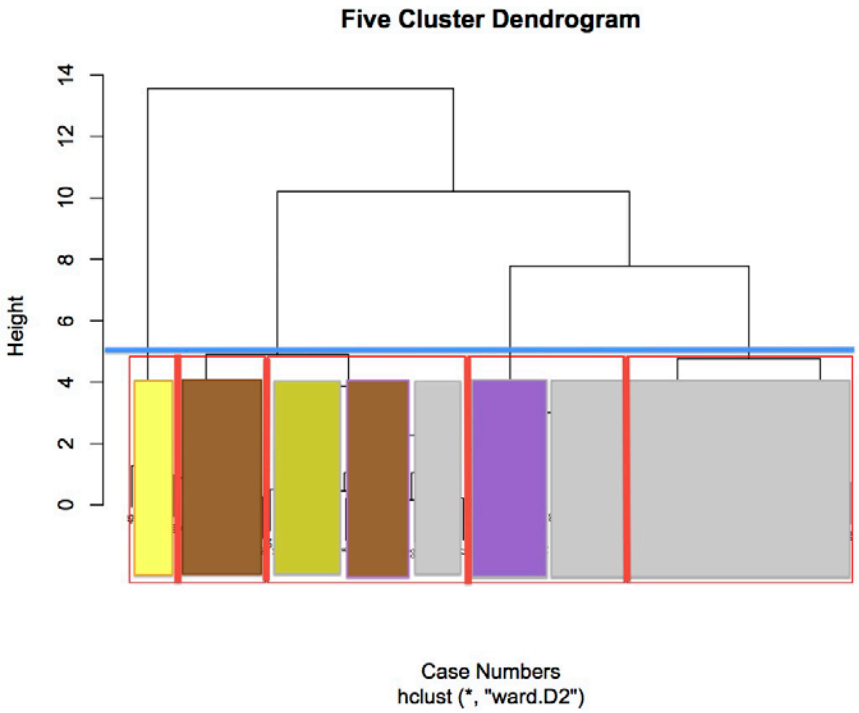

Figure C 5. Dendrogram exhibiting five clusters

Note. The cut height is indicated by the blue line for the five clusters on the dendrogram. The shaded rectangles represent the five clusters based on PAM partitioning.

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