A SPELLING ERROR ANALYSIS OF WORDS WITH CLOSED SYLLABLES FOR
AT-RISK READERS

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Many at-risk readers lack phonemic awareness skills and require explicit systematic instruction to develop these skills (Armbruster, Lehr, & Osborn, 2001; National Reading Panel, 2000). The purpose of this study was to address three questions regarding the spelling error patterns of at-risk readers related to phonemic awareness: 1) Do younger at-risk readers make significantly more phonetically accurate and inaccurate errors than older at-risk readers? 2) Is the proportion of phonetically inaccurate errors greater than proportion of phonetically accurate errors for at-risk readers? and 3) Is the proportion of phonetically inaccurate vowel errors greater than the proportion of phonetically inaccurate consonant errors for at-risk readers? Of particular interest was whether at-risk readers experience significant difficulties processing short vowel information.

To address these questions, data was collected on the spelling error patterns of at-risk readers that occurred during a pretest comprised of words with closed syllable patterns. Sixty-nine at-risk readers in grades one through four participated in the study. All of the subjects were enrolled in a Midwestern city school district summer intervention program for at-risk readers. Participants were administered a spelling pretest consisting of 15 words that contained a limited number of beginning level concepts: 1) initial and final consonants, 2) short vowels, 3) blending of two and three speech sounds, 4) consonant
digraphs, 5) double consonants ff, ll, and ss plus one irregular orthographic pattern (all), and 6) adding the suffix s.

For statistical analyses, grade levels were divided into two groups, younger (grades 1 and 2) and older (grades 3 and 4) at-risk readers. Spelling errors were classified into four main categories: phonetically accurate errors, phonetically inaccurate errors, phonetically inaccurate consonant errors, and phonetically inaccurate vowel errors.

Results showed significant differences between means for younger and older at-risk readers on phonetically accurate errors but not for phonetically inaccurate errors. At-risk readers made a significantly greater proportion of phonetically inaccurate errors compared to phonetically accurate errors. In addition, at-risk readers made a significantly greater proportion of phonetically inaccurate vowel errors compared to phonetically inaccurate consonant errors. Implications of these findings and recommendations are discussed.

Approved: _____________________________________________________________

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CHAPTER ONE

Introduction

Every two years the Department of Education’s National Center of Education Statistics publishes a national report card. This report provides a variety of statistical information to the American public. One topic of grave concern to parents and educators alike is the issue of reading achievement. According to the 2003 National Assessment for Educational Progress (NAEP) report, 69% of fourth graders and 68% of eighth graders were reading below proficient levels (Institute of Education Sciences, 2005b; Toppo, 2003). In 2005, the NAEP report showed that 70% of fourth graders and 71% of eighth graders were reading below proficient levels. These findings indicate the percentages of children reading below proficient levels are increasing rather than decreasing.

Given the rate of reading failure in the United States, literacy has become a primary focus for many school districts across the nation. At the same time, federal budget cuts are limiting educational resources and programs designed to deliver reading interventions to children at-risk for reading failure. As a result, the responsibility of providing quality instruction for at-risk readers falls squarely on classroom teachers. Yet, a recent study conducted by the National Center for Education Statistics revealed that “while 71 percent of the teachers surveyed taught students with disabilities, only 21 percent felt well prepared to meet their needs” (Snow, Griffin, & Burns, 2005, p. 164). Regular education teachers must demonstrate knowledge and skill pertaining to assessment and diagnosis as well as effective instructional strategies to remediate reading difficulties.
Classroom teachers may quickly identify students who are unable to perform on a level commensurate with their peers since poor achievers do not attain satisfactory scores on formative or summative assessments. In particular, at-risk readers frequently perform poorly on spelling assessments. Spelling involves analyzing constituent parts of individual words, and the ability to segment constituent parts of spoken words requires phonemic awareness skills (Adams, Foorman, Lundberg, & Beeler, 1998; Beck, 2006; Henry, 2003). Research reveals that knowledge of correspondences between sounds and their respective spellings predicts the accuracy and speed with which children read single words (Adams, Foorman, Lundberg, & Beeler, 1998; Beck, 2006; Henry, 2003).

Robust evidence also reveals that children at-risk for reading failure present with core deficits in phonemic awareness skills (Adams, Foorman, Lundberg, & Beeler, 1998; Beck, 2006; Ehri & Nunes, 2002). Phonemic awareness is a requisite skill for spelling since spelling involves the manipulation of speech sounds. Recent research reveals that good spellers “use both sublexical and lexical processes” (Norton, Kovelman, & Petitto, 2007, p. 57). Lexical analysis is necessary for words containing irregular letter/sound correspondences, as in the word who; this word must be recognized as a whole unit. In contrast, sublexical processes are employed for words containing regular letter/sound patterns as in the word splash. A sublexical analysis entails segmenting a word into phonemes and the successful performance of this task requires skill in phonemic awareness. Spelling difficulties result when at-risk readers are unable to successfully segment phonemes in words, and this inability may be the direct result of core deficits in phonemic awareness.
Therefore, investigating spelling error patterns in beginning level reading concepts in at-risk readers may provide a means of identifying or diagnosing potential deficits in phonemic awareness. The early identification of spelling difficulties could assist teachers in assessing student strengths and weaknesses relative to phonemic awareness skills. In addition, a proper diagnosis of underlying causes for spelling difficulties may provide valuable information to guide instruction. With a clearer understanding of the primary reasons for specific types of errors, teachers may tailor instruction based on students’ instructional needs.

By examining spelling errors for a discrete number of beginning level reading concepts, it is possible to identify specific phonemic awareness weaknesses in at-risk readers. Early literacy instruction typically involves teaching young children the sound-symbol relationships of the consonants and short vowels in the English language. Short vowel sounds have unique properties that present particular difficulties for many beginning readers. Since short vowels are typically taught at the onset of formal reading instruction, failure to assimilate these concepts may cause students to perceive themselves as incompetent learners. Negative perceptions such as incompetence affect motivation which compounds learning difficulties (Bandura, 1989; Deci & Chandler, 1986). According to Bandura (1989), “cognitive simulations in which individuals visualize themselves executing activities skillfully enhance subsequent performance” (p. 1176). Negative perceptions regarding competence or self-efficacy may be circumvented through appropriate diagnosis and remediation. Therefore, it is critical to examine difficulties in processing linguistic information in a timely fashion. Early identification is
the first step in providing effective instructional intervention. At-risk readers who lack phonemic awareness have need of appropriate and timely instructional intervention to develop these necessary skills.

Background of the Study

Many students who fail to achieve are referred for extensive evaluations to determine the underlying causes of reading failure. Sometimes the acquisition of reading skills is hindered by a lack of cognitive skill. Reading problems may also result from visual or auditory impairments. If a multi-factored evaluation reveals average cognitive abilities and no sensory impairments, reading difficulties are sometimes attributed to a developmental lag. In such cases, teachers and parents are encouraged to give these children the gift of time to catch up with their peers. But if these children do not catch up with their peers, what then?

At-risk Readers/Spellers

Aside from salient conditions such as cognitive inability or serious sensory impairments, the underlying causes for reading difficulties are oftentimes less obvious to the classroom teacher. In cases where a student demonstrates average to above average cognitive abilities and there are no visual or auditory impairments, what possible explanations might be offered for a student’s failure to acquire requisite skills for early literacy?

When young children fail to experience success in reading, failure is attributed to various factors. Indeed, many of these factors are viable explanations for reading difficulties. Family background and/or socioeconomic status may definitely influence
literacy development (Coladarci, 2006; Howard, 2006). Children from impoverished conditions, in which there is little exposure to language or print, frequently lag behind in reading achievement (Catts, Adlof, & Weismer, 2006). Other possible explanations for reading failure may include absenteeism, attention deficit disorders, lack of motivation (Mattison, 2000; Unrau & Schlackman, 2006), class size, insufficient human resources, a developmental lag, or a lack of needed funding to provide special services for at-risk readers (Archibald, 2006). However, failure to appropriately diagnose the root cause of reading difficulties may also contribute to the high percentage of at-risk readers in our nation’s schools.

Assessment Informs Instruction

The early identification of potential reading difficulties is critical for providing appropriate instructional intervention. According to the International Reading Association (IRA, 2004), reading professionals must be able to use varied assessments for the purpose of planning and evaluating instructional practices. In order to appropriately assess effective instruction, teachers must first know what skills are necessary for children to develop early basic literacy skills. Results from a meta-analysis of the National Reading Panel (2000) indicate there are five different skills characteristic of good readers: phonemic awareness, phonics, vocabulary, fluency, and text comprehension. The report of the panel clearly states that explicit instruction is necessary to assist children in the development of these needed skills for reading proficiency. These five skills provide a framework for comprehensive assessment regarding reading achievement.
Knowledge of English Phonology

Of the five skills outlined in the Report of the National Panel (2000), there is no single skill that is more important than the other four. However, this study will focus only on two of the five skills: phonemic awareness and phonics. These are foundational skills that are typically addressed in the primary grades. Research indicates that alphabetic knowledge is one of the best predictors of reading achievement (National Reading Panel, 2000; Shaywitz, 2003; Snow et al., 2005). Some children possess implicit knowledge of phonemic awareness and phonics prior to any formal instruction. Children with implicit phonemic awareness develop the ability to decipher the alphabetic code through multiple literacy experiences (Goodman & Goodman, 1990; Smith, 2004).

However, learning an alphabetic code is often difficult for at-risk learners. Alphabetic knowledge is essential for the acquisition of basic early literacy skills. At-risk readers must not only understand that speech sounds map to printed symbols, they must be explicitly taught to segment and sequence phonemes for the purpose of encoding and decoding (Ehri & Nunes, 2002; Leu, Kinzer, Wilson, & Hall, 2006; Yeh, 2003). Segmenting a stream of speech is not a natural process for young children. Children who lack these requisite skills require explicit, systematic instruction.

Explicit Instruction for At-risk Readers

Despite the pressing need to address the reading failure rate in our nation, reading professionals, teacher educators, and educational theorists remain at odds about how to address code based issues (Moats, 2000b). The reading wars continue to rage in the field of reading instruction. Proponents of whole language prefer analytic phonics; they prefer
a top-down, meaning-based approach to literacy through immersion in a text-rich environment. This method is often referred to as the *look-say* or whole language approach to reading instruction since whole words are the unit of analysis for word identification. One major tenet of whole language is the belief that learning to read is as natural a process as learning to speak (Goodman & Goodman, 1990; Smith, 2004).

Indeed, infants are biologically endowed with an innate language faculty that enables them to naturally develop oral language through repeated exposure to the language of caregivers (Chomsky, 1980; Gopnik, Meltzoff, & Kuhl, 1999). When children learn to speak, they do so by using whole words in meaningful contexts. For this reason, proponents of whole language believe that children will develop literacy skills through exposure to whole words rather than individual phonemes (Goodman & Goodman, 1990; Smith, 2004). Teachers predisposed to this philosophy often prefer a meaning-based rather than skill-based approach to reading instruction.

In contrast, advocates of a bottom-up approach to literacy development favor code-based instructional methods. They believe children need a more direct approach to phonics instruction to gain an adequate knowledge of phoneme-grapheme correspondences. Understanding how individual phonemes map to printed symbols is a foundational skill for sequencing and segmenting speech sounds (National Reading Panel, 2000; Snow et al., 2005; Yeh, 2003). This skill facilitates the decoding and encoding of regularly phonetic words. Decoding skills must be mastered and automatic to efficiently employ the grapho-phoneme cueing system for word identification. Teachers who embrace this philosophy would be more apt to teach phonics directly. This type of
instruction often involves phonics workbooks or worksheets that contain pictures of objects for which children must identify initial, medial, and/or final sounds.

Relative to phonemic awareness skills, at-risk readers frequently have difficulty processing vowel information. In the English language, a vowel forms the nucleus of every syllable; knowledge of vowel sounds is essential for recognizing syllabic units. Of particular interest for this study are the difficulties at-risk readers have in learning the short vowel phonemes in the English language. Short vowel sounds are some of the first concepts taught in beginning reading programs; therefore, children are confronted with these difficult phonemes at an early stage of literacy development. How these difficulties are addressed may be a critical factor in the development of early basic literacy skills.

Statement of the Problem

Young children often experience problems with the auditory processing of short vowel information (Adams, 1991; Adams, Foorman, Lundberg, & Beeler, 1998; Bertucci, Hook, Macaruso, & Bickley, 2003). An inability to accurately process short vowel information may cause reading difficulties at the on-set for formal reading instruction. Words with closed syllables are frequently found in beginning reading programs, and closed syllables contain short vowel sounds. The accurate and fluent decoding and encoding of closed syllable patterns requires the accurate and fluent processing of short vowels. Therefore, it is critical to identify specific linguistic information that poses difficulty for at-risk readers, in order to provide timely and appropriate intervention.
Research Hypotheses

It is the intent of this research to identify difficulties of at-risk readers relative to the processing of linguistic information and more specifically the difficulties related to the processing of short vowel information. To explore this domain related to early basic literacy skills, the following research questions will investigate: 1) phonetically accurate and inaccurate spelling errors and, 2) phonetically inaccurate consonant and vowel errors in younger and older at-risk readers before explicit, systematic instruction.

1. Research hypothesis #1: Younger at-risk readers make significantly greater phonetically accurate and inaccurate spelling errors than older at-risk readers.

Null hypothesis #1: The mean vector of phonetically accurate and inaccurate errors for younger at-risk readers equals the mean vector of phonetically accurate and inaccurate errors for older at-risk readers.

\[
\begin{bmatrix}
\mu_{ya} \\
\mu_{yi}
\end{bmatrix} =
\begin{bmatrix}
\mu_{oa} \\
\mu_{oi}
\end{bmatrix}
\]

where \( \mu_{ya} \) is mean for younger accurate errors
\( \mu_{oa} \) is mean for older accurate errors
\( \mu_{yi} \) is mean for younger inaccurate errors
\( \mu_{oi} \) is mean for older inaccurate errors

2. Research hypothesis: #2: The proportion of phonetically inaccurate errors is greater than the proportion of phonetically accurate errors for at-risk readers.

Null Hypothesis #2: The proportion of phonetically inaccurate errors equals the proportion of phonetically accurate errors for at-risk readers.

Ho: \( \pi_i = \pi_a \)
3. Research hypothesis: #3: The proportion of phonetically inaccurate vowel errors is greater than the proportion of phonetically inaccurate consonant errors for younger and older at-risk readers

Null Hypothesis #3: The proportion of phonetically inaccurate vowel errors equals the proportion of phonetically inaccurate consonant errors.

Ho: $\pi_v = \pi_c$

Significance

The results of this study may be significant for classroom teachers, special education teachers, reading coaches and professional development providers, curriculum directors, publishers of beginning reading curriculums, and researchers. It is important to ascertain what concepts present the most difficulties for at-risk reader. By doing so, those responsible for providing appropriate interventions may make informed judgments relative to the manner in which these concepts are presented. It is critical to secure these concepts in memory before moving on to other complex structures of the English language. (Klatzky, 1975; Shaywitz, 2003).

Investigating the processing of short vowel information is an important subject for further study. It is essential that instructional practice be guided by scientifically based research. Requirements for the approval of novice reading programs or methodologies must be just as rigorous as for pharmaceutical companies establishing the benefits and acceptable use of different medications. Literacy failure is a public health concern; and empirical evidence should inform instructional practice.
Delimitations and Limitations of the Study

1. This study examined the spelling errors of at-risk readers in grades one through four; therefore, the results of the study may only be generalized to at-risk readers in grades one through four from school districts with similar demographics.

2. Data was collected from only one school district; thus the application of findings is limited to school districts that share similar demographics.

3. No claims may be made regarding the effectiveness of explicit, systematic instruction since there was no control group.

4. The instrument used to measure decline in spelling errors had been piloted previously in a very limited sample of 6 at-risk readers in grades K-3.

5. The differences in the number of errors committed before and after the instruction will be limited to the specific instruction used in the study.

6. At risk students were identified based on teachers’ evaluations only and no other criterion were available; the inclusion of at-risk readers was limited to the validity of teachers’ judgments.

Definition of Terms

For the purpose of this study, these terms will be defined accordingly:

1. addition – the insertion of an extraneous phoneme (ex. best for bet) (Moats, 1983)

2. at-risk – “students who require extra support learning to read” (Bursuck & Damer, 2007, p. 321)
3. closed syllable – syllable pattern in which the vowel sound is followed by one or more consonants (ex. *ap*) (Fox, 2005)

4. consonant digraphs – two consonant graphemes combining to form one phoneme (ex. *sh*) (Cunningham, 2005)

5. decoding – the process of synthesizing individual speech sounds to pronounce a word (Cunningham, 2005)

6. explicit instruction – instruction in which letter/sound correspondences of the language are directly taught to students rather than taught opportunistically (pointing out phonic elements in the context of beginning readers (Beck, 2006)

7. encoding – the act of writing or spelling words (Cunningham, 2005)

8. explicit instruction – directly pointing out the relationship between letters and sounds (Beck, 2006)

9. grapheme- written symbol that represents a speech sound (ex. *pit* has three different graphemes: *p, i,* and *t*) (Cunningham, 2005)

10. morpheme – “the smallest meaningful unit of language” (Heilman, 2006)

11. multisensory instruction – instruction in which visual, auditory, kinesthetic, and tactile pathways for learning are employed simultaneously (Henry, 2003)

12. omission – the exclusion of a required phoneme (ex. *bet* for *best* (Moats, 1983)
13. onset – consonant or consonant clusters preceding a vowel (ex. in the word *stamp*, *st* is the onset) (Fox, 2005)

14. orthography – the writing system of a language (Beck, 2006)

15. phoneme – the smallest unit of speech sound (Heilman, 2006)

16. phonemic awareness – sensitivity to the distinctive features of phonemes and the ability to manipulate individual phonemes (Moats, 2007)

17. phonetically accurate error – an error that is orthographically illegal yet a perfectly logical representation of a phoneme (ex. substituting *kw* for *qu*) (Moats, 1983)

18. phonetically inaccurate error – an error that alters the sound of the word (ex. *chruck* for *truck*) (Moats, 1983)


20. pre-conventional error – spelling errors in which a letter name containing the target sound is substituted for the correct grapheme (ex. using *y* for /w/). (Moats, 1983)

21. rime – part of word that includes the vowel and following consonants (ex. in the word *stamp, amp* is the rime) (Fox, 2005)

22. schwa – the sound /ə/ (Rome & Osman, 1993)

23. serial order error – an error in which correct graphemes are in the wrong order (ex. *best* for *bets*). (Moats, 1983)

24. substitution – replacing a required phoneme with another (*best* for *bent*) (Moats, 1983)
25. systematic instruction – a pre-established sequence for the presentation of
letter/sound relationships (Beck, 2006)

Summary

In conclusion, reading failure is a critical issue facing public education. In spite of
the legislated No Child Left Behind Act (2001), a large percentage of American school
children are, indeed, being left behind (Institute of Education Sciences, 2005a; Toppo,
2003). Research reveals that many children at-risk for reading failure present with core
deficits in phonemic awareness. Spelling errors may provide evidence of a deficit in
phonemic awareness; it is believed that a spelling disability points to a linguistic problem
(Moats, 1995b). In addition, spelling errors may point to specific areas of concern related
to the processing of linguistic information. According to the National Reading Panel
(2000), at-risk readers who lack phonemic awareness skills must receive explicit,
systematic instruction to remediate reading difficulties. The following chapter will
investigate what the literature has to say about these important issues.
CHAPTER TWO

Literature Review

There is robust research revealing that struggling readers have core deficits in phonological processing skills (Bertucci et al., 2003; Mann & Foy, 2003; National Reading Panel, 2000; Shaywitz, 2003). Impaired readers often confuse different speech sounds and experience much difficulty with decoding and encoding tasks. These difficulties with reading and spelling are sometimes viewed by educators as the result of a developmental lag.

However, maturation is not the cure-all for reading problems, and failure to address these issues in a timely manner produces negative impacts to self-esteem and self-efficacy. The ability to segment phonemes does not necessarily develop as a result of cognitive maturity or repeated exposures to rhyme. Learning to segment speech sounds develops in the context of learning to read and write an alphabetic language (Henry, 2003; Moats, 1995b; Read, Yun-Fei, Hong-Yin, & Bao-Qing, 1986). At-risk readers have difficulty segmenting a stream of speech into individual phonemes and require explicit instruction to develop this skill (Kavanagh & Mattingly, 1972; National Reading Panel, 2000; Snow, Burns, & Griffin, 1998).

Reading failure is currently a primary concern in our nation. The federal government has invested billions of tax-payer dollars in an effort to solve this problem. For elementary and secondary public education, the United States has the highest per-pupil expenditures in the world, yet 40% of the fourth graders in our country are reading below an acceptable level according the National Assessment of Educational
Performance (Stern, 2007). Even worse, the reading failure rate for inter-city minorities is 65%. It is estimated that out of the learning disabled population in public education, approximately 85% of those students are at-risk for reading failure. A critical step toward solving the problem of reading failure is the early identification of phonemic awareness deficits. Error analysis enables teachers to efficiently evaluate the early basic literacy skills of at-risk readers.

This literature review will address topics related to the analysis of spelling errors in closed syllable patterns among at-risk readers prior to explicit, systematic instruction in phonemic awareness. Four topics are relevant to this purpose: 1) the nature of the learning needs for at-risk readers/spellers, 2) the use of error analysis to highlight areas of strength and weakness, 3) the role that linguistic knowledge of the English language plays in addressing the needs of at-risk readers, and 4) the role of explicit, systematic instruction for at-risk readers.

The Nature of Needs for At-risk Readers/Spellers

Literacy educators are keenly aware of the need for differentiated instruction and multiple grouping options (IRA, 2004). Not all learners share the same strengths and weaknesses. Though some children intuitively decipher our alphabetic code and learn to read quite effortlessly, at-risk readers do not readily acquire these skills (Beck, 2006; National Reading Panel, 2000; Snow et al., 2005). Therefore a one size fits all model is inappropriate. Children who lack early basic literacy skills have specific instructional needs. This section will address three primary instructional needs of at-risk readers. The first part will address the need for phonemic awareness instruction. The second area of
The need relates to facilitating information processing for at-risk readers, and the third section will highlight the need for explicit systematic instruction.

*The need for phonemic awareness instruction.* An extensive body of research reveals reading difficulties experienced by at-risk readers stem from two core deficits, the first of which is a deficit in phonological or phonemic awareness (Adams et al., 1998; Bertucci et al., 2003; Ehri & Nunes, 2002; Shaywitz, 2003). Phonemic awareness skills enable children to use phoneme/grapheme correspondences to decode unknown words. According to a meta-analysis of research by the National Reading Panel (NRP) (2000), 1) good readers are skilled in phonemic awareness, and 2) explicit instruction in phonemic awareness is essential for children who lack these requisite skills. Phoneme awareness skills are foundational for decoding or recognizing unknown words. The reading difficulties of at-risk students stem from core information processing deficits related to word recognition (Stanovich, 1996).

Phonemic awareness is the ability to manipulate the smallest speech sounds in a given language. Unlike learning to talk which occurs quite naturally, phoneme manipulation is quite unnatural. From infancy children have learned to process language as a steady stream of speech. Sounds run together to form words, and words flow together to form sentences. Children are not accustomed to hearing adults segment speech sounds. Yet, in kindergarten and first grade, phoneme manipulation is a requisite skill for reading (Armbruster, Lehr, & Osborn, 2001; National Reading Panel, 2000). Children who have weak decoding and encoding skills will require intensive intervention in phonemic awareness instruction (Ehri & Nunes, 2002; Leu et al., 2006;
Yeh, 2003). Therefore, it is critical to provide appropriate instruction that will enable at-risk readers to process linguistic information. Certain types of instruction facilitate the acquisition of these literacy skills for at-risk readers. Because many at-risk readers have difficulty with phonemic awareness, instruction must be fashioned in such a way as to expedite the storage of linguistic information in long term memory for the efficient and automatic retrieval of the same to decode unknown words and comprehend text.

*The need to facilitate information processing.* Information processing theories may provide a useful framework for instruction that facilitates the acquisition of early literacy skills for at-risk readers. Early approaches to storing information in long term memory are explained by stimulus-response (SR) theories. According to Klatzky (1975), information processing involves a series of stages. First, a stimulus enters the sensory register where it remains for a very brief time. Once information enters the sensory register, either global pattern recognition or specific pattern naming may occur, a process influenced by prior knowledge as well as selective attention (Klatzky, 1975). Next, information proceeds to short-term memory (STM) where it may be held for a limited time through rehearsal. With sufficient rehearsal, the information may finally move into long-term memory (LTM), a more permanent storage for information.

This model of human memory presents some potential limitations for at-risk readers. In addition to the brevity of time information may be held in STM without rehearsal, another limitation of STM is its capacity. Usually, memory span is limited to holding up to seven items simultaneously in short term memory. Short-term or working memory is commonly assessed by having a child repeat a list of items in the same
sequence as presented. Children who fail to perform well on memory span tasks are considered to have poor working memory.

The final stage of information processing is the successful storage of information in long-term memory (LTM), a more permanent storage structure from which information is retrieved as needed. The brevity of time that information may be held in the sensory register and STM as well as the limited number of items STM may hold affect the ability to process information. In addition, without sufficient rehearsal “information in STM is lost” (Klatzky, 1975, p. 8). With this in mind, phonemic awareness instruction must be tailored to address the limitations of information processing structures.

This rather simplified view of information processing provides a framework for instructing children with phonemic awareness deficits. Instructional strategies may facilitate the processing and storage of linguistic information in LTM. More specifically, there are particular instructional elements that characterize effective phonemic awareness instruction for at-risk readers.

According to stimulus-response theories, “the ability to remember depends on the formation of associations, or bonds, between stimuli and responses” (Klatzky, 1975, pp. 1-2). Stronger associations between a stimulus and response would result in more efficient processing. This would explain why certain sound/symbol relationships are easier for children to remember. For example, there is a strong association between saying the name of the letter $t$ and the sound of /t/ because the same place of articulation is used when producing either the name or the sound of the letter. Therefore, if children
know the name of the letter, it is easier to remember the sound that letter makes. In contrast, short vowels are extremely difficult for at-risk readers to process (Bertucci et al., 2003). Though the names of the vowels are easily associated with long vowel sounds, there is no association with their respective short vowel sounds.

To facilitate the processing of linguistic information for which associations between stimuli and responses are weak, instruction must include strategies that will strengthen those associations. Using age appropriate pictures and respective key words of familiar objects that resemble letter shapes may strengthen associations between sound/symbol relationships. In addition, kinesthetic clues may provide helpful mnemonic devices to strengthen bonds between stimuli and responses. However, the selection of key words and kinesthetic clues must take into consideration the prior knowledge of individual students. For example, if the word olive is not in a child’s lexicon, it would be counter productive to use olive as a key word for the short o sound.

Children “understand by interpreting new information in light of their prior knowledge” (Gillet, Temple, & Crawford, 2004, p. 230). Building on prior knowledge is critical for efficient information processing (Gillet et al., 2004; Piaget, 1976; Vacca & Vacca, 2002). Information entering the sensory register must be recognized before it goes on to working memory, and the recognition of the pattern necessitates connecting the input with prior knowledge (Klatzky, 1975). This would explain why knowledge of letter names is one of the best predictors of reading success (Adams, 1991). Literacy instruction should build on what students already know, for this base provides a foundation for scaffolding subsequent learning.
As mentioned previously, rehearsal or practice is a critical factor for processing information. Stimuli will decay quickly in working memory without rehearsal. Information must be recycled in STM until it is stored in LTM. It is an accepted fact that serious athletes and musicians must regularly schedule time for practice to improve their talents. A skilled piano teacher knows that knowledge of musical notation and the fluent speed and accuracy of playing scales are prerequisite skills for accurately playing a musical score. It would be counterproductive to expect a piano student to play a song before mastering rudimentary skills. By doing so, the student would easily become frustrated and intrinsic motivation would wane. Conversely, practice and drill to the exclusion of playing real music would also cause a child to become bored and lose interest in playing the piano. There must be balance between practice and practical application of learned skills, and this principle applies to early literacy instruction as well.

Although knowledge of the alphabetic principle is an excellent predictor of reading achievement in young children (Adams, 1991), at-risk readers are often expected to read books before mastering this requisite skill. The accurate and fluent speed of identifying the sound/symbol relationships of English orthography is a foundational skill for developing fluent readers. Children are often encouraged to rely primarily on contextual and/or pictures clues. Though these are useful strategies, expecting children to read without mastering the alphabetic principle is much like attempting to read music with no knowledge of musical notation. Therefore, to facilitate information processing, sufficient time must be allocated for phonics instruction and rehearsal of skills.
Information processing is also facilitated by appropriate pacing. First and foremost, instruction should be developmentally appropriate. Children need time to develop certain readiness skills for formal reading instruction. Attempts to hurry this process along by starting literacy instruction at earlier ages neglects the importance of developing necessary readiness skills (Clay, 2001; Zull, 2002). Pushing children into developmentally inappropriate learning situations may create long-lasting, negative impacts to a child’s emotional well-being.

Pacing involves not only the when of instruction but also how much over a given time span. In an age of educational accountability to governmental entities, there is pressure to increase the amount of information presented to students. Zull (2002) contends that “information comes too fast for us to integrate and comprehend” (Zull, 2002, p. 42). This emphasis on quantity, at the expense of quality, results in students being overwhelmed by the sheer number of facts being presented. In addition, at-risk readers are often expected to maintain the same academic pace as proficient readers. An inappropriate academic pace generally translates into insufficient rehearsal and unreasonable demands on cognitive load, resulting in failure to secure necessary concepts in long term memory. When new concepts are introduced before previous concepts have been given ample opportunity to be learned to the point of mastery and fluency, information processing is hindered.

Information processing involves multiple senses. Young children construct meaning about their world through seeing, hearing, feeling, smelling, tasting, and moving. Some of these same senses can be employed simultaneously to enhance the
processing of linguistic information. Since there is a sensory register for each sense (Klatzky, 1975), input of information via visual, auditory, kinesthetic, and tactile modes would employ four sensory registers as opposed to using only one or two. Instructional approaches to reading and written language that simultaneously employ multiple sensory pathways have been proven effective for at-risk readers (Birsh, 1999; Evangelista, Nolan, Fox, Hamel-Lambert, & Owens, 2005; Joshi, Dahlgren, & Gooden, 2002).

The need for systematic instruction. Systematic instruction begins with concepts that are secure in memory and builds upon that prior knowledge, moving from simple to more complex concepts. In addition, a conscious effort is made to systematically avoid introducing concepts that are potentially confusing. For example, the introduction of concepts that are visually similar should be scheduled in such a way as to allow adequate time for the securing of the one concept in LTM before the introduction of the other. Teaching phonemes according to the order they appear in the alphabet may seem to be a logical sequence for the presentation of concepts. However, this sequence would cause letters such as $b$ and $d$ to be taught in close proximity to one another, thus creating visual discrimination difficulties between two letters that look very much alike to a young child. This same principal would apply to stimuli that possess auditory similarities.

Many at-risk readers have problems with auditory discrimination. Short vowel sounds are particularly difficult for children to store in long term memory. Confusion between the vowel sounds of short $e$ and $i$ have been found to persist even through adolescence (Bertucci et al., 2003). Some letters present difficulty for both auditory and visual discrimination. Therefore, careful consideration must be given to the order in
which linguistic concepts are presented to avoid potential confusion and facilitate information processing.

Instructional scaffolding capitalizes on students’ previous knowledge and builds thereon. Through the activation of prior knowledge, the teacher facilitates the subsequent learning of new concepts (Clay, 2001; Vacca & Vacca, 2002) Children with phonemic awareness deficits may need to begin with the manipulation of familiar sounds. Sequencing and counting sounds related to known concrete objects activates prior knowledge and prepares children for ordering more abstract concepts dealing with the sound/symbol relationships of English phonology. By prefacing phonemic awareness instruction with a more generalized awareness of known object/sound relationships in the lives of young children, instruction builds upon previously established neuronal networks (Clay, 2001; Shaywitz, 2003; Zull, 2002).

In conclusion, the nature of the at-risk reader’s needs is influenced by a variety of factors. These factors play an important role in either ameliorating or exacerbating reading difficulties. Many at-risk readers are not skilled in phonemic awareness and require explicit, systematic instruction to remediate these problems. Factors that influence information processing include: prior knowledge and the strength of the associations between what is known and what is being taught; appropriate pacing, instructional scaffolding, and sufficient rehearsal time to master new concepts. Additionally, learning is facilitated when at-risk readers engage multiple sensory pathways for learning (Evangelista et al., 2005; Joshi et al., 2002; Stern, 2007). Systematic instruction carefully considers these influences and makes adjustments accordingly.
The Use of Error Analysis to Inform Instruction

Error analysis provides invaluable information for teaching professionals. A math teacher may choose to score student homework on the basis of right or wrong answers or look at errors in a much closer fashion. For example, when intermediate students are learning to multiply three digit numbers by two or three multipliers, different types of errors are conceivable. A student may not know certain multiplication facts; in addition aligning and/or summing the partial products could produce an error. Simply judging errors according to correct or incorrect responses does not yield sufficient information to guide instruction. It is conceivable that a math student could multiply and add perfectly yet arrive at the wrong answer due to an alignment problem. In this case, error analysis would reveal the need for explicit, systematic instruction in aligning the digits. On the other hand, this student may benefit from something as simple as providing graph paper on which to work complex multiplication problems. By writing only one digit per quarter-inch square the student may be able to maintain the correct alignment of all digits and arrive at the correct answer. Merely assigning additional practice in the form of more multiplication problems would only reinforce existing error patterns and possibly make it more difficult for the student to break bad habits.

The following paragraphs will examine different types of error analyses that may afford teachers valuable insights into students’ reading difficulties. The first sections will look at information that may be gleaned from miscue analysis, informal inventories, and running records. The remaining sections will examine insights that may be garnered from
examining informal word writing tasks, phonetically accurate spelling errors, and phonetically inaccurate spelling errors.

**Miscue analysis.** Analyzing errors made during oral reading tasks yield valuable information to guide instructional practice. A great deal may be gleaned about students’ basic early literacy skills by analyzing errors or miscues (Black, 1980; Johns, 2001). Types of miscues for oral reading include: semantic, syntactic, and grapho-phonic miscues. The prevalence of semantic and/or syntactic miscues may indicate the student is not constructing meaning from the text. Problems such as these would necessitate providing instructional strategies for text comprehension. On the other hand, a considerable number of grapho-phoneme miscues would indicate the need for explicit, systematic instruction in phonemic awareness or phonics. In addition to oral reading miscues, errors occurring in the context of writing tasks may also provide insight to inform instruction.

**Informal reading inventories.** Another classification of oral reading miscues includes additions, omissions, substitutions, and reversals (Johns, Lenski, & Elish-Piper, 2005). Though oral reading assessments provide teachers with valuable information about a student’s early literacy skills, they are costly in terms of time and human resources. For example, the Informal Reading Inventory (Johns et al., 2005) (IRI) is an individual assessment and may not be administered in a group setting. Using informal reading inventories is costly and labor intensive in terms of time and human resources.

**Running records.** Running records is another individualized assessment that tracks student errors (Clay, 2001). During a running record, the teacher listens to or tape
records a student’s oral reading as he or she reads a passage. As the student reads, the teacher marks all the student’s miscues. By tape recording this oral reading, the teacher has an opportunity to listen multiple times, if need be, to ensure an accurate account of miscues. Types of miscues include additions, omissions, substitutions, and reversals. Clay’s (2001) system of scoring the running record also tracks student strengths. Good readers frequently self-correct when they read something that does not make sense. The marking system for the running record keeps track of those positive reading behaviors as well. The major disadvantage of the running record is that it is labor intensive; it cannot be administered in a group setting. For assessing multiple students, running records are time consuming, and this may take time that teachers cannot afford. Therefore running records are also not a cost effective alternative for analyzing student errors.

On the other hand, assessments designed to be administered in group situations are more appropriate for classroom teachers and require less time to administer. With increased accountability for student performance and growing numbers of at-risk readers included in regular education classes, teachers have need of quick and easy assessments that may be administered in whole class or small group settings. Since reading and writing are reciprocal processes, student writing may provide a visual window through which teachers may evaluate student needs and tailor instruction accordingly. In addition, writing assessments enable classroom teachers to assess student knowledge and skill in the context of whole class or small group administration.

*Word writing assessments.* Student writing tasks may also provide pertinent information about a student’s competence related to early basic literacy skills. There is a
strong correlation between reading achievement and a student’s ability to employ invented spellings (Grove, 2005; Niessen, 2003). Beginning readers are frequently encouraged to use invented spellings in written communication. Using this strategy affords young children a greater freedom to express their thoughts freely without having to concern themselves with accurate spelling conventions. For example, a student might write, *yil u plees bee mi frend* for *will you please be my friend*. Though this student would benefit from instruction in acceptable spelling conventions, the spelling errors do not necessarily indicate a need for intensive intervention in phonemic awareness. Using an invented spelling task has a distinct advantage over an individual assessment in terms of time and energy expended. This type of informal assessment allows the teacher to collect data quickly from an entire class in a relatively short amount of time to determine strengths and weaknesses in phonemic awareness.

Another word writing task that may be administered to multiple students at a time is the Word Writing CAFÉ (Leal, 2006). The CAFÉ is a 10 minute assessment designed to evaluate the complexity, accuracy, and fluency of students’ writing abilities. One assessment may be given in the fall and another in the spring. General comments from teachers indicate they enjoy seeing skills increase over time. More importantly, teacher remarks also indicate the assessment reveals areas of weakness in writing abilities that may be addressed through class instruction. A first grade teacher remarked that the students in her class needed “more work with vowel sounds” (Leal, 2006, p. 341), and subsequently, instructional time was allocated for that purpose.
A group spelling assessment is an efficient method of collecting data to determine whether there are significant differences between the types of errors at-risk readers make. It is also helpful to know whether significant differences in error types exist between older and younger at-risk students. Knowledge of error types and the prevalence with which these errors occur is information that may guide instruction. Though there has been other research on spelling errors in at-risk learners (Moats, 1983), a recent literature search on January 30, 2007 produced no studies that explored the differences between error types before and after explicit, systematic instruction. To better understand how to fix a problem, we must first understand what significant problems exist. Early reading instruction should be data-driven and the spelling errors of young children provide an excellent source of data to guide instruction.

Spelling errors provide a visual representation for students’ processing of linguistic information as well as their knowledge of English orthography (Henry, 2003; Moats, 1995a). The nature of children’s spelling errors may provide valuable information that may be used to guide instruction. Different types of errors provide a variety of information about children’s learning needs. More specifically, the study will address specific types of errors in closed syllable patterns.

**Interpretation of different error patterns.** Phonetically accurate errors suggest the emergence of phonemic awareness skills on the student’s part. Phonemic awareness is the ability to manipulate individual speech sounds in a given language. Invented spellings of children speak volumes about their developmental levels of skill relative to the processing of linguistic information. (Moats, 1995b; Read, 1986). For example, if a child
writes here for hurry, there is a degree of logic in that spelling; her plus the open syllable e is a phonetic representation of the word hurry. There are a variety of ways a young child could write hurry which would be perfectly logical: hiry, hirey, herrey, heree, or hiree. These phonetically accurate spelling errors reveal adequate phonemic awareness skills. In his study of the spontaneous writing of 3, 4, and 5 year olds, Read (1971; 1986) showed that some emerging spellers have their logical approach to spelling prior to their learning to read. This logic he found to be based upon the articulatory features of the sound from the child’s perspective. On the other hand, illogical spelling choices suggest possible core deficits in other areas. For spelling errors that are phonetically inaccurate, one must examine the error patterns more closely.

Failure on the part of students to provide appropriate graphemes for corresponding phonemes result in phonetically inaccurate spelling errors. These “bizarre” spellings in at-risk readers may be the result of a deficit in phonemic awareness skills. According to a meta-analysis of the National Reading Panel (2000), phonemic awareness is a requisite skill for the acquisition of early basic literacy skills. Children who lack these skills are at-risk for reading failure, and research reveals at-risk readers require direct explicit instruction to develop phonemic awareness skills (Ehri & Nunes, 2002; Mann & Foy, 2003; National Reading Panel, 2000; Shaywitz, 2003).

Some difficulties in at-risk readers are manifested in the form of reversal errors. A student may confuse letters such as b and d or p and q. These types of letter confusions are quite common in at-risk readers, but single letter reversals do not necessarily suggest a deficit in phonemic awareness. In contrast, serial orders errors in which two or more
letters are reversed are actually the result of the inaccurate sequencing of sounds in a given word. For example, the child who writes *nets* for *nest* is experiencing difficulties in breaking down the word and putting it back together.

In conclusion, many types of error analyses provide teachers with valuable information about the nature of students’ reading difficulties. The use of error analysis to inform instruction is a critical step toward ameliorating reading difficulties in at-risk learners (McKenna & Picard, 2007). Analyzing error patterns may reveal a student’s strengths and weaknesses. Knowing a student’s strengths enables a teacher to build on the prior knowledge of the students. The introduction of new concepts must be built on a firm foundation of that which is secure in memory. Knowledge of students’ weaknesses provides an appropriate blueprint for future instruction.

A reading teacher’s effectiveness is determined not only by his or her level of knowledge and skill, but also in the ability to appropriately identify areas of strength and weakness. Reading teachers must be able to identify children who may be at-risk for reading failure and determine the underlying causes of reading difficulties. In the field of medicine, one of the first steps in treating a physical problem is merely listening to the patient. Though costly and extensive testing may sometimes be required, frequently the attending physician is able to diagnose the problem by merely listening as the patient conveys what is wrong. Likewise, reading teachers may gain tremendous insights into what “is wrong” by closely examining spelling error patterns since spelling difficulties are frequently a manifestation of a linguistic problem (Moats, 1995b). Therefore, reading teachers must possess sufficient knowledge of English language structures to
appropriately discern what the errors really indicate in order to provide appropriate instruction.

The Role of Linguistic Knowledge of English Phonology

A reading teacher’s linguistic knowledge of English phonology is important to fully appreciate the difficulties experienced by at-risk readers. Typically developing readers learn through different instructional approaches to phonics that speech sounds map to printed symbols, and that letters combine to form words. However, teaching the structure of language to at-risk readers requires more expertise than merely knowing letter/sound relationships. The following sections will focus on some issues related to processing linguistic information. The first section will address the manner in which phonemes are produced in the context of instruction. The next section will highlight the phonetic properties of vowels and consonants, and the last section will elaborate on vowel and consonant differences that have implications for reading instruction.

Accuracy of phoneme production. In order to provide effective instruction in the structure of the language, reading teachers must accurately produce the phonemes of our language. For example, it is not uncommon to hear the sound of /b/ pronounced /buh/ or /n/ pronounced /nuh/. If children are taught in this manner, when confronted with the word ban, they are apt to respond: buh ə nuh. The addition of the schwa sounds causes the pronunciation to be closer to banana than it is to ban. In a section on the linguistic development of young children, one college text states that teachers should be able to pronounce “consonants and consonant blends such as ‘buh’, ‘duh’, and ‘struh’” (Ormrod, 2006, p. 49). When college textbooks do not appropriately articulate foundational
knowledge, at-risk readers may be further handicapped by the way their teachers may have been misinformed. When the structure of the language is taught incorrectly, resulting in confusion for at-risk readers, it is not surprising why some reading teachers review phonics instruction with utter disdain.

Since most children at-risk for reading failure exhibit a deficit in phonological processing (Bertucci et al., 2003; Goswami, 2002; Shaywitz, 2003), an accompanying schwa sound to consonant phonemes makes an already difficult blending task all the more challenging for at-risk readers. Therefore, teachers must demonstrate adequate knowledge of linguistic foundations for reading and writing processes (IRA, 2004; McCutchen et al., 2002; Moats, 1995a). A knowledgeable and skilled reading professional may be the greatest asset an at-risk reader could have.

Therefore, a reading teacher must possess certain requisite skills and knowledge with regard to English phonology. Research indicates that many teachers lack the necessary knowledge regarding structure of the English language (Moats, 1995a; Spear-Swerling & Brucker, 2003) According to some surveys, many teachers lack sufficient knowledge to implement research based reading intervention for at-risk readers (Brady & Moats, 1997; Moats, 1995a). One study revealed a sharp contrast between teachers’ scores on a general knowledge test versus a linguistic knowledge. An example of a general knowledge question was, “In what part of the body does the infection called pneumonia occur?” (McCutchen et al., 2002, p. 214) Teachers accurately answered only 30 to 35% of the questions for measures taken on phonological knowledge, while on
general knowledge questions teachers accurately answered 74 to 82% of the questions. (McCutchen et al., 2002).

In general, investigations of teachers’ phonological knowledge suggest that many teachers may not possess necessary phonological knowledge to explicitly instruct and assist those who struggle with reading (Bos, Mather, Dickson, Podhajski, & Chard, 2001; McCutchen et al., 2002; Moats, 1995a). As reading teachers develop a deeper understanding of English phonology, they will be better prepared to address the difficulties of impaired readers (Brady & Moats, 1997; Moats, 1995a; Spear-Swerling & Brucker, 2003).

Phonetic properties of vowels and consonants. The phonetic base for consonant phonemes is quite different from vowels. The tongue generally comes in contact with another articulator that further modifies air flow through the oral or nasal cavity. Therefore, consonants are speech sounds that may either be voiced or unvoiced and are classified according to their manner of articulation, place of articulation, and voicing. With all consonants, air flow is either partially or completely obstructed by articulators such as the tongue, teeth, and/or lips.

In contrast, vowels are voiced speech sounds in which there is no obstruction of airflow by the tongue or other articulators such as the teeth or lips. Subtle changes in tongue height and advancement impact vowel production and perception. Vowels also employ less visible articulators because their production requires miniscule adjustments of the tongue where it is attached in the back of the mouth. While teachers could direct a child’s attention to the movements of the lips, teeth, or tip of the tongue for many
consonant sounds, this is not an effective strategy for teaching short vowels since this area of the oral cavity may not be easily viewed. The place of articulation for vowel production is extremely difficult to see and equally difficult to explain. Low visibility and minimal motor movement are characteristic of both long and short vowels (Bertucci et al., 2003; Ohde & Haley, 1997).

*Consonant and vowel differences-implications for reading.* Consonant and vowel differences carry some notable implications related to reading achievement. Small (2005) reports that studies by Sander and Smit and colleagues indicate that around the age of five, children produce phonemes with greater than 50% accuracy and with 90% accuracy between ages 7 and 8. For most children, these receptive and expressive oral language skills develop quite effortlessly at very young ages without any formal training; however, learning to read an alphabetic language does not develop quite so naturally, especially for at-risk readers.

Teacher knowledge of distinctive features of particular speech sounds is essential to help young children overcome phonological deficits and discriminate between phonemes that create confusions due to similarities in the manner in which certain sounds are produced (Moats, 2000a; Spear-Swerling & Brucker, 2003). Having knowledge of distinguishing features between pairs of consonants enables the teacher to explicitly demonstrate or highlight differences. For example, frequently children confuse /b/ and /p/ and understandably so. The place and manner of articulation are identical; both are bilabial stops. However, the distinguishing feature is voicing; /b/ is voiced, and /p/ is voiceless.
Teachers may help children to distinguish this difference through explicit, systematic instruction. Impaired readers may be instructed to feel the difference between voiced and unvoiced consonants by placing one hand on the throat to feel the vibration in the vocal tract. Feeling the difference produced by voicing may help at-risk readers to discriminate between the two sounds (Birsh, 1999; Evangelista et al., 2005; Moats & Farrell, 1999).

Even with the requisite knowledge of how individual speech sounds map to printed symbols or graphemes, at-risk readers experience further difficulties as they attempt to synthesize individual sounds to form words. Typically, when children come to an unknown word, they are instructed to “sound it out”. Thus, they produce the initial sound and each successive phoneme. The assumption is that upon completion of the final sound, children will recognize the target word. However, this blending strategy is vulnerable to a variety of errors.

Blending at the phoneme level is subject to a number of error patterns: reversals, omissions, additions, and substitutions. Reversals are quite common. For example, after identifying /t/, /i/, and /p/, a typical response might be pit. Krosnick (1999) would explain this error pattern in terms of recency effects. When given a series of information to remember, the last item is often recalled first since it was more recently processed in short-term memory. Hence, the /p/ sound in the word tip was recalled first because it was the most recently perceived stimulus. Other errors patterns include: omissions (reading bet for best), additions (reading best for bet), and substitutions (reading bent for best).
The natural spaces between phonemes provide easy access points for these errors to occur.

Cassady and Smith (2004) compared the acquisition of blending skills using three levels of structural analysis: phoneme, onset/rime, and body coda. At the phoneme level of blending, a word is divided into individual speech sounds as in /t/, /r/, /ū/, and /k/; onset/rime would include the nucleus with the coda as in /tr/ and /ūk/; and body/coda would incorporate the nucleus with the onset as in /trū/ and /k/. The participants in the study included 111 kindergarten students from three different schools in which “instructional environments were reasonably equivalent across settings” (Cassady & Smith, 2004, p. 266). In addition, “reviews of curricula and discussions with the teachers revealed that instruction for blending tasks was focused on onset-rime sets, with minimal attention to blending phonemes” (p. 265). The results of the study revealed that blending tasks with body-coda stimuli were easier for the kindergarten children than with stimuli presented at the onset-rime level (Cassady & Smith, 2004). At-risk and emergent readers benefit from explicit, systematic instruction for combining the onset and nucleus to form the body before adding the coda.

At-risk readers often experience problems with short vowel information (Adams et al., 1998; Bertucci et al., 2003). There are three different factors that may explain the difficulty at-risk reader experience with short vowels. First, short vowels sounds are produces by minimal movements of the tongue. These minimal adjustments to the position of the tongue make it difficult for at-risk readers to discriminate between the sounds of /i/ and /ɐ/. Secondly, in contrast to consonant production, the production of
short vowel sounds involves a minimal tactile experience on the part of the speaker; contact with other articulators in the oral cavity is not necessary for producing vowel sounds. The third factor that may contribute to the difficulty at-risk readers experience with short vowel sounds is the lack of association between the name of the letter and its sound.

Letter names such as $t$ or $z$ seem much easier for students to learn. This could be due to the strength of the association between the name of the letter and the respective sound. The repetition of like motor movements for saying the name of the letter and its corresponding speech sound facilitates the storage of certain phonemes in memory. For example, to say the name of the letter $t$, a child must use two separate speech sounds: /t/ and /i/. To make the sound of /t/, the child merely drops the final /i/ sound after producing the same initial articulatory movement. Thus, knowing the name of the letter $t$ helps to retrieve the sound /t/ because the association between the place of articulation for naming the letter and the identical place of articulation for producing the phoneme. This would explain why knowledge of the letter names is one of the greatest predictors of reading achievement (Adams et al., 1998). These three factors relate to the place of articulation, yet manner of articulation may also influence information processing of short vowel information.

The manner in which short vowel sounds are taught in beginning reading programs may influence the ease with which this linguistic information is stored in memory. Learning short vowel concepts may be facilitated by having at-risk readers increase the production of a short vowel sound as opposed to producing the sound in an
abbreviated fashion. For example, consider the sound of /ssssssss/; the increased duration of the sound increases rehearsal time and input in the sensory register. The phonetic properties of short vowels enable at-risk students to prolong the production of these sounds quite easily because vowels are open-mouthed sounds that can be sustained.

The ease with which short vowel sounds may be sustained may also facilitate the blending of speech sounds to form words. Ohde and Haley (1997) investigated vowel perception in young children and found that increasing the duration of the stimulus enabled children to process these sounds more readily. This would suggest that teaching children to prolong the vowel sound would expedite the storage of that information in memory. The vowel sound is the nucleus of the syllable, and sustaining the vowel sound may facilitate blending skills since young children are able to decode syllabic units of speech with greater ease (Cassady & Smith, 2004; Wydell & Butterworth, 1999).

Most children acquire linguistic competence without any formal instruction. Baring some physiological impairment or other intervening circumstances, children develop receptive and expressive language skills through varied and repeated exposures to their native language. However, at-risk readers require explicit training to overcome particular difficulties associated with processing linguistic information. Speech pathologists are well trained to address an array of linguistic problems children encounter.

In conclusion, teachers must understand the impediments that may arise during phonics instruction and must also be aware of factors that may enhance the processing of linguistic information (Moats, 1995a). Linguistic knowledge is particularly advantageous
for teachers who work with children at-risk for reading failure. However, research indicates that many classroom teachers may lack sufficient linguistic knowledge to skillfully provide appropriate intervention to remediate phonological and phonemic awareness deficits (Moats, 2000a; Spear-Swerling & Brucker, 2003).

The Role of Explicit Instruction for At-risk Readers

Explicit instruction is necessary for teaching at-risk readers how to synthesize individual speech sounds to identify new words. Children must be able to decode unknown words efficiently to facilitate comprehension (Adams et al., 1998; IRA, 2004; Moats, 2000a; Shaywitz, 2003). In addition, children must learn how to segment phonemes for spelling purposes. Reading and spelling are complementary processes in the development of early basic literacy skills. Learning to segment phonemes for the purpose of spelling facilitates the reciprocal process of synthesizing speech sounds to decode unknown words (Beck, 2006; Henry, 2003; Norton et al., 2007). At-risk readers require explicit instruction and sufficient practice to master phonemic awareness skills needed for decoding and encoding.

Phonics is sometimes taught in an opportunistic fashion in which phonics elements are pointed out to children in the context of reading books. In contrast, explicit instruction involves the direct teaching of phoneme-grapheme correspondences. Explicit instruction is both analytic and synthetic. At-risk readers must analyze the component parts of whole words in order to spell; in addition, they must learn to synthesize letter sounds to form words. Children are directly taught to pay close attention to the motor
movements of the mouth, especially when teaching phonemes that may be easily confused with other speech sounds.


Multisensory instruction involves the simultaneous engagement of the visual, auditory, kinesthetic, and tactile pathways for learning. For example, to facilitate learning the sound of /ch/, students are directly instructed to write the grapheme while producing the sound aloud. Thus students hear the sound, see the corresponding grapheme, and feel the motor movements of both the mouth and hand, all at the same time. Since large motor movements are more memorable, children may use arm movements to write a grapheme in the air or use a wet sponge for water writing on a chalkboard. In addition, tactile experiences may be increased by using various mediums for writing such as shaving cream, sugar, or rice. In addition to the multisensory component, OG instruction includes other essential elements. Orton-Gillingham instruction is: alphabetic/phonetic, synthetic/analytic, structured, sequential, cumulative, repetitive, cognitive, diagnostic, and prescriptive (Rome & Osman, 2000).
A recent article, describes Orton-Gillingham (OG) approaches to reading instruction as “direct teaching of individual letters paired with their sounds using a VAKT (i.e. visual, auditory, kinesthetic, and tactile) procedure” (Stahl et al., 1998, p. 345). This is an approach that engages multiple sensory pathways to facilitate learning. Though Stahl, et al. point to a study in which OG trained students made significant gains, the authors report there are relatively few studies about the OG approach given the longevity of its use. This particular study’s result may indirectly contribute to the OG research base since the instruction provided to at-risk readers in this study was based on OG principles.

There are many early reading programs based on the principles of direct instruction: The Voyager Program, Direct Instruction, and Saxon Phonics, to name a few. Likewise, there are many commercially packaged reading programs based on Orton-Gillingham (OG) principles: the Wilson Reading System, Project Read, and Slingerland. The distinguishing difference between the two is the emphasis on multisensory instruction for the OG approaches.

In the literacy field, there exists an on-going phonics debate among reading teachers. The following discussion will contrast opposing views represented in this debate. The first section will present the viewpoint of proponents of whole language who prefer a top-down, meaning-based approach to literacy through emersion in a text-rich environment. The second section will present the viewpoint of advocates for a bottom-up approach to literacy development that favors code-based instructional methods.
Analytic phonics. From birth infants and young children are accustomed to hearing whole words and they learn to speak without any formal training (Chomsky, 1980; Goodman & Goodman, 1990; Gopnik et al., 1999). Therefore, prior to formal reading instruction, young children learn to process linguistic information at the syllable level. Processing linguistic information at the syllable level is much easier than at the phoneme level (Cassady & Smith, 2004; Kroese, Hynd, Knight, Hall, & Hiemenz, 2000). For this reason, many in the field of reading education believe that reading instruction should involve whole words as the unit of analysis rather than teaching individual phonemes. This line of thinking is popular with reading professionals who embrace a whole language approach to reading instruction (Clay, 2001; Goodman & Goodman, 1990; Moats, 2000b; Smith, 2004).

Goodman and Goodman (1990) and Smith (2004), proponents of whole language, prefer analytic phonics. One major tenet of analytic phonics is the belief that learning to read is as natural a process as learning to speak (Goodman & Goodman, 1990; Smith, 2004). They contend children learn to read just as they learn to speak. Infants are biologically endowed with an innate language faculty that enables them to naturally develop oral language through repeated exposure to the language of caregivers (Chomsky, 1980). When children learn to speak, they do so by using whole words in a meaningful context; therefore, proponents of whole language argue that children will develop literacy skills through exposure to whole words rather than individual phonemes. Analytic phonics is based on the philosophy of holism that emphasizes the importance of examining development in the context of whole structures. Therefore, Goodman &
Goodman (1990) believe children learn best when given ample opportunities to engage in purposeful reading and writing activities. Smith (2004) and Goodman et al. (1990) believe children develop literacy skills when learning takes place within meaningful contexts.

Indeed, the acquisition of expressive oral language is a natural process; but the segmentation of phonemes is not a skill that children have practiced from birth. If using phonemes as the unit of analysis is not natural, then why use phonics at all? The answer to this question seems clear when we examine other disciplines that involve a code-based skill. For example, using the rationale of whole language proponents, those who want to learn to play the piano should just listen to music. After all, listening to a song is an authentic context and provides enjoyment to those who appreciate music. However, playing a musical instrument requires an ability to read music. Musical notation is basically a code and, with relatively few exceptions. Indeed, learning these fundamental skills sometimes seems arduous and tedious. Yet, those who have developed those skills to the point of automaticity may ultimately derive great satisfaction from their accomplishments. Of course, there are those exceptions to the rule, those talented individuals who merely hear a score of music and play the same piece quite effortlessly.

The same is true for reading; some individuals learn to read through exposure to text rich environments, much like the gifted musician. However, many more children need to learn the fundamental building blocks of the English language. The average beginning musician starts with the rudimentary knowledge of musical notation, and must learn the musical code accurately and fluently. Code-based skills are practiced until they
become automatic. Likewise, the at-risk reader must develop fluency at the phoneme level to develop accurate and fluent decoding skills. However, despite robust findings in a meta-analysis of the National Reading Panel (2000), Smith (2004) in his elaboration of phonological awareness, makes reference to “phonemic awareness, which has nothing to do with reading” (p. 146). It is unfortunate that at-risk readers stand in the cross-fire of this much heated debate.

*Synthetic phonics.* Adams (1991), Moats (2000), and Foorman (1995), prefer a synthetic approach to phonics instruction that is code or skill based. Those predisposed to skill-based instruction believe children need direct instruction in phonics to gain an adequate knowledge of phoneme-grapheme correspondences. Understanding how individual phonemes map to printed symbols is a foundational skill for sequencing and segmenting speech sounds. Children learn individual phonemes and blend these sounds to read new words. This skill facilitates decoding and encoding regularly phonetic words. Decoding skills must be mastered and automatic to efficiently employ the graphophoneme cueing system for word identification.

Research indicates that alphabetic knowledge is one of the best predictors of reading achievement (Adams, 1991; Foorman, 1995; National Reading Panel, 2000; Shaywitz, 2003; Snow et al., 1998). Synthetic phonics is essential for developing an understanding of how individual speech sounds map to printed symbols. However, to say that phonics is being taught does not necessarily translate into effective phonics instruction. Not all phonics programs are created equally even though they include much the same content. Not all phonics programs address the needs of at-risk readers. This
being the case, it is not surprising that many educators decry the implementation of phonics instruction. When phonics instruction involves the mindless completion of worksheets, at-risk readers have the most to lose and the least to gain.

Explicit, systematic instruction in sequencing phonemes is needed for at-risk readers to learn how to synthesize speech sounds to read new words. Children must be able to decode unknown words efficiently to facilitate comprehension (Adams, 1991; Adams et al., 1998; IRA, 2004; Moats, 2000a; Shaywitz, 2003). In addition, children must learn how to segment phonemes for spelling purposes. The development of spelling skills is considered essential for developing phonemic awareness skills. Therefore, spelling from dictation is an important aspect of explicit, systematic instruction. Children need daily opportunities to write words from dictation. Reading and spelling are complementary processes in the development of literacy skills, and children need adequate time to practice these skills to the point of mastery.

Explicit, systematic instruction is both analytic and synthetic because children are explicitly taught how to break words down into their individual speech sounds for the purpose of spelling. Yet for reading they are explicitly taught how to synthesize two sounds before adding the third, and three sounds before adding the fourth, and so on. When a student is able to sequence and segment up to five or six speech sounds accurately and fluently, the student is ready to advance to syllable division rules and perform similar tasks only with syllabic units of speech rather than phonemes.

Synthetic phonics instruction is only one part of a comprehensive reading program. Effective reading programs allow for the development of fluency, vocabulary,
and comprehension. Furthermore, proponents of synthetic phonics instruction concur that a pleasurable and interesting literacy environment will motivate children to read, thus providing additional opportunities to increase reading skills.

Summary

In order to appropriately address the reading difficulties of at-risk readers, it is important to understand the nature of their needs. Utilizing spelling error patterns may provide an efficient method for identifying the root causes of spelling difficulties that may stem from linguistic problems. Teacher knowledge of English phonology is a critical factor in ameliorating specific linguistic problems encountered by at-risk readers. In addition to knowledgeable teachers, at-risk readers must be provided explicit systematic instruction in phonemic awareness.

In conclusion, at-risk readers require differentiated instruction to remediate phonemic awareness deficits. With sufficient knowledge of English language structures, a reading teacher is able to gain valuable insights into the core deficits of reading difficulties. Informal assessments provide an efficient manner in which to collect student data. By examining spelling errors for a finite set of English language structures, it is possible to diagnose areas of weakness in at-risk readers related to specific concepts. An understanding of the underlying causes for the error types enables the teacher to tailor instruction to address the needs of students based on the types of errors made.
CHAPTER THREE

Methodology

Generally, beginning readers are expected to learn the consonant and short vowel sounds of the English language. These concepts are typically introduced in the context of words with closed syllable patterns. Young children often experience confusion while trying to learn these phonemes. Many at-risk readers fail to master short vowel concepts to the point of automaticity. (Adams, 1991; Adams et al., 1998; Bertucci et al., 2003). An inability to secure short vowel concepts in memory may result in slow and/or inaccurate word identification. The accurate and fluent decoding and encoding of closed syllable patterns requires the skillful processing of short vowel sounds. An inability to master these concepts poses difficulties at the on-set of formal reading instruction. It is critical to identify specific weaknesses in processing both consonant and vowel information in order to provide timely and appropriate intervention, and spelling errors may be utilized to highlight these specific difficulties relative to phonemic awareness.

How may we better understand the spelling errors of at-risk readers relative to the processing of linguistic information? More specifically, what types of difficulties do at-risk readers experience related to the processing of short vowel information? To explore these questions, this study addressed two main topics: 1) phonetically accurate and inaccurate spelling errors in younger and older at-risk readers, and 2) inaccurate vowel and consonant errors before explicit, systematic instruction.

The impetus for this study arose out of an earlier pilot study that raised specific questions concerning the peculiar spelling errors of at-risk readers. Specifically, do
younger at-risk readers make significantly more phonetically accurate and inaccurate errors than older at-risk readers? Do at-risk readers experience linguistic processing difficulties predominantly associated with short vowels? Results from the pilot suggested that at-risk readers experience particular difficulties with short vowel information. However, the pilot study’s external validity was threatened by the small sample size. Therefore, to further explore these questions, an existing data set was utilized to conduct a spelling error analysis to investigate the nature of spelling errors in a larger sample of younger and older at-risk readers.

The existing data set was obtained during a summer intervention program for at-risk readers. Participating students were recruited for the summer program on the basis of teacher referrals; any students deemed at-risk for reading failure were potential candidates for the program. At the beginning of the program a spelling pre-test was administered prior to instructional intervention. Teachers were trained to provide explicit systematic instruction to at-risk readers, and at the culmination of the intervention program, students were reassessed to determine which error types were responsive to intervention and which were resistant to treatment.

This chapter will describe the research design, operationally define the variables of interest, describe the instrumentation used in this study, the data collection procedures, and statistical procedures used in data analysis.

**Research Design and Questions**

This study analyzed spelling errors related to a limited number of concepts: 1) initial and final consonants, 2) short vowels, 3) segmenting and blending of three and
four speech sounds, 4) consonant digraphs, 5) doubling of consonants *ff, ll*, and *ss* plus one irregular orthographic pattern (*all* was introduced to reinforce the doubling rule for *l*), and 6) adding the suffix *s*. These concepts were addressed within the context of closed syllable patterns containing short vowels, consonants, and consonant digraphs. The purposeful selection of closed syllables was necessary to determine specific difficulties experienced by at-risk readers relative to short vowel information.

This analysis of spelling errors was conducted on pre-existing data for which the Ohio University Institutional Review Board (IRB) granted prior approval. The data set was employed to answer the following research questions:

1. Do younger at-risk readers make significantly more phonetically accurate and inaccurate errors than older at-risk readers?

2. Is the proportion of phonetically inaccurate errors greater than proportion of phonetically accurate errors for at-risk readers?

3. Is the proportion of vowel errors greater than the proportion of consonant errors for at-risk readers?

*Operational Definitions of the Variables*

This section will discuss the variables of interest for this research study. The dependent variables were two different measures of error types. To explore possible phonemic awareness deficits, errors were subdivided into two main categories: phonetically accurate and phonetically inaccurate errors. In addition, phonetically inaccurate errors will be subdivided into consonant and vowel errors. These spelling error classifications were adapted from a previous study (Moats, 1982, 1983).
Although the original taxonomy of errors included a pre-conventional classification of errors, a preliminary analysis revealed a limited number of pre-conventional errors. Since these errors were highly correlated with phonetically accurate errors, pre-conventional errors were combined with phonetically accurate errors. Therefore, the final analyses included only two dependent variables: phonetically accurate and phonetically inaccurate errors. Supplementary analysis of phonetically inaccurate errors examined in terms of consonant and vowel errors.

The independent variable in this study was student group. At-risk readers in grades one through four were grouped into two separate groups. The four grade levels were recoded into 2 groups, younger and older at-risk readers: grades 1 and 2 formed Group 1 (n = 24) and Group 2 was comprised of grades 3 and 4 (n = 45). The justification for deciding to collapse the independent variable into two groups was that the small sample size precluded an examination of the four groups separately.

Identification of the Population

Participants included 69 children who participated in a summer intervention program for at-risk readers. Participants attended nine different elementary schools in a Midwestern school district and represented four different grade levels: grades 1 (n = 16), 2 (n = 8), 3 (n = 30), and 4 (n = 15). The intervention program lasted three-weeks, during which time attending students received approximately 15 hours of phonemic awareness instruction. During the program, the summer teaching staff received professional development for delivering explicit, systematic instruction in phonemic awareness to at-risk learners.
All the children in this study attended a small city school district with an approximate student population of 5,800 students in K-12. The ethnic composition of the district is 97.3% white, 1.1% multiracial, 0.8% African American, 0.4% Hispanic, and 0.3% Asian. With regard to socioeconomic status, 36.8% of the student population is economically disadvantaged, qualifying for free or reduced lunch. The percentage of students with disabilities was 12.6%. It was uncertain if the sample was reflective of school demographics as that information was not available to the researcher.

In the spring of 2005, prior to the intervention, 78.3% of the third graders and 76.3% of the fourth graders in the district scored at or above proficient levels on the state proficiency test. Since proficiency tests were not administered to first and second graders, no data existed for first and second grade students. For the sample used in this study, no other test data was collected other than the pre and post spelling assessments.

Sampling Plan

This research involved a group of children enrolled in a summer intervention program during June of 2005. To recruit students for the 2005 summer program, the district curriculum director sent a memo to building principals informing them of an opportunity for at-risk readers to receive extra instructional support in reading during an up-coming summer intervention program. Principals instructed teachers to compile a list of possible candidates for the program. The teaching staff for each of the nine elementary schools in the district recommended students in their classes who they perceived were not achieving at a level commensurate with their peers. There were no additional reading test scores used to confirm whether these children were scoring below their peers. Teacher
referral was the only criteria used. These children were not necessarily identified as having learning disabilities or specific language disabilities. Student referrals for the summer program were made strictly on the basis of classroom teacher judgments.

Names of potential candidates for the summer program were forwarded to the district office. The school district mailed letters to the families of potential candidates to inform parents about this opportunity for remedial instruction in reading. Parents interested in having their child/children participate in the intervention program completed the necessary enrollment forms and submitted them to their respective schools to register their children to receive additional support in reading.

Any student lacking one or more of the following essential skills outlined in the meta-analysis of the National Reading Panel (2000) was considered a potential candidate for the intervention program: phonemic awareness, phonics, fluency, vocabulary, and text comprehension. Students were not required to qualify for the program on the basis of any past normative or informal test results indicating insufficient knowledge relative to any of the above stated skills.

**Instrumentation**

The school district determined that a spelling test located in Book 1 of the Wilson Reading System (WRS) (Wilson, 1996) would be used to collect spelling data from participating students. The instrument identified the types of errors that students from grades one through four might show for a limited number of beginning level concepts. These concepts included letter/sound correspondences for initial and final consonants as well as short vowels.
Selection of the Instrument

Data for this study was obtained using an informal spelling test located in Book 1 of the Wilson Reading System (WRS) (Wilson, 1996). The pre-test consisted of 15 words located at the top of page 90 of Book 1 of the WRS (Appendix A). The test contained a limited number of beginning level concepts: 1) initial and final consonants, 2) short vowels, 3) blending of two and three speech sounds, 4) consonant digraphs, 5) double consonants \textit{ff}, \textit{ll}, and \textit{ss} plus one irregular orthographic pattern (\textit{all}), and 6) adding the suffix \textit{s}. The focus of instruction for the WRS Book 1 Student Reader was processing consonant and short vowel information in the context of closed syllable patterns.

Pilot Study

A pilot study was conducted in which this same instrument was used in case studies for 6 at-risk readers in grades K through 3 (Evangelista et al., 2005). Each child was administered the same pre-test, after which they received 10 hours of explicit, systematic instruction in phonemic awareness. These 15 items were not revisited during the 10 hours of explicit, systematic instruction; rather children were taught to segment closed syllables in the context of different words or pseudo-words. After receiving intensive intervention in phonemic instruction, the post-test was administered to determine whether the intervention had affected phonemic awareness skills.

Results from the pilot study suggested at-risk readers experience considerable difficulties processing short vowel information, yet there was substantial improvement after explicit, systematic instruction. From the findings of the pilot study, this author concluded that the instrument was an appropriate measure for use as a pre/post
assessment of students’ abilities to decode and encode words with closed syllables (Evangelista et al., 2005).

Reliability Issues

Using the Kuder-Richardson formula 20, pre-test scores for the 69 students in this study were analyzed to determine the reliability of the measure; the test reliability of the pre-test was .84. In addition, the same analysis was performed for the post-test scores for existing data; the reliability of the post-test was .85. These analyses of pre and post data revealed the measure had good internal consistency.

Validity Issues

With regard to content validity, this measure includes the specific domains of interest: ability to accurately identify target phonemes, ability to represent phonemes with logical graphemes, and the ability to segment individual speech sounds. All items on this measure assess student knowledge and skill in manipulating consonants and short vowel sounds. With regard to face validity, the author of Wilson Reading System and other experts trained in phonemic awareness instruction concurred that the measure does, in fact, assess what it is designed to assess. The items on the instrument were matched to concepts taught in Book One of the Wilson Reading System.

Data Collection Procedures

Data were collected in June of 2005, during a district-wide summer intervention program in the Midwest for at-risk learners. Classroom teachers administered a spelling pretest consisting of 15 words with closed syllable patterns prior to instructional intervention. Teachers scored students’ pretest based on correct or incorrect responses.
Although pre and post measures were obtained for each student, significance testing was only conducted on pretest scores. Comparisons of pre and post measures would infer that differences between the two measures were attributed to the intervention. However, the absence of a control group and random assignment of subjects to treatment precluded the application of statistical analyses to make inferences regarding the effectiveness of the intervention. Therefore, all significance testing was performed on pretest data only.

Data Analysis Procedures

Pre and post measures were assigned a numeric identifier and phoneme errors on both the pre and post tests were classified according to the following taxonomy as shown in Tables 1, 2, and 3 (also in Appendix B). The classification system for this study was adapted by this author from an earlier analysis of spelling errors conducted by Moats (1983). Though letter confusions between letters such as b and d are quite common in at-risk readers, letters written backwards do not necessarily indicate an inaccurate processing of phonemic information. Because this study is primarily interested in phonetically inaccurate errors, backward letter formations were not classified as errors for the purpose of this study.
Table 1.

*Classifications of Pre-conventional Errors*

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-conventional consonant and vowel errors</td>
<td>A pre-conventional consonant error is one in which a letter name contains the sound of the target phoneme (ex. when a student names the letter $y$, the initial production of sound is the same as for /w/; when the letter $u$ is named, the initial production is the same as for /y/; a pre-conventional vowel error is one that has a transitional vowel spelling (ex. <em>bued</em> for <em>bud</em>).</td>
</tr>
</tbody>
</table>

Table 2.

*Classifications of Phonetically Accurate Errors*

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Description</th>
</tr>
</thead>
</table>
| Phonetically accurate consonant additions, omissions, and substitutions or vowel substitutions | Consonant addition –ex. *budd* for *bud*  
Consonant omission,-ex. *mis* for *miss*  
Consonant substitution- *loks* for *locks*  
Vowel substitutions- ex. *fol* for *fall*). |

Note: these spelling errors do not alter pronunciation of the syllable
Table 3.

Classifications of Phonetically Inaccurate Errors

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Description</th>
</tr>
</thead>
</table>
| Phonetically inaccurate consonant and vowel additions, omissions, and substitutions or serial order errors | Consonant addition – ex. *phuf* for *huff* undone
Consonant omission, -ex. *cips* for *chips*
Consonant substitution- *pad* for *pan*
Vowel addition- ex. *pane* for *pan*
Vowel omission- ex. *qut* for *quit*
Vowel substitutions- ex. *hoff* for *huff*
Serial order confusions- ex. *nest* for *nets*

Note: these spelling errors alter the pronunciation of the syllable

Inter-rater Reliability

To ensure interrater reliability, three experts in the field of phonemic awareness scored the data. Raters received scoring instructions (Appendix C) and an opportunity to score sample data prior to scoring the data set to clarify any questions pertaining to the classification errors. For each of these 69 cases, raters examined each item on both pre and post measures, classified each phoneme error on the students spelling test, and placed a tally mark in the appropriate category to indicate the error. After classifying each error for all 69 cases, raters totaled the tallies and indicated raw score totals for each error category. Scoring forms (Appendix D) with individual case numbers were provided and raters had an opportunity to become acquainted with the marking system on the form. In addition, raters received instructions for handling missing data.
After scoring was completed by each rater, raters’ totals were computed for phonetically accurate (PA) and phonetically inaccurate (PI) errors. Inter-rater reliability was determined by establishing correlations between raters, computing the simple proportion of agreement and disagreement, and adjusting that proportion for chance agreement.

Procedures for Missing Data

In this data set there were three types of missing data. The first type of missing data involved the actual items on the spelling assessment. There were seven instances (4 on the pre-test and 3 on the post test) where students failed to write entire words. For example, if a student failed to write the word *rush* when it was dictated, this omission was treated as missing data. In cases such as this, raters were instructed not to second-guess what types of errors the students may have made had they attempted to spell the word. Therefore, raters were instructed not to mark any tallies for missing items on the test. Given that each test contained 15 items, each student was required to spell a total of 30 items, 15 for pre-test and 15 for the post assessment. Thirty items multiplied by 69 cases equals a total of 2,070 items. There were only 7 instances of missing items (4 on the pretest and 3 on the posttest), which was insignificant compared to the total number of available items.

Four students were absent the last day when the post test was administered. In cases where post test measures were missing, those particular cases were excluded from the study. The last type of missing data involved one case that was set aside due to illegible hand writing and an inappropriate match between the skill level of the student
and the required task. For this reason, this case could not be scored and was removed from the analysis. Therefore, 69 cases were included in the final analyses.

**Statistical Analyses**

Before running statistical analyses, data entries in SPSS were cross-checked with the scoring form to confirm the accuracy of data entries into the software program. For any discrepancies, the researcher referred to the original data set for needed clarification. Descriptive statistics were obtained for the data, and different analyses were employed to determine whether assumptions for conducting a one-way multivariate analysis of variance were met. The Kolmogorov-Smirnov (K-S) test was used to test for a normal distribution of error types for younger and older children, and the Box’s test was used to test for the homogeneity of variance among error types for younger and older children.

These assumptions were met, and two different statistical procedures were employed to test for significance. A one-way multivariate analysis of variance (MANOVA) was conducted to test the first null hypothesis to determine the effect that the grouping variable had on the dependent variables. To test null hypotheses #2, a Chi Square test of proportions was used to determine whether significant differences existed between the proportion of phonetically accurate and inaccurate errors observed in at-risk readers. In addition, a Chi Square test of proportions was conducted to determine significant differences between the proportion phonetically inaccurate consonant and vowel errors. In summary, the following null hypotheses were tested to determine significance:
1. Null hypothesis #1: The mean vector of phonetically accurate and inaccurde errors for younger at-risk readers equals the mean vector of phonetically accurate and inaccurate errors for older at-risk readers.

\[
\begin{bmatrix}
\mu_y^a \\
\mu_y^i
\end{bmatrix} = \begin{bmatrix}
\mu_o^a \\
\mu_o^i
\end{bmatrix}
\]

where \( \mu_y^a \) is mean for younger accurate errors, \( \mu_o^a \) is mean for older accurate errors, \( \mu_y^i \) is mean for younger inaccurate errors, and \( \mu_o^i \) is mean for older inaccurate errors.

2. Null Hypothesis #2: The proportion of phonetically inaccurate errors equals the proportion of phonetically accurate errors for at-risk readers.

\[ \pi_i = \pi_a \]

3. Null Hypothesis #3: The proportion of phonetically inaccurate vowel errors equals the proportion of phonetically inaccurate consonant errors.

\[ \pi_v = \pi_c \]

Summary

The research design of this study involved testing for significant differences between younger and older at-risk readers for phonetically accurate and inaccurate errors. In addition, the design tested for significant proportions of error types between phonetically accurate and inaccurate errors and between phonetically inaccurate consonant and vowel errors. The instrument employed to assess error types was a 15 word spelling test that investigated spelling errors in words containing closed syllable patterns. The participants included 69 at-risk readers in grades one through four from a small Midwestern school district. Data were collected during a summer intervention...
program for at-risk readers held in conjunction with a professional development workshop for summer program instructors.

Teachers received training in multisensory explicit, systematic instruction for at-risk readers. The goal of reading intervention was to assess students’ phonemic awareness skills and provide explicit, systematic instruction to increase students’ skill levels. To accomplish this goal, teachers first assessed student knowledge on a finite number of concepts using a 15 word pre-test of closed syllable patterns. Instructional objectives addressed any weak areas for these six domains. At the culmination of the intervention program, subjects were again assessed using the initial measure.

The data from the pre-test and post-test administrations were scored by three raters, all of whom received extensive training in phonemic awareness instruction. Each error was classified according to the provided taxonomy and tallied on a scoring sheet. Next, the coefficient Kappa was used to determine interrater reliability. Once interrater reliability was established, data was input into SPSS and cross checked with the original scoring sheet.

Descriptive statistics were obtained for dependent and independent variables, error type and grouping variable. A one-way multivariate analysis of variance (MANOVA) was used to test for significant effects between groups for hypotheses #1. To test hypotheses #2 and 3, a Chi Square test was used to test for of significant differences between proportions of phonetically accurate and inaccurate errors as well as phonetically inaccurate consonant and vowel errors.
CHAPTER FOUR

Results

In order to analyze spelling errors, three questions were developed to compare differences between younger and older at-risk readers relative to error types and compare the proportionate relationships between major types of errors. To address these points of interest, the following questions were investigated:

1. Do younger at-risk readers make significantly more phonetically accurate and inaccurate errors than older at-risk readers?

2. Is the proportion of phonetically inaccurate errors greater than proportion of phonetically accurate errors for at-risk readers?

3. Is the proportion of vowel errors greater than the proportion of consonant errors for at-risk readers?

This study used a comparative approach to investigate the effect that types of spelling errors had on group membership. Pre-existing data was used to compare mean differences between younger and older at-risk readers on different types of spelling errors. The spelling data used in this study were obtained from students enrolled in a summer intervention program for at-risk learners needing additional instructional support in math and reading. Students in the summer program were administered pre and post spelling assessments as mandated by the school district.

On the first day of the program, all participants were administered a 15 word spelling pretest containing closed syllable patterns. At the conclusion of the 14 day program, a post-test was administered to assess students’ mastery of the following
concepts: 1) initial and final consonants, 2) short vowels, 3) blending of two and three speech sounds, 4) consonant digraphs, 5) double consonants *ff, ll,* and *ss* plus one irregular orthographic pattern (all), and 6) adding the suffix *s*. Pre and post assessments were part of the school district’s plan to evaluate both teacher and student outcomes for the summer program. Within this limited number of constructs, a variety of spelling errors were observed and classified. For the purpose of analyses, errors were categorized as follows: phonetically accurate, phonetically inaccurate, phonetically inaccurate consonants, and phonetically inaccurate vowels.

The researcher was particularly interested in measuring the following subset of skills: 1) student knowledge of: short vowel concepts, 2) student ability to segment individual speech sounds in the context of closed syllable patterns, and 3) student ability to map phonemes to printed symbols. The instrument (Appendix A) used in this study to measure students’ prior knowledge had good content validity since it measured these specific domains of interest. In addition, the instrument had good face validity. The creator (Wilson, 1996) of the instrument and three specialists with prior phonemic awareness training agreed that the items on the instrument matched concepts covered in the first student reader of the Wilson Reading System (1996).

To determine how well the items on the instrument were related to one another, the Kuder-Richardson Formula 20 was applied to both pre and post measures. Analysis of pre and post scores revealed that the instrument had good internal consistency. The test reliability of the pre-test was .84, and the reliability of the post-test was .85. Therefore, the instrument was a reliable measure of the constructs of interest in this study.
Using this instrument, error classifications were investigated to answer several research questions. This chapter presents the results of data analyses pertaining to phonemic awareness and more specifically the processing of short vowel information in at-risk readers. The following sections will address data entry, descriptive statistics, research questions and hypotheses, and the results of data analyses applied in this study.

Data Entry

Prior to entering data into a Statistical Package for the Social Sciences (SPSS) statistical program, cases were screened for missing data. Initial screening revealed missing data at the item level. On rare occasions, students failed to write entire words during the dictation of spelling assessments. Failure to write a given word when dictated did not disqualify that particular case from inclusion in the data analysis because the remaining items provided data that were pertinent to the study. Only four instances were observed in which students failed to respond to dictated items on the pre-test and these omissions were noted on the students’ papers. In such cases, raters were unable to make judgments about phonetic accuracy or inaccuracy of missing items. For example, if a student failed to write the word rush, the three missing phonemes were neither classified as phonetically accurate or inaccurate. Therefore, no error classifications were assigned for the number of phonemes comprising each word. To avoid sacrificing a large quantity of available data, cases containing occasional missing items were retained for the purpose of statistical analysis.

However, cases with incomplete data due to absences were excluded from subsequent analyses. Four students were absent on the last day when the post test was
administered; therefore these cases were excluded from the study. In addition, one case was completely illegible, indicating an apparent lack of fit between the task at hand and the student’s cognitive abilities. As a result, this case could not be scored and was removed from the analyses. For the purpose of statistical analyses, a total of five cases were excluded from the study leaving a total of 69 subjects. Data was photocopied and distributed to raters for scoring purposes.

**Inter-rater Reliability**

The researcher and two additional raters trained in phonemic awareness scored the data for the purpose of establishing inter-rater reliability. Raters received scoring instructions and were given opportunities to score sample data to clarify questions relative to the error classification system. Raters identified and tallied the total number of errors in each category on the scoring form. After scoring was completed by each rater, the data were entered into a Statistical Package for the Social Sciences (SPSS) software program to determine correlations between raters’ calculations.

Correlations between raters were higher for phonetically inaccurate (PI) errors than for phonetically accurate (PA) errors. This discrepancy was partially the result of a miscommunication with raters; additional training may have resulted in higher correlations. The Pearson Correlation Coefficients for phonetically accurate and phonetically inaccurate errors were significantly correlated at alpha level 0.01 as shown in Table 4.
Table 4.

*Pearson Correlation Coefficients for Inter-rater Reliability*

<table>
<thead>
<tr>
<th>Raters</th>
<th>Correlations for PA Errors</th>
<th>Correlations for PI Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 1 vs. Rater 2</td>
<td>.929*</td>
<td>.968*</td>
</tr>
<tr>
<td>Rater 1 vs. Rater 3</td>
<td>.915*</td>
<td>.970*</td>
</tr>
<tr>
<td>Rater 2 vs. Rater 3</td>
<td>.902*</td>
<td>.964*</td>
</tr>
</tbody>
</table>

* Significant correlation at alpha = .01

In addition, the simple proportion of agreement between raters was computed for each combination of raters. Error classifications were compared between two raters at one time. Each instance of agreement and disagreement between raters was recorded. For example, if Rater 1 and Rater 2 both agreed that *pann* for *pan* contained a phonetically accurate error, this would constitute 1 agreement. On the other hand, if the raters disagreed, that would constitute 1 disagreement. After comparing each error for both raters, sums were computed for agreements and disagreements. Agreement and disagreement totals were computed for both phonetically accurate errors and phonetically inaccurate errors for all inter-rater combinations as shown in Tables 5, 6, and 7.

Table 5.

*Frequencies of Agreement and Disagreement for Raters 1 and 2 for PA and PI Errors*

<table>
<thead>
<tr>
<th>Rater 1</th>
<th>PA</th>
<th>PI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>168</td>
<td>44</td>
<td>212</td>
</tr>
<tr>
<td>PI</td>
<td>32</td>
<td>347</td>
<td>379</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>391</td>
<td>591</td>
</tr>
</tbody>
</table>
Table 6.

*Frequencies of Agreement and Disagreement for Raters 1 and 3 for PA and PI Errors*

<table>
<thead>
<tr>
<th>Rater 3</th>
<th>PA</th>
<th>PI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 1</td>
<td>170</td>
<td>40</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>340</td>
<td>376</td>
</tr>
<tr>
<td>Total</td>
<td>206</td>
<td>380</td>
<td>596</td>
</tr>
</tbody>
</table>

Table 7.

*Frequencies of Agreement and Disagreement for Raters 2 and 3 for PA and PI Errors*

<table>
<thead>
<tr>
<th>Rater 3</th>
<th>PA</th>
<th>PI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 2</td>
<td>138</td>
<td>63</td>
<td>201</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>318</td>
<td>361</td>
</tr>
<tr>
<td>Total</td>
<td>181</td>
<td>391</td>
<td>591</td>
</tr>
</tbody>
</table>

Based on the ratio of total agreement the total number of observed errors, the percentage of agreement was computed for all three combinations of raters. In addition, the coefficient Kappa (Crocker & Algina, 1986) was used to determine the adjusted proportion of agreement between raters due to chance agreement. Kappa values revealed a sufficient level of inter-rater reliability. Table 8 shows the unadjusted and adjusted proportion of agreement between raters for phonetically accurate (PA) and phonetically inaccurate (PI) errors.
Table 8.

*Unadjusted and Adjusted Proportion of Agreement between Raters*

<table>
<thead>
<tr>
<th>Raters</th>
<th>Percent of Agreement</th>
<th>Kappa Value</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 1 vs. Rater 2</td>
<td>87.14 %</td>
<td>.72</td>
<td>.001</td>
</tr>
<tr>
<td>Rater 1 vs. Rater 3</td>
<td>87.00 %</td>
<td>.72</td>
<td>.001</td>
</tr>
<tr>
<td>Rater 2 vs. Rater 3</td>
<td>81.00 %</td>
<td>.58</td>
<td>.001</td>
</tr>
</tbody>
</table>

*Independent Variable*

The independent variable in this study was a grouping variable. Before conducting analyses, data were transformed using a recoding technique. Four grade levels were recoded into two levels: younger and older at-risk readers. The younger group was comprised of first and second graders, and the older group included third and fourth grade students.

*Dependent Variables*

The dependent variables in the study were different classifications of spelling errors. The spelling errors of participants were initially classified according to three primary error types: pre-conventional, phonetically accurate, and phonetically inaccurate errors. However, a frequency distribution of error types revealed a limited number of pre-conventional errors. Fourteen children committed a single pre-conventional error and one student made 2 of these errors for a total on 16 pre-conventional errors. Pre-conventional errors were recoded as phonetically accurate errors for the purpose of conducting data analyses. Subsequently, error subtotals were computed to form the four dependent
variables: phonetically accurate errors, phonetically inaccurate errors phonetically inaccurate consonant errors, and phonetically inaccurate vowel errors.

Data Analyses

The data in this study were analyzed using a variety of statistical procedures. The following sections will describe the data and discuss the statistical analyses employed for hypotheses testing. Analyses of descriptive statistics provided general information about the data set regarding measures of central tendency, standard deviations, frequencies, outliers, and range of scores. In addition, statistical procedures were conducted to test for significant differences between groups. A one-way MANOVA was employed to test for between-group differences relative to error classifications, and a Chi Square test of proportions was used to compare the frequencies of phonetically accurate and inaccurate errors as well as phonetically inaccurate consonant and vowel errors.

Descriptive Statistics

This section will provide a brief description of the data in terms of transformations performed on the dependent and independent variables as well as other useful information that describes the data. The participants in the study totaled 69 students in grades one through four. The four grade levels were recoded into 2 levels. Grades one and two comprised level 1 or the younger group ($n = 24$), and grades three and four comprised level 2, or the older group ($n = 45$). The four dependent variables of interest were derived from the original thirteen error classifications: phonetically accurate errors (PA), phonetically inaccurate errors (PI), phonetically inaccurate consonant errors (PIC), and phonetically inaccurate vowel errors (PIV). Phonetically inaccurate errors included
PIC errors, PIV errors and serial order errors. However, serial order errors were not included in the analysis for comparing the proportion of PIC and PIV errors since serial order errors could involve either vowels or consonants. An overall summary of mean scores and standard deviations for each of the four dependent variables, excluding serial order errors is shown in Table 9.

Table 9.

Descriptive Statistics for Dependent Variables

<table>
<thead>
<tr>
<th>Error Types</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA Errors</td>
<td>69</td>
<td>0</td>
<td>13</td>
<td>2.97</td>
<td>2.629</td>
</tr>
<tr>
<td>PI Errors</td>
<td>69</td>
<td>0</td>
<td>23</td>
<td>5.55</td>
<td>4.870</td>
</tr>
<tr>
<td>PIC Errors</td>
<td>69</td>
<td>0</td>
<td>8</td>
<td>2.09</td>
<td>2.120</td>
</tr>
<tr>
<td>PIV Errors</td>
<td>69</td>
<td>0</td>
<td>14</td>
<td>3.13</td>
<td>3.134</td>
</tr>
</tbody>
</table>

Outliers

Preliminary analyses of the data revealed two different outliers for the dependent variables. Raw scores were converted to $z$ scores (a standardized residual or difference between a score and the mean of that particular variable) to detect outliers in the data; $z$ scores beyond positive or negative 2.5 are indicative of outliers. Case #1 had an extreme score ($z = 3.92$) for phonetically accurate errors, and Case #39 had an extreme score ($z = 4.32$) for phonetically inaccurate errors. An examination of original data revealed the outliers were not the result of erroneous data entry but rather reflective of legitimate
values. For this reason, a decision was made to include these cases in the statistical analyses.

Testing for Assumptions

Before conducting the MANOVA, it was necessary to conduct preliminary analyses to determine whether assumptions were satisfied for performing this statistical procedure: This parametric procedure assumes the following: 1) scores for each measure of the dependent variables are normally distributed; 2) the population variance among dependent variables are equal across all levels of the factor; and 3) the score on a dependent variable for one subject must be independent from other subjects on the same variable.

The assumption of normality was tested using the Kolmogorov-Smirnov Z statistic. Results from the Kolmogorov-Smirnov Z test revealed that both phonetically accurate and inaccurate errors were not statistically different from a normal distribution for either phonetically accurate errors: (K-S $Z = 1.253$, $p = .087$) or phonetically inaccurate errors: (K-S $Z = 1.109$, $p = .171$) as shown in Table 10.

Table 10.

| One Sample Kolmogorov-Smirnov Test for Normal Distribution for Dependent Variables |
|--------------------------------------|-----------------|-----------------|
| Phonetically Accurate Errors         | Phonetically Inaccurate Errors |
| Kolmogorov-Smirnov Z                 | 1.253            | 1.109            |
| Assymp. Significance                 | .087             | .171             |
For testing the homogeneity of variance assumption, the Box’s Test was used. The results of the Box’s M test indicated that the matrices were heterogeneous. \( F (3, 59213.694) = 2.954, p = .031 \). Though this assumption was violated, the MANOVA is robust for the violation of homogeneity of variance assumption. The null hypothesis may be retained, but the indications for differences between the means is dubious (Tabachnick & Fidell, 2001). Therefore, Pillai’s Trace was used rather than Wilk’s Lambda to determine multivariate significance since Pillai’s Trace is more robust to violations of homogeneity of variance (Tabachnick & Fidell, 2001). Last, the assumption of independence was satisfied since all subjects were selected and completed assessments independently from one another.

**Research Findings**

This investigation examined the effect of the dependent variables on group membership. The dependent variables were four types of spelling errors: phonetically accurate errors, phonetically inaccurate errors, phonetically inaccurate consonants errors and phonetically inaccurate vowel errors. Of particular interest to this researcher was the question of whether at-risk readers made significantly more phonetically inaccurate errors related to short vowels as opposed to consonant errors. The following sections will address the primary questions of interest, the alternate and null hypotheses, the statistical procedures performed on the data, and the results of significance testing.

**Between Group Differences**

Do younger at-risk readers make significantly more phonetically accurate and inaccurate errors than older at-risk readers? The means for phonetically accurate and
phonetically inaccurate errors as shown in Table 11 indicate that younger at-risk readers made a greater number of errors in both classifications.

Table 11

*Descriptive Statistics of Both Levels for PA and PI Errors*

<table>
<thead>
<tr>
<th>Errors</th>
<th>Levels</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA Errors</td>
<td>1</td>
<td>4.00</td>
<td>2.00</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1.67</td>
<td>1.665</td>
<td>45</td>
</tr>
<tr>
<td>PI Errors</td>
<td>1</td>
<td>6.50</td>
<td>3.432</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.64</td>
<td>5.258</td>
<td>45</td>
</tr>
</tbody>
</table>

The research hypothesis was that younger at-risk readers make significantly greater phonetically accurate and inaccurate spelling errors than older at-risk readers. To test this hypothesis, a one-way Multivariate Analysis of Variance (MANOVA) was conducted to test the following null hypothesis: the mean vector of phonetically accurate and inaccurate errors for younger at-risk readers equals the mean vector of phonetically accurate and inaccurate errors for older at-risk readers.

\[
\begin{align*}
\mu_{ya} & = \mu_{oa} \\
\mu_{yi} & = \mu_{oi}
\end{align*}
\]

where \( \mu_{ya} \) is mean for younger accurate errors, \( \mu_{oa} \) is mean for older accurate errors, \( \mu_{yi} \) is mean for younger inaccurate errors, and \( \mu_{oi} \) is mean for older inaccurate errors.

Results from the one-way MANOVA, as shown in Table 12, revealed a significant difference between the vector of group means \( F(2) = 13.329, p < .001 \). The \( F \) statistic was computed using alpha = .05 and was based on Pillai’s Trace because it is
more robust to violations of homogeneity of variance-covariance for the MANOVA. For the grouping variable there was a large effect size, partial $\eta^2 = .286$ (Cohen, 1987).

Table 12.

Summary of MANOVA Using Error Classifications as Dependent Variables

<table>
<thead>
<tr>
<th>Grouping Variable</th>
<th>Pillai’s Trace</th>
<th>F Statistic</th>
<th>df</th>
<th>p value</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger and Older</td>
<td>.286</td>
<td>13.329</td>
<td>2</td>
<td>.001</td>
<td>.286</td>
</tr>
</tbody>
</table>

The one-way MANOVA revealed a significant difference in the vector of group means for phonetically accurate errors $F (1, 67) = 26.680, p < .001$. However, the vector of group means for phonetically inaccurate errors failed to reach a level of significance $F (1, 67) = 2.423, p > .05$. as shown in Table 13.

Table 13.

Tests of between Subjects Effects

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>F</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA Errors</td>
<td>26.680</td>
<td>1</td>
<td>.001</td>
</tr>
<tr>
<td>PI Errors</td>
<td>2.432</td>
<td>1</td>
<td>.124</td>
</tr>
</tbody>
</table>

Phonetically Accurate and Inaccurate Errors

Is the proportion of phonetically inaccurate errors greater than the proportion of phonetically accurate errors made by at-risk readers? The research hypothesis stated that the proportion of phonetically inaccurate errors would be greater than the proportion of phonetically accurate errors for at-risk readers. To test the null hypothesis (Ho: $\pi_i = \pi_a$)
that the proportion of phonetically inaccurate errors in the population equals the proportion of phonetically accurate errors in the population for at-risk readers, a non-parametric Chi Square test of proportions was conducted.

Test results revealed significant differences in the proportion of phonetically accurate and inaccurate errors in at-risk readers ($\chi^2 (1) = 70.216, p < .001$). As shown in Table 14, younger and older at-risk readers made a greater proportion of phonetically inaccurate (PI) errors than phonetically accurate (PA) errors. Therefore, the null hypothesis was rejected.

Table 14.

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Frequencies</th>
<th>Observed N</th>
<th>Expected N</th>
<th>Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA Errors</td>
<td>171.00</td>
<td>171</td>
<td>268.0</td>
<td>-97.0</td>
</tr>
<tr>
<td>PI Errors</td>
<td>365.00</td>
<td>365</td>
<td>268.0</td>
<td>97.0</td>
</tr>
</tbody>
</table>

Phonetically Inaccurate Consonant and Vowel Errors

Is the proportion of phonetically inaccurate vowel errors equal to the proportion of phonetically inaccurate consonant errors for at-risk readers? The researcher hypothesized that the proportion of phonetically inaccurate vowel errors is greater than the proportion of phonetically inaccurate consonant errors for younger and older at-risk readers. The null hypothesis ($H_0: \pi_v = \pi_c$) was tested using the same non-parametric procedure used for Question 2. The Chi Square test of proportions revealed significant differences in the proportion of phonetically inaccurate consonant and vowel ($\chi^2 (1) = 10.848, p = .001$). As
shown in Table 15, younger and older at-risk readers made a greater proportion of phonetically inaccurate vowel (PIV) errors than phonetically inaccurate (PIC) consonant errors. Therefore, the null hypothesis was rejected.

Table 15.

*Frequencies for PIC and PIV Errors*

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Frequencies</th>
<th>Observed N</th>
<th>Expected N</th>
<th>Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIC Errors</td>
<td>141.00</td>
<td>141</td>
<td>171.5</td>
<td>-30.5</td>
</tr>
<tr>
<td>PIV Errors</td>
<td>202.00</td>
<td>202</td>
<td>171.5</td>
<td>30.5</td>
</tr>
</tbody>
</table>

*Summary*

In conclusion, results of the MANOVA revealed significant differences between older and younger at-risk readers for phonetically accurate errors. However, there was no significant difference between younger and older at-risk readers for phonetically inaccurate errors. Yet, when the outliers were removed from the analysis, there were significant differences between groups for both phonetically accurate and inaccurate errors.

In comparing frequencies for phonetically accurate and inaccurate errors revealed significant differences between the proportions of phonetically accurate vs. phonetically inaccurate errors. At-risk readers made significantly more phonetically inaccurate errors than phonetically accurate errors. A comparison of frequencies for phonetically inaccurate consonants and vowels revealed significant differences between the proportion of phonetically inaccurate consonants and phonetically inaccurate vowels. At-risk readers
made significantly more vowel errors than consonant errors. The following chapter will
discuss these results, draw some conclusions, and make recommendations for teachers
and future research.
CHAPTER FIVE

Discussion

Reading failure is a serious issue facing our nation’s public schools. According to the 2005 National Assessment of Educational Progress, 71% of the nation’s fourth and eighth grade public school students are reading below proficient levels. To address this problem, educators must look to the research on reading assessment and instruction for at-risk readers.

This study was based on four factors that impact learning for at-risk readers. First, at-risk readers have special instructional needs, one of which is the need for phonemic awareness instruction. Robust evidence points to the fact that many at-risk readers present with a core deficit in phonological processing or phonemic awareness skills (Armbruster et al., 2001). Second, evidence shows that early detection and intervention are essential for ameliorating reading difficulties (Shaywitz, 2003; Snow et al., 1998; Snow et al., 2005). Third, knowledge of English phonology may enable teachers to provide effective instruction to at-risk readers. Last, explicit, systematic instruction plays an important role in the information processing of at-risk readers.

This study was designed to examine the spelling error patterns of at-risk readers. In order to identify specific difficulties at-risk readers encounter with spelling tasks, this study employed a between-subjects research design with one independent variable and multiple dependent variables. The independent variable was a grouping variable with two levels: younger and older at-risk readers. The dependent variables included four classifications of spelling errors: 1) phonetically accurate errors, 2) phonetically
inaccurate errors, 3) phonetically inaccurate consonant errors, and 4) phonetically inaccurate vowel errors. The questions of interest to the researcher were as follows:

1. Do younger at-risk readers make significantly more phonetically accurate and inaccurate errors than older at-risk readers?

2. Is the proportion of phonetically inaccurate errors greater than proportion of phonetically accurate errors for at-risk readers?

3. Is the proportion of vowel errors greater than the proportion of consonant errors for at-risk readers?

The following discussion will examine the outcomes of this study for 69 participants in grades one through four who participated in a summer intervention program for at-risk readers.

*Discussion of Findings*

Statistical analyses were conducted to determine significant differences between the vector of group means for phonetically accurate and inaccurate spelling error patterns. In addition, the proportionate relationships of particular error patterns were examined. The following sections will summarize and discuss the findings for each area of interest.

*Between Group Differences*

Prior to running a one-way MANOVA, a preliminary analysis revealed two extreme scores. The original data were inspected to determine whether these outliers were legitimate values or the result of incorrect data entry. It was decided to include these cases in the analysis since they were found to be legitimate values. With outliers included, a one-way multivariate analysis of variance was conducted to compare the
vector of means for phonetically accurate and inaccurate errors between groups. The results revealed significant differences in the means between groups for phonetically accurate errors. The mean for the younger group was greater than the mean for the older group \( (M_y = 4.000; M_o = 1.667) \). In contrast, there was no significant difference between groups for the phonetically inaccurate classification of errors.

*Grade level impacts phonetically accurate errors.* Experience using an alphabetic writing system appears to give older at-risk readers a distinct advantage over younger at-risk readers for phonetically accurate errors. These results suggest that additional years of reading and spelling instruction may help at-risk readers to master beginning level phonics concepts. Hence, it is not surprising that the younger group of at-risk readers made significantly more phonetically accurate errors.

*Grade level fails to impact phonetically inaccurate errors.* There was no significant difference in the vector of means between groups for phonetically inaccurate errors. This indicates that the vector of means for phonetically inaccurate errors for older at-risk readers was not significantly different than the vector of means for phonetically inaccurate errors for younger at-risk readers.

*Proportion of Phonetically Accurate and Inaccurate Errors*

To test for significant differences between the proportion of phonetically accurate and inaccurate errors, a Chi Square test of proportions was conducted. Results revealed that at-risk readers made a significantly greater proportion of phonetically inaccurate errors than accurate errors. For phonetically accurate errors, the observed \( N \) was 171 and
the expected $N$ was 268; for phonetically inaccurate errors the observed $N$ was 365 and the expected $N$ was 268.

*Phonetic accuracy assumes alphabetic knowledge.* The consonant errors made by at-risk readers in this study included doubling additions, doubling omissions, and consonant substitutions. The occurrence of doubling additions and omissions were either the result of over-generalizing the doubling rule for $f$, $l$, and $s$ at the ends of words after one vowel or ignorance of the rule altogether. The consonant substitution errors were largely due to the three words for which there were multiple spellings for the sound of /k/ in *quit*, *fix*, and *locks*.

Phonetically accurate errors indicate a fundamental understanding of the sound/symbol correspondences of an alphabetic writing system. For example, writing *loks* for *locks* is a logical choice, albeit incorrect. Plausible spellings, commonly referred to as invented spellings are highly correlated with reading achievement (Grove, 2005; Niessen, 2003). Therefore, phonetically accurate errors would not necessarily indicate a phonemic awareness deficit.

*Phonetic inaccuracy assumes core difficulties.* The phonetically inaccurate errors committed by at-risk readers were varied. Phonetically inaccurate errors on the pretest measure could represent multiple difficulties with English orthography. Phonetically inaccurate errors may result from phonemic awareness deficits, an inability to map speech sounds to print, and/or an inability to accurately sequence phonemes. Unlike phonetically accurate errors, phonetically inaccurate errors suggest a deficit in phonemic awareness.
Proportion of Phonetically Inaccurate Consonant and Vowel Errors

Within the phonetically inaccurate classification of errors, a Chi Square test of proportions was conducted to compare the proportion of phonetically inaccurate consonant and vowel errors. Results showed that at-risk readers made a significantly greater proportion of phonetically inaccurate vowel errors than inaccurate consonant errors. For phonetically inaccurate consonant errors, the observed $N$ was 141 and the expected $N$ was 171.5; for phonetically inaccurate vowel errors the observed $N$ was 202 and the expected $N$ was 171.5.

Phonetically inaccurate consonants errors. The reason why students in this study may have made fewer consonant errors is that consonant phonemes share properties that facilitate learning. Consonants are frequently visible and highly tactile. Voiced and unvoiced consonant phonemes are produced when airflow through the oral or nasal cavity is modified as multiple articulators come in contact. For many consonant phonemes, there is a point of contact that can be both felt and seen during speech production.

Phonetically inaccurate vowel errors. This research revealed at-risk readers made significantly more phonetically inaccurate vowel errors than phonetically inaccurate consonant errors. This may be because, unlike consonants, during the production of vowel sounds there is no contact between primary articulators such as the tongue, teeth, and lips. Only slight adjustments in tongue height and advancement account for differences between vowel sounds, and these adjustments are made at the back of the tongue where it attaches to the mouth. Hence, these subtle adjustments are not easily visible. Furthermore, there is minimal motor movement in articulators.
Implications

Since reading and spelling are reciprocal processes (Henry, 2003; Norton et al., 2007), findings from this study may have implications for spelling as well as reading assessment and instruction. An understanding of specific difficulties that at-risk readers demonstrate on spelling tasks may provide insight into underlying causes of reading difficulties. Assessing students’ reading weaknesses is essential for establishing instructional objectives which give clear direction for what needs to be taught. The following paragraphs will discuss some implications these findings have for teachers as well as future researchers.

The Needs of At-risk Readers/Spellers

This study implies that at-risk readers have a core deficit in phonemic awareness which is supported by a large body of evidence (Armbruster et al., 2001; Bursuck & Damer, 2007; Ehri & Nunes, 2002). Phonemic awareness is the ability to manipulate the smallest units of speech. Manipulation of phonemes may include a variety of tasks such as phoneme segmentation, deletion, addition, or substitution. One author maintains that “an understanding of the segmental nature of language promotes analytical approaches to word learning and processing, simply because the concept of segmentation bolsters the capacity for identifying the structure of words and their internal elements.” (Koda, 2005, p. 72).

Phonemic awareness instruction. This study implies that instruction in phonemic awareness is necessary for at-risk readers and this is supported by a large body of evidence (Armbruster et al., 2001; National Reading Panel, 2000). Some believe children
are not able to break words into phonemes until they are able to read independently (Koda, 2005). However, the inability to read independently does not preclude the development of phonemic awareness skills. Children who are not independent readers may not possess implicit knowledge to perform segmenting tasks, but they are able to learn how to segment syllables into constituent phonemes when provided appropriate instruction to develop these skills.

*The need to facilitate information processing.* This study implies that at-risk readers require additional support to facilitate information processing. Strategies may be employed to strengthen associations between graphemes and phonemes. In addition, at-risk readers benefit from multisensory instruction (Moats & Farrell, 1999; Thorpe & Borden, 1985). Techniques to facilitate information processing are especially helpful when at-risk readers encounter difficulty processing phonological information (Tijms, 2004; Watson & Miller, 1993). For many instructors of reading, it is an accepted fact that children must understand the alphabetic principle; speech sounds map to symbols, and letters represent speech sounds. In addition, at-risk readers benefit from instruction regarding the distinctive features of phonemes, as well as how multiple phonemes combine to form words.

Information processing is facilitated through strength of associations and through the use of multisensory instruction (Moats & Farrell, 1999; Thorpe & Borden, 1985). The simultaneous use of visual, auditory, kinesthetic, and tactile pathways for learning affords children opportunities to capitalize on individual learning strengths. Some children are better visual learners, others prefer auditory input as opposed to printed matter, and
others thrive in learning environments that are rich in kinesthetic and tactile experiences to facilitate the processing of new information. Literacy acquisition requires a substantial amount of information processing relative to our alphabetic writing system during the primary grades.

In general, instruction in these elemental structures of English is generally not continued beyond second grade. Therefore, students in grades three and four rarely receive systematic instruction even for more advanced patterns of English orthography. It is a well-accepted fact that the primary focus in the lower grades is learning to read. However, from third grade on, the focus becomes reading to learn. According to this current study, there was no statistical difference between older and younger at-risk readers on the phonetically inaccurate error classification. Older at-risk readers seem to be experiencing the same phonemic awareness difficulties as younger at-risk readers.

Older and younger at-risk readers experiencing the same difficulties implies that older at-risk readers do not outgrow these reading and/or spelling difficulties as they move up through the grades. When reading difficulties are attributed to a lack of maturity, it is expected that children will catch up with their peers over time as they mature. These children may need more than the gift of time to develop requisite skills for literacy development. Older at-risk readers still have need of explicit systematic instruction since they apparently continue to demonstrate difficulties relative to phonemic awareness skills.
The Use of Error Analysis to Inform Instruction

This study implies that spelling instruments are useful for assessing underlying causes of reading difficulties. For this research a spelling pretest was used to assess the prior knowledge of at-risk readers relative to phonemic awareness. Spelling tasks necessitate the segmentation of individual phonemes. The spelling patterns of at-risk readers in this study revealed a significant proportion of phonetically inaccurate spelling. This finding would imply that many at-risk readers lack the necessary phonemic awareness skills to become accurate and fluent readers.

The Role of Linguistic Knowledge of English Phonology

Findings from this study also imply that short vowel phonemes are more difficult to process than consonant phonemes. At-risk readers made a significantly greater proportion of short vowel errors compared to consonant errors. Short vowel sound/symbol relationships are difficult for at-risk readers to learn. The lack of contact between articulators minimizes the motor movements of the oral tract. In addition, the lack of association between the name of the letter and its corresponding sound makes this linguistic information difficult to process. This indicates a need to develop effective strategies that will strengthen the associations between these sound/symbol relationships. Memory devices that aid in building associations between the letter and its short sound may be a valuable asset to at-risk readers as well as the teachers responsible for phonemic awareness instruction.
Recommendations

Findings from this study provide insight for addressing the needs of at-risk readers. The following discussion addresses recommendations for teachers relative to assessment and remediation of reading and spelling difficulties. In addition, recommendations are made for researchers regarding possible future replications of this investigation.

For Teachers

Early detection of potential reading difficulties is a critical step in providing appropriate and timely intervention. When teachers suspect reading difficulties are the result of deeper issues other than maturation, formal testing services are generally requested for children in question. Formal testing is costly and time-consuming. As a result, these services may not be delivered in a timely fashion. However, individual classroom teachers may make use of inexpensive, efficient, and informative curriculum based assessments.

Writing assessments. It is recommended that informal spelling assessments be utilized to assess students’ prior knowledge of English language structures. It is possible to gain a great deal of information regarding students’ knowledge of sound symbol relationships by examining spelling errors. Teachers may make use of informal spelling assessments to determine the nature of students’ difficulties. Spelling tests may be used to assess alphabetic knowledge as well as phonemic awareness. The detection of phonetically accurate errors is not as great a concern as is the detection of phonetically
inaccurate errors. Teachers may be relatively confident that children making phonetically accurate error are attempting to use their knowledge of letter/sound correspondences.

It is further recommended that teachers use instruments that represent a limited number of concepts, such as the one used in this study. The instrument used in this study assessed a limited number of beginning level concepts and progressed to more complex orthographic patterns. For example, the items on the pretest used in this study consisted of closed syllable patterns that are frequently taught first in beginning reading programs. Since consonant and short vowel sounds are foundational building blocks for closed syllables; it would be important to assess student knowledge of these concepts first. Subsequent assessments could include student knowledge of the other five syllable patterns found in English orthography: open syllables, silent e syllables, R-control syllables, vowel team syllables, and consonant le syllables.

The instrument used in this study consisted of a finite set of beginning level reading concepts in the context of closed syllables: 1) initial and final consonants, 2) short vowels, 3) blending of two and three speech sounds, 4) consonant digraphs, 5) double consonants ff, ll, and ss plus one irregular orthographic pattern (all), and 6) adding the suffix s. By assessing a limited number of related concepts, teachers were able to easily ascertain areas of weakness. Teachers identified which concepts needed to be explicitly taught to the students and tailored instruction to address specific difficulties.

*Informed instruction.* The detection of phonetically inaccurate errors may signal core deficits in phonemic awareness. This being the case, teachers may be relatively confident these difficulties will not go away without appropriate intervention. A lack of
phonemic awareness skills would require explicit systematic instruction to develop these skills. Research shows that phonemic awareness skills can and should be explicitly taught to children who lack these requisite skills for reading (Armbruster et al., 2001; Beck, 2006; National Reading Panel, 2000; Stern, 2007). To increase phonemic awareness skills, it is recommended that at-risk readers be taught how to segment speech sounds in words and write corresponding graphemes for each phoneme.

In this study, at-risk readers experienced specific difficulties with short vowel concepts. To address these difficulties it is recommended that teachers introduce one short vowel concept and teach it to the point of mastery before introducing subsequent short vowel concepts. Instruction must be paced in such a manner as to allow sufficient time for rehearsal of introduced short vowel concepts to insure students can both decode and encode words with the short vowel concept taught. It is also recommended that teachers use mnemonic devices to strengthen associations between the letter names of short vowels and their corresponding sounds.

_Differentiated instruction._ With regard to reading instruction, it is recommended that teachers adjust instruction to meet the needs of at-risk learners. A one-size-fits-all model is not an effective approach for at-risk readers. Young children in beginning reading programs come to formal instruction with a wide range of language abilities. “Seventy to 80 percent of American children learn how to transform printed symbols into a phonetic code without much difficulty’ (Shaywitz, 2003, p. 51). In contrast, at-risk readers require explicit systematic instruction in phonemic awareness (Armbruster et al.,
This researcher recommends that reading teachers differentiate between these skill levels and provide appropriate instruction for each.

When differentiated instruction is not provided, a situation is created in which many students are placed at-risk for reading failure. Typically, teachers must strictly adhere to curriculum guides for instructional planning for reading in order to cover specific grade level concepts. Most basal reading programs are designed in such a manner that if followed religiously, teachers will complete most of the lessons before the end of the school year. Pacing which ignores individual learning difference is a major factor contributing to the reading difficulties of at-risk readers. This problem may be effectively addressed through differentiated instruction.

Explicit instruction. Findings from this study suggest that at-risk readers lack phonemic awareness skills. Therefore, it is recommended that phonemic awareness skills be explicitly taught. According to robust evidence, at-risk readers with phonemic awareness deficits require explicit, systematic instruction in phonemic awareness to ameliorate these difficulties (Adams et al., 1998; Ehri & Nunes, 2002; National Reading Panel, 2000). Those who tenaciously endorse whole language methodologies as a panacea to the nation’s reading failure rate remain oblivious to the detrimental impact this approach is having on at-risk readers (Moats, 2007). While the battle rages between the two different ideologies, it is unfortunate that at-risk readers are victims caught in middle of this strife. Unlike typically developing readers, at-risk readers require explicit instruction in phonemic awareness to acquire basic early literacy skills (Bursuck &
Damer, 2007; Ehri & Nunes, 2002; Snow et al., 2005). It is critical that at-risk readers receive differentiated instruction that effectively addresses their learning needs.

For Researchers

As with many endeavors, much may be learned during the process, and lessons learned may be used to improve future studies. This particular study included a number of limitations relative to the research design, instrumentation, and data collection procedures. Therefore, researchers who wish to replicate this study may want to consider the following recommendations to address these issues.

The design. An experimental design is recommended for future replications in order to make statistical inferences regarding the intervention. One serious limitation of this study was the lack of a control group and random assignment of subjects to treatment. It is critical that reading instruction be grounded in scientifically based research. Research for reading intervention should be just as rigorous as it is for medical research. Medical research requires true experimental research designs because peoples’ lives may be dramatically affected by decisions made concerning medical treatments. It seems only right that reading research should be subject to the same high standards since decisions made regarding instructional quality also may have serious impacts on reading achievement and personal perceptions of competency. An experimental design using pretest and posttest measures with an intervening treatment would test for significant differences between the experimental group and controls to determine the effectiveness of the treatment. Details of the intervention used in this study are described in Appendix E. In this study, the effectiveness of treatment was influenced by teacher response to
professional development training. For this reason, it recommended that a teacher survey be administered to obtain data regarding teacher response to training and instructional methods employed during the intervention.

Although pretest and posttest measures were obtained for participants in this study, only pretest scores were used for data analyses. Statistical comparisons between pre and post measures would infer that any change in scores was attributed to the intervention. Future studies should employ the scientific rigor necessary to make any claims regarding the effectiveness of intervening treatment by including comparison groups. Having said this, comparison of pretest and post measures indicated a dramatic decline in phonetically inaccurate spellings. The participants in this study demonstrated substantial improvement in their abilities to map speech sounds to printed symbols and represent these sounds in a written format. Descriptive statistics of posttest results are located in Appendix F.

This decline in errors suggests that explicit systematic instruction in phonemic awareness was beneficial for at-risk readers as evidenced in the literature. Students were explicitly taught letter/sound correspondences. Also, they were given sufficient time to rehearse and master previously taught concepts before learning new concepts. Children were explicitly taught how to segment and count phonemes in a dictated word. The substantial decline in student errors from pretest to posttest administrations would suggest the intervention was effective. However, this study would need to be replicated using a comparison group and random assignment to determine significant differences
between treatment and control groups. This type of research design is required to substantiate statistical inferences regarding the effectiveness of the intervention.

**Definition of the sample.** It is recommended that future studies would include additional information to describe the sample population. The only definition for this sample was that these children were in grades one through four and were at-risk readers. Additional information such as other measures of reading or spelling achievement and demographic information would have enabled the researcher to better define the population.

**Instrumentation.** A different instrument is recommended for future replications of this study. Although the instrument used in this study had good reliability and content validity for the constructs taught during the intervention, there were complex items that increased the occurrence of phonetically accurate and inaccurate consonants. For example, the inclusion of items containing the doubling rule for \( f, l, \) and \( s \) and multiple spelling choices for \( /k/ \) increased the occurrence of phonetically accurate errors. In contrast, the inclusion of items containing the digraphs \( ch, sh, \) and \( th \) and adding the suffix \( s \) increased probability of committing phonetically inaccurate errors. Future research should omit items that contain more difficult orthographic patterns to test for significant proportions of error types. This researcher also recommends an investigation of spelling error patterns using a instrument that would compare the differences at-risk readers make on real words and pseudo words with closed syllable patterns.

**Improving data collection procedures.** To expedite the scoring process, the researcher recommends students be given a standard sheet of paper so that all scoring
documents are identical. A standard document with numbered items would increase the probability of students using the designated space for an item rather than writing words close together. Cases in which words were bunched closely together took much longer to score.

It is also recommended that the researcher instruct teachers to clarify students’ intended responses when handwriting samples are unclear. While the majority of the handwriting was legible in this study, some items were quite difficult for the raters to decipher. For example, the word rush on Case 51 appeared to be written ruse or ruse. As a result, one rater classified the c as a phonetically inaccurate consonant addition while another classified the e as a phonetically inaccurate vowel addition. Likewise, on Case #69 it was difficult to tell whether the student wrote quiet or quiet for quit. As a result, one rater classified the error as a phonetically inaccurate consonant addition while another classified the error as a phonetically inaccurate vowel addition. In future studies it would be helpful for teachers to confer with students regarding their intended response and ask the students to make needed changes for clarification purposes.

Last, it is recommended that the researcher instruct teachers not to make corrections on students’ incorrect responses to items. When data was copied for raters to classify errors, teacher corrections showed up on the copied data. The researcher had the advantage of reviewing original data for clarification. Though most of these instances were clarified in the instructions provided to the raters, some were overlooked. For example, for case 48, the student had written net for nets. The classroom teacher added the missing s while grading the pretest. On the original data this correction was written in
red ink; however, when the original data was copied, the black s appeared to be a student response. In this case, one rater failed to classify the consonant omission. Blue ink had the same effect on Case 54 for the word miss. Though these confusions did not interfere with hypothesis testing, they did have an impact on inter-rater reliability.

Conclusion

According to the National Assessment of Education Progress Report, 71% of the nation’s fourth and eighth grade students are reading below proficient levels (Institute of Education Sciences, 2005a) A meta-analysis of reading research (National Reading Panel, 2000) concluded that good readers are skilled in phonemic awareness, phonics, fluency, vocabulary, and text comprehension. Furthermore, the panel reported that these five component skills can and must be explicitly taught to students who lack these requisite skills for literacy development (Armbruster et al., 2001; National Reading Panel, 2000).

Phonemic awareness is one of these foundational skills for reading achievement (2000). At-risk readers who lack phonemic awareness skills have difficulty processing linguistic information (Adams et al., 1998; Good & Kaminski, 2002). As a result, confusions may arise with the letter/sound correspondences of an alphabetic writing system. Given a spelling task, a child’s failure to make necessary phoneme/grapheme connections may well result in phonetically inaccurate errors. The fluent skill of mapping phonemes to print may pose considerable challenges for at-risk readers.

The purpose of this study was to examine spelling errors of 69 at-risk readers in an effort to identify specific difficulties at-risk readers experience relative to processing
linguistic concepts. There were three important findings from this study. One finding suggests that older at-risk readers do not necessarily outgrow these phonemic awareness difficulties as they are promoted from one grade level to the next. The second finding revealed that at-risk readers make significantly more phonetically inaccurate errors than accurate errors. The third finding revealed that at-risk readers experience significant difficulties processing short vowel information. This was true for younger and older students alike.

The finding that older at-risk readers did not differ significantly from younger at-risk readers on mean scores for phonetically inaccurate errors provided evidence that third and fourth grade students continue to exhibit a lack of phonemic awareness skills despite additional years of formal education. Therefore, third and fourth grade students must be provided appropriate instruction in phonemic awareness to ameliorate reading difficulties. These at-risk readers are expected to read third and fourth grade textbooks without the foundational skills of a first grader. These children cannot be expected to read content area textbooks when they lack foundational skills for reading.

The finding that at-risk readers made a significantly greater proportion of phonetically inaccurate errors than phonetically accurate errors supports previous research findings that many at-risk readers present with core deficits in phonemic awareness. Phonemic awareness is a necessary skill for reading success. Phonemic awareness can be taught and children may develop these necessary skills with appropriate intervention. An inability to accurately and fluently map speech sounds to printed symbols adversely affects the development of early basic literacy skills.
The last finding that at-risk readers made a significantly greater proportion of phonetically inaccurate vowel errors compared to consonant errors suggests that short vowel concepts are more difficult for at-risk readers to learn. The processing of difficult linguistic concepts may be facilitated by providing instructional scaffolding to enhance information processing. Short vowel sounds are some of the first linguistic concepts taught during beginning reading instruction. Early reading failure may have devastating effects on self-esteem and self-efficacy. These negative effects impact motivation for learning. For this reason, it is critical for instruction to address these difficulties in a timely fashion.

A plethora of scientifically-based reading research reveals that essential skills for reading achievement include phonemic awareness and phonics instruction (Armbruster et al., 2001; National Reading Panel, 2000). This study may contribute to an existing body of literature related to at-risk readers that is quite robust. In addition, this investigation may also contribute to a paucity of literature comparing the relative difficulty that short vowels and consonants present for at-risk readers. The phonemic awareness difficulties that at-risk reader experience are more pronounced with short vowel concepts. This study highlights the challenge at-risk readers experience with short vowel information and the significance of mastering these difficult concepts to become successful readers.
References


Appendix A

Spelling Test for Closed Syllables

1. pan  
2. bud  
3. chips  
4. miss  
5. rush  
6. quit  
7. ham  
8. locks  
9. nets  
10. fall  
11. fix  
12. shell  
13. path  
14. huff  
15. maps  

Total consonant phonemes = 34

Total short vowel phonemes = 15

Total phonemes = 49

Appendix B
Outline of Error Classifications

Error Classifications

I. Pre-conventional phonetically accurate errors

   A. Pre-conventional consonant errors (ex. using a letter that contains the
sound (ex. y for /w/ or u for /y/; q for qu); Explanation: the word my is
comprised of two speech sounds, /m/ and /i/; likewise, the letter name y is
comprised of two speech sounds, /w/ and /i/; hence, children may confuse
y for /w/.

   B. Pre-conventional vowel errors (ex. transitional vowel spellings (ex.
bued for bud)

II. Conventional phonetically accurate errors

   A. Consonant errors

       1. Consonant doubling; (unnecessary addition of a doubled letter
(ex. budd for bud)

       2. Consonant doubling; omission of a doubled letter as in mis for
miss

       3. Substitution of an alternate grapheme for phoneme (loks for
locks or cwit for quit)

   B. Vowel substitutions (ex. foll for fall)

III. Phonetically inaccurate errors

   A. Consonant non-phonetic
1. Consonant addition
2. Consonant omission (nes for nets)
3. Consonant substitution

B. Vowel non-phonetic
1. Vowel addition (pane for pan)
2. Vowel omission
3. Vowel substitution (pon for pan)

C. Letter order errors (ruhs for rush)

Coding Legend: (Phonetically Accurate = P/A; Phonetically Inaccurate = P/I)

IA = Pre-conventional consonant errors
IB = Pre-conventional vowel errors
IIA1 = Conventional P/A consonant doubling addition
IIA2 = Conventional P/A consonant doubling omission
IIA3 = Conventional P/A consonant substitution
IIB = Conventional P/A vowel errors
IIIA1 = P/I consonant addition
IIIA2 = P/I consonant omission
IIIA3 = P/I consonant substitution
IIIB1 = P/I vowel addition
IIIB2 = P/I vowel omission
IIIB3 = P/I vowel substitution
IIIC1 = Serial order errors
Appendix C

Directions for Scoring Data

Directions: Read the following error classifications. Place tally marks on scoring sheet for every phoneme error in each item (word) for both pre and post tests in respective columns. Letters written backwards or missing items will not be classified as errors. Give students the benefit of the doubt if responses appear to indicate a self-correct or an attempt to erase. When the data was copied, some responses did not duplicate clearly; in other cases it was difficult to distinguish the teacher’s writing from the student’s. Some examples of responses not depicted clearly are listed below. Please note the following clarifications as you score:

Case #2 pre-test in the word miss the teacher wrote the second s
Case #13 pre-test- maps appears not to have an s on the end, but it is on the original
Case #37 post-test -student erased the second /s/ in the word nets
Case #66 pre-test -student wrote lockes (not real clear on the copy). Also student self-corrected nets.
Case #69 pre-test- student did double the s in miss.
Case #70 pre-test -student wrote fix (she uses large circles for dotting i’s so it looks like fox. rather than fix.

Note: you do not have Case #25 as it was removed from the data. This case was removed due to illegible handwriting and the apparent inappropriateness of fit between the required task and the student’s cognitive abilities. Please return scoring forms at your earliest convenience. Thank you for your assistance
Appendix D

Sample Tally Form for Scoring

(Raters received 70 of these tally forms, one for each student.)

<table>
<thead>
<tr>
<th>Case # 1</th>
<th>Tallies</th>
<th>Totals</th>
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<tbody>
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Appendix E

Description of the Summer Intervention Program

The goal of the summer program was twofold: 1) to provide remedial reading instruction for at-risk readers, and 2) to provide teacher training in an Orton-Gillingham multisensory approach to reading and written language. The program provided remedial instruction to participating students in conjunction with professional development for participating teachers (n = 20). The following describes the teacher training, teacher requirements, materials used, teacher procedures, and student procedures.

The summer intervention program was designed to provide extra support in reading and math for at-risk learners. As mandated by the district, children daily received 1.5 hours of reading instruction followed by 1.5 hours of math instruction during the summer program. Reading intervention for at-risk readers consisted of 14 days of explicit, systematic instruction in phonemic awareness.

The goal for the summer program was to assess students’ phonemic awareness skills and provide explicit, systematic instruction to increase students’ phonemic awareness skills. To accomplish this goal, teachers first assessed student knowledge of a limited number of beginning level concepts: 1) initial and final consonants, 2) short vowels, 3) blending of two and three speech sounds, 4) consonant digraphs, 5) double consonants *ff, ll, and ss* plus one irregular orthographic pattern (*all*), and 6) adding the suffix *s*. Instruction addressed insufficient knowledge in these areas according to the above sequence, beginning with number one and progressing to number six. Students received multiple opportunities to apply each concept before moving on to new concepts.
In addition, spelling from dictation was cumulative in nature; previously taught concepts were interspersed with the teaching of new concepts.

Teacher Training

On the Friday before the first day for students, teachers met for a four hour orientation and training session. During this time, teachers were provided with instructional materials for the summer program and received an abbreviated training in multisensory instruction. Teachers received basic knowledge in the following areas relating to structures of the English language: 1) the six syllable types, 2) syllable division rules, 3) orthographic patterns in English that signal the use of a short vowel sound, 4) mnemonic devices for teaching short vowels, and 5) the four spelling rules: the doubling rule for *f*, *l*, and *s*, and the three rules for adding suffixes to the end of base words.

Teachers received an additional 14 hours of professional development, excluding observation and in-class modeling of strategies by the professional development provider. After the initial four hours of training, teachers met with the trainer for one hour each morning before meeting with their students. During this hour the trainer would highlight a particular strategy to be used with students that day, allowing time for peer modeling between staff members and a question/answer period to clarify potential confusion among the staff.

On two consecutive days during the first full week of the program, the first hour was set aside for demonstration lessons. One second grade student consented to be the trainer’s assistant to help participating teachers learn new skills. The teaching staff
observed the teaching assistant and trainer as explicit, systematic instruction in phonemic awareness was presented according to a prescribed lesson plan (Appendix G). At the end of the hour set aside for teacher training, teachers went to their respective classrooms to practice the strategies they had learned.

While teachers worked with children, the trainer observed the staff throughout the building and provided support when needed. On multiple occasions the trainer was invited by the teachers to model particular strategies with the students. When children were dismissed for the day, the staff and trainer met again for one-half hour to share student responses to phonemic awareness instruction.

**Teacher Requirements**

To receive two hours of graduate credit, participating teachers had to complete course requirements: collection of daily writing samples from student performance on dictation tasks, submitting daily lesson plans with students’ written work attached, completing short assessments of their knowledge regarding English language structures, such as syllable patterns, syllable division rules, spelling rules, and short vowel signals (orthographic patterns that signal a short vowel sound. The submitted writing samples and accompanying lesson plans provided the trainer with evidence that students were applying phoneme segmentation of consonants and vowels on a daily basis.

**Materials Used**

Materials used during the program consisted of teacher prepared lesson plans (Appendix G) and commercially designed resources. The lesson plans consisted of the following components: 1) visual drill, 2) auditory drill, 3) blending drill, 4) introduction
of a new concept and reading of words, phrases and sentences, containing the new concept, and 5) spelling dictation using new concept and previously taught concepts.

The school district purchased needed resources for teachers to design effective lesson plans for addressing phonemic awareness deficits. Each teacher was given useful materials for implementing explicit, systematic instruction. Participating teachers were provided the following resources: a Language Tool Kit (Rome & Osman, 1993), three different levels of Fingertip Books (Chiodi, 1999), and a complete set of the Wilson Reading System Student Readers (Wilson, 1996). The Language Tool Kit is a set of 4 x 6 index cards. These cards are essentially flash cards containing 90 different graphemes that represent approximately 44 different speech sounds in the English language.

The Fingertip Books are leveled instructional materials that provide lists of words targeting specific linguistic concepts. For each lesson addressing a particular phoneme, there is a student page that provides many opportunities to read words, phrases, and sentences that contain the linguistic concept being taught (Appendix H).

The Wilson Reading System also contains lists of words and sentences to be read and used for spelling dictation. Teacher resources such as these assist teachers in providing multiple opportunities for children to apply linguistic knowledge to decoding words. All three of these resources facilitate explicit, systematic instruction for teaching reading.

**Teacher Procedures**

The summer teaching staff was instructed to administer a spelling pre-test consisting of 15 words (Appendix A) prior to providing explicit, systematic instruction in
phonemic awareness. In addition, teachers were instructed not to revisit any pre-test items during the course of instructional intervention to control for practice effects on the post-test. The instructional objective was to teach consonant and short vowel concepts rather than have students memorize a list of 15 words. Teachers received training for explicit systematic instruction and implemented the same during the intervention program. At the conclusion of the program teachers administered the same measure for the post test. In summary, teacher procedures included the following:

1. Teachers administered spelling pre-test.

2. Teachers received four hours of instruction pertaining to English language structure: a) six syllable types, b) hand signals for short vowels, c) orthographic patterns that follow short vowels, d) mnemonic devices for remembering multiple spelling choices for particular phonemes, e) how to teach students to finger spell while paying close attention to motor movements of articulators, f) how to properly produce consonant and vowel phonemes, g) how to execute a visual, auditory, and blending drill, and h) the four main spelling rules used in the English language.

3. Teachers were instructed not to revisit any of the pre-test items during the course of instructional intervention

4. Teachers worked in pairs to practice visual, auditory, and blending drills.

5. Teachers created daily lesson plans to address concepts taught in Book 1 of the Wilson Reading System (Wilson, 1996).
6. Teaches provided approximately 1 hour of explicit systematic phonemic awareness instruction each day to small groups of children (5 -8 students per group) for three weeks.

7. Teachers administered the post test on the final day of the intervention program

Student Procedures

For the pre-test, students were required to write their name and date at the top of their paper. Afterwards individual classroom teachers in grades one through four administered a 15 word spelling test (Appendix A) to their respective students. During the 14 day program, students were required to segment and count the number of speech sounds in dictated words. Per the training specified previously, teachers had a variety of word lists from which to choose without having to revisit words from the pre/post assessment. On the final day of the program, teachers dictated the same 15 words (Appendix A) for the post test.

Each day children were provided explicit instruction for mapping speech sounds to printed symbols. Teachers modeled strategies for the students to facilitate the manipulation of phonemes for the purpose of decoding and encoding. Children were instructed to attend closely to the different motor movements of articulators as they repeated dictated words. Children received instructions for segmenting individual speech sounds in words in order to count and sequence the number of phonemes. As they experienced the movement of articulators, children would count each phoneme using their fingers.
In summary, the intervention for this study employed systematic instruction for at-risk readers. Through systematic instruction, children were taught less complex concepts before progressing to more complex patterns of English orthography. New material was not presented until previously taught concepts were secure in memory. Systematic instruction followed a prescribed sequence so as not to introduce potentially confusing phonemes one right after the other. Systematic instruction facilitated the acquisition of requisite phonemic awareness skills (Armbruster et al., 2001; Beck, 2006; Bursuck & Damer, 2007). This study utilized appropriate pacing, strengthened associations between letter/sound correspondences, and provided systematic multisensory instruction to facilitate information processing.

The school district had mandated that both pre and post assessments be administered to evaluate student progress at the conclusion of the program. The pretest was administered prior to the intervention, and at the conclusion of the summer program, teachers administered a posttest using the same instrument utilized for the pretest. Teachers scored the posttest documents and compared pre and post assessments to determine students’ progress during the intervention program. Although the lack of a comparison group and random assignment to treatment precluded conducting significance testing, at-risk readers experienced a substantial decline in both phonetically inaccurate errors and phonetically.
Appendix F

Descriptive Statistics for Posttest Errors

<table>
<thead>
<tr>
<th>Error Types</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post PA Errors</td>
<td>69</td>
<td>.00</td>
<td>7.00</td>
<td>1.71</td>
<td>2.629</td>
</tr>
<tr>
<td>Post PI Errors</td>
<td>69</td>
<td>.00</td>
<td>16.00</td>
<td>2.29</td>
<td>4.870</td>
</tr>
<tr>
<td>Post PIC Errors</td>
<td>69</td>
<td>.00</td>
<td>6.00</td>
<td>.86</td>
<td>2.120</td>
</tr>
<tr>
<td>Post PIV Errors</td>
<td>69</td>
<td>.00</td>
<td>13.00</td>
<td>1.41</td>
<td>3.134</td>
</tr>
</tbody>
</table>
### Appendix G

**Sample Lesson Plan**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Teacher Procedures</th>
<th>Student Response</th>
<th>Materials Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory drill</td>
<td>1. Produces letter sound</td>
<td>1. Repeats the sound</td>
<td>paper and pencil</td>
</tr>
<tr>
<td></td>
<td>2. Repeats while writing corresponding letter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blending drill</td>
<td>1. Manipulates cards in the initial, medial, and final positions to make pseudo words</td>
<td>1. Blends the sounds to make nonsense syllables</td>
<td>pocket chart or stand on which to place the index cards for blending purposes</td>
</tr>
</tbody>
</table>
| Introduce a new concept and decode ay words | 1. Shows card  
2. Provides key word: Example: *day*  
3. Connects with prior knowledge | 1. Writes and says the sound 3 times while writing  
2. Decodes words, phrases and sentences | student page of words, phrases, and sentences that contain /ay/ |
| Segment sounds to spell words | 1. Dictates words and/or phrases for students to spell | 1. Repeats word, etc.  
2. Writes word, etc.  
3. Reads back word, etc. | paper and pencil |
Appendix H

Examples of Words, Phrases, and Sentences Read by Students

ten  set  keg
get  hen  pet
van  fell  egg
not  shed  dash
get the dish
pet the pup
met his pal
get one egg
dish the hash

Hens have eggs.
Who can get in the gate?
Do you have ten legs?

Fingertip Books Beginning Level


Note: The actual student copy of this page is typed with a much larger font size (24) for students to read the words, phrases, and/or sentences. Afterwards, the teacher dictates selected words, phrases and/or sentences for students to write.