Summer 1998

Does a Phonological Intervention Program Using a Modified Auditory Discrimination in Depth Program Make a Difference in Kindergarten Students' Ability to Manipulate Phonemes?

Julie Kay Osbourne  
Grand Valley State University

Follow this and additional works at: http://scholarworks.gvsu.edu/theses  
Part of the Education Commons

Recommended Citation  
http://scholarworks.gvsu.edu/theses/380

This Thesis is brought to you for free and open access by the Graduate Research and Creative Practice at ScholarWorks@GVSU. It has been accepted for inclusion in Masters Theses by an authorized administrator of ScholarWorks@GVSU. For more information, please contact scholarworks@gvsu.edu.
DOES A PHONOLOGICAL INTERVENTION PROGRAM USING A MODIFIED AUDITORY DISCRIMINATION IN DEPTH PROGRAM MAKE A DIFFERENCE IN KINDERGARTEN STUDENTS' ABILITY TO MANIPULATE PHONEMES?

Julie Kay Osbourne

Summer, 1998

MASTER'S THESIS

submitted to the graduate faculty at

Grand Valley State University

in partial fulfillment of the Masters of Education
Table of Contents

Table of Contents

Abstract

Chapter 1: Phonological Awareness ................................................................. 1

Chapter 2: Review of Literature ..................................................................... 7
  Rhyming ........................................................................................................ 8
  Working Memory ......................................................................................... 12
  Segmentation and Blending Intervention Strategies .................................... 26
  Computer-based Phonological Interventions ............................................. 52
  Interventions Using the Auditory Discrimination in Depth Program ........ 62
  Conclusions ............................................................................................... 67

Chapter 3: Research Study ............................................................................ 71
  Subjects and Setting .................................................................................. 72
  Measures .................................................................................................... 73
  Intervention ............................................................................................... 75
  Procedures ................................................................................................. 76
  Results ........................................................................................................ 79
  Conclusions ............................................................................................... 81

References ..................................................................................................... 84

Appendix A: Graphs of Results
The purpose of this study was to determine if a training program based on the Lindamood Auditory Discrimination in Depth Program made a difference in students' abilities to manipulate phonemes and identify similarities and differences in initial consonants between words. Kindergarten students were pre and posttested using the Test of Phonological Awareness (TOPA) and the Test of Auditory Analysis Skills. While students showed substantial improvement in their abilities to manipulate phonemes, their improvement on initial consonant skills, as measured by the TAAS was not as substantial.
Chapter One

Phonological Awareness

In my experiences as a resource room teacher, I have found that children with reading difficulties lack phonological awareness. Phonological awareness is "the ability to reflect on and manipulate the phonemic segments of speech." (Tunmer, 1991, p. 105). For example, students who are phonologically aware are able to form rhymes, blend one syllable words together, divide words into syllables, and substitute speech sounds (e.g., say man, now put a /p/ in front of man to get pan). According to research it is one of the strongest predictors of later reading success (Stanovich, 1991). Children who are phonologically unaware have a greater difficulty learning to read and comprehend material than students who are phonologically aware.

The Effects of Phonological Awareness

There are several reasons why children's lack of phonological awareness may be problematic. One reason is because our language is based on an alphabetic code. In order to learn to read, children need to be able to decipher this code. For example, in a study done with preschool children, Liberman and Shankweiler (1991) found that the phonemes in a word were more difficult to isolate and tap out than the syllables. In other words, the task of isolating the individual sounds in cool, as c/oo/l was more difficult for a child than to tap out the syllables in elephant. Many of the children did not have an understanding of phonemes, linguistic structures, or syllables (Liberman & Shankweiler, 1991). Liberman and Shankweiler (1991) felt that these children are at
risk because they do not have the linguistic awareness to give themselves entry into the alphabetic system of language. An awareness of linguistic structure is important to the later acquisition of reading and spelling (Liberman & Shankweiler, 1991). For children to be metalinguistically aware that "words compromise sequences of phonemes is particularly critical to their realization of what the alphabet is all about because phonemes are more or less what letters represent" (Mann, 1991, p. 122).

A second reason why children's lack of phonological awareness may be problematic is that children have difficulty segmenting words and breaking words down into individual phonemes or units of sound. Being able to identify letters and segment words into phonemes are the two strongest predictors of reading achievement, even stronger than intelligence measures (Ehri, 1991). This awareness allows children to have an understanding of the alphabetic code. It gives them the opportunity to identify "words encountered for the first time as well as the progressive elaboration of orthographic codes for an ever-increasing number of words" (Alegria & Morais, 1991, p.143).

Finally, children that are poor or weak readers would also be expected to have difficulty comprehending what they have read. If one labors over each sound and stumbles over each word, the meaning will probably be lost. One of the most difficult parts of learning to read is being able to be a fluent reader, that is being able to "process graphemic cues accurately, automatically, and rapidly" (Ehri, 1991, p. 58). Researchers have also shown that children that are phonologically unaware, also have
problems with short term memory. These children seem to have difficulties recalling specific words or naming simple objects (Liberman & Shankweiler, 1991). Children's attention is so focused on decoding the words that the future retrieval of specific material from the text becomes too difficult (Liberman & Shankweiler, 1991).

In conclusion, research suggests children who lack basic phonological awareness struggle when learning to read. Children need to be taught some skills to make them more phonologically aware. "Children who [do] not develop good word-recognition skills in first grade, read considerably less than good readers, both in and out of school. They thus [lose] the avenue to develop vocabulary, concepts, ideas, and so on that is fostered by wide reading" (Juel, 1988, p. 445). This quote supports the need for early intervention programs to build up the phonological awareness skills of the beginning reader.

Theories of Why Children Lack Phonological Awareness

There are many theories of why children may have difficulty with phonological awareness. One theory why children lack phonological awareness is that some children simply do not hear the different phonemic segments when a word is spoken. Children with reading disabilities often are not aware of speech sounds (Donnelly, 1996). They are not aware of speech sounds because when speaking, one does not say each sound individually. If one did, listening to someone speak would be a very arduous process. When speaking, we do not say "Duh-ah-duh" for dad (Liberman & Shankweiler, 1991). Coarticulation of speech sounds allows speech to move in a
speedy manner. However, it is problematic for the beginning reader as there is "no neat correspondence between the underlying phonological structure and the sound that comes to the ears" (Liberman & Shankweiler, 1991, p. 6). For example, the word bag has only one pulse of sound when uttered, however it is made up of three phonemes. Beginning readers can only understand that the spoken word bag has three letters, if and only if, they understand that bag is made up of three phonological segments (Liberman & Shankweiler, 1991). Liberman and Shankweiler (1991) believe that young children can be trained in phonological awareness, and this training can allow these children to become better readers and spellers.

Another theory of why children have difficulty with phonological awareness is the whole language approach to reading instruction being used in most schools. This approach to reading submerges the reader into literature hoping that by repeated exposure to the literature, the child will pick up on and learn the words. Fortunately, most children learn to read through the whole language approach. But for the children with phonological deficiencies, "the so-called 'whole language', 'psycholinguistic guessing game,' or 'language experience' approaches are likely to be disastrous" (Liberman & Shankweiler, 1991, p. 14). With the whole language approach, no problem solving skills are being taught to help the child figure out an unknown word. Teachers should be exposing children to good literature, while at the same time teaching students, at risk of having reading difficulties, prerequisite phonological skills.
Finally, Tunmer (1991) theorized why children may lack or be behind their peers in phonological awareness skills. He felt that the metalinguistic skills of breaking a word into segments and reflection of the parts of spoken words relates to Piaget's process of deconstruction. To deconstruct means to "shift one's attention from message content to the properties of language used to convey content" (Tunmer, 1991, p. 116). According to this theory, not being able to break a word into phonemic segments is due to a developmental lag in deconstruction processes (Tunmer, 1991). This theory implies that most children, when they reach formal schooling will be able to perform metalinguistic operations, even though they may have never encountered situations where they have had to do so before (Tunmer, 1991). However, children that are behind in the deconstruction processes would benefit from specific training in phonemic segmentation skills (Tunmer, 1991).

In summary, all of these researchers' theories why children lack phonological skills point to the need for early phonological intervention programs for children at risk of having reading difficulties. All three theories support the need for helping children to hear and manipulate individual phonemes and syllables in words. At risk students need more than just a whole language reading curriculum to help them to attain the skills necessary to become proficient readers.

Statement of Purpose

The purpose of this study is to find out whether early intervention programs at the kindergarten level are beneficial in helping students to become more phonologically
aware. Many researchers believe that children can be trained to become more phonologically aware. If phonological awareness is one of the biggest predictors of later reading success, then educators need to keep this in mind when developing a reading curriculum for early elementary students. Perhaps having phonological awareness training built into kindergarten programs would make educators jobs easier in teaching first graders how to read.

What I purport to do in this study is to compare two kindergarten classrooms to see if phonological awareness makes a difference in their ability to both manipulate phonemes and identify similarities and differences in initial consonants between words (e.g., leg has the same beginning sound as lamp; or shirt has a different beginning sound than foot). Students in both classrooms will be pretested and posttested using the TOPA Kindergarten Version (TOPA) and Rosner's TAAS. However only one classroom will receive phonological awareness training. Through this comparison, I will be able to ascertain whether or not the intervention strategy used is effective for teaching students to both manipulate phonemes and identify similarities and differences in initial consonants between words.
Since many researchers agree that phonological awareness is a strong predictor of early reading success, it is important that educators study ways in which they can increase the phonological awareness of their students. According to Adams (1990), phonemic awareness essentially links the relatively easy sensitivity to sound similarity and rhyme to the harder ability to recognize individual phonemes. In this paper, five areas of research related to intervention programs will be discussed. The first area will focus on rhyming games and strategies to help young children become more phonologically aware. Researchers theorize that "to recognize that two words rhyme is, therefore, to know something about their component sounds" (Maclean, Bryant & Bradley, 1987, p. 255). Possibly the reason why rhyming is considered an important predictor for early reading success is the fact that a child needs to focus in on ending sounds to hear if they are the same or not. By looking at research that focuses on rhyming tasks for young students, strategies may be discussed that could be implemented in early childhood reading programs. The second area of research will look at the involvement of working memory in the ability to learn to read and how this relates to phonological awareness. According to McDougall, Hulme, Ellis and Monk (1994), "memory problems experienced by poor readers are attributable to their difficulties with the use of phonological codes" (p. 112). Students that have memory deficits will more than likely have difficulty remembering what they have read, and
therefore probably struggle with reading comprehension. The third area of research to be discussed involves research on segmentation and blending skills. This particular area of review will give strategies teachers may implement in their classroom to help students learn to segment words, blend words together, and learn letter to sound correspondence. The fourth area of research will focus on computer based phonological interventions. Finally the last area will focus on a specific program to teach phonological awareness, the Lindamood ADD Program (Lindamood & Lindamood, 1975).

Rhyming

The first skill that children learn prior to school related to phonological awareness is that some words rhyme. Many children are exposed to nursery rhymes and other rhyming stories long before they come to school. According to Cunningham (1995), "rhythm and rhyme inherent in nursery rhymes are important vehicles for the beginning development of phonological awareness" (p. 40). She follows by explaining that rhyming books and nursery rhymes should play a large part in all kindergarten programs (Cunningham, 1995). The following studies look at the importance of rhyme and how rhyme can be implemented into classrooms.

In the only study reviewed, Maclean, Bryant, and Bradley (1987) assessed young student's knowledge of nursery rhymes and their phonological skills, as well as their parent's socioeconomic status (SES) and educational levels. The purpose of this study was to ascertain whether or not young student's knowledge of nursery rhymes is
a predictor of their phonological awareness, and how their parents SES relates to the student's knowledge of nursery rhymes. For example, do parents of children of higher SES expose their children to more nursery rhymes and rhyming games than parents of lower SES status. And does this increased exposure by these higher SES status parents give their children a phonological awareness advantage over other children. In this study, 66 subjects with a mean age at the start of the study being 3 years 3 months and at the end of the study 4 years 7 months. The subjects came from a wide and varied background, and were obtained from play group leaders, local health visitors, and through the medical staff at a local factory.

The students were then assessed on their knowledge of nursery rhymes and their parents' SES was taken into account. All students were pretested given two standardized tests: (a) the British Picture Vocabulary Scale (BPVS) and (b) the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). The social class of the father and educational level of both parents was determined using the Registrar-General's classification of occupations. Educational levels were determined by the parent's own history and divided into the following five levels: (a) university/polytechnic degrees, (b) college attendance, (c) school till 18 years, (d) school till 16 years, and (e) left school. Students were met with by the examiners over a period of five sessions. In the first session, students with a mean age of 3 years 4 months were first asked to recite five common nursery rhymes (e.g., "Jack and Jill" and "Humpty Dumpty"). Second, researchers recorded if the student could recite all,
part, or none of the rhyme. Finally students were given a rhyme-oddity task in which three pictures were presented to them with two of the pictures rhyming. The student had to pick out the picture that did not rhyme. Two examples were given with feedback, and ten items were then given without feedback.

In the second session, first the rhyme-oddity task was given, however in this task words were categorized by their beginning sound (e.g., pin pig tree). Second, students with a mean age of 3 years 8 months were asked to produce a word that started the same as a word the examiner gave them (e.g., tell a word that starts the same as fox). Third, students were asked to produce a word to rhyme with a word the examiner gave them. Fourth, students were introduced to a puppet named Joe, and given two words, one of which rhymed with Joe and the other that did not. Fifth, the students were told that Joe only liked words that rhymed with his name, and to tell the examiner of the two words which one did they think Joe liked. Finally in this session, students were asked to produce "just a little bit" of a phrase, a syllable, and a phoneme. In session three, the rhyme oddity task was again given to students with a mean age of 4 years. For the fourth session, each student, with a mean age of 4 years 7 months was shown 12 high frequency words and asked if they knew any of them. Some of the words included see, on, car, dog, and my. Students were then tested with letter knowledge starting with the letters in their own name. The letter testing was discontinued when there were five consecutive failures.
The results of this study indicated that students as young as three show phonological awareness. Many of these students did well on the rhyme and alliteration tasks, and had a reasonable knowledge of nursery rhymes. This study also indicated that children demonstrate some phonological abilities long before they learn to read. Student's knowledge of nursery rhymes did not seem to be affected by social or educational differences. While it appeared that parents with university degrees seemed to initially draw their children's attention to beginnings of words, the effects of this encouragement were not permanent. Researchers found, however, that there is a high relationship between a child's knowledge of nursery rhymes and later development of their phonological skills (even after controls for IQ and mother's educational level were put into place). Researchers also found that phonological skills measured at three years of age predicted the very beginning of reading. Overall, researchers concluded that "an increase in the amount of experience that 3 year old children have with nursery rhymes should lead to a corresponding improvement in their awareness of sounds, and hence to greater success in learning to read" (Maclean et al., 1987, p. 281).

Summary

This article supports the idea that rhyme is a good predictor of later reading success. One positive result that came out of this study was that SES did not seem to affect children's knowledge of nursery rhymes. This result suggests that children of all backgrounds can be exposed to nursery rhymes at a young age and therefore have
some phonological abilities prior to coming to school (Maclean et al., 1987). "One of the best indicators of how well children will learn to read is their ability to recite nursery rhymes when they walk into kindergarten" (Cunningham, 1995, p. 39).

Preschool teachers and parents of young children should take note of these results and expose children to rhyme. For example, reading Mother Goose to students, having children complete the rhymes in nursery rhymes (e.g., "Humpty Dumpty sat on a wall, Humpty Dumpty had a great ____."), doing finger plays, and playing rhyming games with students. All of these activities should increase the chances of a child having success in learning to read at school.

Working Memory

In order for children to become more skilled readers, they must be automatic with phonological processes in order to be fluent. When children have difficulty with fluency, and are phonologically unaware, it makes sense that they will have more difficulty remembering what they have read. As children become better readers, their memory capacity for what they have read should increase thus enabling them to comprehend more successfully (Adams, 1990). The following studies all look at memory and how it relates to phonological awareness and processing.

In the first study, Snowling, Hulme, Smith, and Thomas (1994) examined students' performance on tests of sound categorization. The purpose of this study was to separate the phonological analysis and working memory components of sound categorization tasks and show their relationship to individual differences in reading
skills. Three experiments were conducted. In the first experiment 18 six year old students and 18 eight year old students participated in the study. The students were chosen for being average readers for their age according to the British Abilities Scale (BAS) Test of Word Reading. Those selected for the study were then given The Digit Span Subtest from the Weschsler Intelligence Scale for Children-Revised (WISC-R) to give a measure of their memory span (forward digit span was measured only). In the first part of the experiment, students were introduced to the concept of rhyme using pictures. Students were then asked to detect the odd one out from a sequence of words in strings of three, four, or five words. There were eight sequences at each list length, and all of the odd ones out differed in the final consonant. While the position of the odd one out was randomized, the list lengths varied systematically "using a Latin square design to produce three different orders (3,4,5;4,5,3;5,3,4)" (Snowling et al., 1994, p. 165).

In the second experiment, 26 seven year old students participated in the study. The subjects were all considered to be normal readers based on the BAS. The test items were the same as used in experiment one with eight sequences of words of list lengths three, four, and five. However in this experiment, presentation of the list lengths were randomized, so children could not predict if they would be given three, four, or five words. The students in this study were also given the WISC-R Digit Span Subtest (forward span only). Students were told that they would be hearing lists of different lengths, and they should wait until the end before responding.
In the third experiment, 21 five and six year old students, 21 seven and eight year old students, and 21 nine and ten year old students participated in the study. Again the students were administered the BAS. To measure word span, three sets of eight items were used throughout the experiment. The three sets of words were: (a) one syllable words, (b) two syllable words, and (c) three syllable words. To measure memory span, students were presented with four lists of items at each sequence length beginning with a small number of items. The length of the lists was extended by one item until the subject made errors on three or more lists at a given length. Unlike the previous two experiments items were presented using a Macintosh SE/30 computer with an amplified speaker. In the sound categorization task, three levels of phonetic differences were included: (a) phonetic voicing (e.g., pad, had, mad, bat), (b) articulation (e.g., rob, mob, sob, nod), and (c) combination of voicing and articulation (e.g., got, cot, lot, knob). The order of presentation was randomized across phonetic features and the target words occurred equally in all positions of the sequence.

In the first experiment, the eight year old students outperformed the six year olds on the odd one out task. Results on this experiment also indicated that students had more difficulty with the task when the odd one out was phonologically similar to the other items. However, researchers found it surprising that no significant effect of list length was found.

In the second experiment, students still had difficulty with the tasks when the items were phonologically similar to the other items. While longer lists did seem to
produce more difficulty with students, an analysis of variance (ANOVA) performed on
the data did not reach significance on the correlation between sound categorization
and digit span length.

Finally, in the third experiment, an ANOVA showed significant effects for both
age and word length. The older students performed better on the task than the
younger students, and all of the students showed a decrease in memory, as the word
length increased. As with the previous two experiments, students had difficulty when
the words were phonetically similar. While a significant correlation was found
between sound categorization and memory span, reading ability appeared to be a much
better predictor of performance on the sound categorization task. When age was
controlled for, researchers found that digit span only was found to be significant, when
it was entered before reading ability.

In this research study, all three experiments indicated that the storage capacity
of short-term memory did not seem to play a role in the performance of students on
sound categorization. The last experiment was the only one of the three that showed
some significance related to memory span, but even in this study the reading ability of
the students seemed to be a stronger predictor of performance on the sound
categorization task.

In a second study, Leather and Henry (1994) looked at complex span tasks,
simple span tasks, and phonological awareness tasks, and they asked whether those
tasks are equivalent in predicting individual differences in reading comprehension or
whether they contribute to the variance in reading scores in a different way. Subjects consisted of 71 seven year old students randomly selected from five primary schools. A battery of 11 tests were administered over three testing sessions. The first session consisted of the British Picture Vocabulary Scale, the WISC-R Arithmetic Ability Subtest, and the Neale Reading Ability Test. The second session included two simple memory span tests, one for rhyming words, and one for non-rhyming words. During this session, trials began with lists of two words, progressing up to the longest list length the subject could repeat in the correct order at least two out of three trials. The complex memory tasks consisted of a counting span task and a listening complex memory task. For the counting span task, the subject was presented with cards with colored dots on them, which the subject was asked to count. After the last card was counted, the subject was asked to recall the number of dots on each card in order. The trials began with two card sets and continued to grow in length until all three trials were failed. The listening complex memory span task involved subjects listening to a series of sentences which were read aloud at a constant rate. The child had to fill in the missing final word. After a signal, the child then had to recall the lists of final words in order. Trials began with three two sentence sets and continued to increase. For the third session, four phonological awareness tasks were chosen: (a) a strip initial phoneme task, (b) a strip final phoneme task, (c) a blending task, and (d) a phoneme tapping task.

Results of this study found that three of the phonological tasks (phoneme
blending, strip initial blending, and strip final phoneme) and both of the complex span tasks were highly correlated with reading comprehension, reading accuracy, and arithmetic abilities. Both the phoneme tapping task and the simple memory span tasks were weak predictors of cognitive ability. Researchers found that listening span shared much more variance with the phonological awareness tasks than simple span. Researchers also found that the phonological awareness tasks proved to be excellent predictors of reading accuracy, reading comprehension, and arithmetic ability. The results indicated that phonological awareness tasks make a contribution to reading and math scores, even when complex and simple span tasks are considered.

In a third study, Herdman and LeFevre (1992) attempted to relate the demands of word recognition to individual differences in reading efficiency. The subjects in this study consisted of 32 undergraduate university students in second and third year psychology courses. Each subject was given two lists of 80 letter strings (40 words and 40 nonwords). Each list was arranged in two columns. Subjects were given 25 seconds to cross out the nonwords. On the reading span test, subjects read sentences presented with a slide projector. If a particular sentence made sense, students recorded an S. If a particular sentence did not make sense, students recorded an N. At the end of each set, the word "recall" would appear on the screen, and students were to write down the last word of each sentence that appeared. The sentences ranged in length from two to five words, and half of them did not make sense. Performance was scored as the number of final words recalled. In order to measure attentional demands of
word recognition, a Microtech Unlimited laboratory computer was used to present words on a Panasonic video monitor. Each subject completed three blocks of trials; a practice, a single task, and a dual task. In the single task procedure, subjects looked at a centrally presented asterisk, after 500 milliseconds this asterisk was replaced by a word. Subjects were to pronounce the word as quickly as possible. In the single task auditory tone condition, the center asterisk was replaced by five asterisks. When a distracter tone was present, subjects continued to hold the center key until the word reset appeared. When a probe tone or high tone was heard, subjects were to push the top key on the computer as quickly as possible. This single task was to prepare them for the dual tone task to follow. In the dual tone task activity, subjects were to continue with the naming task when a low tone was presented. However, when a high tone was presented, they were to quickly push the top key and refrain from naming the word that appeared on the screen. An equal number of high and low frequency words were used on the experimental trials, 48 in the single task condition and 192 in the dual task condition.

The results of this study indicated that efficiency as measured by the individual differences in making decisions about words, activation of phonological information, and reading span is related to the attentional demands of word recognition. In this study, subjects with strong phonological codes performed better and were found to require fewer attentional resources to process words than were subjects with weak phonological codes. The implication for young children with this study is that children
with weak phonological awareness have greater demands placed on their working memory, and may have more difficulty understanding what they have read.

In a fourth study, Cornwall (1992) examined the relationships between phonological awareness, rapid naming and verbal memory to the reading and spelling skills of children with severe learning disabilities. Subjects consisted of 54 Caucasian children with a mean age of 9 years 7 months, who had been referred for assessment for learning disabilities. To be selected for the study, the students needed to have average intelligence (Full Scale IQ of 90 or more on the WISC-R) and a standard score on the Wide Range Achievement Test-Revised (WRAT-R) at least 16 points below his or her full scale IQ providing for a significant discrepancy between IQ and achievement. SES was computed using the Blishen and McRoberts Scale for Canadian occupations. The externalizing T score from the Child Behavior Checklist which is a composite of items measuring aggressive, attentional, and delinquent behaviors was computed for analysis. Each subject was given the following tests: (a) the WISC-R, (b) the WRAT-R Reading and Spelling Subtests, (c) the Gray Oral Reading Test Revised (GORT-R), (d) the Word Attack Subtest of the Woodcock Reading Mastery Test-Revised, and (e) the Child Behavior Checklist. Four other normed measures were also employed: (a) the Sentence Memory Test, (b) the Verbal Selective Reminding Test, (c) the Rapid Automatized Naming Test, and (d) the TAAS.

Results of the study suggested that when controlling for age, SES, behavior
problems, and intelligence, performance on tests of phonological processing, rapid
naming, and word list memory added a unique share in the variance of academic
achievement of children with severe reading disabilities. The findings support the idea
that phonological analysis task reflect the ease with which children establish
sound-symbol relationships and subsequently learn to read and spell words.
Researchers found that rapid naming speed also is related to reading speed and
fluency. Performance on the Sentence Memory Test did not seem to influence the
academic test scores. However, the scores obtained on the Verbal Selective
Reminding Test added a unique share to the variance in word identification skills. This
test may have reflected a students ability to identify whole words. Researchers found
that phonological awareness, rapid naming, and list learning were related to a wide
variety of reading subskills for the children involved in the study. Possibly, list
learning skills and rapid naming tasks might lead to children being better able to recall
words automatically when reading.

The purpose of a similar study by McDougall et al. (1994) was to look at the
relationships between individual differences in reading ability and phonological
awareness and in short-term memory skills between good and poor readers. The
researchers also wished to examine the nature of the differences in short term memory
skills between good and poor readers. Subjects consisted of 69 seven to nine year old
students. The students were randomly drawn from schools and had varied SES. IQ
scores were obtained using the short form of the WISC-R, consisting of the Block
Design, Object Assembly, Similarities, and Vocabulary Subtests. The sample was then divided into three reading ability groups based on their reading ability based on the BAS Word Reading Test. The memory span test in this study was the same as in the previous study. An SE/30 computer with an amplified speaker "read" a list of items to the student made up of three sets: (a) one-syllable words, (b) two syllable words, and (c) three syllable words. Subjects were presented with four lists of items at each sequence length beginning with two items. After each set of four items, the sequence length was increased by one. Testing was continued until the subject missed three out of four trials. After the memory span task, subjects speech rate was assessed. Each subject was given a three word triad and asked to repeat that triad three times as quickly as possible. The times obtained were transformed into speech rates for words per second. To make sure that the memory span for words was not just due to general differences in memory, the researchers designed a test for memory span for non-nameable abstract shapes. The shapes were drawn on the center of a white card. To start, subjects were presented with two shapes at a rate of one second per item. The items were then removed, and all nine items were laid out. The students then needed to point to the two objects they had just seen. List length was increased by one, as long as the child was correct on one of the four trials. Phoneme detection and rhyme recognition were the two phonological awareness tasks given. In the phoneme deletion task, the word formed when deleting a letter was always a real word.

For the results of this study, each subtest was subjected to a one-way analysis
of covariance. For the memory span tasks, researchers found that both reading ability and word length had significant effects on reading ability, but there was no interaction between the two factors. For speech rate, significant effects were found for both reading ability and word length, and unlike memory span, an interaction between reading ability and word length was found. Researchers found that the differences in memory span were associated with speech rate. Significant differences were found between reading groups with the rhyming and phoneme deletion tasks, with the high readers scoring the best on both measures. Researchers found the reading ability, phonological ability, and short-term memory span for words were highly correlated, however memory span for abstract shapes did not correlate significantly with the other measures. Speech rate appeared to be a much better predictor of reading ability than memory span. In fact, when speech rate was entered into the third step and entered into the regression equation, memory span no longer had a significant effect on reading ability. Even when age, IQ, and both measures of phonological awareness had been taken into account, speech rate was still significant. According to this study, short-term memory may not significantly contribute to later reading success, though a closely related process of speech rate does impact reading. Differences in reading are related to the speech based component of short term memory. Children that are poor readers had lower speech rates for the words they were to remember, and these same students performed poorly on the memory span task providing evidence that speech rate is related to short term memory span.
Finally, the last study that looked at memory and how it relates to phonological awareness was conducted by Naslund and Schneider (1996). The researchers had two objectives when conducting this study: (a) does performance on various phonological tasks in kindergarten predict later reading performance? and (b) does the relationship of phonological awareness and reading skills vary as a result of preschool letter knowledge? This study also looked at phonological awareness and memory span over time to find if either influenced reading acquisition. Subjects consisted of 134 four year old students at the start of the study. Parents responded to an advertisement in a Munich newspaper to participate in a longitudinal study. Children in Germany usually begin kindergarten at around age three or four and remain until age six or seven. Children were tested over a period of three years for the study. At age four, a word span task was given. Children were given two lists ranging in length from three to seven words long. They were asked to listen to the list and repeat the list in order. Trials were continued until a child missed both lists of a given length. At age six, a memory span task with phonologically similar words was administered. The following letter knowledge and phonological awareness tasks were given: (a) letter knowledge; (b) rhyme detection, (c) syllable count, (d) sound in word detection, (e) syllable segment, (f) pseudoword repeat, (g) syllable blend, (h) onset/rime blend, and (i) phoneme oddity. At the end of first grade, students were administered the Hamburg-Wechsler Intelligence Test for Grade School Children and were also given a word discrimination task. For second grade, the word span task previously used for
the preschool session was repeated. Phoneme recognition and phoneme manipulation were the two phonological tasks completed during this session. Word and nonword decoding speed was also measured using words of four letters in length. Reading comprehension was assessed using a test at the beginning of second grade, and one again at the end of second grade. The first part of the test had students complete a sentence (e.g., "You cannot read a _____," (a) book, (b) radio, (c) newspaper, or (d) story). The second part of the test included five short stories with multiple choice questions following each. A spelling test was administered in the fall and early summer of their second grade year, as well.

Results indicated that using speech cues for syllabic and comparison task did not seem to require a high level of metalinguistic skill, however it was more difficult for children to manipulate the speech units such as phoneme deletion, syllable blending and segmenting skills. The analyses suggested that verbal memory span and phonological awareness interacted with most students in kindergarten. By second grade, the interaction between these two ideas appeared to be mutually influential and appeared to be redundant. In other words, by the age of six, phonological recoding and rehearsal strategies develop and influence verbal memory for some students. In this study, children with a low memory span for the phonologically dissimilar words recalled less phonologically similar words than dissimilar words in general. The children with poorer reading skills tended to have poorer working memories. Another finding of this study was that phonological processing skills significantly impact a
child's later reading performance, and this finding seems to be independent of early letter knowledge.

Summary

While all of these studies put some emphasis on the importance of memory in being able to read, memory was not as strong of a predictor in later reading success as some of the other predictors such as rhyme detection, general phonological awareness, and speech rate. Two of the studies found that short term memory may not significantly impact later reading success (McDougall et al., 1994; Snowling et al., 1994). In the Snowling et al. (1994) study, researchers believed that phonological awareness played a bigger role as a predictor, and in the McDougall et al. (1994) study, speech rate seemed to be a greater predictor of reading success.

Five out of six studies talked about automaticity of word recall, and how this may free children to focus on other skills in reading (Cornwall, 1992; Herdman & Lefevre, 1994; Leather & Henry, 1994; McDougall et al., 1994). In the study by Herdman and Lefevre (1994), students with stronger phonological codes needed fewer attentional resources for word recognition, and were more automatic in their word recall. Similarly, Cornwall (1992) found that the Verbal Selective Reminding Test, which assessed the ability to remember a word list, may have reflected the ability of students to identify whole words. McDougall et al. (1994) also found that poor reading students with low speech rates had difficulty remembering words on word span tasks, and probably were less fluent readers. Finally, Naslund and Schneider
(1994) reported that the students with a lower memory span were the poorer readers. Phonological recoding and rehearsal strategies seemed to impact the students' verbal memories. Students with stronger working memories seemed to be more automatic in their word recall, and therefore were probably better readers. Since reading is comprised of many skills, being able to read automatically frees up children to concentrate on the other task of comprehending what they are reading.

Two of the studies found that certain phonological tasks were easier and less demanding for children to figure out than others (Naslund & Schneider, 1994; Snowling et al., 1994). Snowling et al. (1994) found that children had an easier time of detecting beginning consonant or rhyming differences than final consonant differences when trying to do odd man out activities. Similarly, Naslund and Schneider (1994) found that children had more difficulty manipulating speech units. Researchers theorized that the children had to maintain speech units in working memory longer in order to manipulate speech sounds. These results correlated significantly with all of the literacy measures. In both these studies, researchers found that the students that had more difficulty with the more complex phonological tasks were the weaker readers. These findings suggest that children need to be taught phonemic segmentation skills. The next section of this paper will look at intervention programs utilizing segmentation and blending skills.

**Segmentation and Blending Intervention Strategies**

In order to be better readers, children must have an understanding of the
alphabetic code (Alegria & Morais, 1991). "To acquire the alphabetic code, the child has to mentally isolate the different elements of speech to which letters correspond" (Alegria & Morais, 1991, p. 139). These isolated elements are in fact segments of words. The understanding follows that to understand the alphabetic code, and therefore be a better reader, a child must be able to segment and blend words together. The following studies will describe intervention programs involving letter knowledge, segmentation tasks, and blending tasks.

The first study by Ball and Blachman (1991), was conducted to evaluate the effects of training in phonemic segmentation and instruction of letter names and sounds on kindergarten children's subsequent reading and spelling skills. To select subjects, 151 children were given the Peabody Picture Vocabulary Test-Revised (PPVT-R). Children that scored more than 1.5 points below the mean were eliminated from the study. The Word Identification Subtest of the Woodcock Reading Mastery Test (Woodcock) was also administered. All Students that were reported to be readers or obtained raw scores of 3 or better on the Woodcock were also eliminated leaving a subject pool consisting of 89 students from three urban public school districts in the United States. Other pretests that were given were a phoneme segmentation test and a test of letter names and sounds. These students were then randomly assigned to three different groups: (a) a phoneme awareness training group, (b) a language activities group, and (c) a control group. Students were taught by the author and two trained elementary teachers for a seven week intervention program, all of
whom received four hours of training prior to teaching. Students from all three schools continued to participate in the regular kindergarten curriculum, which included some whole group instruction in letters and sounds. The phoneme awareness group consisted of five students who met four times per week for 20 minute sessions. This training was made up of the following three components: (a) say it and move it, (b) other segmentation related activities such as categorizing pictures by rhyme or alliteration; and (c) letter name and letter sound training. The language activities group also consisted of five students who met four times per week for 20 minute sessions. These students participated in a variety of language activities including the following: (a) general vocabulary development, (b) listening to stories, and (c) categorization activities such as putting vehicles in categories. The control group consisted of no intervention other than the traditional kindergarten curriculum. At the end of the seven week training program, students were posttested on phoneme segmentation, alphabet letter names and sounds, and the Woodcock Word Identification Subtest. In addition, they were asked to read 21 phonetically regular words and spell five words.

The effect of training in phoneme segmentation scores was analyzed using an ANOVA. Results indicated that the phonemic awareness group scored significantly better than the language activities or control group. Researchers found that children in the segmentation training group improved not only in segmenting trained items, but also in items that were matched closely to the trained items (matched transfer), and
even in items that were very different from those used in the training (broad transfer). The control group and the language activity group also showed significant gains in both segmenting trained items and matched transfer, but their gains were not nearly as significant as those for the trained students. There appeared to be no significant difference in the three groups for letter names, however both the trained and language activities groups performed better on the letter sounds than the control group. A one-way ANOVA was applied to the reading scores from the phonetically controlled word list. This analysis showed significant gains for the children in the phonemic awareness group. Children in the phonemic awareness group also scored significantly higher with their spelling scores. Because both the trained group and the language activities group had high letter name and letter sound knowledge at the end of the training, this finding shows that an increased letter-sound knowledge does not lend itself to being a better segmenter of words. If this were the case, the language activities group should have outperformed the control group in the area of segmentation. This study shows that young children can in fact be taught to segment words, and when combined with letter-sound knowledge, children are given a firm start in important prerequisite skills for reading.

A second study by Foorman, Francis, Novy, and Liberman (1991) looked at the changes first graders exhibit in learning to read and spell when exposed to more or less letter sound instruction. Subjects consisted of eighty first graders from Houston, Texas of middle class and lower middle class populations. Forty of the students were
enrolled in three classrooms in a public school that used a basal reading series, and reading was taught using a whole word method. The other forty students were enrolled in three classrooms in two parochial schools in which a basal was used, but more emphasis was placed on letter sound correspondences. All of the teachers were experienced first grade teachers. The 40 students receiving more letter sound instruction (more-LS) and the 40 students receiving less letter sound instruction (less-LS) were comparable in ethnic diversity, age, reading achievement, and intelligence. Students were administered the Gates-MacGinitie Reading Test, consisting of the following Subtests: (a) Letter Sounds, (b) Vocabulary, (c) Letter Recognition, and (d) Comprehension. After the Gates-MacGinitie Reading Test, students were given the Peabody Picture Vocabulary Test Revised (PPVT-R), a reading test consisting of 60 words, a spelling test, and Rosner's (1979) TAAS. The PPVT-R was given in October only, with all of the rest of the tests being administered in October, February, and May. The format for teaching reading was standardized across the classrooms. The three more LS rooms were focused on teaching letter sound correspondences and blending and segmenting of phonemes, and the three LS teachers were focused on teaching words in whole contexts. Spelling instruction in the Less LS rooms consisted of 20 minutes in the morning, and utilized the Stetson reading-spelling approach in which a word was projected on an overhead, pronounced as a whole, pronounced in syllables, and pronounced in individual phonemes. In the more LS rooms, the spelling sessions took place for 20 minutes in the afternoon.
Students were given a pretest at the beginning of each week with misspellings corrected. Then during the week students had different spelling exercises (e.g., list the two words that start with b, spelling bees, write sentences using words).

Results of this study indicated, for phonemic segmentation, there was no significant effect due to the letter sound instructional group, however all classrooms showed improvement from October to February to May. In spelling, there were significant differences in improvement in spelling favoring the more LS classrooms. The more LS classrooms seemed to improve at a faster rate in spelling both exception and regular words than the less LS classroom. The more LS classrooms improved in reading nonphonetic words from 20% to 40% to 51% from October to February to May, respectively compared to 17% to 31% to 35% for the less LS classroom. To discover individual differences in growth in reading and spelling, a Hierarchical Linear Model was used. Findings indicate what would be expected considering the previous results reported. In May the group receiving more LS instruction performed better overall in both reading and spelling than the less LS group, and also showed a faster rate of improvement. The educational implications for this study indicate that combining a reading and spelling program with letter sound instruction and phonemic awareness strategies makes sense for teaching children beginning reading skills.

In a third study Byrne and Fielding-Barnsley (1991) researched a training program that was designed to teach an aspect of phonological awareness to young children. The purpose of this study was to evaluate this phonological awareness
program. Subjects consisted of 64 students assigned to an experimental group and 62 students assigned to a control group. Assignment within the two groups was random, however the following variables needed to be the same across groups: (a) the two groups had to have equal numbers of subjects from the four preschools, (b) equivalent mean PPVT-R scores, and (c) equivalent mean phonological awareness scores. All subjects were pretested using the PPVT-R and Clay's Concepts About Print Test, Sand Version. Knowledge of familiar signs (e.g., McDonald's, Coca-Cola), letter recognition, rhyme recognition (e.g., which word sounded like cat), and phoneme identity where students had to name the picture that either started the same as a target picture or ended the same as a target picture. Two forms of both the initial phoneme test and the final phoneme test were used, one form of each containing phonemes used in the training (e.g., s, m, t, and l) and one form of each test containing phonemes that were not part of the training (e.g., f, n, b, and k). Therefore there were four phoneme identity tests in all. For posttests for the subjects, the phoneme identity tests were repeated, letter knowledge retesting was restricted to only the sounds of letters learned in the training. Again this letter knowledge testing was in the form of letter recognition (e.g., "Can you find the one that says /s/ ?"). Students were then posttested on a type of word "reading" (e.g., "Does this word ("sat" for example) say 'sat' or 'mat'? "). In the experimental group, children were trained in subgroups of 4 to 6 children for 25-30 minutes, once a week for 12 sessions. Five consonants (e.g., /s/, /m/, /t/, /l/, and /p/) and short vowels /a/ and /e/ were the focus of the study. In each
session, one consonant was introduced in initial position, the following week the same consonant would be introduced in final position. The lesson each week was introduced in the following manner. First, poems and jingles using a consonant in either the initial or final position were provided. Second, the sound of the letter was discussed. Third, a student had to pick out pictures of words beginning or ending with that sound from a poster. Fourth, students were provided with worksheets and given feedback, if needed. Finally, the last week of training consisted of games where consonants were in beginning and ending position. The students in the control group were also trained in groups of 4 to 6 students for 25 to 30 minutes per week. Their sessions consisted of: (a) story reading, (b) activities involving searching for categories such as animals, and (c) games based on these categories.

In order to obtain results for this study, the researchers used subgroup means as the unit of analysis for looking at the effects of the training. For both the experimental and control group, there was an increase in scores from pretest to posttest on phoneme identity, but the increase was much greater for the experimental group. The experimental group also increased on non trained phonemes as well as trained phonemes. On the word choice test, the experimental group averaged 8.1 words and the control group averaged 6.1 words, a significant difference in means. These results seem to show that phoneme identity is a stable skill, and once taught, children are able to transfer this skill to other phonemes which have not been taught. The analysis of the word choice test, letter knowledge, and phoneme identity suggests
that students should be taught both letter sound awareness and phonological awareness, in order for them to understand the alphabetic principle.

In a follow-up study, Byrne and Fielding-Barnsley (1995) looked to see if their training in preschool gave students an advantage over other students. The initial training consisted of the phonemes m, p, t, and g, and the short vowels a and e. The procedure was the same as in the aforementioned study. At the end of first grade, 64 (of 64) students were left from the experimental group, and 54 (of 64) of the control group were left from the original study. These same children were used for this study. At the end of first grade, students from both the experimental and the control group were tested with the following tests: (a) word lists containing pseudowords, regular, and irregular words, (b) spelling, (c) alphabet dictation, (d) phoneme identity, and (e) rapid naming of numbers. At the end of second grade, 62 children from the experimental group remained, and 53 children from the control remained. Students at the end of grade two were tested individually for two twenty minute sessions. Each test was given to a child on a computer screen with a voice operated relay. Seven tests were given to the second graders consisting of the following: (a) naming single digit numerals, (b) written form of numbers, (c) word lists containing pseudowords, regular, and irregular words, (d) reading and listening comprehension and (e) title recognition.

In the original study, students were trained in phonemic awareness in groups of 4 to 6 children. For the purposes of this study, results were obtained using the same
small group means as the unit of analysis. For Grade One, findings showed a
significant difference between the experimental and control group, favoring the
experimental group in ability to read pseudowords. The experimental group also had a
higher mean score on reading regular words than the control group, although the
effect was marginal. No significant differences were found in the reading of regular
words or in the spelling. The majority of students in both groups knew all of their
letters, and performed similarly on phoneme identity, as well. For the second grade
group, differences between means in favor of the experimental group occurred for all
three pseudo reading tasks, but not for identification of real words or numerals. The
two groups also did not differ in their tendencies to give irregular word analogies for
pseudowords (e.g., dalk to rhyme with chalk). Further analysis was performed, in
which five infrequent words (hundred, topic, silk, crop, and tax), were chosen for
students to decode. The experimental condition was correct on an average of 4.35
words, and the control condition of 3.93. Further analysis on the pseudoword list 2,
showed that while the experimental and control groups performed similarly on one
syllable words, the experimental group outperformed the control group on two syllable
words. To see if the children in the study were decoders or more sight word readers,
the researchers regressed pseudoword reading onto irregular word reading using the
small group means and then identified those groups above the regression line and
below the regression line. Researchers found that 9 out of 12 experimental groups
were above the regression line, and 3 out of 12 control groups were above the line
This finding means that students that were above the regression line could read more pseudowords than would be expected on the basis of their scores for irregular words. These children were considered decoders. Children that are better decoders seem to fare better in reading than children that are strictly sight word readers. There was significant difference between the experimental and control groups in reading comprehension, as well, but not in listening comprehension.

In a fifth study, Torgesen and Davis (1996), looked at individual differences in response to twelve weeks of training in phonological awareness. The experimenters were interested in seeing if there was wide variability in response to training and which intellectual skills were predictive of response to the training. Four categories of skills appear to be most relevant in determining predictive intellectual skills: (a) pretest levels of phonological awareness, (b) other phonological processing skills (authors looked at phonological coding in working memory and phonological access in long-term memory, (c) beginning reading/spelling skills, and (d) general verbal ability. Subjects were 100 kindergarten students from two elementary schools serving mostly low SES black children. Students within the sample who scored below the eightieth percentile were randomly assigned to a treatment and control group. Sixty students were in the treatment group with 40 students in the control group. The screening measure, which also served as one of the pretests was the TOPA. The test was given to students in small groups of eight to ten children. This test consists of two different parts. In the first part, students had to identify which of three pictures began with the
same sound as the target picture, and in the second part, which of four pictures began with a different first sound than the other three. Pretest measures assessed the aforementioned four skills and included: (a) phoneme segmentation test, (b) sound isolation test, (c) phoneme blending, (d) naming rate for digit, (e) digit span test, (f) letter name knowledge, (g) letter sound knowledge, (h) reading nonwords, (i) spelling nonwords, and (j) general verbal ability.

Training consisted of groups of 3 to 4 students who met with their instructors for 20 minute sessions four times a week over 12 weeks. The instructors were six graduate students in psychology, who were trained to do the program in six two hour sessions over three weeks. Training consisted of three introductory sessions in rhyme, followed by instruction and practice in blending and segmenting using different word sets. Students were taught first to blend phonemes together to make words, and then to pronounce phonemes at given positions in words and to also tell what position specific phonemes were in, and finally to pronounce all of the phonemes in a whole word to make a word. These skills were taught over five different word sets. Over the last three weeks of training, children were introduced to the letters that went with the small group of phonemes they had learned in training. They then were asked to combine their letter knowledge, and knowledge of segmenting and blending to read a small group of real words. Students in the control group were not given any special intervention, and were taught the kindergarten curriculum which followed the whole language philosophy. The growth of children's awareness skills was measured using
the segmenting and blending tests before training began, midway through training, and at the end of training.

To consider individual growth differences in the growth of phonological awareness after training, researchers first employed individual growth curve analysis. When the individual growth curves were plotted, researchers found that the average slope for the trained group in segmenting was 6.21, compared to 1.54 for the control group. The average slope for the blending task was 10.26 and 2.24 for the treatment and control group, respectively. An analysis using the dichotomous variable of groups to predict growth rate showed significant differences for both blending and segmenting. The growth in blending skills was better predicted by pretest variables than the variability in segmenting ability. The biggest predictor of growth in both sets of skills was the ability to spell nonwords with general verbal ability prior to training. Performance on the TOPA, sound isolation measures, and letter name knowledge all predicted growth in both skills. However, reading nonwords and naming rate predicted growth in blending skills only, while the blending pretest predicted growth in segmenting only. Since many of the pretests predicted growth in segmenting and blending skills, the researchers set out to see whether these relationships were independent or redundant with each other. To do this, the researchers modeled growth for both types of skills as a simultaneous function of several different pretests. The strongest predictor within each of the four classes of variables (phonological awareness, phonological processing, reading/spelling/letter knowledge, and general
verbal ability) was selected for the model. The three predictor variables for segmenting were spelling nonwords, verbal ability, and the TOPA. Researchers found that for growth in segmenting skills, Model one combining TOPA, spelling nonwords, and verbal ability were redundant with each other, however model 3 consisting of spelling nonwords and verbal ability indicated that spelling nonwords and verbal ability are independent of one another. The four predicting variables for blending skills included the TOPA, verbal ability, spelling nonwords, and digit naming. In the models for growth in blending skills, researchers found that phonological awareness and naming rate each predict unique variance in this growth, however spelling nonwords seemed to capture all of the variance in phonological awareness in predicting growth. One interesting finding is that in models that included spelling nonwords and the TOPA, the TOPA was not a significant predictor of growth. However in the models not including spelling nonwords, the TOPA was a significant predictor of growth in blending skills. There were children in this study who made little if no gains from the training. Twenty-one subjects scored only one or zero on the segmenting posttest, and six students received a score of two or smaller on the blending posttest. This finding indicates that there are other types of instruction in addition to phonological awareness training.

In a sixth study, Torgesen, Morgan, and Davis (1992), compared the effectiveness of a training program that teaches both segmenting and blending skills to a program that only teaches synthesis skills. Fifty-one students from seven
kindergarten classes were selected as subjects of the study based on their scores on the Screening Test of Phonological Awareness (STOPA). Those children scoring between the 15th and 50th percentiles on this test were selected as subjects. In addition to the STOPA, other pretests included the following: (a) phoneme segmentation test, (b) phoneme blending test, (c) measure of alphabetic reading, and (d) measure of general verbal ability. Groups of three to five students met with their trainers for 20 minute sessions three times a week. Trainers consisted of two elementary school teachers and one experienced learning disability tutor. Training for the analysis and blending group (AB group) and blending group (B group) was proceeded by four sessions of rhyming games to establish rapport. Students in the AB group were taught about beginning, middle, and ending sounds. They were also taught to segment words and to blend sounds together. Children in the B group were introduced to blending through multiple choice pictures. They had to identify the picture of the word that had been spoken in its segmented form by the trainer. They were then asked to give the word, the trainer had spoken without visual cues. The same seven word sets consisting of 15 to 20 words were used for both groups. Students had to achieve 75% mastery in order to move on, however this criterion was later changed for the whole group in the AB group because they had difficulty moving on. The control group or C group was exposed to many activities with books including listening to stories, answering comprehension questions, and dramatizing events from stories. Posttesting consisted of the same segmenting and blending measures used in the pretest. In addition a
reading analog task was given. This task included children's learning of the following letter sounds (/k/, /p/, /t/, /a/, /n/, and /m/). Following the learning of these letters, students then were asked to read 6 consonant-vowel-consonant words such as man, cat, and pan. Both the letter sound teaching and the word reading were taught until mastery was achieved, which consisted of two consecutive errorless trials on all six letter sounds and six words.

Six students were dropped from the study because they could not learn the words on the reading analogue task. At the end of the study, 42 students remained with 15 in the AB group, 15 in the B group, and 12 in the C group. Due to the fact that students were trained in small groups, the unit of analysis was the mean for each of the training groups. To maximize the power of the analysis, Dunnett's alpha-controlled procedure was employed to test unidirectional hypotheses about differences between the means between the treatment groups and the control groups. As was expected, for segmenting gains, the only significant difference was between the AB group and the C group. In contrast, for blending gains, the means of both the AB and B groups were significantly higher than the C group. The AB group was significantly better at blending and segmenting than the C group, and the B group was significantly better at only blending than the C group. On the reading analogue task, the only significant difference found was that the AB group required fewer trials on word learning than the control group. No significant differences were found between the B and C groups.
In a seventh study, Slocum, O'Connor, and Jenkins (1993) studied if training in one phonological skill transfers to a second phonological skill due to increased phonological awareness. A second purpose to this study was to test the effectiveness of phonological training with children who have language difficulties. Thirty-five students were included in this study, all of whom were minority head start students, who had scored an average of one standard deviation below the mean on the PPVT. Two phonological manipulation tasks were employed by the researchers. The first task consisted of onset-rime segmenting. In this task mastery was met if a child succeeded in segmenting four out of five items correctly in the initial assessment of a new set of items. In other words, mastery involved transferring the skill learned to a new set of items. The second phonological manipulation task was auditory blending.

The design of this study included two treatment groups and two control groups, with each group receiving two instructional phases. The word manipulation then segmenting group provided a control for the blending then segmenting group. Each student in the two groups was randomly assigned a partner in the other group. When the student from the blending then segmenting group reached criterion level, both students moved on to the second instructional phase (e.g., from blending to segmenting and from word manipulation to segmenting). In the second phase, partners were not linked and they remained in the phase, until they both met criterion. The word manipulation then blending group served as a similar control for the segmenting then blending group.
Tests of blending and segmenting were given before the first phase, between instructional phases, and at the end of the second instructional phase. For the blending tests, all of the students showed similar pretest scores. Improvement was only shown in the tests performed after the students had received training in blending. For example, only the segmenting then blending and the word manipulation then blending groups made significant gains from midtest to posttest. Results from the segmenting test showed very similar results. That is only students receiving direct instruction in segmenting improved in their scores on the mid and posttests given. Comparisons were made between the three groups of students, those who learned each phonological skill: (a) with no previous training, (b) with previous training in word manipulation skills, and (c) with previous training in either blending or segmenting skills. Of the three groups of students that learned blending skills (see above three groups in what manner they learned the skill), no statistically significant differences were found between groups. Of the three groups of students that learned segmenting skills (again see above three methods) there was no significant difference between groups. However, the difference between the word manipulation then segmenting group and the blending then segmenting group approached significance favoring the blending then segmenting group. These findings imply that there was little or no transfer between phonological skills, and that the skills had to be specifically taught to all of the children in the study no matter if they had received previous training in a phonological skill or not.
In a similar study, O'Connor, Jenkins, Leicester, and Slocum (1993) sought to find out the effects of specific phonological manipulations to young children who were expected to have difficulties with the beginning stages of reading acquisition. Subjects consisted of 47 students enrolled in preschool at the Experimental Education Unit of the University of Washington. Cognitive Ability was ascertained using the McCarthy Scales of Children's Abilities, the WPPSI, and The Stanford Binet IQ test. Nine subtests in the categories of rhyme, segmenting, and blending were given as pretests. Each category contained three subtests as the following: (a) rhyming, (b) blending, and (c) segmenting. The researchers used a randomized block design, in which children were separated into groups according to age and rank ordered according to their performance on the McCarthy General Cognitive Index. Children then were randomly assigned from these groups to one of the treatment groups or a control group. Children were trained over 7 weeks in groups of 3 to 5 children for 10 minute sessions. For the first three weeks, each treatment group received training in only one task. For example rhymers practiced rhyme production. After the first phase of training, children were given a midtest to see if children could transfer from one task to another in their treatment area. For example, could blenders move from blending continuous sounds to blending individual sounds to form words. In the second phase of training for 4 weeks, the previously taught skill was reviewed, and children were also trained in the other tasks. For example, rhymers continued to produce rhymes, but they also told which word out of three did not rhyme with the other two, and
identified whether two words rhymed or not. Children in the control group participated in the routine preschool curriculum which included listening to stories, and circle time. For the posttest students were individually tested on the nine subtests previously described. In addition, students were given a mastery test on the skill they learned.

A univariate ANOVA was performed for each phonological posttest, and to find significance results, Tukey's Test of Honestly Significant Differences was used. The ANOVA found significant effects for blending training on all three tasks of blending continuous sounds, blending onset-rime, and blending separate sounds. Pairwise comparisons found that blenders outperformed the treatment and control groups on blending of onset-rhyme and blending separate sounds. However, for blending continuous sounds, the blenders and segmenters both outperformed the rhymers and the control group. Pairwise comparisons also found that the segmenters outperformed the other groups on segmenting task. In fact, only one student of the 35 not trained in segmenting improved in their segmenting skills. Treatment results were significant for the rhyme oddity and rhyme production tasks, but results for rhyme recognition were not significant. The researchers selected mental age (average of 3.8 years) to partial out developmental readiness from posttest performance through a multiple regression technique. Mental age accounted for variance in only three of the posttests (blending onset-rime, segmenting first sound, and rhyme oddity). After the training in phonological manipulations was taken into account, this training added 45
significant independent variance in all of the tasks except for rhyme recognition. For the control group, mental age accounted for significant variance in all of the rhyming and blending posttests, and no items were scored correctly on the segmenting subtests. These results indicated that most of the children benefited from training in phonological manipulations.

In a final study, O'Connor (1994) examined outcomes of different phonological instruction. The subject pool consisted of 88 students in a low-skilled experimental group and 23 high skilled students to serve as a comparison group. Students were pretested with the following tests: (a) blending, (b) segmenting, (c) rhyme production, (d) rapid letter naming, (e) word identification, and (f) PPVT-R. Based on the testing, low skilled students were randomly assigned to one of four experimental conditions, and high skilled non-readers were considered for an end-of-intervention comparison group. Both treatment groups utilized picture boards to illustrate the meaning of words to be blended, puppets, and frequent responding. Both groups as well as the letter/sound control group were exposed to the following phoneme/grapheme correspondences: A, S, T, M, P, O, K, and L. The experimental treatment groups consisted of a blend/segment treatment and a global treatment group. In the blend/segment group, instruction started with stretched blending (e.g. SSSaamm for Sam). It then continued into onset-rime blending and eventually blending individual phonemes. To teach segmenting skills, students used two and three square laminated forms. For onset-rime, the student would touch the first word and say /s/ and touch
the second square and say /aɪl/ for sail. The global treatment group was exposed to several phonological tasks and activities. Each day students were exposed to a new word, and were then asked to do several activities with that word. For example, if the word was sat, the teacher might blend individual sounds with students having to guess the word, rhyme production with sat, and say sat without the s. Games were also played to review and teach specific phonological tasks. The letter sound control group was designed to control the influence of practice with letter/sound correspondences. The untreated control group was exposed to the traditional kindergarten curriculum being taught in the schools. Posttests were given individually to the students in the treatment and control groups, as well as the high skilled students. Posttests consisted of the following: (a) blending, (b) segmenting, (c) rhyme production, (d) rapid letter naming, (e) identifying the first sound, and (f) sound repetition. The Lindamood Auditory Conceptualization Test (LAC) was given to see if there was transfer from one phonological skill to another for the trained subjects. The LAC did not closely follow the tasks that were taught in the treatment groups, and was used to measure students' abilities to process and arrange phonetic sequences. In the first part of this test, students use colored blocks to show the pattern the examiner says (e.g., if the examiner says /s/ /s/ /m/, the child might show that with two red and one blue block). In the second part of the test, the examiner shows a block pattern, and tells student what the pattern stands for, then the student manipulates the blocks to create a new word. A reading analog test was also given to see if children would try to decode
unfamiliar words upon coming to them in the text. And finally, students were assessed in spelling by manipulating the letters S, M, A, and T.

The researcher for this study used a multivariate ANOVA, followed by univariate tests to compare the following subgroups: (a) the two treatments versus the control, (b) the treatments versus the letter-sound control, (c) the two phonological treatments, and (d) the combined phonological treatments versus the high skilled group. In the two phonological treatment groups versus the control, the multivariate statistic was significant, and the univariate statistics were significant in all areas except for rapid naming. Students in the training groups also showed transfer based on their performance on the LAC, reading, and spelling posttests. In the two experimental treatments versus the letter-sound training control, the multivariate test was significant, as were all but three of the univariate tests, including rapid letter naming, and first sound favoring the phonological treatment groups over the letter-sound groups. Students in the phonological treatment groups also scored significantly higher on all three transfer tasks, suggesting that training in phonological awareness is superior to just training in letter-sound correspondences. An interesting result was found in the blend/segment versus global treatment groups. Neither the multivariate analysis nor the univariate analysis for specific skills showed any significance whatsoever between the groups. When looking at the two experimental treatments versus the highly skilled children, O'Connor found that the multivariate test was significant, and the tests of rapid letter naming and reading favored the highly skilled
children. There were no other significant differences. The highly skilled children seemed to significantly improve without the benefit of instruction, however the children who lacked phonological skills needed the training to show improvement. In order to figure out which abilities contributed most directly to the performance of reading, the authors performed a series of regression analyses including the following: (a) regression on the LAC, (b) regression on the reading analog, and (c) regression on the spelling test. On the regression of the LAC, it was found that blending and segmenting accounted for the most of the variance on LAC scores, although rhyme also accounted for significant variance. It was also found on the regression of the reading analog, blending and segmenting were found to be more important than other phonological skills. The LAC did not account for significant additional variance on reading scores. Finally on the regression of the spelling scores, again LAC scores did not add significant variance, even though phonological abilities such as saying the first sound in words and being able to rhyme increased spelling scores.

Summary

The results of all of these studies indicate that children who are weak in phonological awareness skills make significant gains when they receive training over similar groups of children that are not trained. Five out of nine studies found that letter sound training alone did not lend itself to becoming a better segmenter of words (Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1991; Byrne & Fielding-Barnsley, 1995; Foorman et al., 1991; and O'Connor, 1994). Ball and
Blachman, 1991; Byrne and Fielding-Barnsley, 1991; Byrne and Fielding-Barnsley, 1995; and Foorman et al. (1991) all agreed that phonological awareness should be taught in a combined approach with letter sound awareness in order for children to have a full understanding of the alphabetic code. While many of the students in these studies had awareness of letters and possibly letter sounds, this finding did not indicate that the child would be a better reader based on this knowledge alone (Ball & Blachman, 1991., Byrne & Fielding-Barnsley, 1995; O'Connor, 1994).

However, two studies did illuminate the causal relationship between phonological awareness and reading ability. Specifically these studies found that students in the treatment groups performed significantly better on their abilities to read pseudowords than the control groups (Byrne & Fielding-Barnsley, 1995; Torgesen & Davis, 1996). In the study by Byrne and Fielding-Barnsley(1995), the researchers regressed pseudoword reading onto irregular word reading. Those students found to be above the regression line were found to be able to read more pseudowords than would be expected based on their irregular word scores. These children were considered decoders. Torgesen and Davis (1996) found that the ability to spell nonwords along with general verbal ability was the strongest predictor of growth for both blending and segmenting skills. These results suggest that being able to read nonwords that follow phonetic patterns such as trane and flusk is a strong predictor of decoding skills.

Three of the studies showed that students showed transfer within the skill
learned (e.g., matched transfer) (Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1991; O'Connor, 1994). However, in the studies that showed transfer from one skill to the other, the skills to be transferred were similar in what was being asked of the student. For example, in the Ball and Blachman (1991) study, students improved not only in the segmenting trained items, but in items that were matched closely to the training items. In the Byrne and Fielding-Barnsley (1991) study, students in the experimental group scored higher on non-trained phonemes (f, n, b, and k) as well as trained phonemes (s, m, t, and l). Finally in the O'Connor (1994) study, all students that received treatment were instructed in both segmenting and blending skills, however the global treatment group was exposed to more phonological tasks and activities. Both experimental groups showed transfer on the LAC, reading, and spelling posttests. One of the studies showed no transfer between phonological skills unless the skills were taught to students directly (Slocum et al., 1993). Students trained in blending only showed improvement in the tests performed after students had been instructed in blending. The same was true of segmenting posttests. In studies performed by Torgesen et al., (1992) and O'Connor et al., (1993), the researchers found that if students were not specifically trained in a skill, improvement was not shown. In the study by Torgesen et al., (1992), students that received training in analysis and blending improved in segmenting skills over the control, however students receiving only blending training was only significantly better at blending. Similarly in the study by O'Connor et al., (1993), researchers found that only one student not
trained in segmenting improved in segmenting tasks on the posttest. Also students trained in blending outperformed the segmenters and control group in all areas of blending except for blending continuous sounds, in which segmenters also outperformed the blenders. All of these studies support the conclusion that students need to have specific instruction in blending and segmenting in order to learn manipulate phonemes and that this ability to manipulate phonemes usually results in creating better readers. One study by O'Connor (1994) did find that students already possessing phonological skills improve in their reading without the benefit of phonological instruction. These students would probably improve no matter what reading method was used, however for the at-risk reader, teachers should utilize phonological awareness skills and letter sound skills to help their students become more successful readers.

**Computer-based Phonological Interventions**

Since most classrooms today are equipped with at least one computer, researchers would want to look at computer interventions for teaching students with phonological impairments. According to Torgesen and Barker (1995) "computers have the potential to provide substantial help in both preventing the emergence of serious reading problems in young children and in providing remedial help to children who have demonstrated difficulties in the area of reading" (p.77). The interventions discussed in the following studies would possibly fit into an instructional program for children with reading difficulties, and might also supplement a phonological program.
In a first study, Roth and Beck (1987) evaluated two computer programs focusing on word recognition and decoding skills, and looked at the extent to which decoding skills improve reading comprehension. Subjects for this study consisted of 108 students from fourth grade classrooms in two schools in a large city. These students were from a low SES background and were all black. In the school in which the computer instruction was given, there were 59 students with an average total reading score of 3.7 on the California Achievement Test (CAT), and in the control school, there were 49 students with an average total reading mean score of 3.8 on the CAT. Subjects in the treatment groups were trained for three 20 minute computer sessions a week. Students never missed special activities, reading instruction, or the same activity twice in one week. Students in the treatment classrooms used the Construct-a-Word (CAW) program in the fall for 10 weeks. This program involved students putting together letter strings and phonemes to produce real words when combined correctly. Students were required to produce words of increasing length in decreased amounts of time. For example, the left column would contain word beginnings such as l, p, and st, and the right column would contain word endings such as og, in, and ot. The goal of the game was to make enough real words to fill the computer stack. When the stack was complete, feedback was given about the number of words formed and the time taken to form them. If a nonsense word was formed such as stin, the word was "read" orally by the computer and presented visually. When the HELP command was pressed, the computer gave the child an example of a
real word they had not used. After 10 weeks, the students in the treatment group, then used the Hint and Hunt (HH) computer program for 10 more weeks. This activity also focused on subword letter strings, however this activity focused more closely on the subtle differences vowels play in words. For example, the difference between bat and bait. In the first part of the program, HINT, students heard the effect of changing vowels in a letter string. For example, in one set (consisting of bat, bait, bet, beet, bot, and boat), bat was displayed and said aloud followed by the t moving to the right to make bait, and so forth. After similar displays, the b and t were displayed, a word was said orally, and the student decided what vowel or vowel team fit in the word. In the HUNT portion of the game, students ran a little man through a maze to find all of the visual words that matched the word the computer said. For example, if the computer said beet, students looked for the word beet. Sometimes, students put the ee in for beet, when confronted with this symbol (b * t). Students earned points based on time that elapsed until the word was found. After each string was matched, a new word was spoken until the student completed the maze or three consecutive errors were made. The control group received traditional fourth grade curriculum with the same reading texts in the first four years of school as the treatment groups.

The Word Attack Subtest of the Woodcock was administered in both the fall and in May after the treatment of all students involved in the study. The subtest required students to read a list of nonsense words until a criterion number of errors were made. The CAT was given to students at the end of each school year. The
subjects’ third and fourth grade tests were obtained. The subtests that the researchers were interested in were the Reading Vocabulary (RV) and the Reading Comprehension (RC) because they provide measures for meaning. The RV Subtest requires students to make decisions regarding meanings of words, clauses, and sentences, whereas the RC Subtest has students read lengthy passages and answer literal, inferential, and critical comprehension questions. Two laboratory tasks were also administered. They consisted of a vocalization task (VT) and a semantic decision task. The VT involved measuring the time it took for subjects to vocalize a word or pseudoword. Students were asked to not sound the word out aloud or say the word so quickly that they made silly mistakes. This task was given before and after training in the HH program. Because of the lengthiness of this testing, a subset of 48 students (based on the pretest semantic decision task, and randomly taken from the low, middle, and high thirds) were selected to receive this task. The semantic decision task was administered to a subtest of 60 subjects before and after the CAW training. Researchers used this task to see if transfer was made from decoding training to tasks involving figuring out word meaning. For example, students were asked if a person could do the following: (a) build a house, (b) grip a tool, (c) drive a glass, or (d) drink a tire. The items on the task were formed from subword strings used on the CAW, but none of the same words used in the CAW were utilized.

Results were obtained using ANOVAS based on the variables of (a) pre and posttest, (b) treatment or control, and (c) ability (high, medium, and low). An unequal
sample size ANOVA was performed on the pre and posttests of the Woodcock Word Attack Subtest. Significant main effects of treatment were found. The effects for the low and medium groups were significant between pre and posttests, but no significance was found with the high group. The VT was assessed for both accuracy and speed (latency for correct responses). For both the pseudoword and the real word analyses, the only significant results were found with the low ability group in both latency tasks and accuracy tasks. On the Semantic Decision Tasks which measured transfer on comprehension tasks, the only significant result on accuracy was again for the low group between pretest and posttest. In the analysis of latency, significant results were found for both the medium and low instructional groups. In terms of the RV subtest of the CAT, again only the low instruction group made significant gains from instruction. On the RC subtest of the CAT, the treatment and control groups either remained the same or fell further behind national averages. One interesting finding was the improvement that occurred for the students involved in the treatment only occurred for the low students, and even after the training, the instructed students still remained about a year behind their grade level in reading. While improvement was shown in the reading vocabulary and semantic decision tasks, students did not show improvement on the reading comprehension tasks. This finding suggested that students need additional components of reading instruction to master reading of passages.

In a second study, Wise and Olson (1995) compared the effects of two
different training programs, one stressing phonological awareness, and the other stressing metacognitive comprehension strategies. Both supplementary programs were used in conjunction with the Reading with Orthographic and Speech Segmentation (ROSS) programs. These computer programs have children read stories on the computer screen. The student then highlighted an unknown word with the "mouse". The computer then highlighted the word either as a whole or in syllables or in sub-syllable segments. The authors sought to find out whether phonological awareness could be boosted with computer based practice. Subjects consisted of students from 2nd to 5th grade, recommended by their teachers because they were in the lower 10% on reading ability. Of those recommended 111 students were selected based on the scores on the Wide Range Achievement Test (WRAT), and their IQ scores of 90 or above on the WISC-R. Sets were matched on age, word recognition, and nonsense words and then randomly assigned to a condition. In the comprehension strategy (CS) training group, students were trained using the Reciprocal Teaching Strategy. In this program, "teachers first model, and then students take over the teaching role, using and evaluating their use of the four comprehension strategies of predicting, generating questions, clarifying, and summarizing" (Wise & Olson, 1995, p.107). Students were instructed over seven total hours in small groups of five students in 30 minute and 15 minute sessions. Training was interspersed with individual time on the computer. On one of every three days, when students worked on the computer, they worked with the trainer and engaged in reciprocal teaching. As
in the CS group, students in the Phonological Awareness (PA) training were trained for 7 hours in 30 minute and 15 minute groups. Four of the seven hours were used to introduce letters and their sounds, mouth pictures for all consonants and vowels using the Lindamood ADD program (Lindamood & Lindamood, 1975), as well as individualized computer instruction interspersed with the training. Concepts such as vowel digraphs, r-controlled vowels, and open and closed syllables were taught using the following programs: (a) ADD computer program, (b) Phonological Analysis with Letters (PAL), (c) Nonword choice (Non), (d) Marvin (students decided whether computer pronounced nonsense word printed on the screen or not), and (e) Spelling exploration (computer pronounced word to be spelled, and pronounced any attempt typed in by students). Movement through PA was based on performance and moved from simpler to complex tasks, after 80% mastery on simpler tasks was achieved. As students improved, their PA time decreased and ROSS time increased up to 18 minutes. In both the CS and PA groups, children were provided with ROSS training on the computer. Children read passages and answered comprehension questions. If a child missed a comprehension question, the computer would highlight the appropriate section in the text and have the child reread it. When a student highlighted a word, the computer highlighted it in segments. One syllable words were highlighted as onset (blue) and rime (green) (e.g., plant), and multisyllabic words in syllables (e.g., September). Sight words such as were, the, and said were not segmented. Children were then encouraged to segment words at their own pace, however, the computer
would read the word in segments if the mouse was clicked again. Trainers only reminded students to highlight a word if they misread it in a sentence. In the CS group, trainers simply pointed to the misread word to remind students to target it. In the PA group, the trainer would cover the word and remind the students of an incorrect mouth action from the word they had pronounced. For example, if the child misread house for home, the trainer would say "Now, when you said 'home,' what did you feel at the end (a 'nose sound'). Now (trainer uncovers word), what do you see at the end of this word? (a 'skinny air')." (Wise and Olson, 1995, p. 110). This feedback was only used when children failed to self-correct. Students were administered daily word tests of 15 words they had targeted that day. If they did not target that many words, longer words from the text were included. Students were given a monthly word test of 30 previously targeted words.

Students were pre and posttested using the following standardized tests: (a) Untimed Word Recognition, Spelling Recognition, and Sentence Reading Comprehension Subtests from the Peabody Individualized Achievement Test (PIAT), (b) Reading Comprehension of Passages using the Gates MacGinitie Reading Tests using the appropriate grade level for the age of the student, and (c) Spelling Production and Math Subtests from the WRAT. Experimental tests consisted of the following (a) Time-Limited Word Recognition, (b) Phonological Decoding, (c) LAC, and (d) Phoneme Deletion. ROSS reading measures consisted of the following: (a) Targeting (the computer recorded each time student clicked on mouse to receive
assistance with a word), (b) Comprehension responses were scored by the computer, (c) Final Word Test, and (d) Final Analog Nonword Reading Test (e.g., students might be asked to read fant). After pretesting, students were trained with using ROSS and how to target hard words. After that, the supplemental training programs began.

Results were obtained by using univariate ANOVAS obtained on each test with pre and posttest scores as a repeated measure. Compared to CS students, PA students scored significantly higher in phoneme awareness using the LAC and Phoneme Deletion tests. PA students also gained significantly in nonword reading. The groups did not differ significantly in gains in untimed word recognition and in reading comprehension. The CS group, however, did show significant gains over the PA group in time-limited word recognition. Despite having less time with ROSS (8.4 hours compared to 18 hours for the PA versus the CS group), the PA students scored significantly higher on all word progress tests in the ROSS program, as well as scoring higher on the nonword tests. Even though the CS children performed better on the monitored daily reading comprehension tasks, there was no difference between groups on the independent days. Correlations between initial phonological awareness and all measures of gains and progress checks were calculated using the average z scores of pretest raw scores on phoneme deletion and the LAC. Contrastly, the initial phonological awareness for the CS group correlated positively with all gains, whereas
for the PA group, initial phonological awareness did not correlate significantly with any gain in reading.

**Summary**

In both of the computer-based instruction studies, researchers found that the instruction in computers, while showing some improvement with the students in the study, supplementary instruction seemed important for significant effects (Roth & Beck, 1987; Wise & Olson, 1995). In the study by Roth and Beck (1987), supplemental phonological training was not used in addition to the computer programs. However, only the low group made significant gains in the posttests, and even with this progress, the students were still a year or more behind their grade level in reading. These results suggest that the use of computer programs alone is not enough to help students read at grade level. In Wise and Olson's (1995) study, the PA students scored higher in all of the ROSS word progress tests than the CS trained group despite having less time on ROSS. This finding suggests that having some prerequisite phonological skills taught in the supplemental training may have given the PA group an advantage over the CS group in phonological skills. In other words, computer programs should not be the sole instructional tool for teaching phonological awareness, but instead should serve to supplement programs that teach phonological awareness. According to Torgesen and Barker (1995) computers should be used to enhance instruction.
Interventions Using the Auditory Discrimination in Depth Program

According to Truch (1990), the Auditory Discrimination in Depth (ADD) Program was the best program out there in terms of training students in phonological awareness. This program contains many features that help the student at risk of having reading problems. These include the following: (a) judging the identity, number, and order of phonemes in a spoken syllable, (b) segmenting and blending phonemes, and (c) recognizing when and where a phoneme change occurs in an addition, shift, substitution, or repeat in a spoken syllable (Truch, 1994). For example, a student might be asked to change id to di to bid (Lindamood & Lindamood, 1975).

Students in the ADD Program are first introduced to letters using their eyes, ears, and mouth to identify, classify, and label phonemes (Truch, 1994). For example the sounds /p/ and /b/ are labeled as "lip poppers" because of the articulatory processes involved. After being introduced to the vowels and the consonants, the student is then taught to track speech sounds using colored wooden blocks to represent the sounds. Once students can track sounds and manipulate the colored blocks, the instruction moves to decoding and spelling both real and nonsense words. The following studies assess the effectiveness of the ADD program.

In the first study, Truch (1994), assessed whether significant gains were made in phonological awareness by using pretest and posttest data prior to and after the implementation of the ADD program. Subjects for this study consisted of 281 people, 60% of whom were 6-12 years old, 25% were 13 to 17 year olds, 15% were adults 18
years and older. All of the subjects had an initial deficit in phonological awareness according to the LAC and all had difficulty with some aspect of reading. All subjects were pretested using the following tests: (a) the LAC, (b) sound-to-symbol test, (c) Word Attack Subtest from Woodcock, (d) Reading and Spelling Subtests from WRAT-R, (f) GORT, (g) PPVT-R and or the Vocabulary Subtest from the WISC-R, the WISC-III or the Weschler Adult Intelligent Scales-Revised. The majority of subjects attended the clinic for four hours daily, five days a week, for four straight weeks. The scope and sequence of the ADD program was followed closely as outlined in the ADD manual. Since the manual lacks detail at the multi-syllabic level, the phonological structure of these words was made explicit during training.

Two-hundred eighty-one students completed at least 80 hours of instruction in the ADD program. A univariate analysis of covariance was performed, in which the pretests previously listed served as the dependent variables with pretest and posttest being the independent variables. Age and vocabulary using either the PPVT-R or the Weschler Scale were covaried. Results indicated significant gains on all variables. All of the students except one showed gains in phonological awareness as measured by the LAC. On the sound/symbol test, 88% of the students scored 30/32 or better. Students also showed significant gains on the Woodcock Word Attack Subtest. These results indicated that training in the ADD program would lead to better decoding skills. On the Reading subtest of the WRAT-R, students as a group generally scored two standard deviations below average and ended up in the lower end of the average
range on posttests. While gains in reading were high, gains in spelling tended to be lower. Although gains were less on spelling, the students did seem to becoming more phonetic spellers even in their misspellings. Group results on the GORT also indicated significant gains. These results are encouraging in that children and even adults can benefit from remediation in phonological awareness training.

In a final study, Brady, Fowler, Stone, and Winbury (1994) designed, implemented, and evaluated a phonological training program, and further looked at the consequence of such a training program on other phonological tasks such as memory lexical access, speech production, and speech perception. Subjects consisted of 96 kindergartners from four classes in four different inner-city schools, consisting of a lower SES population. The method utilized consisted of three different components: (a) achieving phonological awareness above the level of the phoneme, (b) isolating the phoneme, and (c) representing the internal structure of the syllable. Students in the control group were exposed to a traditional kindergarten curriculum. In phase I, phonological awareness above the level of the phoneme, which was implemented for three 20 minute sessions a week for weeks 1 through 4, students were exposed to: (a) rhyming tasks, (b) segmenting tasks, (c) categorization, and (d) identification. In Phase II, isolating the phoneme for weeks 5-10, the authors focused on articulation of sounds in language using the ADD program. Phonemes were introduced using mirrors and articulatory labels for the pairs of phonemes introduced (e.g., /p/ and /b/ were introduced as lip poppers and distinguished in terms of noisiness). The ADD
instruction was supplemented with activities to go with the pair of items being introduced. For example, students might be asked to complete the following tasks: (a) say a little bit of pan or boat, (b) name the word that did not contain a final lip popper out of 4 final lip popper words, or (c) delete the noisy lip popper in boat. Finally in the last phase of training, representing the internal structure of the syllable, students were taught to "say it and move it". Students were provided with a picture of a word and empty squares underneath the picture represented phonemes. Students were given tiles to put in the squares as they said the word in separate phonemes. In other words, students would see a picture of a man with three blank squares underneath him. As they said the word slowly (e.g., mmm-aaa-nnn), they would put a tile in each square.

Children were posttested using the following tests: [achievement tests]: (a) PPVT-R, (b) Triangles Subtest of Kaufman Assessment Battery for Children, (c) Woodcock, (d) WRAT-R for spelling and math, [phonological awareness tests];(e) rhyme generation, (f) phoneme segmentation, (g) Rosner's TAAS, (h) memory for word strings, [phonological processing tests]: (i) Perception, (j) Tongue Twister, and (k) Boston Naming Test (BNT).

Sixty-one students completed the study with 24 in the training group, and 37 in the control group. Since students showed a marked increase in receptive vocabulary scores on the fall PPVT-R scores, analyses were performed on the results, all showing nonsignificant results. Researchers found that the treatment and control groups seemed to be comparable in terms of receptive vocabulary knowledge, in gains over
the year, and in overall aptitude. The Mann-Whitney U was used to compare group performance on the achievement, phonological awareness, and basic phonological processing variables. No significant differences were found on the posttest achievement variables. Similar gains were made by the control and the treatment groups in letter knowledge, reading, spelling, and math. In the spring, the training group performed significantly better than the control group on both rhyme and segmenting skills; and on the deletion task, the training group was markedly, though not significantly, better than the control group. In the basic phonological processing measures, the only significant result was with the speech production measure. Perception, memory, and BNT results were not significant compared to the control group. The following spring, 42 of the children from the original study were tested on word identification and decoding abilities. The training group performed significantly better on both the Word Identification Subtest and on the Word Attack Subtest from the Woodcock.

Summary

While both of these studies utilized the ADD program in their instruction. The first study by Truch (1994), used the program in its most true form, while the second study by Brady et al. (1994) used many additional supplementary activities with the program, so it was more difficult to partial out whether the program caused the gains in phonological skills or the other skills being taught such as rhyming did. The computer study by Wise and Olson (1995) also used the ADD program in their
training of the phonological group in addition to the ROSS computer programs. The phonological awareness group in this study made significantly more gains in PA than the CS group despite the CS group having more ROSS computer training. Perhaps the ADD program used with the PA group was what made the difference for the students in the study. Both programs showed improvements on their decoding skills as well as some of their phonological skills. Interestingly the Brady et al. (1994) study showed no significant gains on the standardized achievement scores between the treatment and control group. One marked disadvantage of the ADD program according to the Truch (1994) study is the amount of time taken to train students in its pure form. Students were trained for four hours daily, five days a week for four consecutive weeks. Obviously, this type of grueling training would be hard to implement in a classroom setting.

Conclusions

The first sections of research focused on both the involvement of rhyming and working memory in the ability to read. Rhyming is a strong predictor of student's later ability to learn to read. Maclean et al. (1987) found in their study that children as young as three show some phonological abilities. One very positive finding from this research, showed that student's knowledge of nursery rhymes did not seem to be dependent on their parents' SES or educational levels. This finding means that all children can and should be exposed to rhyme, because these same researchers also found that the phonological skills measured at three years of age, predicted later
reading ability. While rhyming came out to be a strong predictor of future reading success, memory was not as strong of a predictor of future reading success. Two of the studies found that short term memory may not be a later predictor of reading success, and that general phonological awareness and speech rate were stronger predictors of later reading success, respectively (McDougall et al., 1994; Snowling et al., 1994). Several of the researchers found that students that were better readers had better working memories (Cornwall, 1992; Herdman & Lefevre, 1994; Snowling et al., 1994; Naslund & Schneider, 1994). Since so many of the students with weaker reading abilities had difficulty with the working memory tasks, it makes sense that these students would need more help and intervention programs to make them stronger readers.

The next set of research studied focused on intervention strategies to help students with phonological awareness skills. All of these studies focusing on intervention strategies led to some improvement in phonological awareness skills, however, some interventions were more effective and more simple to utilize than others. In the basic segmenting and blending intervention strategy studies, the findings of all of the studies indicated that students with weak phonological skills made significant gains after receiving intervention strategies in segmenting and blending skills. Students need to be specifically trained in blending or segmenting strategies, in order to improve in these skills (Torgesen et al., 1992; O'Connor et al., 1993). Specific training in the manipulation of phonemes should lead students to become
better readers. Furthermore, students that can decode nonsense words, are much more likely to be better readers than students that cannot (Byrne & Fielding-Barnsley, 1995; Torgesen & Davis, 1996). Findings also indicated that training in letters and letter sounds alone is not enough to create phonologically aware students (Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1992; Byrne & Fielding-Barnsley, 1995; and Foorman et al., 1991).

The findings for the computer based intervention strategies found that computer programs were best utilized as a supplemental program to a phonological awareness intervention program (Roth & Beck, 1987; Wise & Olson, 1995). In the Roth and Beck (1987) study, no supplementary programs were used, and only the low group was found to make progress, and this progress did not place the students at risk at or near grade level. Wise and Olson (1995) used the ADD program to supplement their phonological awareness group, and comprehension training for the other group. The students that were supplemented with the phonological training, specifically the ADD program performed much better on the phonological tasks than the computer strategies group, despite having less hours on the computer. Perhaps, it was the ADD training that made the difference for these students.

The final area of research, which focused on the ADD program for teaching phonological awareness, researchers found that students made gains in their phonological and decoding skills (Brady et al., 1994; Truch, 1994; Wise & Olson, 1995). While the ADD program does appear to be beneficial in training students in
phonological awareness, the program takes a tremendous amount of time to implement (Truch, 1994). This time commitment of four hours daily, five times a week may not be practical in the classroom setting.

What all of these studies have in common is the importance of phonological training, specifically in the area of being able to segment and blend words together. While schools have jumped on the whole language bandwagon, it seems necessary to supplement these programs with strong phonological intervention programs that stress segmenting and blending skills. At risk preschool and kindergarten students need more than exposure to letters and their sounds, they need to rhyme and learn to manipulate phonemes, if they are to become good readers.
Chapter 3
Research Study

Introduction

Research supports the idea that children, who lack phonological awareness, have difficulties in learning to read. Skills these children lack include the following: (a) being able to isolate sounds in words or syllables, (b) being able to hear speech sounds in spoken words, (c) being able to rhyme, (c) being fluent in reading, and (d) being able to transfer what is read to working memory (Donnelly, 1996; Ehri, 1991; Liberman & Shankweiler, 1991; Maclean et al., 1987). Fortunately there are solutions to teaching students to become more phonologically aware. Several researchers have found that children who receive phonological awareness training in the areas of segmenting, rhyming, and blending skills make significant gains over children who do not receive any training (Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1991; Byrne & Fielding-Barnsley, 1995; Foorman et al., 1991; O'Connor et al., 1993; O'Connor, 1994; Slocum et al., 1993; Torgesen et al., 1992; Torgesen & Davis, 1996). These researchers' findings support the idea that most young children could benefit from some sort of training in phonological awareness. Further research has found that while phonologically geared computer programs serve as good supplementary aids to phonological programs, teacher directed instruction was more important than the use of computer programs alone (Roth & Beck., 1987; Wise & Olson, 1995).

With many methods available to teach phonological awareness to children, one
method that some researchers have chosen to focus on includes the ADD Program (Lindamood & Lindamood, 1975). This program was found by Truch (1990) to be one of the best programs out there in that it provides for blending and segmenting skills, manipulation of speech sounds, and looks at the number and order of phonemes in words (Truch, 1994). However one major disadvantage to this program is that in its pure form, it requires four hours daily instruction, five days a week for four consecutive weeks (Truch, 1994). Obviously this kind of training would not be feasible in an elementary school setting. However due to the benefits of this training found in research studies (Brady et al., 1994; Truch, 1994; Wise & Olson, 1995), a modified version of the ADD Program (Lindamood & Lindamood, 1975) was used in the following study.

Subjects and Setting

Subjects consisted of 52 kindergarteners from two classrooms in the same elementary school in Tri County Area Schools in Howard City, Michigan. Twenty-six children in one classroom served as the treatment group (A days) and 26 children in the other classroom served as the control group (B days). Subjects ranged in age from 5-0 at the start of the study to 7-3 at the end of the study. In the treatment group, three students received speech services with two of those students having additional disabilities, as well. One of these students was classified as hearing impaired (HI), and received resource room services, and the other student was classified as educable mentally impaired (EMI), and he received services in a self-contained EMI
classroom. The EMI student did not qualify for services until April of 1997, and he remained in the general education classroom during the intervention. In the control group, two students received speech services.

Students came from a predominantly white rural setting, in which 39 percent of the students received free and reduced lunch. Both kindergarten classrooms had a full-time aide that helped with tasks such as testing students, taking them out for recess, instructional tasks, and discipline. Both classrooms received traditional kindergarten curriculums, in which they were exposed to the following: letters, letter sounds, and story reading, among other reading activities. In addition, the treatment group received about 20 minutes of additional instruction in phonological awareness on the days they attended school. In this particular school, students attended all day every other day (e.g.,, one week would consist of Monday, Wednesday, Friday, and the following week would consist of Tuesday, Thursday for one group of kindergarteners).

Measures

Most students were pretested in November of 1997, with about 20 % of students being tested the first week of December using Rosner's TAAS (1975). This test consisted of two sample items, in which the examiner said "Say cowboy. Now say it again, but don't say boy," The student would then respond with the word cow. If the student was incorrect on the sample item, feedback was then given. Items on this test started out simple with students being asked to delete syllables to more and more
complex tasks with students being asked to delete individual phonemes in the middle of the word. Students were again posttested using the TAAS in May of 1997.

Students were also pretested using the TOPA Kindergarten Version (Torgesen & Bryant, 1994) in November of 1997 with about 20% of the students being tested the first week of December of 1997. On this test, students were first taught how to mark their tests by drawing a diagonal line from one dot to another. The first part of the test dealt with initial sounds being the same. On this portion of the test, students were given three sample items in which they received feedback after everyone had answered the question. If a student made an incorrect response, he was asked to change his answer to the correct response after feedback was given. Students were given a stimulus picture such as a bat. This stimulus picture was followed by three other pictures, such as horn, bed, and cup. Students should have marked bed because bed and bat begin with the same sound /b/. The second part of the test dealt with initial sounds being different. Again students were given three practice items with feedback. On this portion of the test students were asked to look at four pictures in a row, such as bed, bus, chair, and ball. The examiner then asked the student to mark the "one picture that [had] a different first sound than the other three" (Torgesen et al., 1994, p.7). In this case, the student would mark chair. Students were then posttested using the TOPA at the end of May and the beginning of June of 1997.

Intervention

The intervention consisted of an examiner, a special education resource room
teacher, going into the treatment group classroom every other day from the first week in December of 1997 until the second week of May of 1998 for 20 minute periods. This ended up to be about 18 and a half weeks of instruction because students were not instructed on days that the examiner was absent, which ended up to be about 4 sessions. Sessions ran for 15 to 20 minutes at a time and were conducted after the students had come in from lunch recess. A modified version of the Lindamood ADD Program was used (Lindamood & Lindamood, 1975). Since there was only one examiner providing the program, students were taught in a whole group setting instead of small groups, as the authors recommend (Lindamood & Lindamood, 1975). It is also not feasible in an elementary school setting to teach the program for four hours a day, five days a week for four consecutive weeks as was recommended by Truch (1994). The scope and sequence of the program was followed closely, as outlined in Book 2 Implementing the Program, the teaching manual for ADD. Some modifications were made to adjust for whole group instruction, such as having the students come up to manipulate colored flannel squares on a felt board instead of having individual students manipulate colored cubes.

Procedures

Students in the treatment group (A days) began instruction in the first week of December. The first set of lessons lasting for about two weeks of instruction consisted of lessons in which the examiner worked with the students to get them accustomed to listening and using their ears to monitor sounds. These lessons
consisted of some of the following: (a) identifying and listening to environmental sounds, (b) manipulating objects and having students identify sounds (e.g., cutting paper), and (c) having students close their eyes and determine where a sound was coming from.

The second set of lessons lasting approximately seven weeks devoted themselves to introducing the consonants. Consonants were always introduced in either groups of two or three letters. These letters were grouped together by their phonological features. For example, p and b were introduced together because both letters make one's lips pop as they blow air out, thus they are known as lip poppers. Students were taught in a discovery way in which the teacher instructed the students to say the sound, feel if air came out of their mouths, and then talk about how their mouth felt or what their mouth was doing to form the sounds. For all of the letter pairs, students were then asked to find the quiet and the noisy brother. Students were taught to feel their throats for the vibration they would feel with a noisy brother versus no vibration for a quiet brother. They were also taught to put their hands over their ears, so that they could feel the loudness in their heads when continually saying a noisy sound such as /zzzz/. As each pair of letters was introduced a picture of the letters was also shown to the students. These pictures were placed on a bulletin board in the classroom, as they were introduced. The classroom teacher would sometimes review the mouth form pictures with the students when there was extra time in the day. After three or so pairs were introduced, a review lesson was conducted.
The third set of lessons focused on the vowels and vowel sounds. Students were introduced to the vowels by placing felt squares into a vowel circle. This circle represents the tongue placement of the mouth as one says the vowel sounds, and the labels of smile, open, and round describe what our mouth is doing when we say these sounds. After placing the felt squares in the vowel circle, lessons focused on the grouped sounds, such as smile sounds. Most of the five weeks of lessons were spent on smile, open, round, and sliders. Very little time was spent on the r control vowels because the examiner felt that this vowel combination was too complex for kindergarten students. When students were introduced to a group of sounds such as smile sounds, they were asked to focus on the examiner's mouth to see what the examiner was doing. When one says /ee/, one is smiling. Hopefully students would come up with this idea on their own, and thus would label the smile sounds themselves. Students also were to observe that the examiner's mouth enlarged, as the examiner went down the stairsteps from /ee/ to /u/. After students were introduced to smile sounds, a smile picture was introduced.

The final set of lessons lasting about five weeks consisted of students manipulating and tracking speech sounds using colored felt squares. Lessons started out with simple tasks and gradually moved to more complex tasks. The first lesson consisted of the examiner showing students the color purple, and saying "If I let this be /v/, how can you show me /v/ /v/. A student would then come up and put two purple squares down. The examiner would also ask students what the label for /v/ was (e.g.,
Most lessons consisted of the student putting the lip form picture above the felt square (e.g., the lip cooler picture above the purple square of felt). In the same lesson, the examiner would have the student show 3 different unrelated sounds, and choose 3 different colors of felt squares to represent these sounds. As the lessons became more complex, students would be asked to manipulate speech sounds as well as track them. For example, the examiner might ask the students to show me /ood/, which consists of a round sound and a tip tapper. The examiner would then say "if this says /ood/, show me /eed/. The student would then have to not only change the round picture to a smile picture, but would also have to change the color of the first felt square in the sequence. Most of the sequences used in training consisted of simple syllable nonsense words such as gad, roke, lep, and elp. The last lessons consisted of manipulating longer and more complex speech segments. For example changing /foost/ to /floost/ to /floosp/ to /floosp/. Many of the students became quite adept at making these changes, and realizing which felt squares needed to be moved or changed or eliminated altogether. For students that had more difficulty with these tasks, the examiner would blend the word very slowly, and guide the student to making the correct changes in the word, so that all students could feel some success with manipulation of the sequences. After students placed the felt up on the flannel board, they were then asked to either read the word individually or the entire class was asked to read the word. When a child read the word individually, the entire class was almost always asked to repeat the word. Toward the end of training
real words were introduced, and in addition to having students show the manipulations using mouth form pictures, and felt squares, the examiner would also have students dictate the letters of the words and the examiner would write them on a chalkboard. For example, the word cat would show the tongue scraper, smile, and tip tapper pictures over red, white, and blue felt square, and the word would also appear on the chalkboard.

Results

In the A treatment group, of the 26 subjects that began the study, two children moved to another district and therefore were not included in the study. One child was not included due to being absent on one of the testing days. One child moved into the classroom late in the year and also was not included. Another student, who was present for all of the testing, was also excluded from this study. This particular student was dropped because based on the examiner's knowledge of this student's abilities, his test scores did not reflect his abilities. This left 22 students in the treatment group. In the B control group, two students moved out of the district and another moved into pre kindergarten. These students were dropped from the study. Two students that moved into the district late also were not included in the study. Five children were not included due to missing a test score because they were absent on testing days. This left 18 students in the control group.

The average pretest raw score on the TAAS for the treatment group was 2.5. The average pretest raw score on the TAAS for the control group was 2.6. Both
groups were very comparable on their pretest scores, scoring within one tenth of a
point of each other. However posttests scores differed significantly favoring the
treatment group. Posttests scores on the TAAS for the treatment group averaged 3.9,
a gain of 1.4 points. Posttest scores on the TAAS for the control group averaged 2.9
points, a gain of only .3 points. In the treatment group, three students made
substantial gains improving their pretest to posttest scores from five to eight points.
Also, the EMI, HI, and speech students in the treatment group all showed
improvements of at least two points. Contrastly, the speech students in the control
group made no gains from pretest to posttest. While one child in the control group
made a 6 point gain from pretest to posttest, all of the other students that made gains
only made one to two point gains. For a graph of the results on the TAAS for the
treatment and control groups, see figure 1 in appendix A.

Students were pre and posttested using the TOPA kindergarten version. Since
this test only scores students up to age 6 years 11 months, four 7 year old students,
who were at the most 7 years 3 months, at the time of posttesting, were scored based
on the 6 year 11 month scale. The average pretest raw score on the TOPA for the
treatment group was 11.0 The average pretest raw score on the TOPA for the control
group was 9.5. The treatment group's raw pretest scores placed students, on average,
at the 46th percentile, just below average. The control group's raw pretest scores
placed students, on average, at the 37th percentile, below average for other students
their age.
The average posttest raw score on the TOPA for the treatment group was 13.3, giving students a 2.3 point gain from pretest to posttest. While students in the treatment group did make gains from pretest to posttest, the gains were not as substantial as those made by the control group. Surprisingly, the control groups average posttest raw score was 14.4. This was a gain of 4.9 points from pretest to posttest. When these raw posttest scores were converted into percentiles, students in the treatment group scored, on average, in the 50th percentile, placing them in the average range. Students in the control group scored, on average, in the 55th percentile, just above average for other students their age. Five students in the treatment group made substantial gains of 4 to 13 points from pretest to posttest. However, most of the students that started out with low scores, ended with low scores. Most of these at risk students scores either stayed the same or went up by at most three points. Of the nine students in the treatment group, who earned raw scores of 7 or below, 3 made substantial gains from pre to posttest. In the control group, on the other hand, 11 students went up from 5 to 14 points from pretest to posttest. Of the 9 students in the control group, who earned raw scores of 7 or below, 4 made substantial gains from pre to posttest. For a graph of the results on the TOPA, for the treatment and control groups, see figure 2 in appendix A

Conclusions

Students in the treatment group showed substantial gains in their abilities to be able to manipulate phonemes based on their scores on the TAAS. This finding shows
that students can be trained to be able to manipulate phonemes, and isolate phonemes in words.

One of the reasons for the substantial gain made by the control group on their TOPA scores could be that the control group scored so much lower on the pretest, and this low score did not reflect their true abilities. Because they were kindergarteners, and therefore not accustomed to taking tests, they might have just randomly marked their tests on the pretests. If one compares the posttest scores of both groups, they only differed by 1.1 points, with the control group scoring an average of 14.4, and the treatment group scoring an average of 13.3. Perhaps, the two groups were really more comparable at pretest time than the test scores would have one believe. The ending scores may have been closer at the end because the control group and treatment groups had both been in school long enough to be able to listen and follow directions to take a test.

Perhaps one of the reasons the treatment group did not have higher percentiles was because of the items being tested. The TOPA focused on testing students on their ability to be able to identify similarities and differences between initial consonants. The ADD program did not focus on teaching students to be aware of initial phonemes in words. While the program worked on tracking phonemes in a sequence, there was no specific instruction on initial consonant sounds. Perhaps a future study, could incorporate work on beginning consonant sounds.

Since the at risk students did not make the gains one would like to see on the
TOPA, perhaps these students would benefit more from a small group program in phonological intervention. The students that struggled were the same students that were reluctant to volunteer for turns during the whole group lessons. It would be interesting to conduct a follow-up study utilizing the same ADD program with some changes. Perhaps, the examiner could train the aide and the kindergarten teacher in the ADD program, so that each adult could work with a smaller group of children. In this way, students would be taught in groups of 8 or 9 instead of a large group of 26 children. It would also be interesting to add rhyme oddity and recognition tasks, as well as initial phoneme activities to the skills being taught by the ADD program. It would also be beneficial to train students for a longer period of time, and perhaps in the morning, when the students are still fresh, instead of right after lunch. Hopefully with these modifications of the study, students would make more substantial gains in their phonological awareness abilities.
Appendix A

**TAAS Test Results**

![Graph showing TAAS Test Results](image)

*Figure 1*

**TOPA Test Results**

![Graph showing TOPA Test Results](image)

*Figure 2*
References


