Analogous Nonword Reading in Normal and Poor Decoders

at a Variety of Word Recognition Levels:

Comparisons Before and After Remedial Intervention

by

Barbara DiBenedetto

A dissertation submitted to the Graduate Faculty in Educational Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

1995

UMI Number: 9530867

This manuscript has been read and accepted for the Graduate Faculty in Educational Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

4/26/95
Date

Linnea C. Ehri
Chair of Examining Committee

4/26/95
Date

Executive Officer

Linnea C. Ehri

Carol K. Tittle

Zita Cantwell

Supervisory Committee

The City University of New York

Abstract

Analogous Nonword Reading in Poor and Normal Decoders
at a Variety of Word Recognition Levels:
Comparisons Before and After Remedial Intervention

by

Barbara DiBenedetto

Advisor: Professor Linnea Ehri

The results of the majority of studies that have compared the nonword reading of poor and reading-level matched normal readers indicate that poor readers are specifically impaired in their ability to phonologically recode unknown words (i.e., to translate a word's graphemes into sounds and blend them to produce the word). However, these investigations have not led to definitive conclusions regarding the poor reader's ability to analogize in decoding unknown words. In analogizing, the reader uses the sound of an orthographic pattern in a word known to the reader (e.g., each in teach) to generate the pronunciation of a word that the reader has not encountered previously (e.g., bleach).

It has been hypothesized that the ability to analogize develops prior to the ability to phonologically recode, that it is easier than recoding, and that poor and normal readers do not differ in their ability to analogize.

This study compared the analogous nonword reading of poor decoders (i.e., those who have difficulty identifying words) with that of normally developing decoders. Poor and normal decoders were matched at word recognition levels ranging from late first grade to late fifth grade. A large sample of poor decoders received remedial treatment, designed to improve their decoding skills, over periods of one and two years. The analogous nonword reading of both treated and untreated poor decoders was compared to that of normal decoders.

The results indicate pervasive differences between normal and poor decoders in their ability to decode analogous nonwords at virtually all levels of word recognition under consideration. Differences were evident when analogous nonwords were both monosyllabic and polysyllabic, and persisted even after poor decoders had received one and two years of remedial treatment.

Results support the hypothesis that poor decoders are specifically impaired in their ability to analogize in much the same way that they are specifically impaired in their ability to phonologically recode. Results do not support the hypothesis that the ability to analogize develops prior to the ability to phonologically recode, despite the fact that it may be easier to analogize than to phonologically recode.

Acknowledgments

This dissertation is dedicated to my parents, Florence and William DiBenedetto. I regret that my father did not live to see his daughter receive her doctorate.

I wish to thank: my committee members Carol Tittle, for her unwavering support and patience, Zita Cantwell, for her astute criticism, Robert Chabot, for his advice, and my committee chairwoman Linnea Ehri, who showed me where to find the dissertation that I was meant to write; my friends John Goodman and Robert Morris, for their support, and Christine Nucci, Stacy Lonstein, and Ken Silver, who provided invaluable access to libraries; my friends and colleagues in Texas, Jo Reinhart and Rose Ann Martinez, without whom the SRD Program would not exist, and the children, teachers, and administrators of the El Paso school districts; and the members of my family, Juan Corona, for his love and understanding, and Ellis Richardson who, in sharing his life-long commitment to solving the problem of reading disability, provided me with something useful to do in my life.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

Chapter

Page

Appendices (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

Chapter 1

INTRODUCTION

A vast amount of research has been devoted to explaining why many children fail to develop adequate reading skills during the elementary school years. Do children who have difficulty learning how to read simply develop reading strategies more slowly than children who do not have difficulty? Or do poor readers, in contrast to normally developing readers, approach the reading task with different, and less effective strategies that retard their development in learning how to read? The answer to this question is crucial in determining how we define reading disability and is in fact central to the question of whether or not reading disability, as a specific form of learning disability, actually exists (Felton & Wood, 1992; Stanovich, 1988a).

Most of the research on reading failure has centered on the word recognition processes (see Stanovich, 1991). The ability to read words is central to the reading process because text cannot be comprehended unless the words can be identified (Juel, 1988; Juel, Griffith, & Gough, 1986) and failure to comprehend text is primarily the result of failure at the word recognition level (Conners & Olson, 1990; Perfetti, 1985). Therefore, reading disability is widely regarded as a failure in the word recognition processes (Snowling & Thomson, 1991).

The recognition of words can be referred to as <u>decoding</u> because it involves the translation of printed symbols into the sounds of words (Sonday, 1991). Words may be recognized in a number of ways (Ehri, 1994). Some of these involve the use of associations between individual printed letters and their sounds. However, words may be recognized in other ways. If we define reading in terms of word recognition, and word recognition as decoding, it is clear that a reading disabled person is a poor decoder. This means, simply, that a reading disabled person has difficulty identifying words.

A great deal of research has centered on whether or not poor readers employ the same strategies in word reading as do normally developing readers who are reading at the same word recognition levels as the poor readers. (The normal readers are, necessarily, younger than the poor readers in studies that employ this design.) A considerable amount of this research has demonstrated that poor readers are specifically impaired in their ability to read nonwords (e.g., Beech & Awaida, 1992; Felton & Wood, 1992; see also a review by Rack, Snowling, & Olson, 1992). This has been interpreted as evidence that poor readers are specifically impaired in their ability to use letter-sound information to decode unknown words. However, this research is far from conclusive and may apply to some strategies that involve the use of letter-sound information in decoding, but not all of them.

Strategies for Reading Unknown Words

Ehri (1994) describes five ways of reading words. Words may be read: 1) by sight (i.e., remembering how to read a word because it has been read previously), 2) by phonological recoding, 3) by analogizing to known words, 4) by generalizing orthographic (i.e., spelling) patterns shared by several known words, and 5) by guessing from context. Strategies two, three and four enable readers to read unknown words, particularly when they occur out of context.

Phonological recoding refers to pronouncing a word by translating its letters (i.e., graphemes) into their associated sounds (i.e., phonemes) and blending them to form the pronunciation. For example, the reader produces a sound for each letter in VAT and then blends these sounds to pronounce vat. In analogizing, the reader uses the sound of an already learned written word as a clue in pronouncing an unknown word that has some of the same letters. For example, the reader knows how to read the word cat and uses this to determine how to pronounce VAT. Similarly, in generalizing from orthographic patterns, the reader has already learned to read the words cat, mat, sat, and hat, she deduces from these words the sound of the shared vowel-consonant (VC) bigram AT, and applies this knowledge in decoding VAT. Baron (1979) distinguishes between reading through analogy and reading through orthographic generalization: In analogizing, the reader uses knowledge of only one word as the clue, while in orthographic generalization, a number of examples of a particular spelling pattern are known and used by the reader.[1] The procedures used to read words in these three ways (i.e., phonological recoding, analogizing, and orthographic generalization) differ. However, the underlying processes and knowledge sources are not independent because they all rely, at least to some degree, on knowledge of the relationship between letters and their associated sounds (Ehri, 1994).

Analogic Relationships

Words may be analogous in a number of ways that involve shared relationships between letters and how they are pronounced. Single-syllable words may share letter strings at the beginnings of words that are pronounced the same way (e.g., BEA in bean and beak), or they may share letter strings at the ends of the words that are pronounced the same way (e.g., EAK in peak and beak). They may also share smaller units involving consonants (e.g., TR in trip and trick) or vowels (e.g., EA in heap and beak). The letter string consisting of the medial vowel(s) and final consonant(s) of a one-syllable word is referred to as the rime stem. The consonant or consonants at the beginning of the word are called the onset. The rime stem is usually considered the most useful subsyllabic unit of the one-syllable word because the pronunciations of rime stems are more consistent across words containing them than are the pronunciations of other letter groups. Orthographic "neighborhoods" of words are usually defined in terms of rime stems. For example, pet, wet, net, and set are all in the ET neighborhood. Multisyllable words may be analogous in a number of ways. Words such as muppet and puppet are clearly analogous because only the onsets of these words differ. Few multisyllable words are analogous in this way. However, it is usually possible to find many words that are analogous to the individual syllables of multisyllable words. For example, in the word splendid, SPLEN is

[1]The distinction between orthographic generalization and analogizing is not considered relevant to this study. Both strategies involve the generalization of the orthographic-phonological relationship carried by a string of letters (e.g., AT). Furthermore, when nonwords that are analogous to a number of real words are read, it is difficult to tell whether the reader is analogizing or orthographically generalizing. For the purpose of this study, both strategies will be collapsed under the term analogizing.

rime-stem analogous to ten, men, and pen; DID, in addition to being a word, also has many rime-stem analogies (e.g., rid, kid, lid).

Words with a large number of orthographic neighbors, whose pronunciations are similar, are easier to read by analogy than are words whose patterns have less consistent pronunciations (Glushko, 1979). For example, the words cat, bat, fat, hat, mat, and sat all contain the rime stem AT. AT is also a word, and all of these words rhyme with each other. On the other hand, the words come, some, dome, and home all contain the rime stem OME. OME is not a word, and is pronounced in two different ways. A reader confronted with an unknown, one-syllable word ending in OME might pronounce the word by analogy to a word in the come branch or to a word in the home branch of this family. Similarly, the reader might generalize the pronunciation of OME from words in either branch. A word in the AT family can be said to have many "friendly neighbors," while a word in the OME family has some "unfriendly neighbors" (Brown & Watson, 1991). The results of several studies have indicated that children are able to read "friendly" nonwords easier than "unfriendly" nonwords (Laxon, Coltheart, and Keating, 1988; Laxon, Smith, & Masterson, 1995). However, studies comparing the effect of orthographic neighborhoods on the real-word reading of good and poor readers have yielded conflicting results (e.g., Brown & Watson, 1991; Foorman & Liberman, 1989; Zecker, 1991).

Analogic Strategies in Reading Development

Goswami (1993) hypothesizes a model of the development of word recognition in which analogizing plays an important role: First, the reader is able to read unknown words by analogy to other known words with the same rime stem. Then, as the store of recognized words expands, the reader is able to make use of less obvious analogous relationships such as those that involve shared beginning letter strings. Finally, the reader is able to abstract the letter-sound relationships of embedded letters (i.e., medial vowels) and use this knowledge to read other words containing the same letters.

Ehri (1994) describes a somewhat different developmental sequence. Building on several earlier models of the development of word recognition skills (e.g., Frith, 1985; Gough & Hillinger, 1980), Ehri distinguishes three phases in which letter-sound relationships are used to read words: rudimentary alphabetic, mature alphabetic, and orthographic. A reader in the rudimentary alphabetic phase might be able to read some words on the basis of a few letter sound clues. However, this strategy would not be effective in reading nonwords or real words with which the reader is totally unfamiliar. In the mature alphabetic phase, the reader possesses more knowledge of individual letter-sound relationships and can use phonological recoding strategies to read nonwords with relative accuracy. In the orthographic phase, the reader is able to use large-unit relationships, such as rime-stem pronunciations, to read nonwords. In Ehri's model, some phonological recoding ability is necessary before an analogic strategy can be used, because the reader must be able to distinguish between the sounds of the letters that occur in the large units (e.g., between the sound of the E in <u>end</u> and the sound of the A in <u>and</u>) in order to be able to use such relationships in reading nonwords.

There is a basic difference between the models proposed by Ehri (1994) and Goswami (1993). In Ehri's model, some phonological recoding ability must develop before the reader is able to make use of large-unit analogic relationships. In Goswami's model, the reader uses rime-analogy prior to phonological recoding, and extensive ability to analogize enables the reader to phonologically recode.

<u>Good and Poor Reader Comparisons</u>

A number of studies have compared good and poor readers at the same levels of word recognition in their ability to read nonwords. Most of these studies have shown that poor readers do not read nonwords as well as good readers read them, despite having obtained comparable levels of word recognition. This has been interpreted as evidence that poor readers are specifically impaired in their ability to use phonological recoding strategies. However, not all of the studies in which this comparison has been made have found this difference. Rack et al. (1992), who reviewed 16 such studies, have raised the possibility that poor readers may not be impaired specifically in their ability to read nonwords by analogy to real words and that specific nonword deficits may be evident in poor readers only when nonwords are orthographically complex (e.g., polysyllabic).

Furthermore, although groups of good and poor readers in these studies are equated on their mean word recognition scores (as a necessary precondition for comparison), scores of individuals within the groups may cover a wide range. Therefore, it is impossible to tell if strategic differences occur at some word recognition levels but not at others.

Effects of Instruction

The vast majority of good and poor reader studies did not examine the effects of instruction on the ability to read nonwords, or on the strategies that may be used to decode them. It is possible that poor readers who have received instruction directed at their specific weaknesses may exhibit improved use of decoding strategies and therefore not display the specific nonword reading deficits that are evident in many poor readers. Code emphasis instruction is viewed as a weakness-directed form of instruction, because its objective is to improve word reading by improving the reader's ability to use strategies that involve letter-sound relationships.[2] If such instruction helps poor readers shift from less efficient to more efficient word attack strategies, it should also help them learn to read words faster and, as a result, enable them to "catch up" to their better-reading peers.

Therefore, a number of questions regarding differences in the strategies used by normal and poor readers to decode nonwords have remained unanswered. These questions

[2]It should be noted that all code-emphasis approaches are not alike. Some provide instruction in individual letter-sound relationships, others teach larger units such as rimes, still others present only whole words (i.e., in the context of word families). However, all code-emphasis approaches have a common instructional goal involving the alphabetic principle: Students learn that there is a relationship between the way words sound and the way they are written and that this relationship must be understood in order to learn how to read. This is distinctly different from approaches, such as whole-language, that do not have this instructional goal (Liberman & Liberman, 1992).

can be addressed within the framework of a design in which comparisons are made between younger normal readers and older poor readers who are matched in terms of their word recognition levels:

1) It is probable that poor readers are impaired specifically in their ability to phonologically recode nonwords. However it is possible that they are not specifically impaired in their ability to use an analogic strategy to read nonwords. There are two reasons for this. If analogizing precedes phonological recoding in the developmental sequence, analogizing may be available to poor readers while phonological recoding is not. Furthermore, all nonwords are not alike. Some lend themselves more readily to analogizing (e.g., jit can be read by analogy to hit, fit, bit, and many other words) than others (e.g., hoz has no real word analogy). Thus, poor readers may be able to read analogous nonwords as well as good readers read them, but not be able to phonologically recode other nonwords that cannot be read through specific analogy to real words.

2) It is possible that normally developing and poor readers differ in their ability to use analogic strategies to decode nonwords at some levels of word recognition but not at others. Different developmental sequences for phonological recoding and analogizing suggests different patterns of differences: Normal and poor readers may differ at early levels of word recognition but not at later levels. They may differ at later levels but not at earlier levels. However, if the two strategies are interdependent, normal and poor readers might differ at all levels of word recognition.

3) It is possible that normal and poor readers do not differ in their use of analogy when decoding simple one-syllable nonwords, but that poor readers are specifically impaired in using the strategy when confronted with more complex, multisyllable words.

4) It is possible that, given instruction specifically designed to help poor readers develop word attack strategies, they will be able to use an analogic strategy to a degree that is commensurate with their level of word recognition (i.e., as demonstrated by normally developing readers) after receiving such instruction.

Purpose of the Present Study

The purpose of this study was to compare normal and poor decoders in their use of rime-analogy in the decoding of nonwords. Normally developing and poor decoders, whose word recognition levels ranged from late first-grade to late fifth-grade, were matched at eight specific levels of word recognition. Poor decoders were compared with normally developing decoders, at each of these word recognition levels, on their ability to read monosyllabic and polysyllabic real words and rime-analogous nonwords. Word recognition level was determined by Subtest 1 of the Decoding Skills Test (DST) (Richardson & DiBenedetto, 1985) and analogous nonword reading was measured by Subtest 2 of the same instrument. Comparisons were made between the scores of normal decoders and the scores of three groups of poor decoders: 1) poor decoders who had not yet received remedial treatment, 2) poor decoders who had received one year of remedial treatment, and 3) poor decoders who had received two years of remedial treatment.

The study addressed the following questions: 1) Do poor decoders use rime-analogy to the same extent that (younger) normally developing decoders use it? 2) Do they use this strategy to the same extent as normal decoders use it at some developmental levels of word recognition but not at others? 3) Do they use this strategy to the same extent as normal decoders use it when reading certain types of nonwords but not others? 4) Does code-emphasis instruction improve poor decoders' use of rime-analogy?

Chapter 2

LITERATURE REVIEW

Learning to read is an aspect of human development that does not occur naturally (Gough & Hillinger, 1980). Most children learn to read only as a result of years of instruction and many children fail to develop adequate reading skills in the primary grades. In order to achieve mastery in reading, "the learner [must] discover how the segments of the orthography represent the phonological segments of the language" (Shankweiler, Crain, Brady, & Marcuso, 1992, p. 278). The process of discovering how to read words requires the acquisition of many subskills. The reader must be aware of the salience of sequence (both visual and auditory) and left-right orientation, be able to discriminate among word sounds, understand that the sounds of words are encoded in visually represented orthography, and remember the specific relationships between the phonological and visual representations of words.

Differences between normally developing readers and disabled readers in the strategies used to read unknown words are thought to hold the key in explaining why many children fail to develop adequate reading skills. This study focuses on one of these strategies, analogous word reading, and compares normally developing and poor readers, who are matched for reading levels, in their ability to read nonwords that are analogous to real words that they can read.

Literature in several related areas is relevant to this topic. I will discuss literature concerning the intrasyllabic units, onset and rime, believed to be most relevant when words are read through analogic strategies. Literature relevant to the involvement of analogic strategies in the word recognition process and its development is reviewed. Phonological processes that are related to the development of word recognition ability, with particular emphasis on rhyme, are discussed briefly.

An understanding of the phonological deficit hypothesis is crucial to answer questions regarding specific differences in the decoding strategies used by good and poor readers. Studies that have addressed this hypothesis using the reading-level matched design and nonword tasks are reviewed. Particular emphasis is placed on studies of the use of analogic strategies in decoding nonwords and on studies in which analogic relationships between real words and nonwords were controlled.

Finally, studies in which analogic strategies have been taught to normally developing readers, as well as poor readers, are discussed with emphasis on how improving analogic strategies may affect the development of word recognition ability.

Onsets, Rimes, and Nonwords

There is a relationship between the way a word sounds and the way it is alphabetically encoded (Stanback, 1992; Wylie & Durrell, 1970). Many words can be thought of as residing in families in which relationships are defined by word sounds and spellings (Taraban & McClelland, 1987; Treiman, Goswami, & Bruck, 1990). The familial aspect of written English is particularly apparent if one views the single-syllable word in terms of the subsyllabic units called onset and rime. Onset consists of the consonant (or consonant cluster) that initiates most one-syllable words. Rime consists of the vowel that follows the onset and everything that follows the vowel. Thus, the word mat can be divided into M (onset) and AT (rime); the word street can be divided into STR (onset) and EET (rime). While some single-syllable words do not have onsets (e.g., at, and, end) almost all have rimes. Words that share rimes often rhyme (e.g., hat and slat; beak and streak), but this is not always the case (e.g., beak and steak). The analogous relationship between written words resides primarily in the rime. Thus, mat, cat, and slat are analogous because they share the rime AT.

Treiman (1986, 1992) contends that onset and rime constitute logical intermediate subdivisions between the entire syllable and the individual phoneme. A number of studies indicate that even very young children can divide spoken words into onset and rime more easily than they can divide them into phonemes (Kirtley, Bryant, Maclean, & Bradley, 1989; Treiman, 1985; Treiman & Zukowski, 1991). The usefulness of the onset-rime subdivision is apparent from the fact that the vowel-consonant pattern at the end of a one-syllable words governs its pronunciations much more consistently than do its individual phoneme-grapheme relationships (Baron, 1979) or the pattern formed by a combination of the initial consonant and the vowel that follows (e.g., BEA in beak) (Treiman, 1992). For example, the letters EA are pronounced with a long E sound in many words (e.g., beam, lean, steal), with a short E sound in other words (e.g., head, thread, bread), and with a long A sound in still other words (e.g., break, steak, great). However, if the words end in the rime EACH, the long E sound is consistent (e.g., beach, reach, teach).

Classifying single-syllable words, as well as syllables in multisyllable words, in terms of the rime (i.e., spelling) unit appears to be quite useful as well as parsimonious. Wylie and Durrell (1970) found that only 37 rimes can be used to construct 500 of the most frequently occurring words in primary grade texts. Stanback (1992) analyzed rimes in over 17 thousand words (including multisyllable words) and found that only 616 rimes can be used to make almost all of some 43 thousand syllables in these words. There is also a high degree of consistency between spelling and sound in the vast majority of these rimes as they occur in words.

Thus, it appears that knowledge of onsets and rimes should be useful in learning how to read words through analogic strategies because they are a logical and practical way of dividing the phonological and orthographic information in most single-syllable words and also because they are easier to detect auditorily than individual phonemes and, perhaps, other subsyllabic divisions. Indeed, Wise, Olson, and Treiman (1990) found that first-graders were able to learn words faster when the words were visually segmented into onset and rhyme (e.g., CR-IB) than when they were segmented into one unit composed of the initial consonant plus the medial vowel and another composed of the final consonant (e.g., CRI-B). However, the difference between the groups of subjects who learned to read words under these two conditions was not sustained on a retention task that was given shortly after training. These results suggest that learning words through an onset-rime strategy may be easier, but in the long run not more effective, than other phonologically based strategies.

Pronounceable nonwords have been used frequently to study the word recognition strategies used by good and poor readers as well as more general issues involving word recognition processes and how the ability to read develops. Because nonwords are, by definition, not in the lexicon and therefore unknown, nonword tasks afford an investigator the opportunity to ask specific questions about the strategies that may be used to decode unknown words. Nonwords may be used to investigate the use of analogic strategies, because analogous nonwords can be created easily by altering the onsets of real words and leaving the rime intact.

Before describing how nonwords (and more particularly, analogous nonwords) have been used to explore the specific deficiencies of poor readers, it is important to understand what is known about how analogic strategies fit into the word recognition process as well as their place in the development of the ability to read words. The importance of an analogic strategy in word recognition is relevant because, if the strategy is crucial in reading unknown words and is not available to poor readers, this helps to explain why poor readers are deficient in their word recognition processes. If poor readers do not develop an analogic strategy at the same point that normal readers develop it, this may indicate the developmental stage at which the word recognition processes of poor readers are interrupted so that their reading skills do not develop at the same rate as those of normal readers.

Strategies for Decoding Unknown words

Virtually all models of word recognition include a phonological processing route for the recognition of unknown words (e.g., Baron 1979; Coltheart, 1978; Ehri, 1987; Goswami & Bryant, 1992; Treiman, Goswami, & Bruck, 1990). Phonological recoding, analogizing, and orthographic generalization may all be thought of as having an underlying phonological base. However, the use of these strategies in decoding nonwords is the source of some controversy.

Originally, it was assumed that the reader segments the nonword into graphemes (i.e., single letters or digraphs such as EA), translates each grapheme into its corresponding phoneme, and then blends the phonemes to pronounce the word (Coltheart, 1978). In this model, rules such as those proposed by Venezky (1970) for individual grapheme-phoneme relationships, specify the sounds that the reader assigns to the letters in the non-word. That is, the nonword is phonologically recoded.

A study by Treiman et al. (1990) suggests that this is not the only way to read non-words. These researchers found evidence that it is easier for children to read nonwords by rime-analogy than by phonologically recoding them. In this study, children at first, second, and third-grade reading levels read more nonwords correctly when the nonwords shared rime elements that occurred with high frequency in real words (e.g., tain) than when the nonwords contained rime elements that occurred with low frequency (or not at all) in real words (e.g., taich). This position is consistent with conclusions drawn from previous studies (e.g., Baron, 1979; Glusko, 1979; Kay & Marcel, 1981). It suggests that rime-based analogy influences the process of reading nonwords when the orthographic structure of the nonword permits the application of such a strategy, and that phonological recoding is used mainly when frequently occurring, rime-analogous real words cannot be located in the reader's lexicon.

However, results of partial correlational analyses conducted by Treiman et al. (1990) indicate that knowledge of individual letter-sound relationships is related to the ability to decode nonwords, even when the nonwords may be read by rime-analogy. Treiman et al. found that knowledge of individual grapheme-phoneme relationships, as well as the frequency of rime-analogous real words, were both significantly and independently correlated with nonword reading. This suggests that phonological recoding plays a role in nonword reading, even when an analogic strategy is used.

Analogic Strategies in Reading Development

Researchers disagree about when developing readers become able to read words by analogy. The controversy centers on whether phonological recoding ability develops before or after the ability to read unknown words by analogy to known words.

Fairly early on, Baron (1979) suggested that the use of analogy to decode unknown words is a more primitive strategy than grapheme-phoneme decoding as proposed by Venezky (1970). However, in the cognitive developmental model proposed by Marsh, Friedman, Welch, and Desberg (1980), phonological recoding and blending of small phonemic units is asserted to precede hierarchical decoding, which involves the application of higher order rules such as those used in analogic strategies, in reading unfamiliar words.

Marsh, Desberg and Cooper (1977), compared the strategies used by of fifth graders, eleventh graders, and college students to decode analogous nonwords and found that the percentage of responses indicating the use of individual grapheme-phoneme strategies dropped and those indicating the use of analogic strategies increased as a function of age. However, a close examination of the results presented in this study shows that when the analogous real word was known to the reader, the eleventh graders were actually more likely than the fifth graders to apply the smaller unit, grapheme-phoneme strategies in their nonword responses. Thus, it appears that the tendency to use an analogic strategy may be largely a function of whether or not the analogous word is known.

Indeed, this is precisely the position adopted by Goswami (1986; 1988, 1993; Goswami and Bryant, 1992). Goswami (1986) investigated the ability of very young nonreaders, beginning readers, and slightly more advanced readers to read words as well as nonwords by analogy. During experimental sessions, children were provided with a clue word on which to base analogies and this word was pronounced for them. Goswami found that all groups of children were able to read target words that were analogous to the clue words better than words that simply shared some letters or were totally unlike the clue words. She further found that the beginning readers and the slightly more advanced readers: 1) read analogous words that shared rimes better than those that did not, and 2) did not differ on their reading of analogous nonwords. Goswami concluded from these results that: 1) analogies that share rimes are easiest to make, 2) reading unknown words by analogy to known words is easier than reading them through phonological recoding, and 3) the ability to read words by analogy develops earlier than the ability to read words by sequential phonemic decoding. Commenting on this study, Goswami and Bryant (1992) also concluded that "analogies are used in reading irrespective of reading level" (p. 59) because there were no differences between the beginning readers and the slightly more sophisticated readers in their use of analogies to read nonwords.

These findings led Goswami (1993) to hypothesize an interactive analogy model of reading development. The primary assumptions of this model are that awareness of onset and rime is a very basic form of phonological awareness, that it develops before children begin to learn to read, and that it forms the basis of the strategies used by beginning readers to approach unknown words when they first encounter orthographic representations. Thus, when beginning readers are exposed to printed words, they are first able to recognize orthographic units that correspond to the onset-rime phonological segments. However, as the reader's store of recognized words expands, knowledge of phoneme-grapheme relationships expands, so that analogies can be made from less accessible orthographic units, such as the initial consonant-vowel combination, and finally from the sounds of the imbedded vowels themselves.

According to this model, vowel decoding should develop as follows: 1) Early beginning readers should be able to transfer vowel information as part of a rime segment but not otherwise. That is, they should be able to use knowledge of the word <u>bug</u> to read RUG because both of these words share the rime UG. However, they would not be able to use knowledge of the word bug to decode BUD (shared onset-vowel combination BU) because this requires breaking the natural and most accessible end segment of the word (i.e., the rime UG) to form a less obvious initial segment (i.e., BU). They would also be unable to use the word bug to decode CUP (shared vowel-sound only) because this requires the inference of an individual phoneme-grapheme relationship for the vowel from a larger orthographic set bounded on both sides by consonants. Such a parsing requires phonemic segmentation, one of the most sophisticated of all phonological processes (Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977). 2) Somewhat more advanced readers should be able to transfer vowel information that occurs as part of an onset-vowel unit. For example, knowing how to read bug might provide a basis for decoding BUD because the more sophisticated reader is able to break the vowel sound apart from its rime element. 3) Finally, extensive exposure and increased levels of word recognition would enable the reader to make use of individual phoneme-grapheme correspondences. Such a reader would be able to infer the sound of the U in bug and transfer this knowledge to the decoding of CUP.

In order to test this model, Goswami (1993) conducted three experiments that involved groups of beginning readers at two early levels of word recognition and a somewhat more advanced group of readers. The experimental tasks were similar to those described in Goswami (1986).

Results provided Goswami (1993) with a fair amount of support for her model. As predicted from the model, the lowest reading group (mean reading age = 6 years, 5 months on the Schonell graded word lists) were able to make use of rime analogies to read a word such as rug from knowing how to read bug but were unable to employ onset-vowel units or individual vowel-graphemes to make analogies. The second highest reading group (mean reading age=6 years, 10 months) also used rime analogies best when reading words that contained long-vowel digraphs. (e.g., used the learned word beak to read PEAK) and also demonstrated some ability to employ the onset-vowel units (e.g., used beak to read BEAN) as well as individual vowel graphemes (e.g., used beak to read HEAP). However, when more sophisticated readers (mean reading age =7 years, 6 months) were given a task involving words with consonant clusters and individual vowel-graphemes (as opposed to vowel digraphs), they were able to use both rime units (e.g., use wink to read PINK) and onset-vowel units (e.g., use trim to read TRIP) but were unable to use individual vowel graphemes in learned words to read unknown words (e.g., use bump to read MUST). Goswami interprets these results as indicating that the "degree of grapheme overlap" may be a factor in transfer at a phonemic level. For example, the vowel digraph EA in beak is associated with a single phoneme (long E) and this constitutes one half of the graphemes and one third of the phonemes in the words beak and heap. On the the other hand, the U in bump is one of four graphemes, as well as four phonemes, in the words bump and must, constituting one quarter of the graphemes and phonemes in these words. Thus, abstracting the phoneme associated with the grapheme U in bump may be more difficult than abstracting the phoneme associated with the vowel-digraph EA in beak.

Overall, Goswami (1993) interprets the results of these experiments as support for her hypothesis that children begin to read by using analogic strategies involving rime and progress to more sophisticated phonological recoding strategies.

However, the results of a study by Ehri and Robbins (1992) suggest a somewhat different developmental sequence. Ehri and Robbins contend that knowledge of the relationship between graphemes (i.e., how a word is spelled) and phonemes (i.e., how a word is pronounced) is used by the reader to store the spellings of specific words in lexical memory. According to this view, a reader must be able to relate a vowel grapheme to its sound in order to distinguish between similar rime elements (e.g., END, AND, OND), and to use them in making analogies. In fact, a series of experiments by Byrne (1992) indicate that novice readers do not deduce the sounds of individual phonemes (in this case, those associated with initial consonants) simply from learning words that contain them.

Children in the Ehri and Robbins (1992) study were beginning readers who were either 1) decoders (children who were able to phonological recode at least some CVC [i.e, consonant-vowel-consonant] nonwords) or 2) nondecoders (who could not recode any of the nonwords). Decoders and nondecoders were placed (equally) into two treatment conditions in which they learned to read five real words to criterion. They were then shown five transfer words. Children in the analogy condition were asked to read transfer words that contained rime elements from the first set of words, so that the transfer words could be read by analogy. Children in the control condition were asked to read words that contained letter-sound relationships from the original words, but not at the rime level.

Ehri and Robbins (1992) found that decoders who learned to read the analog words did significantly better on the transfer task than those who learned the control words. However, nondecoders did not read analogous words better than control words. In fact, nondecoders read few if any words by analogy. Ehri and Robbins conclude that "decoding skill is necessary for beginners to be able to read novel words by analogy to known words" (p. 17). They find support for Goswami's (1986) claim that reading unknown words by analogy to known words is easier than reading unknown words by phonologically recoding smaller units. However, the results do not support Goswami and Bryant's (1992) claim that the ability to read words by analogy develops prior to the ability to read words by sequential phonemic processing. This presents an interesting paradox: Given two strategies, one that is easier to execute (reading by analogy) and one that is more difficult to execute (phonemic recoding), it is necessary that the more difficult strategy be (at least to some degree) learned before the easier one can be executed. Ehri and Robbins suggest an interesting explanation for this apparent contradiction: The two strategies are not really independent. Phonemic recoding may actually be a more sophisticated form of reading by analogy. "What appears to be a process of blending phonemes to read new words may in truth be analogy reading in which already blended phonemes in subunits are accessed from memory" (p. 20).

The results of another study appear to contradict the findings of Ehri and Robbins (1992). Goswami and Mead (1992) examined the relationship between a variety of phonological awareness tasks and the ability to use different types of analogic strategies. These investigators found that awareness of onset and rime was related to the ability to make use of rime-stem analogies, while higher-level phonological skills (e.g., the ability to delete consonants) were more strongly related to the ability to make use of beginning analogies (e.g., reading BEAN by analogy to beak).

As part of this study, Goswami and Mead (1992) divided their beginning readers into good and poor reader groups based on their ability to read short CVC nonwords and compared their performance on a variety of analogous word-reading tasks both before and after the subjects received training in reading analogous clue words. Results of this comparison led Goswami and Mead to conclude that their good and poor readers "showed the same pattern of a significant improvement in reading the analogous words... [which] suggests that analogies were being made in the same way by both ability groups" (p. 155).

However, there are several problems with this conclusion: Examination of the mean scores obtained by the poor readers on the task designed to measure the use of rime-stem analogies shows that the good readers read more words than did the poor readers both before and after the analogy training and that many poor readers obtained scores close to zero on this task at both test points. This indicates the presence of a "floor effect" which suggests that the task did not accurately measure the use of rime analogy in the poor reader group. Furthermore, in a regression procedure designed to predict improvement in the use of rime-analogies resulting from training, Goswami and Mead (1992) found that nonword reading contributed significantly to the prediction, even after actual reading level was controlled. This finding is consistent with that of Ehri and Robbins (1992), in that it indicates that the subjects with better phonological recoding skills showed more improvement in their use of rime-analogy than did the subjects with weaker phonological recoding skills.

Coltheart and Leahy (1992) investigated the strategies used by beginning, more advanced, and adult readers to decode regular and irregular words as well as nonwords. These investigators found that the more advanced readers (i.e., second and third graders) were more likely to use rime analogy to decode nonwords than were the beginning readers (i.e., first graders) who were more likely to employ phoneme-grapheme correspondence rules. However, Coltheart and Leahy also found that even the more advanced readers were more likely to apply regular, phoneme-grapheme correspondence rules than rime analogy when reading nonwords whose rimes are associated with irregular pronunciations (e.g., to pronounce VIND with a short I sound rather than with the long I sound heard in <u>mind</u> and <u>kind</u>). These authors concluded that even advanced readers are more likely to use phoneme-grapheme correspondence rules than rime analogy even when a rime-analogy strategy is available to them. This study suggests that a decoding strategy based on rime analogy develops later than the phonological recoding strategy and furthermore, that the rime-analogic strategy remains inextricably linked to phonological recoding.

The results of a study by Bowey and Hansen (1994) are also consistent with those of Ehri and Robbins (1992). Bowey and Hansen compared four groups of first-grade readers, whose word recognition scores ranged from beginning to advanced first-grade levels, on their ability to read nonwords containing rime stems that occur 1) with high frequency in real words and 2) with low frequency in real words. Given that the nonwords with low-frequency rime stems are more likely to require individual grapheme-phoneme recoding strategies than are those with common rime stems (which may be read by analogy), Bowey and Hansen hypothesized that the nonwords with common rime stems would be easier to read. Results of this study supported this hypothesis. However, the common rime-stem nonwords were easier than the uncommon rime-stem nonwords only for the two more advanced groups of first-grade readers. The authors concluded that decoding unknown words with a rime-analogy strategy is easier than decoding with other strategies only when the reader has a large enough store of known words that contain the particular rime stems and that the more skilled readers also have more advanced ability to phonological recode using individual phoneme-grapheme correspondence procedures.

The difference between these perspectives is relevant to questions concerning the strategies used by poor readers in word reading. If some phonological recoding ability is necessary for the reader to make use of an analogic strategy, children who cannot phonologically recode (i.e., poor readers) should not be able to analogize either. However, if recoding ability is not a prerequisite for reading by analogy, poor readers may be able to use an analogic strategy without having developed phonological recoding ability.

Phonological Processes and Reading

There is considerable evidence that phonological processing abilities are strongly related to success in learning how to read (e.g., Badian, McAnulty, Duffy, & Als, 1990; Bradley & Bryant, 1983; Brady & Shankweiler, 1991; Catts, 1991; Juel, 1988; Lesgold & Resnick, 1982; Perfetti, 1985; Share, Jorm, MacLean, & Matthews, 1984; Vellutino & Scanlon, 1987). Phonological processes are "linguistic operations that involve utilization of information about the phonological (speech sound) structure of the language" (Felton & Brown, 1989, p. 3). Phonological processes include such skills as the ability to perceive rhyme in spoken words, the ability to segment word sounds into phonemes and syllables, and phonological recoding (Wagner & Torgesen, 1987).

The ability to detect rhyme is particularly relevant to the use of analogic strategies in reading. Bradley and Bryant (1983, 1985) found that poor readers have difficulty detecting rhyme and that an early awareness of rhyme and alliteration influences later success in learning to read. The results of other studies support these conclusions (Ellis & Large, 1987; Lundberg, Olofsson & Wall, 1980; MacLean, Bryant, & Bradley, 1983). Goswami (1988) noted that the use of rime to make analogies "may follow naturally from an earlier appreciation of rhyme" (p.241). Indeed, Goswami and Bryant (1992) found Bradley & Bryant's (1985) rhyming task to be the only one among a number of phonological measures that was consistently related to a measure of the ability to use rime analogies. Goswami and Mead (1992) found that awareness of onset and rime was also related to the ability to make use of rime analogies. One might also conclude from this that poor readers would have difficulty using rime-analogy to read unknown words: If they can't hear the rhyme, how can they use the rime to decode by analogy?

However, the ability to detect rhyme has not consistently been shown to predict word recognition ability (Felton & Brown, 1989). This may be because poor readers do eventually achieve mastery in their ability to detect rhyme. There is evidence that disabled readers' difficulty with detecting rhyme (unlike their difficulty in detecting phonemes) does not persist into adulthood (Bruck, 1992). This suggests that disabled readers at higher word recognition levels might be better able to make use of rime-based analogic strategies than those at lower word recognition levels. However, it must be noted that awareness of rhyme, as well as other types of phonological awareness, are considered necessary, but insufficient, for learning to read words. The reader must also have sufficient letter-sound information (Bradley & Bryant, 1985) and understand how the letter-sound relationship in written words and the sounds that ones hears in words are related (Bradley, 1988; Cunningham, 1990).

The Phonological Deficit Hypothesis

The phonological deficit hypothesis (Stanovich, 1988b) has received considerable attention in research in recent years (see review by Rack et al., 1992). According to this hypothesis, the word recognition ability of disabled readers is specifically constrained by poor phonological processing skills. Disabled readers do acquire some ability to read. However, they do so despite this deficit. Poor readers may employ compensatory strategies, such as memorization of the visual aspects of words, as might be predicted from Frith's (1985) model, or use a less sophisticated phonetic-cue word attack strategy, as described by Ehri & Wilce (1987). However, they would be less likely to make complete or sophisticated use of letter-sound relationships than would good readers in the orthographic stage (Ehri & Saltmarsh, 1995).

The most popular alternative to the phonological deficit hypothesis is the developmental lag hypothesis. According to this hypothesis, the reading development of disabled readers is simply delayed or arrested at an earlier stage. Disabled readers do have poor phonological skills, and their word recognition ability is constrained by this fact. However, it is not more constrained than would be expected given their levels of word recognition (Beech & Harding, 1984; Vellutino & Scanlon, 1987).

To summarize, according to the phonological deficit hypothesis, there is a qualitative difference, specific to phonological processes, in the decoding strategies used by good and poor readers. According to the alternative developmental lag hypothesis, the difference is purely quantitative.

The reading-level-match comparison design was born out of the need to differentiate the specific features of the disabled reader's reading behavior from those that are simply a function of different levels of word recognition (Rack et al., 1992). In this design, poor readers whose reading levels are below that which would be expected based on their ages and grades are matched with normal or good readers whose reading levels are at (or above) expectation. Thus, the two groups have the same average level of word recognition, but the poor readers are, by necessity, older than the good readers.

Nonwords are frequently used to study the phonological deficit hypothesis. According to Rack et al. (1992) nonwords are used because "[they] are visually unfamiliar [therefore] they cannot be recognized directly....so subjects must employ their phonological skills to some extent. Performance on nonword reading therefore gives an indication of phonological skill" (p. 32).

Studies of Nonword Reading in Good and Poor Readers

Rack et al. (1992) reviewed 16 studies that investigated the phonological deficit hypothesis by comparing the nonword reading abilities of reading-level-matched samples of good and poor readers. These reviewers found that 10 of the 16 studies reviewed obtained results in which poor readers performed more poorly than reading-level matched good readers on nonword reading tasks. Therefore, they concluded that there is qualified support for a specific phonological coding deficit in poor readers. Several of the studies reviewed by these authors are particularly relevant to the present investigation because their nonword tasks included many items that are specifically analogous to real words.

In a study by Holligan and Johnston (1988), poor readers differed significantly from their reading-level matched counterparts on a task that included one-syllable nonwords, defined as difficult by the authors, but the two groups did not differ on a task involving easier, three-letter nonwords. The authors concluded that a specific difficulty of poor readers may rest with their inability to use large-unit sound-symbol relationships that overtax their working memories, as opposed to low-level grapheme-phoneme conversion.

However, an examination of the tasks employed by Holligan and Johnston (1988) shows that many of the "easy" nonwords can be read by rime analogy to high-frequency, regular, real words, many of which are taught at first-grade levels (Harris and Jacobson, 1972) (e.g., rop is analogous to stop; wut is analogous to but and cut; lig to big; lat to hat and cat; teg to leg) In contrast, examination of the more difficult nonwords reveals that 1) many have no single-syllable, real-word rime analogies (e.g., hoz, gosp, moath, druv), 2) a number are analogous to words that occur with much less frequency in first grade material, but do occur in material at higher grade levels (e.g., doan is analogous to loan; loast is analogous to roast; brode is analogous to rode), and 3) a few of the nonwords are primarily analogous to high-frequency irregular words (e.g., bon is analogous to son; proe is analogous to shoe). Thus, an equally plausible explanation for the findings in the Holligan and Johnston study is that the easier nonwords were easier because they could be read by rime-analogy to real words that might have been known to the children. This would be consistent with the position of Treiman et al. (1990), who showed that nonwords with many high-frequency analogous real words are easier to read, particularly for poor readers, than are other types of nonwords. It also suggests that the use of analogic strategies may not be a specific deficit of poor readers. Another fact that may have influenced the outcome of this study is that the poor readers, whose mean age was 8.5, were reading only about a year below grade level, and their good reader matches were just over 7 years old.

In Snowling's (1981) study, nonword complexity and the reading age of the poor readers were both considered as factors that might influence the outcome of comparisons. Snowling found that one-syllable nonwords did not discriminate between the poor readers and their reading-matched controls as well as did two-syllable nonwords. Again, examination of items reveals that many (but not all) of the one-syllable nonwords used in this study are highly analogous to real words (e.g., wut, steg, clest). However, Snowling's two-syllable nonwords are not analogous to real words (e.g., tegwop, molsmit, brigbert), although they contain syllables that are analogous to real words. The results of this study also indicate that the word recognition level of the groups being compared may indeed be a factor. In this British study, normal and poor readers who had obtained high scores on a word recognition measure (mean reading age approximately 10.5 years) performed significantly better than normal and poor readers who had obtained low scores on the same word recognition measure (mean reading age approximately 8 years). The difference between poor readers who were less advanced (i.e., those with low word recognition scores) and those who were more advanced (i.e., those with high word recognition scores) was greater on the two-syllable nonword task than it was on the one-syllable nonword task. Furthermore, differences between these normal and poor readers on the nonword tasks were more evident at the lower word recognition level than they were at the higher word recognition level. This was particularly true on the two-syllable nonword task.

Snowling (1981) attributed her findings to a phonological complexity factor. However, it is equally plausible to conclude that there is less difference between normal and poor readers in their ability to use simple analogic strategies (i.e., on the one-syllable task) than there is in their ability to use more complex phonological recoding strategies (i.e., one the two-syllable task).

It should be noted that the mean reading age of the more advanced poor reader group in Snowling's (1981) study was almost a year higher than that of the more advanced normal reader group which served as its reading-level match. This discrepancy may have resulted in smaller differences between the normal and poor readers at the higher word recognition level than at the lower word recognition level (where normal an poor readers obtained mean word recognition scores that were almost equivalent).

Two studies (DiBenedetto, Richardson, & Kochnower, 1983; Treiman & Hirsh-Pasek, 1985) reviewed by Rack et al. (1992) used nonword tasks that were similar to each other. However, these two studies obtained contradictory results. The experimental tasks in both of these studies were modeled after Baron's (1979) test, in which a nonword (e.g., taid) reflects the orthographic construction of two real words, one of which is regular (e.g., maid) and one of which is irregular (e.g., said). In both studies, pronunciations of the nonwords were counted as correct when they were analogous to the pronunciation of either of the parallel real words. DiBenedetto et al. found that the good readers read significantly more nonwords correctly than did the poor readers. Treiman and Hirsh-Pasek found that the matched good and poor readers did not differ on the nonword task. Although these two studies used similar nonword tasks, the ways in which the studies differ may be relevant to the present study and are discussed below.

First, the disabled readers in the Treiman and Hirsh-Pasek (1985) study were considerably older (mean age=11.75) than those in the DiBenedetto et al. (1983) study (mean age=10.21) and their reading matched controls were slightly older (mean age=8.5) than the matched good readers (mean age=8.05) in the DiBenedetto et al. study. Treiman and Hirsh-Pasek noted that older disabled readers might be less likely to display specific deficits (when compared to younger reading-matched normals) as a result of having had more time to overcome their deficiencies in spelling-sound associations. Baddeley, Logie and Ellis (1988) also made this observation with respect to findings similar to those of Treiman and Hirsh-Pasek. This is also consistent with Snowling's (1981) finding that there was less difference in nonword reading between normal and poor readers at higher word recognition levels than between normal and poor readers at lower word recognition levels. However, it is not consistent with the results obtained by Manis, Szeszulski, Holt, & Graves (1988), who found that good and poor readers at third-grade reading levels did not differ on a nonword task, while those at fourth and fifth-grade levels did differ. It is also not consistent with the results of a study by Bruck (1990), in which adult dyslexics displayed nonword reading deficits when compared to good, sixth-grade readers.

A second difference between these two studies, and perhaps more important with respect to their contradictory findings, concerns differences in procedures used to obtained the reading-level matched good and poor reader groups. The disabled and normal readers in the DiBenedetto et al. (1983) study were matched on an independent word reading measure. In fact, these good and poor readers differed significantly on the experimental task that involved regular, real words. In the Treiman and Hirsh-Pasek (1985) study, the two groups were matched on the real word portion of the experimental task. Although the mean score of the poor reader group on a standardized word recognition test is provided by Treiman and Hirsh-Pasek, that for the good reader group is not.

Finally, items in the experimental tasks of the two studies were arranged differently. This may have affected results, because a study by Kay and Marcel (1981) shows that a reader is more likely to use an irregular word (e.g., deaf) than a regular word (e.g., leaf) as the analogic basis for pronouncing a nonword (e.g., yeaf) if the irregular word has been presented recently. This suggests that the reader may be confused by the presentation of words that share orthographic properties but do not have similar pronunciations. There is evidence that this is particularly true for unskilled and disabled readers (Backman, Bruck, Hébert, & Seidenberg, 1984; Manis & Morrison, 1985). In the study by Di-

Benedetto et al. (1983), the three item types (i.e., regular words, irregular words, and non-words) were ordered in a fashion so as to appear random. In fact, some nonwords were presented to the reader before either of their analogous real words were presented. In the Treiman and Hirsh-Pasek (1985) study, regular words were presented first, followed by irregular words. Nonwords were presented last. Thus, priming may have made the analogous relationship between the real words and the nonwords more obvious (and therefore easier to read for the poor readers) in the Treiman and Hirsh-Pasek study.

Rack et al. (1992) noted that most of the studies they reviewed that did not find a specific nonword deficit in the poor readers employed nonwords that were very similar to real words (i.e., Baddeley, Logie & Ellis, 1988; Beech & Harding, 1984; Treiman & Hirsh Pasek, 1985). As we have seen in the Holligan and Johnston study (1988), analogous relationships may, at least in part, be responsible for this. According to Rack et al., if the use of analogic strategies reduces the "load on phonological processing," we might expect that poor readers would not differ from normal readers on nonword tasks that permit the use of analogic strategies.

Rack et al. (1992) also stated that many studies that found specific nonword reading deficits in poor readers (e.g., Kochnower, Richardson, & DiBenedetto, 1983; Manis et al., 1988; Olson, Wise, Conners, Rack, & Fulker, 1989; Snowling, 1981) employed nonword items that were longer, more complex and less like real words. However, in the study by Kochnower et al., all nonwords are analogous to specific real words. Similarly, Siegal and Ryan (1988), who used a task that included many nonwords that are analogous to real words (i.e., Goldman, Fristoe & Woodcock, 1974) also found a specific nonword deficit.

Several studies published after the review by Rack et al. (1992) also compared poor readers and reading-level matched normal readers on their ability to read nonwords. Beech and Awaida (1992) compared groups of British children whose mean reading ages were just under eight years (i.e., at about a late second-grade level in British schools). These researchers found that the poor readers performed worse than the normal readers on the nonword reading task and that neither word length, nor frequency (in real words) of the orthographic sequences used to construct the nonwords, accounted for this difference. The measure of frequency of orthographic sequence used in this study is not specifically a measure of the number of real words that are rime-analogous to the nonwords. However, it does appear to be a measure of the number of real words to which the nonwords are analogous in a general way.

Manis, Custodio, and Szeszulski (1993) also compared reading disabled students and reading-level matched normal readers in their ability to read nonwords. Comparisons were made at two test points that were separated by two years. Nonword tasks included 1) one-syllable nonwords with common spelling patterns, 2) multisyllable nonwords with no close orthographic neighbors (i.e., nonanalog nonwords), and 3) two-syllable nonwords containing syllables with common spelling patterns. The mean age of the reading disabled subjects was just under 12 years at the first comparison point and the mean word recognition score of both groups placed them at an early fourth-grade level. These investigators found that the reading disabled subjects performed more poorly than the normal readers on the first two tasks described above (but not on the third task) at the first test point, and more poorly than the normal readers on all three nonword tasks at the second test point.

It should also be noted that most of the disabled readers in the study by Manis et al. (1993) "were receiving intensive small-group instruction and one-to-one tutoring in reading and writing" (p. 64). (The specifics of the instruction are not stated.) The disabled readers did demonstrate significant improvement between the two test points on the two measures that involved nonwords with common spelling patterns. However, differences between the reading disabled and normal groups on the nonword measures were even greater at the second test point than at the first, particularly on the nonanalog nonword task. This was true despite the fact that the mean word identification levels of the two groups were approximately the same (i.e., early sixth-grade level) at the second test point.

The results of this study strongly suggest that reading disabled children do not "catch up" to normally developing readers in the phonological processing skills that are tapped by these nonword tasks.

Bowey and Hansen (1994) used a task that included nonwords containing rimes that occur with high frequency in real words as well as nonwords containing rimes that occur with low frequency in real words. In this study, fourth-grade poor readers were compared to second-grade normal readers who were matched to the poor readers on several measures of word identification. These researchers found that the normal readers read significantly more nonwords correctly than did the poor readers and that both groups read more common rime-stem nonwords correctly than uncommon rime-stem nonwords. However, this "orthographic rime frequency" effect was the same for both groups. This suggests that poor readers are equally deficient in their ability to read nonwords of both types.

Several other studies are relevant to the specific nonword deficit hypothesis as well as to questions about the use of analogic strategies by poor readers. In these studies, good and poor readers (at approximately equal levels) were compared, but the groups of good and poor readers were not specifically equated on word recognition levels.

Marsh, Friedman, Desberg, and Saterdahl (1981) compared a group of reading disabled fourth graders (reading on a second grade level) with a group of normally achieving second-grade readers. The experimental task consisted of 20 real words (with equal numbers of regular and irregular words) and 20 nonwords that are "parallel" to the real words. The authors state that each nonword differed from a real word by one letter (or phoneme), but it is impossible to determine whether or not the rimes in the nonwords were the same as those in the real words. Marsh et al. (1981) obtained a significant interaction effect (in a factorial ANOVA model) indicating that there was a difference between mean scores on real words and nonwords for the disabled readers but not for the normal readers. An analysis of response type was also conducted (although it is not clear how this analysis was done), from which the authors concluded that there was no statistical difference between the good and poor readers in their use of analogic strategies. This finding tends to contradict that of the main analysis described by these authors (i.e, the interaction effect). Marsh et al. (1981) concluded that their results support a developmental lag hypothesis. However, this conclusion is clearly not indicated by the results of their primary analysis, which tend to support the specific deficit model.

Extending on several studies that established a logical sequence for the development of decoding strategies (Ehri & Wilce, 1985, 1987), Ehri and Saltmarsh (1995) compared advanced beginning readers, novice readers, and reading disabled students on their ability to detect altered spellings in simplified, phonetically spelled words. The results of this study indicate that both novice and reading disabled readers form less complete lexical representations (in memory) than do advanced beginning readers. Ehri and Saltmarsh concluded that both novices and disabled readers employ phonetic-cue strategies rather than the more complete cipher-stage strategies. It is of particular interest to the present study that Ehri and Saltmarsh also administered a nonword task to these children and found that, although the disabled readers were at a higher word recognition level than the novices, the two groups did not differ significantly on the nonword task. Ehri and Saltmarsh note that this finding does not support the developmental lag hypothesis.

Finally, a study by Treiman et al. (1990), which was discussed with relevance to word recognition processes, also has relevance to the use of analogic strategies by poor readers. In this study, first graders who were reading at a beginning second-grade level (i.e, good readers) were compared to third graders who were reading at a mid second-grade level (i.e., poor readers). The experimental task in this study included nonwords containing rimes that occur with high frequency in real words and rimes that occur with low frequency in real words. Results of this study show that the poor readers were somewhat more likely to be correct when nonwords contained high frequency rimes (i.e., 56 percent correct) than were the good readers (i.e., 49 percent correct), and slightly less likely to be correct when nonwords contained low frequency rimes (i.e., 39 percent versus 41 percent). Although this interaction was not statistically significant, Treiman et al. concluded that the specific deficits of poor readers may reside primarily at the phoneme-grapheme level (i.e, phonological recoding) rather than at the larger-unit level (i.e, the analogizing). However, this hypothesis is not supported by the previously described study conducted by Bowey and Hansen (1994), which addressed the hypothesis raised by Treiman et al., directly.

Treiman et al. (1990) also conducted correlational analyses that are relevant to the present study. They found that knowledge of individual grapheme-phoneme correspondence (GPC) was significantly correlated with the first-grade good readers' ability to read nonwords of both types and that GPC was more strongly correlated with the first graders' ability to read nonwords containing uncommon rime stems. However, GPC was not significantly correlated with the third-grade poor readers' ability to read nonwords of either type. (GPC was significantly correlated with third-grade good readers ability to read nonwords with uncommon rime stems, but not those with common rime stems. However, this may be because these older good readers obtained near-perfect scores on the task that involved nonwords with common rime stems.) Strong conclusions cannot be drawn from this type of analysis. However, it does suggest that analogic strategies develop differently in good and poor readers. It suggests that: 1) In normally developing readers at a late-beginning reading level, phonological recoding and analogic strategies are closely linked through their shared dependence on letter-sound relationships, but 2) In poor readers, the link between GPC knowledge and decoding strategies of either kind is much weaker than it is for good readers. That is, even if the reader is aware of grapheme-phoneme relationships, the poor reader is less likely than the good reader to use this knowledge effectively. Thus, the poor reader does not use phonological recoding or analogizing as effectively as the good reader uses either strategy.

Minimal conclusions can be drawn from the studies discussed above regarding poor readers' use of analogic strategies, because none of these studies provided a clear comparison between good and poor readers in their use of analogic strategies at the same levels of word recognition. As Goswami and Bryant (1992) noted, if we want to know if a reader (disabled or otherwise) can read nonwords by analogy, we must first ascertain whether or not the reader can read the analogous real words.

Analogous Nonword Reading in Good and Poor Readers

The Decoding Skills Test (DST) (Richardson & DiBenedetto, 1985) was developed specifically to address hypotheses concerning the differences between good and poor readers. (This instrument will be described in more detail in the Method section.) Subtest 1 of the DST is a general measure of word recognition and yields an Instructional Level score. Subtest 2 of the DST can be used to measure analogous nonword reading. In this subtest, the examinee reads phonetically regular, monosyllabic and polysyllabic words, and then reads analogous nonwords that have been created by changing the onsets of the monosyllabic words (e.g., fed to med) or the onsets of one or more syllables in the polysyllabic words (e.g., mistake to fistake). A specific measure of analogous nonword reading, the Phonic Transfer Index (PTI), is obtained by dividing the number of analogous pairs read correctly by the number of real words read correctly. Two PTIs may be obtained, one for monosyllabic words and one for polysyllabic words. The DST was used in three studies in which good and poor readers, who were matched on their levels of word recognition, were compared.

A study by Kochnower et al. (1983), which was reviewed by Rack et al. (1992), found evidence for a specific phonological recoding deficit. Subtest 2 of the DST was used as the dependent measure in this study. However, while differences between matched good and poor readers on the nonword section of this subtest were significant, the groups were not compared on the PTI.

Richardson, DiBenedetto, and Adler (1982) compared matched good and poor readers on an earlier version of the Phonic Transfer Index, in which a total PTI (monosyllabic plus polysyllabic items) was derived by dividing the number of nonwords correct by the number of real words correct. Thus, as a measure of analogous nonword reading, this version of the PTI is imperfect because it includes nonwords that were read correctly when the analogous real words were incorrect. (However, this occurred infrequently.) In this study, a group of primarily second-grade good readers was compared to a matched group of primarily fourth and fifth-grade poor readers. Both groups of students obtained mean grade equivalent scores at a mid third-grade level on a standardized measure of vocabulary reading, and mean word recognition scores were at a late third-grade level as measured by DST Subtest 1. The mean PTI for the group of good readers was .83, that for the poor readers was .69, and these means were significantly different ($p<.05$). This outcome constitutes some evidence that poor readers may be specifically impaired with regard to their ability to read nonwords by analogy.

The strongest evidence to date that poor readers are specifically impaired with respect to their ability to read nonwords by analogy comes from a study by Felton and Wood (1992). Subtest 2 of the Decoding Skills Test was one of two dependent measures of nonword reading in this study, and Phonic Transfer Indices were obtained on one of two comparison samples. Nondisabled first-grade readers were compared to samples of third and fifth-grade disabled readers who were matched to the first graders on word recognition scores. In the comparison of first graders (good readers) and third graders (poor readers), standardized word recognition measures indicated that each group obtained a mean grade-equivalent score at a beginning second-grade reading level. Thus, the reading-disabled third graders were about a year below grade level and the first-grade good readers were slightly above grade level. In the comparison involving first-grade (good) readers and fifth-grade (poor) readers, the mean grade-equivalent score of each group was at a late second-grade level. Thus, the disabled fifth graders were, on the average, more than two years behind, while their first-grade counterparts were about a year above grade level. Felton and Wood found that, while the good and poor readers in both comparisons did not differ on the number of DST Subtest 2 real words read correctly, they did differ significantly on all measures of nonword reading. (Poor readers read fewer nonwords correctly.)

Felton and Wood (1992) also obtained longitudinal data on their first-grade and fifth-grade matched samples, and these data included the DST Phonic Transfer Index (as it is currently used). The first graders in this comparison were also tested two years later (in the third grade) and the fifth grade disabled readers had been tested two years earlier (also in the third grade). Differences between the groups on the PTI measures (both monosyllabic and polysyllabic) were extremely large (although not tested for significance). For example, on the monosyllabic PTI, the nondisabled readers obtained a mean of .63 when they were in the first grade and a mean of .89 when they were in the third grade. The disabled readers, on the other hand, obtained a mean monosyllabic PTI of .26 when they were in the third grade and a mean of .46 when they were in the fifth grade. Felton and Wood concluded that the improvement in nonword reading for these disabled readers was slight. This conclusion is specifically applicable to analogous nonword reading, since that is what is measured by the PTI.

However, two points should be made regarding the Felton and Wood (1992) study: 1) Discrepancies (between expected reading level and measured reading level) in the comparison between the first and fifth graders were extremely large for both the good readers and the poor readers. We do not know that the same results would have been obtained from poor readers at higher reading levels, or from good readers at lower reading levels. 2) Remedial intervention was not a factor in this study. Therefore, the lack of improvement in analogous nonword reading may have been due to instruction that was inadequate with respect to the poor readers' needs. Nevertheless, the results of this study provide fairly strong evidence that poor readers are specifically impaired in their ability to read unknown words by analogy to known words.

Effects of Instruction

It is impossible to determine the influence that remedial instruction may have exerted on outcomes of the studies discussed above. Rack, et al. (1992) note that disabled readers who have received instruction specifically designed to remediate their phonological decoding deficits might be less likely to differ from their reading-level matched counterparts than would disabled readers whose deficits have not been addressed. Rack et al. suggest that such instruction might tend to obscure the specificity of the nonword deficit.

However, Ehri (1989) takes the position that the source of the phonological deficits in poor readers is primarily due to inadequate instruction. That is, "dyslexics exhibit phonological deficits because they have not learned to read and spell in a way that develops their spelling knowledge so that it penetrates and comes to symbolize their phonological knowledge"(p. 336). Therefore, if adequate instruction were provided, the poor reader should be in a better position to develop the sophisticated decoding strategies that are the hallmark of a good reader.

Training normally developing readers in analogic strategies. Baron (1979) provided analogy training to normally developing, beginning first-grade readers and somewhat more advanced, second-grade readers. Following training, he examined improvement in their ability to read nonwords. Baron found that, while the second graders demonstrated significant improvement on the nonword task, the first graders did not. Given that the second graders benefitted more from the training than did the first graders, Baron concluded that younger readers require more systematic and and extensive training in analogizing than do older readers.

Bruck and Treiman (1992) provided different types of analogy training to beginning first graders who were judged to be ready to learn to read. These children learned a list of 10, one-syllable clue words to criterion over a period of several days. Children were then trained to read one of three types of target words. For example, given the clue words hid and met, the children learned to read: 1) words that share rimes with the clue words (e.g., lid, bet) (rime condition), 2) words that share initial consonants and following vowels with the clue words (e.g., hit, men) (CV condition), or 3) words that share only medial vowels with the clue words (e.g., sit, bed) (vowel condition). During training, the children were shown the learned clue words, when necessary, to assist them in learning the target words. In addition, during part of the training, the graphemes shared by the clue and target words were color highlighted. Children were provided with the sounds of these graphemes when they did not immediately recognize the clue words.

These investigators found that children in the rime condition learned the target words in significantly fewer trials than did the children in the other two conditions. However, when given a retention test a day or two later, children in both the CV and vowel conditions read significantly more target words correctly than did children in the rime group. Furthermore, on a generalization test composed of nonwords that shared rimes (e.g., nid, fet) or shared initial consonant-vowel units (e.g., hin, meb) with the clue words (e.g., hid, met), the children in the vowel condition read significantly more words correctly than did children in either of the other two conditions.

Bruck and Treiman (1992) also found that the effects of training held up on the retention test even when the number of trials required for learning the target words was controlled. Thus, it is unlikely that the rime group performed more poorly on the retention test simply as a result of less practice with the target words. Bruck and Treiman conclude that "Children need instruction not just on the relations between groups of graphemes and groups of phonemes but also on the correspondences between single graphemes and single phonemes, especially vowels" (p. 387).

Peterson and Haines (1992) investigated the effects of teaching onset-rime strategy to kindergarten children who were, on the average, reading at a beginning first-grade level. Children in this study were tested, before and after training, on their ability to segment spoken words into onsets and rimes, as well as on their letter-sound knowledge. These investigators found that analogy training did improve subjects' ability to read words by analogy. However, improvement was significant only for the groups of subjects whose scores on the segmentation task were high prior to training. Subjects whose scores on the segmentation tasks were low prior to training made significant improvement on the segmentation and letter-sound tasks. However, they did not show significant improvement on the task designed to measure their ability to read words by analogy.

These studies suggest that an analogic strategy does not necessarily develop at the earliest stages of beginning to read, even when readers show no sign of reading disability. This is consistent with the findings of Ehri and Robbins (1992).

Training poor readers in analogic strategies. It may be possible to improve the nonword reading of poor readers by providing appropriate instruction. Baron (1979) provided analogy training to a group of learning disabled students (9 to 11 years old) as well as to two groups of nondisabled students (first and second graders). The disabled and older nondisabled groups both showed significant improvement on the nonword reading task following training. Examination of the nonword reading scores of these groups shows that the posttreatment mean for the disabled students was approximately the same as the pretreatment mean for the normally developing second graders.

Gaskins, Downer, Anderson, Cunningham, Gaskins, Schommer, and the Teachers of the Benchmark School (1988) developed a program designed to improve the word recognition skills of elementary school poor readers. This program stressed the use of analogic strategies, development of an understanding of the structural components of words, and improvement of automaticity in decoding. The underlying rational for this program is suggested by the authors' recognition that, "Based on words previously learned, children who are good readers tend to generalize in a flexible manner their knowledge of vowel-consonant patterns and other structural components of words to new words in which these parts are encountered" (p. 37).

The program included a variety of components designed to increase the reader's phonological awareness, knowledge of orthographic structure, and ability to apply knowledge of patterns and consistencies in known words to the decoding of unknown words. Two particularly interesting features of the program are that: 1) It taught children to build their store of recognized words by using sets of key words to generate other one-syllable words, as well as the syllables of multisyllable words that are members of the same rime family, and 2) It employed spelling/writing tasks designed to develop awareness and retention of phonological and orthographic relationships by having children learn to sort and then encode words based on initial consonant clusters as well as rime patterns.

The program was implemented in daily, supplementary lessons (of 15 to 20 minutes). Approximately 275 disabled readers, ranging from beginning readers to those at sixth-grade reading levels, participated in the program over a four year period.

Gaskins et al. (1988) found that students showed significant improvement on a nonword reading test, as well as on a transfer test of words not taught in the program, after one year of program participation. The authors state that the nonwords were "pronounceable and close to English words," which suggests that many of them were rime-analogous to words that the students learned. Scores on a number of standardized (and more general) reading tests did not show significant improvement over the one year period. However, the authors note that the amount of improvement on these tests was related to the degree of program implementation.

Several studies offer further evidence of the effects of instruction on poor readers' nonword reading. These studies employed treatment conditions that were not specifically identified as training in making analogies. However, the treatment conditions did use phonic/linguistic (i.e., code-emphasis) approaches to instruction, in which the relationship between words in rime families was emphasized, and phoneme-grapheme correspondence, as well as sound blending, were taught. Thus, they encouraged the student to make use of analogic strategies.

Lovett, Ransby, Hardwick, Johns, and Donaldson (1989) compared the effects of experimental programs that used 1) a code-emphasis approach to reading words in isolation, and 2) a structured language-development approach. The students in this study were all identified as learning disabled. While the code-emphasis group demonstrated superiority on some measures of words recognition, the groups did not differ on a measure of non-word reading. However, although the treatment programs in this study were intensive, they lasted for only ten weeks.

Researchers at the Bowman Gray School of Medicine (Brown & Felton, 1990; Felton, 1993) compared the effects of code-emphasis and context-emphasis programs. The students in these studies were identified as being at high-risk for reading failure in kindergarten and exhibited phonological processing problems characteristic of reading disability. Treatment was part of these students' regular classroom reading instruction and continued for their first and second-grade years. Results indicated significant differences, favoring the code-emphasis group, on DST Subtest 2 nonwords at the end of two years. Brown and Felton also found that considerably higher percentages of students in the code-emphasis group scored above .70 on the DST Phonic Transfer Indices. (A PTI of .70 indicates that 70% of the nonwords were read correctly, given that the analogous real words were correct.)

Several other studies are relevant to questions regarding the effects of teaching analogic strategies to reading disabled students. Transfer tasks in these studies included real words but not nonwords. Investigators in these studies measured transfer in terms of the improvement in reading words that were not taught during treatment.

Lovett, Warren-Chaplin, Ransby, and Borden (1990) compared a whole-word group that was taught orthographically regular words, with a group that was taught constituent grapheme-phoneme correspondences. Students in this study were identified as reading disabled. Treatment, as in the Lovett et al. (1989) study, was intensive but of relatively short duration. Lovett et al. (1990) found significant improvement in word recognition and spelling for both groups. However, they did not find significant improvement on a word-recognition transfer task, in which items were constructed so as to share rime-analogies with words that had been taught in the treatment programs. Furthermore, the two experimental groups did not differ on most of the posttreatment measures of word recognition and spelling. Goswami (1991), in commenting on this study, notes that it provides "some evidence that dyslexic children do not make connections between the spelling patterns representing shared rimes in words" (p. 120).

Van Daal, Reitsma, and van der Leij (1994) conducted a series of experiments to determine if reading disabled students could be taught to improve their ability to use shared letter clusters in decoding. Subjects in this study were 9 year-old Dutch children who were reading about 1.5 years below age expectations. Training involved practicing word lists and was of short duration. The transfer tasks in these experiments included real (Dutch) words that shared letter clusters with words used in the training tasks. These investigators found that subjects were able to generalize orthographic patterns in practiced words to the decoding of unpracticed words. However, they did not find that grouping words for practice according to spelling patterns (as opposed to presenting them randomly) affected results, nor did they find that onset-rime segmentation cues (e.g., pronouncing c-at) were more effective than post-vowel segmentation cues (e.g., pronouncing ca-t) in reducing error rates on the unpracticed words. However, van Daal et al. caution against over-generalizing their findings because this study was conducted in Dutch. They concluded that the importance of onset-rime subunits may be language specific.

Questions to be Addressed

Based on the results of the studies discussed above, it is unclear whether or not poor readers are specifically impaired in their ability to use analogic strategies in decoding unknown words. If these strategies are qualitatively different from other phonological decoding strategies (Treiman, 1992), if they are, in fact, easier to use and precede the development of other phonological strategies (Goswami & Bryant, 1992), we might expect poor readers to develop analogic strategies that are at least commensurate with their word recognition levels. If the preceding is the case, even given a specific phonological deficit, this deficit might not extend to the use of analogic strategies, because the use of such strategies would serve to reduce the load on phonological processes.

However, if reading words by analogy actually represents the most sophisticated form of cipher reading, we would not expect this to be the case. If, as Ehri (1992) contends, all readers use phonological information in reading, but poor readers do so less well than good readers, we might expect poor readers to be able to make some use of analogic strategies to decode simple nonwords that are analogous to well-recognized real words. However, when the nonwords are more complex, poor readers may revert to a phonetic-cue strategy because they are unable to make use of the more complete, higher order relationships demanded in cipher reading.

Furthermore, the point at which analogic strategies are most important, along the continuum of word recognition levels, is not clear. If normally developing readers at low reading levels do not use analogic strategies, one might not find differences in the use of analogic strategies between (younger) normal readers and (older) poor readers at low reading levels but find them at higher reading levels. On the other hand, if analogic strategies develop at low levels in normal readers but at higher levels in poor readers (i.e., the poor readers "catch up"), we might find specific differences at low levels of word recognition, but not at higher levels. If analogic strategies are important at virtually all levels, we would expect to find differences across the continuum of word recognition levels.

Finally, the effects of instruction on poor readers' ability to use analogic strategies have not yet been clarified. The results of the study by Manis et al. (1993) suggest that poor readers do not "catch up" to normally developing readers in their ability to read nonwords. However, the tasks used in this study were not specifically measures of analogous nonword reading, and the type of remedial instruction provided during the interval between test points was not specified. If poor readers can be taught to develop a decoding strategy that is based on rime analogy, and if they can develop this strategy to a degree that is commensurate with their word recognition levels, their progress in learning how to read should accelerate.

Therefore, this study addressed the following questions: 1) Do normal and poor decoders, who are reading at the same levels of word recognition, make equal use of rime-analogy in decoding nonwords? 2) Do normal and poor decoders make equal use of rime analogy at some levels of word recognition (e.g., low levels) but not at others (e.g., high levels)? 3) Do normal and poor decoders make equal use of rime analogy when decoding monosyllabic nonwords but not when decoding polysyllabic nonwords? Finally, 4) Do poor decoders who have received code-emphasis, remedial treatment for one and/or two years use rime-analogy to the same degree that normal decoders use it?

Word recognition level, obtained from Subtest 1 of the Decoding Skills Test (DST) (Richardson & DiBenedetto, 1985) was the independent measure in analyses. The Phonic Transfer Index (PTI) obtained from Subtest 2 of the DST, was used as the dependent measure of analogous nonword reading. Separate PTIs were obtained for monosyllabic and polysyllabic items. The scores of normal and poor decoders at the same specific levels of word recognition (ranging from late first grade to late fifth grade) were compared. Analyses addressing the remedial treatment question were identical to those described in items one through three, above, except that they employed independent and dependent measures obtained from poor decoders after one and two years of remedial treatment.

Chapter 3

METHOD

Subjects

Students involved in this study were referred to a large-scale remedial intervention program, the Specific Reading Difficulties Program (SRD), in four Texas school districts (Clint, El Paso, Soccoro, and Ysleta), between 1992 and 1994. A total of 85 schools referred students to this program. The SRD program is designed to meet the instructional needs of students in grades one through ten who are having difficulty learning how to read, specifically when the difficulty is manifested in depressed levels of word recognition.

Students having reading difficulties were referred for evaluation of their qualifications for the SRD program by school personnel. Students were referred in the spring and fall of each year. Information was collected on each student's reading level, reading-related skills, and past history of reading problems. Standardized tests scores were also obtained if they were available. After a referral was made, parental consent for testing was requested. If consent was obtained, the student was given the Decoding Skills Test (DST) (Richardson & DiBenedetto, 1985) to determine whether or not the problem could be traced to a fundamental difficulty in word recognition. (The DST is described in more detail in the Materials and Procedures section.) Extra weight was given to word-recognition scores, and students who obtained scores that were below age/grade expectations were strongly recommended for program placement. A majority of the referred students manifested problems in reading. However, many did not. Furthermore, a fairly large number of referred students did not manifest problems in the area of word recognition (i.e., decoding), and these students were not considered appropriate for the SRD program. A school-based committee reviewed the referral and test information and made the final decision as to whether or not a student qualified for the program.

If a student qualified, parental consent was requested for program placement and, if this was obtained, the student was placed in the SRD program. The primary instructional component of this program consisted of the Linguistic Pattern Series (LPS) (Richardson & DiBenedetto, 1989). (The LPS is described in more detail in the Materials and Procedures section.) Participating students received daily, small-group instruction for periods of 30 to 45 minutes. Most SRD classes were held at the end of the school day. However, about one third of the classes met during school hours in periods designated for special activities. Most SRD teachers were classroom teachers in the various schools who volunteered for SRD training. Others were Special Education teachers, Chapter 1 teachers, or reading specialists. All SRD teachers received one full day of training in program techniques, and SRD classes were monitored at various points during the school year to insure that the program was being implemented. Students who participated in the program had high rates of attendance. This was the case because, due to limited program space, students who did not attend regularly were dropped from the program. Reasons for non-attendance generally fell into two categories: lack of transportation or conflicting extra-curricular activities. Because the causes of non-attendance were unrelated to reading problems, it is unlikely that the loss of these students affected study outcomes.

Students who remained in the program for at least one year were retested on the DST at the end of the school year. The school-based committee evaluated each student's progress and decided whether or not the student should continue in the program. Students whose DST scores indicated that their word recognition and decoding skills were consistent with that which would be expected of normal readers were recommended for dismissal from the program. A large percentage of students who were placed in the program remained in it for at least two years.

Table 1 shows the number of students who were referred to the program during the referral periods from fall 1992 to fall 1994. All students represented in the table as Referred received the DST at the time of referral. After referral information was entered

Table 1

Referral and Enrollment Status of Students in SRD Program from Fall 1992 through Fall 1994.

	Referral Period			
Status	Fall 1992	Spring and Fall 1993	Spring and Fall 1994	Total
Referred	2,651	3,189	2,821	8,661
Reported[a]	2,639	3,077	2,037	7,753
Qualified[b]	2,082	2,697	1,767	6,546
Enrolled for at least one year[c]	1,386	1,753	--	3,139
Enrolled for two years[d]	1,033	--	--	1,033

[a]All subjects who were Reported were also Referred.

[b]All subjects who were Qualified were also Reported.

[c]All subjects who were Enrolled for one year were also Qualified.

[d]All subjects who were Enrolled for two years were also Enrolled for one year.

into the SRD data file and summarized for each school, the schools were expected to make final decisions as to whether or not students qualified for the SRD program and report this information for entry in the SRD data file. However, schools did not report these qualifying decisions for every student who they referred. Furthermore, at the time that subjects were selected for the present study, SRD program qualification decisions for many students who were referred during the spring and fall of 1994 had not yet been reported. The number of students shown as Reported in Table 1 are those whose status with respect to program qualification were reported by the schools. As can be seen in the table, qualification status was known for almost all students who were referred to the program prior to spring 1994. (Those with unknown status from these referral periods did not receive SRD instruction, regardless of whether or not they qualified for the program.) However, the qualification status of 784 students referred in 1994 was not known because the schools had not reported this information (as of December 1994). The table also shows the number of students who were reported as qualified for the program, the number who were enrolled in the program (and received instruction) for at least one year, and, of those, the number who were enrolled in the program (and received instruction) for two years. Students shown as enrolled for one year were referred in the fall of 1992 and the spring or fall of 1993. Those shown as enrolled for two years were all referred in the fall of 1992.

In preparation for subject selection, an expected word recognition level was calculated for each student who was referred to the SRD program. This will be referred to as the Expected Instruction Level (EIL) : A student who was initially tested during a fall referral period was assigned an EIL that was his/her grade at the time of testing plus .3 (i.e., the third month of the school year). A student who was tested during a spring referral period was assigned an EIL that was his/her grade level plus .8 (i.e., the eighth month of the school year).

However, because of the high hold-over rate in this group (i.e., many students had repeated one or more grades), a combination of actual grade and age grade (i.e., the grade expected based on the student's birth date) was used to calculate the EIL when there was a discrepancy between actual grade and age grade. When there was a one year discrepancy between actual grade and a higher age grade, actual grade was used to calculate the EIL. When there was a two year discrepancy, actual grade plus one was used to calculate the EIL. (A few students, with discrepancies of more than two years, were eliminated from the selection process.)

All referred students received Subtests 1 and 2 of the DST. Subtest 1 of the DST yields an Instructional Level Grade Equivalent score that was used to measure each student's word recognition level. This will be referred to as the Instructional Level (IL) score. A positive discrepancy between the student's Expected Instructional Level and the Instructional Level score (i.e., EIL minus IL) indicates a deficit in word recognition. A zero or negative discrepancy indicates that the student's word recognition level, as measured by the DST Instructional Level, was on or above the expected level. A student was initially identified as a poor decoder if the Instructional Level score at the time of referral was at least one year below the Expected Instructional Level. These students are represented, categorized by their Instructional Level scores, in the second column (Poor) in Table 2.[3] A student initially qualified for inclusion in the normal decoder group if the student: 1) did not qualify (or was not reported as qualified) for the SRD program, and 2)

[3]Students who obtained Instructional Level scores below 1.8 at the time of referral are represented in Table 2 despite the fact that these students were not candidates for inclusion in the untreated poor decoder group. Many students who obtained very low Subtest 1 Instructional Levels also obtained scores close to zero on the primary dependent measures (i.e., the Phonic Transfer Indices) used in this study and data obtained from students at these levels were not used in analyses. However, many students who obtained very low Instructional Level scores at the time of referral were candidates for inclusion in the treated poor decoder groups, provided that they remained in the SRD program for at least one year and obtained Instructional Level scores above 1.5 at post-treatment test points. It is for this reason that poor decoders with Instructional Levels below 1.8 are represented in Table 2.

Table 2

Number of Subjects Initially Selected as Normal and Poor Decoders and Number in the Four Study Groups, at each Instructional Level (IL)

	Initial selection		Study group[a]			
				Poor decoder group		
IL	Normal	Poor	Normal	Untreated	1-year treated	2-year treated
<1.8		1,113				
1.8	60	435	47	130	89	24
2.3	161	483	109	161	134	33
2.8	104	755	74	135	149	40
3.3	86	302	42	112	57	30
3.8	82	149	55	72	50	29
4.3	119	143	102	109	56	25
4.8	150	141	111	105	119	49
5.3	144	147	115	113	82	33
≥5.8	209	61	207	60	73	40
Total	1,111	2,616[b]	862	997	812	303

[a]Includes subjects who qualified for the study because their DST Subtest 1 word recognition (i.e., raw) scores meet range restriction criteria

[b]Number of subjects with Instructional Level ≥1.8

obtained a zero or negative discrepancy between EIL and the IL score obtained at the time of referral. That is, the student's Subtest 1 Instructional Level score had to be on or above the level expected based on the student's age and grade. These students are represented in the first column (Normal) of Table 2. Students categorized at IL≥5.8 are those whose scores were at the ceiling of Subtest 1.

Because the study design required the selection of subjects reading at specific, grade-based levels of word recognition, further criteria for subject selection were necessary. The students shown in the first two columns of Table 2 were classified in terms of their Subtest 1 Instructional Level (IL) scores. However, there was considerable variability, in the actual number of Subtest 1 words read correctly (i.e., the raw score), among subjects at each Instructional Level. This is because DST administration, like that of many individually administered tests that cover a wide range of achievement levels, requires establishing "basal" and "ceiling" levels for each examinee: Different examinees read different items as well as different numbers of items. Some examinees are able to read only a few words on the list immediately following their basal level list and therefore establish a ceiling level on that list. Others continue to read more than half of the words on several lists following the basal level list before establishing a ceiling level. Therefore, two students may obtain the same Subtest 1 Instructional Level, but also obtain Subtest 1 raw scores that differ by 20 points or more. For example, a student may establish a basal level on List Four (IL=2.3), establish ceiling on List Seven, and obtain a raw score of 58. Another student may likewise establish basal on List Four (IL=2.3), but establish ceiling on List Five, and obtain a raw score of 38. In the present study, students whose Subtest 1 raw scores were extremely different could not be viewed as having truly equivalent levels of word recognition, despite the fact that their Subtest 1 Instructional Levels were the same.

Therefore, range restrictions were imposed on Subtest 1 raw scores for each Instructional Level (IL) to further insure that subjects selected at each IL were reading at approximately the same level of word recognition and that subjects selected at different ILs had different word recognition levels. The raw score range restrictions employed in the subject selection process, for each Instructional level score, are shown in Table 3. Students who were initially identified as poor and normal decoders were selected for inclusion in a study group if their Subtest 1 raw scores fell within the specified ranges for a particular Instructional Level. As may be observed in Table 3, a 15 point range was employed for Instructional Levels ranging from 1.8 to 4.3, a 10 point range was employed at the 4.8 Instructional Level, an 8 point range at the 5.3 Instructional Level, and an 11 point range at the ≥5.8 Instructional Level.[4]

In order to rule out the possibility that limiting subjects to those whose scores fell within these ranges biased the outcome of analyses, a larger subject set involving the normal and poor decoders represented in the first two columns of Table 2 was also created. This set included subjects who met the range restriction criteria as well as those who did not. All students who were originally classified as poor and normal decoders who obtained Instructional Level scores of at least 1.8 and raw scores of at least 32 were included in this data set. Subjects were sorted into word-recognition level groups based only on their Subtest 1 raw scores (i.e., regardless of the Instructional Level score obtained). The analyses involving this larger data set are described briefly in the Results section.

Untreated poor decoder group. A student was selected for inclusion in this group if the student met the following criteria. At the time of referral, the student must have: 1) been designated a poor decoder based on the Subtest 1 Instructional Level (IL) score, 2) obtained an Instructional Level score of at least 1.8, and 3) obtained a Subtest 1 raw score

[4]Different ranges were used because of the groupings of subjects' raw scores at the various ILs. Subjects with ILs ranging from 1.8 to 4.3 obtained a wider range of raw scores than did subjects at the higher ILs. Ranges were constructed to maximize subject inclusion at the different ILs.

Table 3

Subtest 1 Raw Score Range Restrictions at Each Instructional Level Used in Subject Selection

Instructional Level	Subtest 1 raw score range
1.8	32-47
2.3	42-57
2.8	52-67
3.3	62-77
3.8	72-87
4.3	82-97
4.8	92-102
5.3	97-105
≥5.8	100-110

that met the range restriction criterion shown in Table 3. The students selected for inclusion in the untreated poor decoder group are listed in the fourth column of Table 2, categorized by the Instructional Level scores obtained at the time of referral.[5]

It is apparent from Table 2 that only 38% of the students whose Instructional Level scores met the original deficit criterion were actually selected for the untreated poor decoder group after the range restriction criteria were imposed. This is probably due to the fact that poor decoders frequently recognize words that are taught at a wide range of (actual) instructional levels. For example, a fourth grade poor decoder with an Instructional Level score of 2.3 may recognize a few words at each instructional level between the early second-grade level (i.e., the 2.3 Instructional Level) and the late fourth-grade level (i.e., the 4.8 Instructional Level) but not recognize enough words to read fluently at those levels.

<u>One-year treated poor decoder group.</u> A student was selected for inclusion in this group if the student met the following criteria. The student must have: 1) been designated as a poor decoder at the time of referral, 2) received at least one year of SRD program instruction, 3) obtained a Subtest 1 Instructional Level score, after one year of treatment, of at least 1.8, and 4) obtained a Subtest 1 raw score, after one year of treatment, that met the range restriction criterion specified in Table 3. The students selected for inclusion in the one-year treated poor group are represented in the fifth column of Table 2, categorized by their Instructional Level scores obtained after one year of treatment.

<u>Two-year treated poor decoder group.</u> A student was selected for inclusion in this group if the student met the following criteria. The student must have: 1) been designat-

[5] One additional student was dropped from the baseline group because of the possibility that DST Subtest 2 was administered improperly to this student. Any case in which the examinee obtained a Real Word (Monosyllabic or Polysyllabic) score of 20 or more, but a corresponding Nonsense Word score of 0 was eliminated from the subject selection process. This score pattern suggests that the tester failed to administer the Nonsense Word section of Subtest 2, thus making the dependent measure invalid for that particular examinee. An additional 9 candidates for the one-year group and 1 candidate for the normal decoder group were dropped for the same reason.

ed as a poor decoder at the time of referral, 2) received two years of SRD program instruction, 3) obtained a Subtest 1 Instructional Level score, after two years of treatment, of at least 1.8, and 4) obtained a Subtest 1 raw score, after two years of treatment, that met the range restriction criterion specified in Table 3. The students selected for inclusion in the two-year treated poor decoder group are represented in the sixth column of Table 2, categorized by their Instructional Level scores obtained after two years of treatment.

Subject overlap in the poor decoder groups. As is apparent from the subject selection procedures described above, there was subject overlap between the three poor decoder groups: 1) 396 subjects appeared in both the untreated and one-year treated groups, 2) 118 subjects appeared in both the untreated and two-year treated groups, 3) 144 subjects appeared in both the one-year and two-year treated groups, and 4) 78 subjects appeared in all three poor decoder groups.

Normal decoder group. As was mentioned previously, a substantial number of students referred to the SRD program did not exhibit deficits in terms of their word recognition levels. As can be deduced from Table 1, 1,207 students who were referred to the program between the fall of 1992 and the fall of 1994 did not qualify for treatment (i.e., Total Reported minus Qualified) and most of these students were considered for inclusion in the normal decoder group (see Table 2, column 1). Students who obtained Instructional Level scores below 1.8 were not considered for inclusion in the normal decoder group because the scores of students at these Instructional Levels were not used in analyses.

Final selection for the normal decoder group was based on the raw score restriction criteria shown in Table 3. Subjects whose Subtest 1 scores met these criteria are represented in the third column of Table 2, categorized by Instructional Level. As can be deduced from the table, approximately 78% of the students who met the initial normal decoder criteria were selected for inclusion in the normal decoder group.

Table 4 shows the number of subjects in each group included in the present study, categorized by actual grade at the time of referral. As can be seen in the table, normal decoders were in grades one through six when they were referred. Those in the untreated poor decoder group were in grades two through ten at the time of referral. Students in the one-year treated poor decoder group were in grades two through eight at the time of referral. Those in the two-year group were in grades one through seven at the time of referral.

Equivalence of groups. As was mentioned previously, the word recognition levels of subjects in the normal and poor decoder groups should be equivalent so that comparisons between the groups on the Phonic Transfer Index (PTI) can be interpreted. Furthermore, the word recognition levels of subjects at successive Instructional Levels should be different, so that comparisons between subjects across the various Instructional Levels on the Phonic Transfer Index can be interpreted. The classification of subjects in terms of their Instructional Level (IL) scores, in combination with the imposition of the raw score range criteria, were intended to insure that these conditions would be met. However, the mean Subtest 1 raw scores of normal and poor decoders at the various Instructional Levels were examined to determine if these conditions were, in fact, met.

Means scores of all groups on the DST Subtest 1 raw score (i.e., the number of words read correctly), at each Instructional Level, are presented in Table 5. The means of the normal group were compared to those of each of the three poor decoder groups in three factorial Analyses of Variance (ANOVA), each having two levels of the Group factor (normal and poor decoders) and nine levels of the Instructional Level (IL) factor (1.8 to $\geq$5.8). When the ANOVA yielded a significant Group by IL interaction effect, post hoc t-tests, comparing the groups at individual Instructional Levels, were performed.

The analysis comparing the Subtest 1 raw scores means of the normal and untreated

Table 4

Number of Subjects in Each Group, by Grade at Time of Referral

	Group			
Grade	Normal	Untreated poor	1-year treated poor	2-year treated poor
1	62	--	--	4
2	191	35	127	49
3	219	213	239	87
4	216	229	196	76
5	131	200	118	46
6	43	163	95	33
7	--	80	19	8
8	--	75	18	--
9	--	1	--	--
10	--	1	--	--
Total	862	997	812	303

Table 5

Mean Number of Subtest 1 Words Read Correctly by Normal and Poor Decoder Groups, at Each Instructional Level (IL)

		Group			
IL		Normal	Untreated poor	1-year treated poor	2-year treated poor
1.8	M	37.17	39.63	38.99	40.54
	SD	5.40	4.43	4.30	5.12
2.3	M	48.33	48.96	48.79	48.67
	SD	4.87	4.03	3.70	3.82
2.8	M	58.69	58.96	58.02	58.02
	SD	6.43	5.17	4.80	4.50
3.3	M	70.33	70.19	70.12	71.60
	SD	5.40	4.44	4.62	5.80
3.8	M	81.05	81.04	80.52	79.76
	SD	4.30	4.30	4.40	5.29
4.3	M	90.17	91.30	89.59	92.00
	SD	4.88	4.35	4.11	5.05
4.8	M	97.50	97.69	97.67	98.35
	SD	2.84	2.90	3.07	3.32
5.3	M	101.89	102.98	101.98	102.67
	SD	2.46	2.29	2.40	2.51
≥5.8	M	107.86	108.50	107.64	108.65
	SD	2.20	1.81	1.74	2.83

poor decoder groups revealed a significant Group effect ($F=9.55$, $df=1, 1841$, $p<.01$) as well as a significant Instruction Level (IL) effect ($F=7812.66$, $df=8, 1841$, $p<.001$). The Group by IL interaction term was not significant.

The significant Group effect indicates that the untreated poor decoders recognized more Subtest 1 words than did the normal decoders. However, this difference should not affect comparisons on the dependent Phonic Transfer Index (PTI) if these comparisons indicate that the PTI scores of the normal decoders are higher than those of the untreated poor decoders. That is, if analyses indicate that the PTI scores of the the normal decoders were higher than those of the untreated poor decoders, this will not be the result of an inequality in word recognition levels that favors the normal decoders, because the normal decoders' word recognition scores were lower than those of the untreated poor decoders. Furthermore, as may be seen in Table 5, the means of the normal and untreated poor decoder groups differed by 1 or more points only at three of the nine Instructional Levels. Means differed by more than 2 points only at the 1.8 Instructional Level.

The significant Instructional Level effect indicates that the word recognition levels of subjects differed across the Instructional Levels. As Table 5 shows, differences between mean performances at successive Instructional Levels were quite large and the mean values increased as Instructional Level increased.

The analysis comparing the Subtest 1 raw score means of the normal and one-year treated poor decoder groups did not yield significant Group or Group by IL interaction effects. The Instructional Level (IL) effect was significant ($F=7512.81$, $df=8, 1656$, $p<.001$), indicating that mean performances differed at successive Instructional Levels.

The comparison of the Subtest 1 raw score means of the normal and two-year treated poor decoders yielded significant Group ($F=6.50$, $df=1, 1147$, $p<.05$), Instructional Level (IL) ($F=4715.47$, $df=8, 1147$, $p<.001$), and Group by IL ($F=2.02$, $df=8, 1147$, $p<.05$) effects. Post hoc t-tests revealed that the the two-year treated poor decoder group obtained a significantly higher mean score than that of the normal decoder group at the 1.8 Instructional Level ($p<.05$), but not at other Instructional Levels.

These analyses indicate that the normal decoder group and two of the three poor decoder groups differed significantly in terms of their word recognition levels as measured by the number of words read correctly on Subtest 1 (i.e., the raw score). However, differences between the normal and poor decoders at most individual Instruction Levels were extremely small, and where differences were significant, the raw scores of the poor decoder groups were higher than those of the normal decoder group. The somewhat larger differences between the normal decoders and both the untreated and two-year treated poor decoders, at the 1.8 Instruction Level, suggest that comparisons on the measures of analogous nonword reading that involve subjects at this Instructional Level may be difficult to interpret. The consistent finding of an Instructional Level effect offers further evidence that the word recognition levels of subjects were higher at successive Instructional Levels.

Materials and Procedures

The Decoding Skills Test (DST) (Richardson & DiBenedetto, 1985) is an individually administered test that was developed under a project grant from the National Institute of Child Health and Human Development. The objective of the project was to produce an instrument that could be used in research on developmental dyslexia. The DST has three subtests, Basal Vocabulary (Subtest 1), Phonic Patterns (Subtest 2), and Contextual Decoding (Subtest 3). Only Subtests 1 and 2 were administered to students referred to the SRD program. An analysis of test characteristics (Richardson, 1985) indicates that these subtests demonstrate high degrees of internal consistency, test-retest stability, and appropriate patterns of convergent validity. The construction of the DST is described in more detail by Richardson et al. (1982).

Subtest 1 of the DST is a test of the examinee's ability to read words commonly taught in basal reading programs. The subtest consists of 11 graded word lists, each of which contains 10 items (see Figure 1). Words were selected for this subtest by cross-

DST Brief Form Scoring Sheet

Student's Name ____________ School ____________ Grade ___ Room ______

Student's ID ____________ Tester ____________ Test Date ____________ Track ____________

Subtest I: Basal Vocabulary

List #1 (1.2)	List #2 (1.5)	List #3 (1.8)	List #4 (2.3)
to □√ □x	so □√ □x	sing □√ □x	shop □√ □x
yes □√ □x	was □√ □x	when □√ □x	fine □√ □x
the □√ □x	went □√ □x	next □√ □x	end □√ □x
up □√ □x	let □√ □x	thing □√ □x	part □√ □x
a □√ □x	box □√ □x	I'll □√ □x	dear □√ □x
in □√ □x	she □√ □x	now □√ □x	dry □√ □x
at □√ □x	no □√ □x	other □√ □x	wood □√ □x
it □√ □x	am □√ □x	best □√ □x	better □√ □x
is □√ □x	help □√ □x	new □√ □x	begin □√ □x
I □√ □x	jump □√ □x	long □√ □x	start □√ □x
List Total _____	List Total _____	List Total _____	List Total _____

List #5 (2.8)	List #6 (3.3)	List #7 (3.8)	List #8 (4.3)
strong □√ □x	famous □√ □x	natural □√ □x	stalk □√ □x
able □√ □x	daughter □√ □x	mutter □√ □x	project □√ □x
almost □√ □x	crowd □√ □x	coin □√ □x	stern □√ □x
angry □√ □x	indeed □√ □x	prove □√ □x	shallow □√ □x
star □√ □x	field □√ □x	bounce □√ □x	pace □√ □x
space □√ □x	finally □√ □x	pleasant □√ □x	area □√ □x
else □√ □x	sneeze □√ □x	arrive □√ □x	custom □√ □x
knew □√ □x	earn □√ □x	shelter □√ □x	bush □√ □x
short □√ □x	problem □√ □x	square □√ □x	detective □√ □x
banana □√ □x	worry □√ □x	protect □√ □x	design □√ □x
List Total _____	List Total _____	List Total _____	List Total _____

List #9 (4.8)	List #10 (5.3)	List #11 (5.8)
instruction □√ □x	frequent □√ □x	continent □√ □x
contact □√ □x	purchase □√ □x	trudge □√ □x
glare □√ □x	advertise □√ □x	desperate □√ □x
furnish □√ □x	quality □√ □x	awkward □√ □x
justice □√ □x	terrify □√ □x	distress □√ □x
extend □√ □x	vast □√ □x	cautious □√ □x
resolve □√ □x	emergency □√ □x	doubt □√ □x
stride □√ □x	ridge □√ □x	solemn □√ □x
dignity □√ □x	reckon □√ □x	prairie □√ □x
abandon □√ □x	confident □√ □x	swollen □√ □x
List Total _____	List Total _____	List Total _____

Subtest I Scores

Total Score ________

Basal List ______

ILGE _____

Ceiling List ______

FLGE _____

Figure 1. The scoring sheet for DST Subtest 1 (Richardson & DiBenedetto, 1985).

tabulating the word lists of a variety of basal reading programs to find the most commonly taught words at particular basal reader levels. Each Subtest 1 list represents the vocabulary introduced at a particular reader level, beginning with the earliest first-grade level (preprimer) and ending with the highest fifth-grade level (five-two).[6]

Subtest 1 is administered using a sampling procedure so that the examinee is asked to read items within a zone of proximal development, beginning with the first list on which an examinee demonstrates mild difficulty and ending with the first list on which he/she demonstrates extreme difficulty. The examinee is asked to read all items on lists between these two.[7] The tester begins administration by explaining that the examinee is about to read some lists of words aloud and that the words will be easy to read at first but that they will get harder. The tester tells the examinee, "It is okay if you do not know all the words, but try to do the best you can." The tester then shows the examinee the Subtest 1 presentation card and points to each item as the examinee reads it. The tester allows up to 5 seconds for a response and counts items that are self-corrected immediately as correct. The tester provides no feedback on responses other than to tell the examinee, "You're doing fine."

A raw score and an Instructional Level (IL) score are obtained from Subtest 1. (The

[6]Most basal programs, including those surveyed, organize their readers into three first-grade levels (preprimer, primer and first-reader) and two levels for each grade, from second through fifth (e.g., two-one, two-two; three-one, etc.). Most basal programs also specify the words introduced at each level by listing them at the back of each reader. Items were originally selected for DST Subtest 1 by cross-tabulating words from the lists of 10 basal programs, and then using the Harris and Jacobson (1972) word lists for reader-level confirmation. Item difficulty and discrimination indices were then calculated for these items and final item selection included within-list items of approximately equal difficulty and between-list items showing monotonic increases in difficulty.

[7]The tester begins sampling by asking the examinee to read the first 3 words on each list until the examinee reads a word incorrectly. The tester then administers the remaining 7 words in the list immediately preceding the one on which the error(s) occurred. If the examinee does not read at least 8 of the 10 words on this list correctly, the tester moves back to the list that precedes this list. The tester continues to move back through lists until the examinee reaches a list on which he/she reads at least 8 of the 10 words correctly or has read all of the words in List One. After the "80% correct" list has been established, the tester moves the examinee forward through lists (administering all remaining items) until the examinee reaches a list on which he/she reads fewer than 5 words correctly.

raw score is calculated under the assumption that unattempted items below the first list administered are correct and those above the last list administered are incorrect.) The Instructional Level is defined as the reader level (represented by its corresponding DST list) beyond which the examinee reads fewer than 8 of the 10 words on a list correctly. For example, if the examinee reads 10 words correctly on Lists One, Two, and Three, 9 words correctly on List Four and 6 words correctly on List Five, the Instructional Level score is two-one (2-1) because this is the reader level that corresponds to List Four. The Instructional Level score may be viewed as a measure of word recognition because it estimates the highest reader level at which most of the words will be recognized by the examinee. Instructional Level scores may be expressed as grade equivalents ranging from 1.0 to ≥5.8. There are 12 possible Instructional Level scores: 4 at the first grade level (1.0, 1.2, 1.5, and 1.8) and 2 at each grade level after that (e.g., 2.3, 2.8, 3.3, 3.8, etc.). An IL score of 1.0 indicates that the examinee is a virtual nonreader (i.e., less than 8 words were correct on List One). An Instructional Level score of ≥5.8 indicates that the examinee has mastered the words taught at all reader levels up through five-two (i.e., at least 80% of the words were correct on all lists).

Subtest 2 of the DST is designed to measure the examinee's ability to use the letter-sound information conveyed by a variety of orthographic patterns to decode words and nonwords in isolation. The subtest consists of 120 items arranged in lists of 5 items each (see Figure 2). Each list represents an orthographic pattern. For example, in List One, all items are CVC trigrams that follow the short-vowel pronunciation pattern (e.g., hit, fed). Items in List Two follow the same pattern, but include consonant blends and digraphs (e.g., shut, path). Items in List Three follow the long-vowel, silent final-E pattern (e.g., hide, fake). Within each list, real-word items are arranged by reader-level designations derived from the Harris and Jacobson (1972) word lists so that the first item in each list is designated as a second-grade word (i.e., is introduced in second-grade reading material) and the fifth item in each list is designated as a sixth-grade word. One half of the items in

Subtest II: Phonic Patterns

List #1		
hit	□ √ □ x	□ PT
jit	□ √ □ x	
fed	□ √ □ x	□ PT
med	□ √ □ x	
nut	□ √ □ x	□ PT
dut	□ √ □ x	
job	□ √ □ x	□ PT
wob	□ √ □ x	
lag	□ √ □ x	□ PT
pag	□ √ □ x	
RW ___ NW ___		PT ___

List #2		
shut	□ √ □ x	□ PT
thut	□ √ □ x	
path	□ √ □ x	□ PT
sath	□ √ □ x	
brick	□ √ □ x	□ PT
glick	□ √ □ x	
flesh	□ √ □ x	□ PT
blesh	□ √ □ x	
prop	□ √ □ x	□ PT
brop	□ √ □ x	
RW ___ NW ___		PT ___

List #3		
hide	□ √ □ x	□ PT
mide	□ √ □ x	
cute	□ √ □ x	□ PT
fute	□ √ □ x	
doze	□ √ □ x	□ PT
voze	□ √ □ x	
fake	□ √ □ x	□ PT
pake	□ √ □ x	
tone	□ √ □ x	□ PT
sone	□ √ □ x	
RW ___ NW ___		PT ___

List #4		
brave	□ √ □ x	□ PT
clave	□ √ □ x	
drove	□ √ □ x	□ PT
chove	□ √ □ x	
flake	□ √ □ x	□ PT
grake	□ √ □ x	
globe	□ √ □ x	□ PT
trobe	□ √ □ x	
crime	□ √ □ x	□ PT
drime	□ √ □ x	
RW ___ NW ___		PT ___

List #5		
loud	□ √ □ x	□ PT
roud	□ √ □ x	
join	□ √ □ x	□ PT
zoin	□ √ □ x	
raw	□ √ □ x	□ PT
taw	□ √ □ x	
loaf	□ √ □ x	□ PT
woaf	□ √ □ x	
bail	□ √ □ x	□ PT
dail	□ √ □ x	
RW ___ NW ___		PT ___

List #6		
threw	□ √ □ x	□ PT
prew	□ √ □ x	
grain	□ √ □ x	□ PT
thrain	□ √ □ x	
choice	□ √ □ x	□ PT
froice	□ √ □ x	
bound	□ √ □ x	□ PT
spound	□ √ □ x	
preach	□ √ □ x	□ PT
fleach	□ √ □ x	
RW ___ NW ___		PT ___

List #7		
visit	□ √ □ x	□ PT
lisit	□ √ □ x	
pencil	□ √ □ x	□ PT
jencil	□ √ □ x	
mitten	□ √ □ x	□ PT
pitten	□ √ □ x	
puppet	□ √ □ x	□ PT
duppet	□ √ □ x	
combat	□ √ □ x	□ PT
zombat	□ √ □ x	
RW ___ NW ___		PT ___

List #8		
finish	□ √ □ x	□ PT
brinish	□ √ □ x	
pumpkin	□ √ □ x	□ PT
thumpkin	□ √ □ x	
publish	□ √ □ x	□ PT
sublish	□ √ □ x	
splendid	□ √ □ x	□ PT
glendid	□ √ □ x	
stiffen	□ √ □ x	□ PT
bliffen	□ √ □ x	
RW ___ NW ___		PT ___

List #9		
beside	□ √ □ x	□ PT
semide	□ √ □ x	
mistake	□ √ □ x	□ PT
fistake	□ √ □ x	
confuse	□ √ □ x	□ PT
monfuse	□ √ □ x	
rotate	□ √ □ x	□ PT
motate	□ √ □ x	
awoke	□ √ □ x	□ PT
aboke	□ √ □ x	
RW ___ NW ___		PT ___

List #10		
telephone	□ √ □ x	□ PT
delephote	□ √ □ x	
grateful	□ √ □ x	□ PT
clateful	□ √ □ x	
provide	□ √ □ x	□ PT
drovide	□ √ □ x	
explode	□ √ □ x	□ PT
excrode	□ √ □ x	
demonstrate	□ √ □ x	□ PT
bemonthrate	□ √ □ x	
RW ___ NW ___		PT ___

List #11		
tower	□ √ □ x	□ PT
zower	□ √ □ x	
rooster	□ √ □ x	□ PT
cooster	□ √ □ x	
sausage	□ √ □ x	□ PT
wausage	□ √ □ x	
avoid	□ √ □ x	□ PT
atoid	□ √ □ x	
announcer	□ √ □ x	□ PT
azzounder	□ √ □ x	
RW ___ NW ___		PT ___

List #12		
flower	□ √ □ x	□ PT
strower	□ √ □ x	
complain	□ √ □ x	□ PT
lomprain	□ √ □ x	
creature	□ √ □ x	□ PT
threature	□ √ □ x	
embroider	□ √ □ x	□ PT
enfroider	□ √ □ x	
trouser	□ √ □ x	□ PT
clouser	□ √ □ x	
RW ___ NW ___		PT ___

Figure 2. The scoring sheet for DST Subtest 2 (Richardson & DiBenedetto, 1985). Items are administered in four sections: Monosyllabic Real Words (Lists 1 through 6), Polysyllabic Real Words (Lists 7 through 12), Monosyllabic Nonwords (Lists 1 through 6), Polysyllabic Nonwords (Lists 7 through 12). Real Word-Nonword pairs are grouped on the scoring sheet so that the Phonic Transfer score (PT) can be calculated easily.

Subtest 2 are monosyllabic and the other half are polysyllabic. Additionally, one half of the items are real words and the other half are nonwords. The nonwords were constructed by changing the onset of each monosyllabic word (e.g., from hide to mide) or by changing the onset of at least one syllable in each polysyllabic word (e.g., from finish to brinish). Thus, Subtest 2 has four sections (Monosyllabic Real Words, Polysyllabic Real Words, Monosyllabic Nonwords, and Polysyllabic Nonwords).

The tester administers items in each section beginning with the first item and ending when the examinee misses 10 consecutive items. The tester begins by showing the examinee the presentation card containing the monosyllabic real words. The tester tells the examinee, "You may not know some of these words, but all of them can be read by paying attention to the sounds that the letters make in the word. If you don't know a word, try to sound it out. Try not to just guess." The tester then points to each item, beginning with the first item in the section, and asks the examinee to read it. The tester provides no specific feedback to responses but tries to encourage the examinee to attend to the task. After the Monosyllabic Real Word section has been completed, the examinee is shown the presentation card for the Polysyllabic Real Word section. The tester explains to the examinee, "These words are longer than the words you just read, but they can also be read by paying attention to the sounds of the letters."

After the real-word sections are administered, the examinee is shown the presentation card for the Monosyllabic Nonword section. The tester tells the examinee, "These are not real words but they look like real words. They are nonsense words. They can be read only by paying attention to the sounds of the letters in the words and sounding them out. Do not try to make them into real words." The examinee is then shown the Monosyllabic Nonword presentation card and asked to read each item, in turn, as the tester points. If the examinee has difficulty with the first nonword (i.e., jit), the tester covers up the letters IT on the presentation card so that only the J is exposed and asks the examinee, "What is the sound of this letter?" The tester then covers the J and asks the examinee for the sound of the IT. The tester then advises the examinee, "Now try to put the sounds together." If the examinee produces the correct response, it is recorded as correct. However, these instructions are provided to the examinee only for the first monosyllabic nonword item. An examinee who produces a real-word response is reminded, "Remember, I told you this is not a real word." This reminder is given only when the examinee is attempting to read the first 5-item block of nonwords and is not usually repeated more than twice. After completing the Monosyllabic Nonword section, the Polysyllabic Nonword section is administered. The examinee is again advised that the items are nonsense words but that they are longer than the nonsense words previously shown to the examinee.

A number of scores may be obtained from Subtest 2, including raw scores for each of the 5-item lists and total scores for each of the four sections. However, the Phonic Transfer (PT) score is of particular interest for the purposes of this study. The PT Score is the number of real-word/nonword pairs that the examinee has read correctly and may be calculated for monosyllabic and polysyllabic items separately. From the PT, a Phonic Transfer Index (PTI) is calculated by dividing the number of real-word/nonword pairs read correctly (i.e., the PT) by the number of real words read correctly. Thus, the PTI is the proportion of nonwords (to real words) read correctly, given that the corresponding real words were correct. It may be viewed as a measure of the degree to which the examinee has made use of real-word knowledge in decoding nonwords that are analogous to the real words by virtue of their common rime-stems.[8] The two Phonic Transfer Indices obtained from Subtest 2 (one for monosyllabic items and one for polysyllabic items) are the dependent measures in this study.

[8]Subtest 2 nonwords are always judged to be read correctly when they are pronounced using rime-stem analogies to their corresponding real words (e.g., pronouncing jit to rhyme with hit). However, other pronunciations of a nonword may be judged as correct, particularly when the rime-stem analogy may be derived from a real word that is not a test item. For example, the nonword sone is counted as correct if it is pronounced to rhyme with done despite the fact that the word tone is the corresponding real word for sone. Similarly, the nonword strower may be pronounced with a long O sound, as in the word low or as a rhyme with the word flower, which is its real-word counterpart.

Remedial Intervention

Students received instruction in the Linguistic Pattern Series (LPS) (Richardson & DiBenedetto, 1989) in small-group settings (from 4 to 8 students per group). The LPS is essentially a code-emphasis approach designed to improve word recognition skills by strengthening the student's ability to use orthographic-phonologic relationships. However, it does this in the broader context of strengthening: 1) automaticity in word recognition (through practice of lesson material in a variety of contexts), 2) the simultaneous use of letter-sound and context clues, 3) syntactic awareness, 4) encoding skills (i.e., spelling and sentence writing), 5) vocabulary development, and 6) text comprehension.

The entire LPS covers reading instruction from kindergarten (prereading) through late fifth-grade levels. Initially, each student is placed in the series at a level somewhat below the one indicated by his/her word-recognition level (as measured by the DST). A teacher may place a student at a lower level if the student demonstrates difficulty at the initial placement level.

At the earliest levels (prereading), students in the LPS are taught letter-name and letter-sound relationships through the use of picture clues and encoding exercises. The format of LPS lessons is essentially the same at all levels of the program beyond the prereading levels. The core lesson is taught directly by the teacher. In each lesson, a number of words are presented in the context of rime-stem patterns. Students are shown how to read the words by using the rime-stem pattern as well as the sounds of individual letters. (Phoneme and onset-rime awareness as well as blending are included as auditory exercises when necessary, particularly at early program levels.) The meaning of any word not familiar to the students is discussed briefly. The students then read aloud a series of sentences in which the words are embedded and the teacher shows the students how the sentence context (meaning and syntax) provide additional clues for recognizing the words as well as for understanding what they mean. The students then write some or all of the newly introduced words as they are dictated by the teacher. The teacher emphasizes the letter-sound associations of each word as he/she dictates. The teacher also dictates sentences containing the words as the students write them.

Each lesson has three additional support-material components. A series of exercises designed to reinforce lesson objectives (i.e., how to recognize, spell, write, and understand the newly introduced material) are completed by students in their Fun Books, and one or more stories featuring words that reflect the patterns emphasized in the lesson (and prior lessons) are read aloud from the Read Aloud Story Books. Comprehension exercises follow the reading of each story. The students also play an LPS game that reinforces lesson objectives.

The support materials are always introduced by the teacher during the core lesson. When the teacher feels that the students understand the various tasks and can complete them with a high degree of accuracy, the students are permitted to use these materials in interdependent student-led groups. (The Fun Book and LPS games are frequently student-led activities.) However, the teacher monitors students' activity in these groups and checks written exercises as the students complete them.

A complete description of the program, as well as procedures for training teachers in its use, is provided by Richardson and DiBenedetto (1991). Examples taken from core-lessons and a portion of the teacher's guide for one of these lessons are shown in Figures 3 through 5. These lessons are designed for students who are reading at a beginning first-grade level (Lesson A.1) and a beginning second-grade level (Lesson 1.2).

Lesson A.1, from the Beginner Sequence of the LPS, is shown in Figure 3 and part of the teacher's guide for this lesson is shown in Figure 4. In this lesson, the student learns to use the long E sound (triggered by E and EE) and the initial consonants M and S, to read the words me and see. The student also learns three sight words.[9] (Students who have entered the LPS at earlier levels will have already been exposed to this material.)

[9]The authors of the LPS consider these "sight-words" because they are taught with minimal reference to letter-sound relationships. Students at early levels are taught to read them through a combination of exposure and reliance on the phonetic cues provided by initial consonant sounds. The authors consider the distinction between sight words and other types of words to be, primarily, a function of the strategies used to recognize them.

Lesson A.1

"e" and "ee" Can Say E

e	ee
me	see
I	can
run	______ (name)

1. ____ I can run.
2. ____ ________ (name) can run.
3. ____ I can see.
4. ____ ________ (name) can see.
5. ____ Can ________ (name) run?
6. ____ ________ (name) can run.
7. ____ Can I run?
8. ____ I can run.
9. ____ Can ________ (name) see?
10. ____ ________ (name) can see.
11. ____ Can I see?
12. ____ I can see.

Page 1

13. ____ Can ________ (name) see me?
14. ____ ________ (name) can see me.
15. ____ I can see ________ (name).
16. ____ Can ________ (name) see me?
17. ____ ________ (name) can see me.
18. ____ Can I see ________ (name) run?
19. ____ I can see ________ (name) run.
20. ____ Can ________ (name) see me run?
21. ____ ________ (name) can see me run.

SPELLING

1. ________	3. ________	5. ________
2. ________	4. ________	6. ________

DICTATION

____

____

____

____

____

Page 2

Figure 3. Lesson A.1 from the Linguistic Pattern Series showing pattern and sight words introduced in this lesson and sentence, spelling and dictation components (Richardson & DiBenedetto, 1989).

Section II:

Lesson Guide

Level A

The five lessons of Level A are designed to teach students to process initial consonants (and some consonant blends) in words that contain the long *e* sound triggered by *e* or *ee* (e.g., *me*, *see*). Sight words are introduced separately. Some attention may be given to the sounds of letters in sight words, especially initial consonants. Spelling will also reinforce recognition of these words. However, sight words at this level are generally best learned through frequent exposure. Lesson sentences, Spelling and Dictation, and support materials (*Read Aloud Stories* and *Fun Book*) are designed to reinforce recognition and comprehension of both pattern and sight words.

Remember to have games available to reinforce lesson content. ISM games may be used beginning with Lesson A.3.

- **Lesson A.1**
  - **Lesson Administration**

    There are spaces for names in this lesson. Before beginning the lesson, have the students write their names, the names of friends, or even your name in these spaces.

    - **Vocabulary**

      Introduce the vocabulary quickly and get right to the sentences. You should spend no more than three minutes on this step. Do not conduct extensive drilling with the vocabulary. The primary objective of the lesson is to teach the students to learn vocabulary in the context of reading.

Beginner Sequence: Implementaton Guide

- **Pattern Words**

  There are two pattern words (*me* and *see*) presented in this lesson. Point to the letter *e* printed at the top of the pattern word list and ask the students the name of the letter. Point out that you can hear the sound of the name in words like *me* and *see*. Then point to the word *me* and say, for example:

  "Listen to this word . . . *mmmeee*.
  Can you hear the sound *e* in *me*?"

  Then point to the words *see* and say, for example:

  "Look. Here's an *s*. It says *sss*, so what do you think this word is?"

  If the response *see* is not elicited, say the word, but stress the sounds, *ssseee*. You may ask the students to repeat each of the two words two or three times, but no more.

- **Sight Words**

  There are three sight words (*I*, *can*, and *run*). Point to each word, name it, and have the students repeat the word aloud. You may wish to check by asking the students to say each word as you point. However, do not engage in a lengthy drill to teach the words. Remember, in the *Linguistic Pattern Series*, students learn new words through repetition in the context of sentences.

- **Sentences**

  As soon as you have introduced the vocabulary, go immediately to the sentences. Have a student read sentence #1 and watch that the other students point to each word as it is read. It is extremely important that the habit of pointing as another student reads be established immediately, so you may have to spend a little time teaching the students to point throughout this lesson.

Figure 4. Part of the teacher's guide for Lesson A.1 showing how to administer pattern word, sight word, and sentence components of the lesson. (Sections describing administration of spelling, dictation and support material components are not shown.) (Richardson & DiBenedetto, 1989)

Lesson 1.2

"ee" Words Ending in "t" and"d"

eet		eed	
feet	meet	need	reed
sheet	beet	feed	weed
greet	fleet	deed	heed
street	sleet	creed	greed
		speed	steed

1. _____ Do you need to feed your feet?
2. _____ Can a tree be a steed?
3. _____ Do you greet your friends with glee?
4. _____ Do you need a seed to make a weed?
5. _____ Do you need to put peas and beets in your tea?
6. _____ Can you feed beets to a flea?

Figure 5. Part of Lesson 1.2 showing pattern words and some of the sentences introduced in this lesson (Richardson & DiBenedeto, 1989).

After the words are presented, the student reads the words in sentences, and also writes the words individually (spelling) and in sentences (dictation).

The words (and several sentences) presented at a somewhat higher level (Lesson 1.2) are shown in Figure 5. (Additional sentences, poems, spelling, and dictation components are not shown.) In this lesson, the student learns to use the rime stems EET and EED to read words in those families. At this level, most students will already know how to read at least a few of the words (e.g., feet and need) and the teacher encourages the students to use analogous relationships in reading the words that they do not know. When students have difficulty using the analogous relationships, teachers are instructed to show the students how to segment the words into onset and rime, both auditorily and visually, and to blend these units to produce words.

The LPS is a mastery approach to reading instruction. Teachers are encouraged to spend as much time on lessons and support material as is necessary for the students to achieve objectives. Mastery tests, in which lesson material is presented in new contexts, are administered after each level of the program. Teachers review material with students who do not demonstrate mastery at a particular level until a mastery score is obtained.

Design for Analyses

As is clear from the description of subject selection procedures, the three groups of poor decoders involved in this study did not contain the same subjects, although there was some subject overlap between the three groups. However, it should be noted that this was not a longitudinal study in any true sense. Its primary purpose was not to assess the effects of remedial treatment on word recognition or on analogous nonword reading. The primary purpose of this study was to determine whether or not poor decoders at specific levels of word recognition use a rime-analogy strategy in reading nonwords to the same degree that normal decoders, who are reading at the same word recognition levels, use this strategy. The secondary purpose of the study was to determine if poor decoders who have experienced remedial treatment use rime-analogy to the same degree that reading-level matched normal decoders use that strategy. Therefore, it was not necessary that the poor decoders in the posttreatment samples be the same subjects as those in the pre-treatment sample. Scores of each of the three poor decoder groups were compared, independently, to scores of the normal decoder group.

The statistical model used in the analyses was a factorial Multivariate Analysis of Variance (MANOVA) with 2 independent factors: 1) Group (normal, poor), 2) Reader Level (9 levels), and two dependent measures of analogous nonword reading (Monosyllable and Polysyllabic Phonic Transfer Indices). The following hypotheses were tested:

Null Hypothesis 1 (0): There is no significant difference in analogous nonword reading between normal and untreated poor decoders at the same levels of word recognition, across levels of word recognition.

Alternative Hypotheses 1 (1): There is a significant difference between normal and poor decoders at the same levels of word recognition in analogous nonword reading, across levels of word recognition.

1 (2): There is a significant difference between normal and poor decoders in analogous nonword reading at some levels of word recognition, but not at others.

1 (3): There is a significant difference between normal and poor decoders in analogous nonword reading on one item type (i.e., monosyllabic or polysyllabic) but not the other.

1 (4): Significant differences between normal and poor decoders in analogous nonword reading occur on one item type but not the other item type at some levels of word recognition but not at others.

These hypotheses were also tested in the comparisons between the normal decoder group and the one-year treated poor decoder group and between the normal decoder group and the two-year treated poor decoder group.

The hypotheses described above were intended to answer questions regarding differences in analogous nonword reading that may distinguish normal decoders from poor decoders, at a variety of word recognition levels, with and without remedial treatment delivered to poor decoders. However, the design of this study also afforded an opportunity to compare treated and untreated poor decoders on the measures of analogous nonword reading. This was accomplished by comparing the Phonic Transfer Index scores of the untreated poor decoder group to those of the two, treated poor decoder groups. Comparisons involving these groups addressed the following questions: Do treated and untreated poor decoders differ in their ability to read analogous nonwords? Do they differ at some levels of word recognition but not at others? Do they differ in one type of analogous nonword reading but not another type? These comparisons were made using the factorial MANOVA model described above.

Chapter 4

RESULTS

The analogous nonword reading of all subjects was measured by means of the Phonic Transfer Indices (PTI) obtained from Subtest 2 of the Decoding Skills Test (Richardson & DiBenedetto, 1985). As described in the Method section, the PTI score is calculated by dividing the number of Subtest 2 real-word/nonword pairs read correctly (i.e., the Phonic Transfer score) by the number of real words read correctly (i.e., the Real Word score). Calculations were performed separately for monosyllabic and polysyllabic items, resulting in two measures of analogous nonword reading: the Monosyllabic Phonic Transfer Index (PTIms) and the Polysyllabic Phonic Transfer Index (PTIps).[10] Means and standard deviations of the normal and poor decoder groups on the Real Word and Phonic Transfer (PT) measures that were used to compute the Phonic Transfer Indices are shown in Appendices A and B. Analyses comparing the Real Word and Phonic Transfer scores of the normal decoder group with the scores of each of the three poor decoder groups are shown in Appendices C through H.

Comparisons Between Normal and Poor Decoder Groups

Means scores and standard deviations for the four groups, at each Instructional Level (IL), on the two Phonic Transfer Indices (PTIms and PTIps) are shown in Table 6. As can be seen in the table, subjects in all four groups at the 1.8 Instructional Level obtained extremely low means on the Polysyllabic Phonic Transfer Index (PTIps), and standard deviations of the PTIps scores were actually larger than the means. These data reflect the fact that many subjects at the 1.8 Instructional Level obtained scores at or near zero on both the Polysyllabic Real Word and Polysyllabic Phonic Transfer measures. This reveals an additional source contributing to the unreliability of scores obtained from subjects at the 1.8 Instructional Level.

[10]PTIms and PTIps were highly correlated. In the normal decoder group, the correlation between the two measures was .74. In the three poor decoder groups, correlations between PTIms and PTIps ranged from .70 to .83.

Table 6

Mean Scores on Monosyllabic (Ms) and Polysyllabic (Ps) Phonic Transfer Indices of Normal and Poor Decoder Groups, at Each Instructional Level (IL)

			Group			
IL	Word type		Normal	Untreated poor	1-year treated poor	2-year treated poor
1.8	Ms	M	.45	.32	.30	.26
		SD	.31	.24	.25	.22
	Ps	M	.11	.14	.09	.12
		SD	.20	.20	.16	.20
		n	47	130	89	24
2.3	Ms	M	.48	.37	.37	.28
		SD	.24	.24	.24	.18
	Ps	M	.23	.21	.22	.14
		SD	.23	.20	.23	.18
		n	109	161	134	33
2.8	Ms	M	.54	.43	.42	.45
		SD	.22	.20	.20	.22
	Ps	M	.40	.34	.32	.32
		SD	.23	.33	.22	.22
		n	74	135	149	40
3.3	Ms	M	.59	.47	.47	.48
		SD	.17	.19	.22	.20
	Ps	M	.48	.34	.38	.42
		SD	.21	.20	.21	.23
		n	42	112	57	30

(table continues)

Table 6 (continued)

			Group			
IL	Word type		Normal	Untreated poor	1-year treated poor	2-year treated poor
3.8	Ms	M	.62	.53	.58	.52
		SD	.16	.19	.15	.16
	Ps	M	.53	.41	.47	.41
		SD	.21	.18	.19	.17
		n	55	72	50	29
4.3	Ms	M	.71	.61	.60	.63
		SD	.14	.17	.13	.16
	Ps	M	.61	.52	.54	.53
		SD	.16	.19	.17	.18
		n	102	109	56	25
4.8	Ms	M	.80	.71	.70	.70
		SD	.13	.15	.14	.18
	Ps	M	.74	.66	.65	.69
		SD	.15	.15	.16	.18
		n	111	105	119	49
5.3	Ms	M	.80	.74	.76	.75
		SD	.14	.15	.12	.13
	Ps	M	.73	.69	.71	.71
		SD	.14	.15	.12	.14
		n	115	113	82	33

(table continues)

Table 6 (continued)

IL	Word type		Normal	Untreated poor	1-year treated poor	2-year treated poor
			Group			
≥5.8	Ms	M	.89	.86	.81	.86
		SD	.11	.12	.11	.10
	Ps	M	.87	.79	.79	.85
		SD	.11	.13	.12	.10
		n	207	60	73	40

All comparison between groups were made using a factorial, Multivariate Analysis of Variance (MANOVA) with two independent factors (Group [2 levels] and Instructional Level (IL) [9 levels]) and two dependent measures (PTIms and PTIps). Because of the problems raised with regard to data obtained from subjects at the 1.8 Instructional Level, separate analyses, including and excluding data from subjects at this IL, were conducted. (Analyses excluding data from these subjects involved 8 rather than 9 levels of the IL factor). Results of analyses that excluded subjects at the 1.8 Instructional Level are reported when they yielded significant effects that differed from those obtained in analyses that included all subjects. Post hoc t-test comparisons of groups at individual Instructional Levels were conducted when the MANOVA indicated the presence of a significant Group by Instructional Level interaction effect or when univariate F statistics indicated that a significant effect involved one dependent Phonic Transfer Index but not the other.

These analyses were designed to answer the following questions: 1) Do normal and poor decoders who are reading at the same word recognition levels differ in their use of an analogic strategy to decode nonwords? 2) If there is a difference, does it apply to both monosyllabic and polysyllabic word forms? and 3) Do poor decoders who have received remedial treatment differ from normal decoders in their use of an analogic strategy to decode nonwords? Figure 6 depicts comparisons between the mean scores of the normal decoder group and each of the three poor decoder groups on the two Phonic Transfer Index measures of analogous nonword reading.

Normal decoders versus untreated poor decoders. The results of this analysis are shown in Table 7. As can be seen in the table, main effects for both Group and Instructional Level were significant and extremely large. Univariate tests indicated that these main effects involved both Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps). Thus, overall, normal decoders obtained significantly higher scores than did untreated poor decoders on both Monosyllabic and Polysyllabic Phonic Transfer

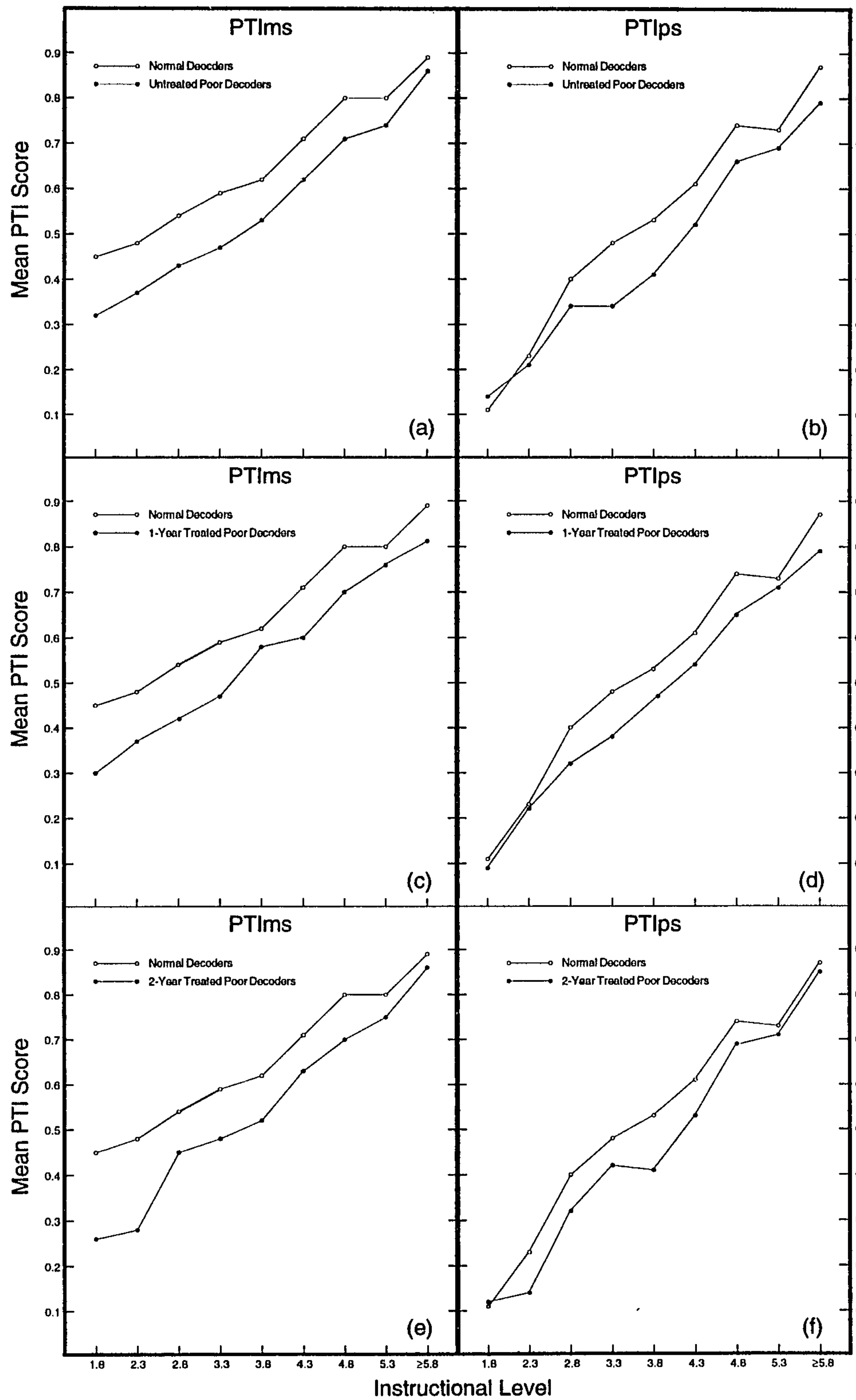

Figure 6 (a-f). Comparisons of mean scores on Monosyllabic (PTIms) and Polysyllabic (PTIps) Phonic Transfer Indices of normal and poor decoder groups, at each Instructional Level.

Table 7

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and Untreated Poor Decoder Groups

Multvariate effect	F[a]	df	p	Univariate effect	F	df	p
Group	54.86	2,1840	<.001	PTIms	103.61	1,1841	<.001
				PTIps	47.18	1,1841	<.001
Instructional	174.74	16,3678	<.001	PTIms	159.09	8,1841	<.001
Level (IL)				PTIps	323.99	8,1841	<.001
Group	2.81	16,3678	<.001	PTIms	1.40	8,1841	n.s.
x IL				PTIps	2.90	8,1841	<.01

[a]Hotellings statistic

Indices. Subjects, including both normal and poor decoders, at the various Instructional Levels differed significantly on these measures as well.

However, the interaction between Group and Instructional Level was significant, and univariate tests indicated that this involved the Polysyllabic Phonic Transfer Index (PTIps) but not the Monosyllabic measure (PTIms). A second MANOVA, conducted without subjects at the 1.8 Instructional Level, did not result in a substantially different outcome.

Post hoc t-tests comparing the mean scores of two groups on the Polysyllabic Phonic Transfer Index, at each Instructional Level, are shown in Table 8. As can be see in the table, differences below the 3.3 Instructional Level were not significant, while differences at Instructional Levels ranging from 3.3 to ≥5.8 were significant. Thus, differences between these two groups on the Polysyllabic Phonic Transfer Index were a function of Instructional Level: Normal and untreated poor decoders differed significantly on PTIps at third grade Instructional Levels and higher, but not at lower Instructional Levels. Differences were largest at Instructional Levels ranging from 3.3 to 4.8. This trend is apparent in Figure 6b.

Normal decoders versus one-year treated poor decoders. The results of this analysis are shown in Table 9. As can be seen in the table, main effects for both Group and Instructional Level factors were significant and univariate tests indicated that these effects involved both Monosyllabic and Polysyllabic Phonic Transfer Indices. Thus, normal decoders obtained significantly higher scores than did the one-year treated poor decoders on both Phonic Transfer Indices. Also, scores at higher intructional levels were significantly higher than scores at lower Instructional Levels.

This analysis also yielded a small, but significant, Group by Instructional Level interaction effect ($p < .05$). Although univariate tests showed that this interaction was not significant for either of the Phonic Transfer Indices considered separately, Figure 6d reveals that differences between the means of the normal and one-year treated poor decoders on

Table 8

T-test Comparisons of Mean Scores on Polysyllabic Phonic Transfer Index of Normal and Untreated Poor Decoder Groups, at Each Instructional Level (IL)

IL	t-value	df	p
1.8	-.81	175	n.s.
2.3	.72	268	n.s.
2.8	1.78	207	n.s.
3.3	3.70	152	<.01
3.8	3.54	125	<.01
4.3	3.92[a]	206.49	<.001
4.8	3.67	214	<.001
5.3	2.31	226	<.05
≥5.8	2.63	265	<.01

Note. Positive t-values indicate that means of the normal decoder group are higher than those of the poor decoder group.

[a]Separate variance estimates were used to compute t-value when the probability of the F statistic for the homogeniety of variance test was $p < .10$. Degrees of Freedom (df) are adjusted for these estimates.

Table 9

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and One-year Treated Poor Decoder Groups

Multvariate effect	F[a]	df	p	Univariate effect	F	df	p
Group	51.01	2,1655	<.001	PTIms	100.21	1,1656	<.001
				PTIps	35.76	1,1656	<.001
Instructional	173.67	16,3308	<.001	PTIms	160.12	8,1656	<.001
Level (IL)				PTIps	324.37	8,1656	<.001
Group	1.74	16,3308	<.05	PTIms	1.61	8,1656	n.s.
x IL				PTIps	1.21	8,1656	n.s.

[a]Hotellings statistic

the Polysyllabic Phonic Transfer Index are less apparent at the two lowest Instructional Levels (i.e., 1.8 and 2.3). However, the MANOVA conducted without subjects at the 1.8 Instructional Level yielded results that were essentially the same as those yielded by the MANOVA that included these subjects.

Normal decoders versus two-year treated poor decoders. The results of this analysis are shown in Table 10. As can be seen in the table, significant effects were again evident for both Group and Instructional Level factors as well as for the Group by IL interaction. Univariate tests showed that only the Monosyllabic Phonic Transfer Index contributed to the interaction effect. The MANOVA conducted without subjects at the 1.8 Instructional Level yielded substantially the same results.

Table 11 shows the t-test comparisons between the means of normal and two-year treated poor decoders, at each Instructional Level, on the Monosyllabic Phonic Transfer Index. As the table shows, normal decoders obtained significantly higher mean scores on this measure at six Instructional Levels. Differences were not significant at the two highest Instructional Levels, nor at the 2.8 Instructional Level. Thus, differences between the two groups on the Monosyllabic Phonic Transfer Index were, to some degree, a function of Instructional Level: Normal decoders obtained significantly higher PTIms scores than did two-year treated poor decoders at most Instructional Levels below 5.3, but normal and poor decoders at the two fifth-grade Instructional Levels did not differ on PTIms. This trend is apparent in Figure 6e.

To summarize, in general, the poor decoders did not use a rime analogy strategy to decode nonwords to the same degree that the normal decoders, at the same levels of word recognition, used this strategy. Differences between the normal and poor decoder groups were smaller on the measure of polysyllabic analogous nonword reading than they were on the monosyllabic measure. However, normal decoders obtained significantly higher scores on both monosyllabic and polysyllabic measures of analogous nonword reading than did poor decoders at most levels of word recognition, with a few exceptions:

Table 10

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and Two-Year Treated Poor Decoder Groups

Multvariate effect	F[a]	df	p	Univariate effect	F	df	p
Group	37.91	2, 1146	<.001	PTIms	75.84	1,1147	<.001
				PTIps	21.41	1,1147	<.001
Instructional	108.11	16,2290	<.001	PTIms	109.33	8,1147	<.001
Level (IL)				PTIps	201.55	8,1147	<.001
Group	2.27	16, 2290	<.01	PTIms	2.68	8,1147	<.01
x IL				PTIps	1.18	8,1147	n.s.

[a]Hotellings statistic

Table 11

T-test Comparisons of Mean Scores on Monosyllabic Phonic Transfer Index of Normal and Two-Year Treated Poor Decoder Groups, at Each Instructional Level (IL)

IL	t-value	df	p
1.8	2.97[a]	62.12	<.01
2.3	5.30[a]	67.68	<.001
2.8	1.95	112	n.s.
3.3	2.60	70	<.05
3.8	2.53	82	<.05
4.3	2.63	125	<.05
4.8	3.89	158	<.01
5.3	1.89	146	n.s.
≥5.8	1.58	245	n.s.

Note. Positive t-values indicate that means of the normal decoder group are higher than those of the poor decoder group.

[a]Separate variance estimates were used to compute t-value when the probability of the F statistic for the homogeniety of variance test was $p < .10$. Degrees of Freedom (df) are adjusted for these estimates.

Level of word recognition, syllabic structure, and whether or not treatment was provided exerted some influence on the outcome of comparisons. Normal and untreated poor decoders did not differ in their use of rime analogy to decode polysyllabic nonwords at lower levels of word recognition, but they did differ at higher levels. The comparison between normal and one-year treated poor decoders revealed a similar pattern, except that differences between poor and normal decoders on both monosyllabic and polysyllabic items were more uniform across word recognition levels than they were in the previous analysis. However, normal and two-year treated poor decoders did not differ in their use of rime analogy to decode monosyllabic nonwords at the two highest levels of word recognition, but they did differ at most lower levels.

Comparison Between Normal and Poor Decoder Groups Using Raw Score Range Categories

As discussed in the Method section, large numbers of potential subjects were excluded from the foregoing analyses because their raw scores (i.e., the number of words read correctly) on Subtest 1 of the DST did not meet the range restriction criteria shown in Table 3. This was particularly true of potential subjects for the poor decoder groups. In order to rule out the possibility that exclusion of these subjects affected the outcome of analyses in substantial ways, a series of analyses were conducted that included scores obtained from a larger subject pool whose raw scores on DST Subtest 1 did not, necessarily, meet the range restriction criteria.

The normal decoders in this data set were all subjects who were initially designated as normal decoders, based on their Subtest 1 Instructional Level scores obtained at the time of referral (see Table 2, column 1), whose Subtest 1 raw scores were at least 32. Untreated poor decoders were all subjects initially designated as poor decoders (see Table 2, column 2), who obtained Instructional level scores of at least 1.8 and raw scores of at least 32, at the time of referral. Subjects in the one-year treated poor decoder group were those who were initially designated as poor decoders who remained in the SRD program for at least one year, and who obtained Instructional Level scores of at least 1.8 and raw scores of at least 32 after one year of treatment. Subjects in the two-year treated poor decoder group were those initially designated as poor decoders who remained in the SRD program for at least two years, and who obtained Instructional Level scores of at least 1.8 and raw scores of at least 32 after two years of treatment. This resulted in greatly increased numbers of subjects, particularly in the poor decoder groups. (The number of subjects in each of these groups is shown in Table 12.)

Subjects were divided into word-recognition-level groups based on the number of words read correctly on Subtest 1 (i.e., their raw scores). Eight raw score range categories (seven with a 10 point range, the last with an 8 point range) were employed.

Comparisons between the normal decoder group and the three poor decoder groups on the two Phonic Transfer Indices were made using the MANOVA model described above, except that the eight levels of the Raw Score Range Category (RSC) factor replaced the nine levels of the Instructional Level (IL) factor. Results of these analyses are shown in Appendices I through L and were essentially the same as those involving data obtained from the raw-score restricted groups discussed above.

Figure 7 (a-f) depicts the comparisons between the means of the normal and poor decoder groups, classified by Raw Score Range Category (RSC), on the two Phonic Transfer Indices. These comparisons indicate patterns of differences that are essentially the same as those depicted in Figure 6 (a-f): Normal decoders obtained higher scores than both untreated and treated poor decoders on both Monosyllabic and Polysyllabic Phonic Transfer Indices at virtually all Instructional Levels. Furthermore, as can be seen in both Figures 6 and 7, differences between the scores of normal and poor decoders appear to be larger on the Monosyllabic Phonic Transfer Index (PTIms) than on the Polysyllabic measure (PTIps).

These results indicate that the effects obtained in the analyses involving the raw-score restricted groups cannot be explained by biases resulting from group selection pro-

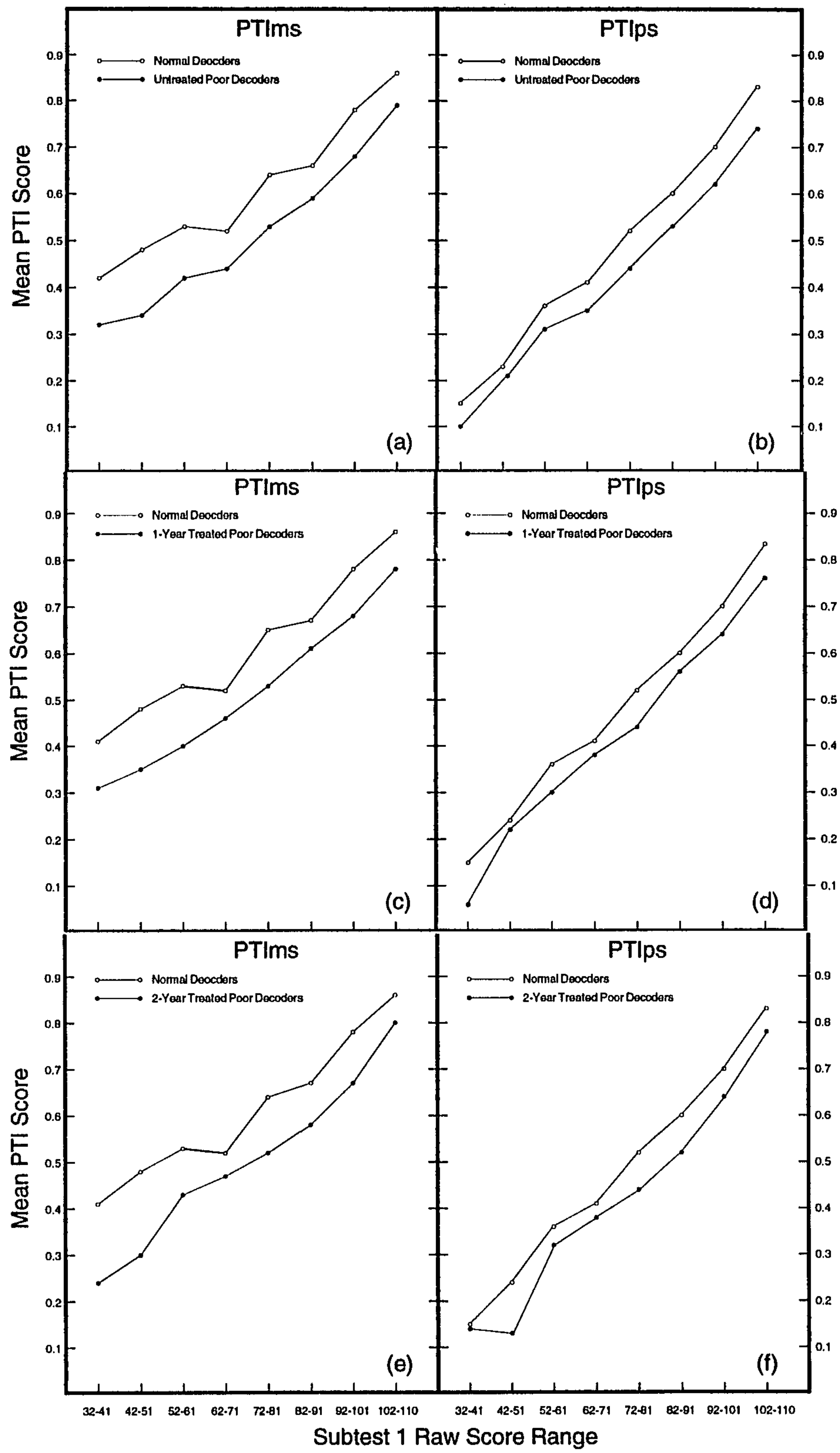

Figure 7 (a-f). Comparisons of mean scores on Monosyllabic (PTIms) and Polysyllabic (PTIps) Phonic Transfer Indices of normal and poor decoder groups, at each Raw Score Range Category.

cedures. However, the comparisons involving subjects classified by Raw Score Range Category are less interpretable than those involving subjects classified by Instructional Level (and meeting the raw score range restriction criteria) for the reason discussed below.

Table 12 shows the mean Instructional Level (IL) scores of the normal and poor decoder groups, classified by Raw Score Range Category (RSC). As is evident in the table, when subjects were classified by Raw Score Range Categories, the Instructional Level scores of the normal decoder group were higher than those of all three poor decoder groups at every RSC. All ANOVAs (shown in Appendices M through O) that compared the Instructional Level scores of the normal decoder group with those of the three poor decoder groups yielded significant Group effects ($p<.001$), indicating that the Instructional Level scores of the normal group were higher than those of all three poor decoder groups . Furthermore, Group by RSC interaction terms were significant in all comparisons ($p<.01$). These analyses indicate that the normal and poor decoder groups, in which subjects' word recognition levels were categorized in terms of their Subtest 1 raw scores, did not have equivalent levels of word recognition (as measured by their Instructional Level scores).

The finding that these groups did not have equivalent levels of word recognition leaves open the possibility that the Phonic Transfer Index scores of the normal decoder group were higher than those of the poor decoder groups because the normal readers were more advanced in their word reading than were the poor decoders. However, the results of the analyses that employed the Raw Score Range Categories and those that employed Instructional Levels (with range restrictions) were very similar, and this serves to strengthen confidence in the effect: Regardless of the measure used to estimate the word recognition levels of the normal and poor decoders, analyses revealed that the poor decoders did not use a rime analogy strategy in decoding nonwords to the same degree that normal decoders used this strategy.

Table 12

Mean Instructional Level (IL) Scores of Normal and Poor Decoder Groups, at Each Raw Score Range Category (RSC)

		Group			
RSC		Normal	Untreated poor	1-year treated poor	2-year treated poor
32-41	M	2.05	1.89	1.92	1.81
	SD	.25	.20	.21	.26
	n	82	242	85	24
42-51	M	2.38	2.20	2.29	2.27
	SD	.24	.31	.32	.38
	n	113	474	188	51
52-61	M	2.74	2.60	2.67	2.69
	SD	.38	.35	.30	.21
	n	99	362	153	37
62-71	M	3.22	2.85	2.96	2.90
	SD	.44	.39	.42	.35
	n	49	255	144	39
72-81	M	3.50	3.04	3.16	3.27
	SD	.51	.44	.51	.45
	n	78	319	143	57
82-91	M	4.08	3.34	3.62	3.54
	SD	.54	.61	.67	.64
	n	143	363	178	55

(table continues)

Table 12 (continued)

RSC		Group: Normal	Untreated poor	1-year treated poor	2-year treated poor
92-101	M	4.80	4.24	4.52	4.57
	SD	.50	.79	.66	.54
	n	216	341	516	73
120-110	M	6.01	5.40	5.53	5.67
	SD	.66	.85	.87	.87
	n	321	214	194	112
Total	n	1,101	2,570	1,305	448

Comparisons Between Untreated and Treated Poor Decoder Groups

Results of the foregoing analyses indicate that the poor decoders did not use the analogic strategy to the same degree that the normal decoders, at the same levels of word recognition, used this strategy. However, did the poor decoders who received remedial treatment use rime analogy to decode nonwords to a greater degree than did the poor decoders who did not receive remedial treatment? This question was addressed using the MANOVA model previously described. (These analyses involved the treated and untreated poor decoders who were categorized in terms of their Instructional Level scores, with the application of the range restriction criteria.)

Untreated versus one-year treated poor decoders. The results of this analysis are shown in Table 13. Differences between the untreated poor decoder group and the one-year treated poor decoder group on the Phonic Transfer Indices were not significant, nor was there a significant interaction effect. The exclusion of subjects at the 1.8 Instructional Level did not alter analysis outcome in any substantial way.

Untreated versus two-year treated poor decoders. The results of this analysis are shown in Table 14. Again, differences between the untreated and treated groups on the Phonic Transfer Indices were not significant. However, the analysis that excluded subjects at the 1.8 Instructional Level resulted in a small, but significant, interaction effect (F=1.88, df=14, 2154, p<.05) and univariate tests indicated this this effect was significant for the Monosyllabic (PTIms), but not the Polysyllabic (PTIps), Phonic Transfer Index. Post hoc t-tests indicate that the untreated poor decoder group at the 2.3 Instructional Level obtained a significantly higher mean PTIms score than did the two-year treated group (p<.05). Comparisons at other Instructional Levels did not yield significant differences. As can be seen in Figure 8, the mean scores of the untreated and treated groups, on both Monosyllabic and Polysyllabic Phonic Transfer Indices, are very similar. The source of the Group by Instructional Level interaction effect in the comparison of the

Table 13

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Untreated and One-Year Treated Poor Decoder Groups

Multvariate effect	F[a]	df	p	Univariate effect	F	df	p
Group	.23	2,1790	<.001	PTIms	.02	1,1791	n.s.
				PTIps	.29	1,1791	n.s.
Instructional Level (IL)	165.85	16,3578	<.001	PTIms	171.22	8,1791	<.001
				PTIps	296.64	8,1791	<.001
Group x IL	.90	16,3578	<.01	PTIms	.61	8,1791	n.s.
				PTIps	1.49	8,1791	n.s.

[a]Hotellings statistic

Table 14

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Untreated and Two-Year Treated Poor Decoder Groups

Multvariate effect	F^a	df	p	Univariate effect	F	df	p
Group	.77	2,1281	n.s.	PTIms	.62	1,1282	n.s.
				PTIps	.23	1,1282	n.s.
Instructional	93.82	16,2560	<.001	PTIms	101.35	8,1282	<.001
Level (IL)				PTIps	167.25	8,1282	<.001
Group	1.07	16,2560	n.s.	PTIms	.96	8,1282	n.s.
x IL				PTIps	1.44	8,1282	n.s.

[a]Hotellings statistic

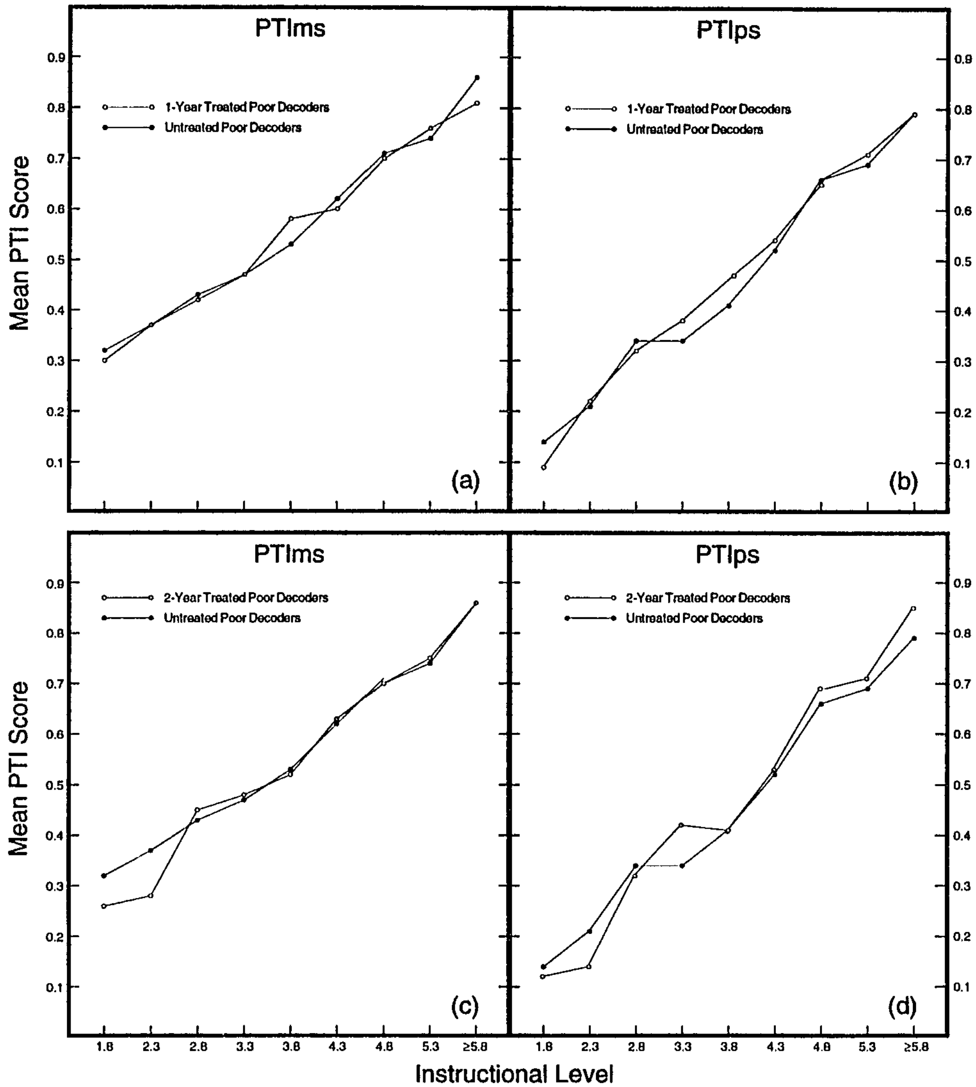

Figure 8 (a-d). Comparisons of mean scores on Monosyllabic (PTIms) and Polysyllabic (PTIps) Phonic Transfer Indices of treated and untreated poor decoder groups, at each Instructional Level.

PTIms scores of the untreated and two-year treated groups is apparent at the 2.3 Instructional Level, as shown in Figure 8c, and is probably anomalous.

Thus, it appears that the poor decoders who received remedial treatment did not use rime analogy to decode nonwords to any greater degree that did the untreated poor decoders. This was true for both monosyllabic and polysyllabic measures of analogous nonword reading and true at virtually all levels of word recognition.

Repeated Measures Comparisons: Pretreatment Versus Posttreatment Scores of Treated Groups

The failure to find differences between the posttreatment Phonic Transfer Index scores of the two groups who received remedial instruction and the scores of the untreated group does not mean that subjects in the treated groups did not make progress in terms of their PTI scores or in terms of word recognition, as measured by the Instructional Level score.

As has been stated, 396 subjects were in both the untreated and one-year treated groups; 118 subjects were in both the untreated and two-year treated groups. Repeated measures comparisons of pretreatment and posttreatment Instructional Level and Phonic Transfer Index scores were conducted using data obtained from these subjects.

Results of these analyses are shown in Table 15. As can be seen in the table, mean Instructional Level scores of subjects from the one-year treated group improved by about .8 of a year; those of subjects from the two-year treated group improved by about 1.4 years. Phonic Transfer Indices also increased, particularly the Polysyllabic Phonic Transfer Index (PTIps). All of these differences were significant ($p<.001$).

However, the gains made by these treated poor decoders on the Instructional Level measure of word recognition were less than one would expect from normal decoders: Normal decoders are expected to show increases of at least one year for every year of instruction. The analyses comparing the the Phonic Transfer Indices of the poor decoder groups with those of the normal decoder group indicate that the gains made by the treated

Table 15

Mean Instructional Level (IL) and Phonic Transfer Index Scores (PTIms and PTIps) of One-Year Treated (N=396) and Two-Year Treated (N=118) Poor Decoders Before and After Remedial Treatment

		1-year treated			2-year treated		
		Pretest	Posttest	t-value	Pretest	Posttest	t-value
IL	M	3.06	3.85	20.86*	3.18	4.60	19.54*
	SD	1.20	1.34		1.34	1.34	
PTIms	M	.44	.55	9.26*	.46	.64	8.97*
	SD	.26	.25		.26	.24	
PTIps	M	.31	.46	13.00*	.34	.58	11.93*
	SD	.27	.27		.26	.26	

Note: All comparisons are repeated measures.

* $p < .001$

poor decoders on the Phonic Transfer Indices were also less than would be expected from normal decoders.

Comparisons Between the Normal Decoder Group and Above Average Responders in the Treated Poor Decoder Groups

Did subjects in the treated poor decoder groups who made the most progress during their remedial treatment periods use rime analogy to decode nonwords to the same degree that the normal decoders used this strategy? In an effort to answer this question, subjects in the two treated poor decoder groups who made more progress than the average, for their respective groups, were identified for comparative analyses. These subjects included one-year treated poor decoders whose word recognition levels (as measured by their Instructional Level scores) improved by at least one year during treatment, and two-year treated poor decoders whose word recognition levels improved by at least 1.5 years during treatment. Subjects retained their Instructional Level classifications, as in previous analyses. For the purpose of these analyses, Instructional Level classifications in which fewer than 15 subjects remained were dropped. In the one-year group, Instructional Levels ranging from 2.3 through ≥5.8 remained in analyses. In the two year group, Instructional Levels ranging from 3.8 through ≥5.8 remained.

Mean scores on the Monosyllabic and Polysyllabic Phonic Transfer Indices for these groups are presented in Appendix P. Results of MANOVAs that compared the Phonic Transfer Indices of the normal decoder groups with those of these two above average responder groups are presented in Appendices Q and R. Results of these comparisons were similar to those of other comparisons: Poor decoders obtained significantly lower scores than normal decoders on both measures of analogous nonword reading ($p < .001$).

These comparisons are depicted in Figure 9. Although Group by Instructional Level interaction terms were not significant in either analyses, differences between the scores of normal decoders and those of these two poor decoder groups do appear to be smaller at the higher Instructional Levels (i.e., 5.3 and ≥5.8) than at the lower Instructional Levels.

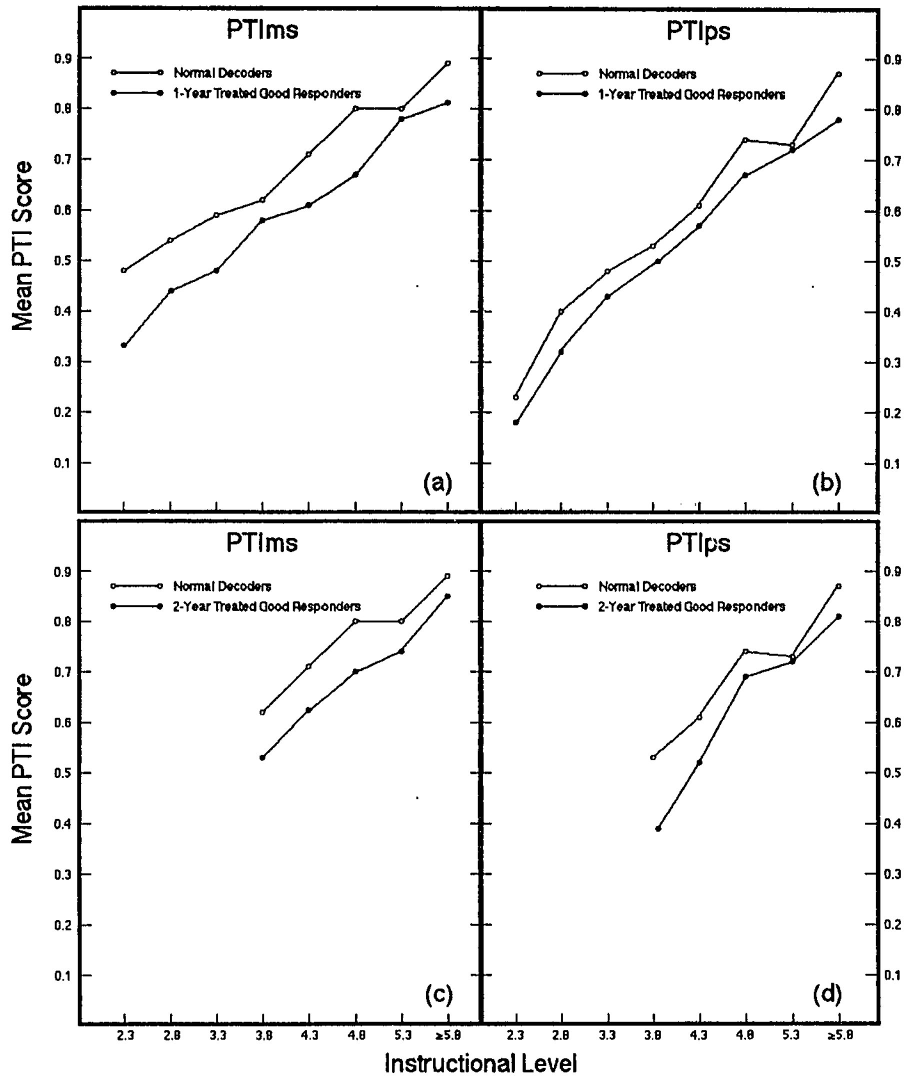

Figure 9 (a-d). Comparisons of mean scores on Monosyllabic (PTIms) and Polysyllabic (PTIps) Phonic Transfer Indices of normal decoders and treated poor decoders who were above average responders to treatment, at each Instructional Level.

This is evident in Figures 9a, 9c, and 9d. However, the difference between the normal and one-year treated decoders on the polysyllabic measure (see Figure 9b) appears to be greatest at the ≥ 5.8 Instructional Level.

The results of these analyses are basically the same as those previously described: Even poor decoders who made better than average progress in their respective treatment groups did not use the analogic strategy to decode nonwords to the same degree that the word-recognition-level matched normal decoders used this strategy.

Chapter 5

DISCUSSION

The results of this study indicate that, when poor and normal decoders are matched for levels of word recognition, poor decoders do not read analogous nonwords as well as normal decoders read them. The general pattern of these results was modified to a minor extent by the word recognition level of the groups being compared, the syllabic structure of the analogous nonwords, and by remedial treatment. The influence of these factors is described below.

These results suggest that there are pervasive differences between poor and normal decoders in their ability to use a rime-analogy strategy to decode unfamiliar words. Furthermore, it appears that the deficits that poor decoders experience in their ability to use this strategy are difficult to overcome, even when deficit-specific treatment is provided.

The Influence of Word Recognition

Clearly, the ability to use rime analogy is closely linked to the number of words that a reader is able to identify. Subjects in the present study were not able to read rime-analogous nonwords when their levels of word recognition were below that expected of a second-grade student. Both poor and normal decoders at higher levels of word recognition were able to read rime-analogous nonwords, and the higher the level of word recognition (as measured by Instructional Level), the greater the use of rime-analogy (as measured by the Phonic Transfer Indices). These results are consistent with those of Coltheart and Leahy (1992) and Bowey and Hansen (1994) who found that more advanced readers, but not beginning readers, were able to decode nonwords containing high-frequency rime stems.

However, regardless of the level of word recognition, the poor decoders in the present study did not use rime-analogy to decode nonwords to the same degree that the normal decoders used this strategy. Because the study was not longitudinal, we cannot draw definitive conclusions regarding the pace of the development of this strategy in normal or poor decoders. However, the results do suggest that the normal decoder develops a rime-analogy strategy more quickly than does a poor decoder, as they both move along a continuum of development in their ability to recognize words.

These results do not support the hypothesis proposed by Goswami (1993) that decoding through a rime-analogy strategy precedes phonological recoding in the development of word identification skills, or the conclusions drawn by Goswami and Mead (1992) that good and poor readers do not differ in their ability to use rime analogy to decode unknown words when rime-analogous clue words are provided. If poor readers were able to use rime analogy to decode unknown words, we would not expect to find such pervasive differences between poor and normal decoders in their ability to read nonwords that are analogous to words that they can read. These findings are consistent with the hypothesis proposed by Ehri and Robbins (1992) that decoding skills must be developed before unknown words can be read by analogy to known words.

Additionally, results of the present study indicate that the difference between good and poor readers in their use of rime-analogy is evident early in the development of word recognition, and remains relatively consistent as word recognition develops through the elementary-school grades. Thus, the suggestion that the nonword decoding strategies used by good and poor readers differ more at lower word recognition levels than they do at higher word recognition levels (Baddeley et al., 1988; Snowling, 1981; Treiman & Hirsh-Pasek, 1985) is not generally supported by the results of the present study. On the other hand, the finding of differences at higher levels, but not at lower levels (Manis et al., 1988) is also not generally consistent with the results of the present study.

The results of the present study suggest that good and poor readers begin to differ in their use of rime-analogy at the point where word recognition is sufficiently developed for good readers to use the strategy effectively. The results suggest that the normal reader is able to use his/her word-recognition base to develop this strategy (as well as other phonologically based strategies), which can be used to decode unknown words, while the poor reader is not able to use the same word-recognition base in this way. Being able to recognize a word does not contribute phonological, letter-sound, or orthographic pattern information to the poor reader to the same extent that it contributes this information to the normal reader. The poor reader relies heavily on remembering words that have been read previously; the normal reader can use phonologically-related information to solidify the identification of partially known words and to decipher words that have not been encountered previously. Thus, this knowledge base enables the normal reader to increase the store of identifiable words.

The discrepancy between normal and poor decoders in their ability to analogize suggests that good and poor readers identify words in qualitatively different ways. This does not mean that poor readers do not use phonological or letter-sound information when they read (Ehri, 1989), as might be inferred from early conceptualizations of the dual-route theory, which hypothesizes that words are read either through a direct visual route or through a phonological route (e.g., Baron, 1979). However, it does suggest that poor readers do not acquire a fully developed <u>cipher</u> strategy, which enables the reader to consolidate information about orthographic and phonological relationships in words, and to organize this information so that it can be generalized when unknown or less familiar words are encountered (Ehri 1987, 1989, 1992).

The difficulty experienced by poor readers in decoding analogous nonwords, suggests that they employ a <u>phonetic-cue</u> strategy, in which partial letter-sound information assists the reader in identifying words (Ehri, 1992). However, this strategy is less effective than the cipher strategy, and results in incomplete representations of words in the reader's memory. The use of a phonetic-cue strategy is consistent with the results of a study by DiBenedetto et al. (1983), who found that the errors made by poor readers in decoding nonwords resulted, primarily, from a lack of awareness of the sounds that can be attributed to vowels. In that study, error analyses revealed that poor decoders mispronounced nonwords because they attribued sounds to vowels that are never attributed to those particular vowels, regardless of orthographic structure (e.g., pronouncing VAD as veed), while normal readers' mispronunciations reflected an awareness of sounds that are, in some cases, attributed to those vowels (e.g., pronouncing VAD as vade).

The use of a phonetic-cue strategy would also explain why the poor decoders, in the present study, tended to identify words sporadically across a wide range of Instructional Levels. This tendency made it difficult to match them with normal decoders on both 1) Subtest 1 Instructional Level, and 2) number of words read correctly on Subtest 1 (i.e., raw score). Poor decoders, whose Instructional Level scores were two or more reader-levels below expectation, were frequently able to recognize a few words at each reader-level up to the level expected. However, their word recognition at these levels can only be characterized as incomplete. This would be expected if representations of words in memory are also incomplete--Only the most frequently practiced words, or those with very distinctive features, would be identified by the poor decoder. The poor decoder, having been exposed to many higher-level vocabulary words during the course of normal instruction, would remember how to read a few of them.

Rime Analogy and Phonological Recoding: Interdependent Strategies for Decoding Non-words

Treiman et al. (1990) entitled a position paper on the use of onsets and rimes in non-word decoding, "Not all nonwords are alike." Research has demonstrated that it is easier to decode nonwords that lend themselves to rime analogy than to decode nonwords that require more detailed phonological recoding strategies (Bowey & Hansen, 1994; Treiman et al. 1990). However, this does not mean that poor decoders do not experience difficulty in using a rime-analogy strategy to decode unknown words, even if this strategy is easier for them to use than a phonological recoding strategy.

The results of the present study are consistent with most of the conclusions drawn by Rack et al. (1992), and others (e.g., Beech & Awaida, 1992; Felton, & Wood, 1992) regarding the differences between poor and reading-level matched normal readers in their ability to read nonwords in general. However, in Rack et al.'s review, these authors suggested that the failure, in some studies, to find differences between the nonword reading of poor and reading-level matched good readers may have resulted from the use of nonwords that could be read by analogy to known real words or to words with high-frequency rime stems. Rack et al. hypothesized that there may be less difference between good and poor readers in their ability to use analogic strategies than in their ability to use phonological recoding strategies. This hypothesis is not supported by the results of the present study, which indicates that poor decoders are less able than normal decoders to read analogous nonwords, just as they are less able to read other types of nonwords (i.e., those that may require the application of phonological recoding strategies). Poor decoders do not seem to use either strategy to the degree that normal decoders use these strategies.

It is also unlikely that the priming effect, discussed in reference to a study by Treiman and Hirsh-Pasek (1985), accounts for these researchers' failure to find differences between the nonword reading of good and poor readers. In that study, the real words were presented before the rime-analogous nonwords, so that subjects may have used the rime clue provided by a real word when attempting to read an analogous nonword. Similarly, in the present study, the real words were presented before the nonwords. However, the poor decoders still performed more poorly than the normal decoders did on these tasks.

It is more likely that studies failing to find differences between reading-level matched good and poor readers on nonword tasks obtained negative findings because the reading measures used to match the good and poor readers did not provide accurate matches on word recognition. Rack et al. (1992) noted that a test that tends to underestimate the word recognition levels of poor readers was used in studies conducted by Vellutino and Scanlon (1987) and Szeszulski and Manis (1987). This may also be true of the study by Treiman and Hirsh-Pasek (1985), who equated good and poor readers on the real word portion of their experimental task. A more general measure of word recognition might have revealed that the poor readers in the Treiman and Hirsh-Pasek study were actually more advanced than the good readers in their ability to identify words.

Differences Between Monosyllabic and Polysyllabic Analogous Nonwords

Poor decoders' use of a rime-analogy strategy may be dependent, to some degree, on an interaction between word recognition level and the length of the analogous nonword that the reader is asked to decode. In the present study, the normal and untreated poor decoders differed in their ability to read monosyllabic analogous nonwords, across a wide range of word recognition levels. In contrast, these two groups differed in their ability to read polysyllabic analogous nonwords only when their measured word recognition was above a second-grade level. Furthermore, while differences between the normal decoder group and the three poor decoder groups were significant on both monosyllabic and polysyllabic nonwords, Group effect sizes were consistently smaller on the polysyllabic measure. Thus, differences between the analogous nonword decoding abilities of poor and normal readers appear to be larger at higher than at lower word recognition levels when items are polysyllabic. These results seem to be in direct opposition to those of Snowling (1981), who found that differences between normal and dyslexic readers were larger on a two-syllable nonword task than on a one-syllable nonword task, and larger at a lower word recognition level than at a higher word recognition level.

It is unlikely that differences between the results of the present study and Snowling's (1981) study are due to differences between the instruments used to measure nonword reading, or the fact that the present study concerns analogous nonword reading while Snowling's study did not. Snowling's nonwords were not specifically rime-analogous to real words known to the subjects in her study. However, the results of the present study indicate that this should not account for the different findings: These results indicate that differences between normal and poor decoders on analogous nonword reading tasks are similar to previously observed differences between normal and poor decoders on other types of nonword reading tasks.

One possible source of the discrepancy between the two studies involves the procedures used to match normal and poor readers in terms of their word recognition levels. In Snowling's (1981) study, the groups of normal and dyslexic subjects who were reading at a high word recognition level do not appear to have been well matched: The mean reading age of the dyslexic readers was almost a year higher (i.e., 11 years) than that of the normal readers (10 years 2 months). This may have resulted in smaller differences in nonword reading between the more advanced normal and dyslexic readers than between the less advanced normal and dyslexic readers (whose mean reading age was approximately 8 years for both the normal and dyslexic groups).

However, differences between the results of Snowling's (1981) study and those of the present study may not be as great as they appear to be at first glance. Snowling's study was conducted in Great Britain, and subjects in the high and low word recognition groups obtained mean word recognition scores that might be loosely translated as late second-grade and early fifth-grade levels. If we consider only subjects at these word recognition levels in the present study (see Figure 10), and compare these results with Snowling's (see Figure 11), it is apparent that the results of these two studies are similar in one respect: Both studies indicate that differences between normal and poor readers are larger at a lower word recognition level (i.e., late second grade) than at higher word recognition level (i.e., early fifth grade). This similarity is not immediately apparent in the results of the present study, because normal and poor decoders were compared at a wide range of word recognition levels, whereas, in the Snowling study, normal and dyslexic readers were compared at two specific levels of word recognition. Results of the present study indicate that differences between normal and poor decoders on polysyllabic analogous nonword reading (PTIps) were actually greatest at Instructional Levels between 2.8 and 5.3 (see Figure 6b). Differences at the upper and lower Instructional Levels were smaller, although differences at the highest levels were also significant.

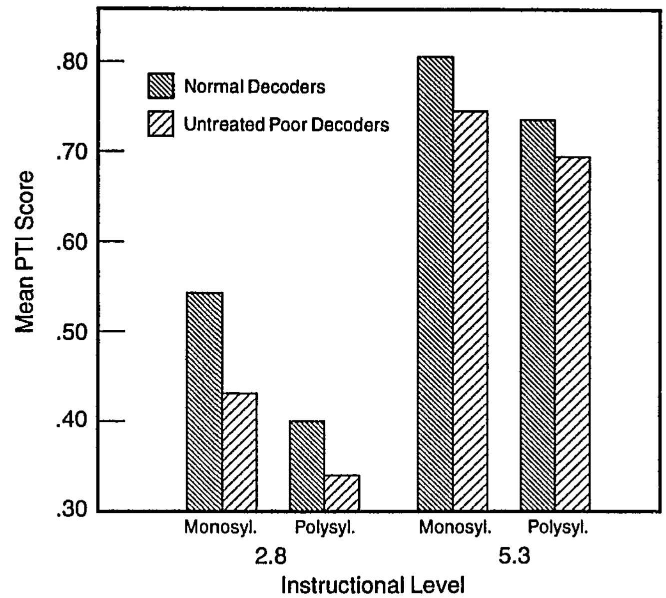

Figure 10. Mean scores of normal and untreated poor decoders at 2.8 and 5.3 Instructional Levels on Monosyllabic and Polysyllabic Phonic Transfer Indices.

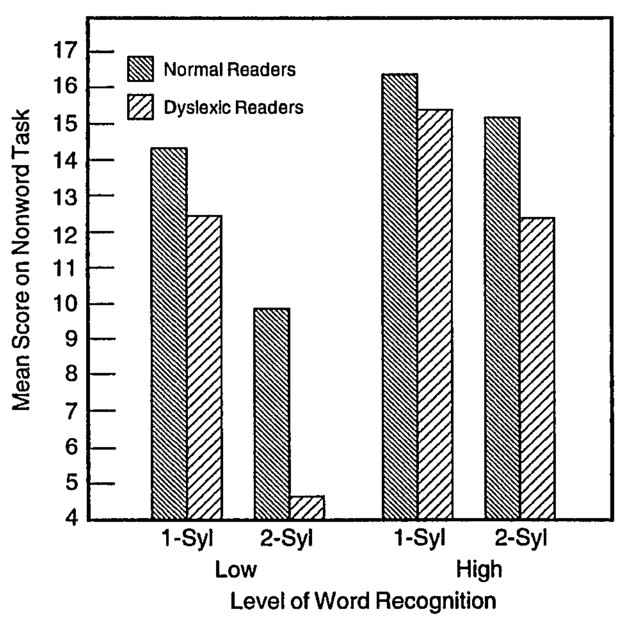

Figure 11. Mean scores of normal and dyslexic readers at high and low levels of word recognition on one-syllable and two-syllable nonword tasks (Snowling, 1981).

However, the second discrepancy between these two studies is more difficult to explain: Snowling's (1981) results indicate that differences between normal and dyslexic readers are larger when nonwords are polysyllabic than when they are monosyllabic; results of the present study generally indicate that differences are larger on monosyllabic nonwords than they are on polysyllabic nonwords.

As can be seen in Figures 10 and 11, polysyllabic nonwords were more difficult to read than were monosyllabic nonwords for all subject in both studies, regardless of the level of word recognition. However, the largest difference in Snowling's (1981) study occurred between normal and dyslexic readers at the low word recognition level. The dyslexic readers at this level obtained extremely low scores on the two-syllable nonword task (see Figure 11). As can be seen in Figure 10, the performance of the poor decoders at the 2.8 Instructional Level on the Polysyllabic Phonic Transfer Index greatly resembles that of Snowling's less advanced dyslexic readers on the two-syllable nonword task: It was also extremely poor. However, the performance of Snowling's less advanced <u>normal</u> readers on that task (see Figure 11) does not resemble the performance of the normal decoders, at the 2.8 Instructional Level, on the Polysyllabic PTI (see Figure 10): Snowling's less advanced normal readers appear to have performed much better on her two-syllable nonword task than did the less advanced normal decoders, in the present study, on the Polysllabic Phonic Transfer Index. Thus, the discrepancy between the findings of these two studies does not concern the performance of the <u>poor</u> readers on the polysyllabic tasks, so much as it concerns the performance of the <u>normal</u> readers on these tasks.

The explanation for this phenomenon may lie in an apparent paradox that was discussed in relationship to a study by Ehri and Robbins (1992): Although analogous strategies may be easier to use than phonological recoding, phonological recoding strategies must be, to some degree, in place before analogic strategies can be used. Snowling's two-syllable nonwords (e.g., <u>tegwop</u>, <u>molsmit</u>) probably required a phonological recoding strategy to decipher. The polysyllabic nonwords in the present study (e.g., brinish, fistake) were directly analogous to real words. In most cases, the reader had to substitute only an initial consonant in order to pronounce the nonword, and a recoding strategy would have been much less efficient than an analogic strategy in reading these words. However, the present study indicates that even normal decoders do not use analogic strategies to decode polysyllabic nonwords until their word recognition is advanced beyond a second-grade level. Thus, the less advanced normal readers in Snowling's study may have been able to phonological recode the two-syllable nonwords, while the less advanced normal decoders in the present study were not able to use the analogic strategy to decode the polysyllabic nonwords. This explanation is consistent with the conclusions drawn by Bowey and Hansen (1992) as well as those of Ehri and Robbins (1992) and Coltheart and Leahy (1992).

The Influence of Deficit-Specific Instruction

The remedial treatment provided to the poor decoders in this study did not influence their ability to read analogous nonwords to any great degree, relative to their levels of word recognition. Poor decoders were able to read more analogous nonwords after treatment than before treatment, and their levels of word recognition also increased during the treatment periods. However, following one year of treatment, poor decoders still did not read either monosyllabic or polysyllabic analogous nonwords as well as normal decoders read them, regardless of their level of word recognition.

Poor decoders who received two years of treatment also did not read polysyllabic analogous nonwords as well as normal decoders read them. Similarly, on monosyllabic analogous nonwords, these treated poor decoders did not perform as well as normal decoders when their word recognition was below the fifth-grade level. However, differences on this measure between the normal decoders and the two-year treated poor decoders at the two highest levels of word recognition (i.e., ILs 5.3 and ≥5.8) were not significant. This suggests that the treatment may have altered the pattern of differences between poor and normal decoders in their ability to decode monosyllabic and polysyllabic analogous nonwords: Untreated poor decoders differed from normal decoders on the polysyllabic analogous nonwords when their word recognition was above second-grade levels but not when their word recognition was at first or second-grade levels. Two-year treated poor decoders differed from normal decoders on the monosyllabic analogous nonwords when their word recognition was below fifth-grade levels, but not when their word recognition was at fifth-grade levels.

However, the results of analyses comparing the monosyllabic and polysyllabic analogous nonword reading of the untreated and treated poor decoders indicate that they did not differ on these measures in any substantial way. Therefore, while treatment may have affected the poor decoders' word recognition levels, as well as their use of rime analogy, it does not appear to have affected their use of rime-analogy, relative to levels of word recognition, to any great degree: Poor decoders who received treatment did not read either type of analogous nonwords any better than poor decoders who did not receive treatment read them, regardless of their word recognition level.

These results are consistent with those of Manis et al. (1993) as well as those of Felton and Wood (1992): Poor decoders may improve in their ability to use analogy as their word recognition levels increase, especially if they are provided with instruction designed to remediate this specific deficit. This was suggested by Gaskins et al. (1988), who provided treatment to poor readers that was similar to that used in the present study. However, the improvement in poor decoders' use of this strategy, which results from increases in the store of identifiable words, does not appear to keep pace with that of normal decoders. Despite the fact that poor decoders in the present study received treatment specifically designed to improve their ability to decode by analogy, differences between poor and normal decoders in their use of this strategy remained, after treatment, fairly consistent at most levels of word recognition.

Limitations of the Study

Evaluation of treatment effects. It must be noted that the present study was not longitudinal and that effects of the treatment program were not measured in any systematic way. We do not know if improvement in the treated poor decoder groups was a result of treatment, because the analogous nonword reading of the treated poor decoder groups was not compared to that of comparable untreated poor decoders (or poor decoders who received different treatment), after intervals of one and two years. However, the results of this study do suggest that deficits in the ability to use phonologically-based strategies in decoding unknown words are extremely difficult to remediate and that the phonological processing deficits of poor decoders are more profound than would be the case if their source was simply inadequate instruction (as has been suggested by Ehri, 1989).

On the other hand, it must be remembered that poor decoders in this study, as in virtually all studies in this area, were identified after they had failed to develop age/grade-expected levels of word recognition. It will be recalled that Peterson and Haines (1992) found that kindergarten children, who were in the earliest states of beginning reading, benefitted from rime-analogy training, but only if their phonological processing skills (e.g., segmentation) were already in place. Students in the Peterson and Haines study who had weak phonological processing skills prior to training might have benefitted, eventually, from continued instruction in the use of the rime-analogy strategy. Nevertheless, it is probable that, if "catch-up" is to occur for children who are even potentially poor decoders, treatment must occur extremely early.

Therefore, it is likely that the effects of treatment on poor decoders ability to use phonologically based decoding strategies can be studied more effectively if potentially poor decoders are identified at the earliest stages of learning to read. Furthermore, treatment should be extensive enough to actually remediate the general word recognition deficits of the poor decoders. The vast majority of poor decoders who received treatment in the present study were not reading on grade level, even after two years of remedial treatment, and poor decoders who exhibited gains in word recognition that were above average for their treatment groups still did not read analogous nonwords as well as normal decoders read them.

Additionally, the importance of linking a rime-analogy strategy to instruction in specific letter-sound relationships cannot be overlooked. It is possible that the treatment program that these subjects received did not provide enough instruction on individual letter-sound relationships, particularly those involving vowels.

Measurement of analogous nonword reading. The Decoding Skills Test (DST) (Richardson & DiBenedetto, 1985), which was used in this study to measure analogous nonword reading, does not provide a good measure of this ability for students whose word recognition levels are below that expected of a second-grade student. (This is a feature of the test's construction.) Therefore, it was impossible to evaluate the analogous nonword reading abilities of subjects in the early stages of learning to read. A measure designed to evaluate monosyllabic analogous nonword reading at early first-grade levels of word recognition could be designed, using rime-analogous nonwords constructed from orthographically regular, first-grade vocabulary words (e.g, hat, can, run). On the other hand, a polysyllabic analogous nonword measure would be more difficult to construct because beginning readers learn very few polysyllabic words, and those that they do learn are usually orthographically and phonologically complex sight words (e.g., bicycle, country). However, polysyllabic analogous nonwords could be designed for use in experimental studies in which subjects learned to read rime-analogous, polysyllabic real words during training.

Appendix A

Mean Number of Monosyllabic (Ms) and Polysyllabic (Ps) Real Words Read Correctly by Normal and Poor Decoder Groups, at Each Instructional Level (IL)

IL			Normal	Untreated poor	1-year treated poor	2-year treated poor
1.8	Ms	M	9.72	8.63	8.12	8.54
		SD	4.74	4.41	4.04	5.49
	Ps	M	3.45	6.19	4.97	6.37
		SD	4.36	5.15	4.75	6.80
2.3	Ms	M	14.58	12.86	13.09	11.21
		SD	4.44	5.11	4.88	4.58
	Ps	M	9.93	10.84	10.70	9.24
		SD	4.81	5.47	5.71	5.02
2.8	Ms	M	18.35	17.57	17.19	17.57
		SD	4.55	4.52	4.29	4.81
	Ps	M	14.97	15.98	15.44	15.85
		SD	4.54	4.94	4.40	4.80
3.3	Ms	M	21.52	21.08	19.07	20.37
		SD	4.14	4.10	3.72	4.10
	Ps	M	18.81	18.70	18.49	19.37
		SD	3.74	4.07	3.90	4.62
3.8	Ms	M	23.31	22.69	23.26	22.38
		SD	3.07	3.34	3.26	3.54
	Ps	M	21.14	21.99	22.16	21.31
		SD	3.22	2.95	3.03	2.70

(Appendix A continues)

Appendix A (continued)

IL			Group: Normal	Untreated poor	1-year treated poor	2-year treated poor
4.3	Ms	M	25.73	24.17	23.91	24.48
		SD	2.70	3.53	3.32	2.83
	Ps	M	23.93	23.85	23.37	23.68
		SD	3.07	3.32	4.52	2.67
4.8	Ms	M	26.70	26.56	25.96	25.96
		SD	2.60	2.60	2.31	2.86
	Ps	M	26.21	26.00	25.96	26.10
		SD	2.54	2.53	2.54	2.00
5.3	Ms	M	27.47	26.88	26.65	26.76
		SD	2.06	3.20	2.11	2.08
	Ps	M	27.28	27.10	27.32	27.48
		SD	2.53	2.98	2.02	2.24
≥5.8	Ms	M	28.80	29.03	28.23	28.70
		SD	1.49	1.19	1.64	1.57
	Ps	M	29.10	29.32	28.73	29.05
		SD	1.29	1.14	1.77	1.36

Appendix B

Mean Monosyllabic (Ms) and Polysyllabic (Ps) Phonic Transfer Scores of Normal and Poor Decoder Groups, at Each Instructional Level (IL)

			Group			
IL			Normal	Untreated poor	1-year treated poor	2-year treated poor
1.8	Ms	M	5.04	2.91	2.73	3.12
		SD	4.35	2.79	3.26	3.63
	Ps	M	.89	1.38	.71	1.71
		SD	1.63	2.40	1.42	5.56
2.3	Ms	M	7.53	5.30	5.34	3.48
		SD	5.18	4.41	4.58	3.06
	Ps	M	2.95	2.88	2.98	1.54
		SD	3.50	3.04	3.84	2.26
2.8	Ms	M	10.43	7.97	7.67	8.35
		SD	5.71	4.86	4.53	5.26
	Ps	M	6.54	6.07	5.45	5.82
		SD	4.52	4.83	4.47	4.83
3.3	Ms	M	12.98	10.20	9.35	10.13
		SD	5.20	5.15	5.07	4.51
	Ps	M	9.40	6.72	7.42	8.68
		SD	5.38	4.45	4.44	4.71
3.8	Ms	M	14.54	12.33	13.70	11.96
		SD	4.77	5.20	4.62	4.73
	Ps	M	16.53	9.29	10.82	8.76
		SD	5.18	4.52	5.09	3.99

(Appendix B continues)

Appendix B (continued)

			Group			
IL			Normal	Untreated poor	1-year treated poor	2-year treated poor
4.3	Ms	M	18.59	14.90	14.52	15.64
		SD	4.59	5.37	4.07	4.95
	Ps	M	14.75	12.60	12.97	12.72
		SD	4.66	5.47	4.96	5.21
4.8	Ms	M	21.44	18.70	18.29	18.26
		SD	4.72	4.85	4.49	5.47
	Ps	M	19.48	17.25	17.12	18.18
		SD	5.12	4.75	4.79	5.29
5.3	Ms	M	21.90	20.17	20.33	20.21
		SD	5.10	4.78	4.04	4.42
	Ps	M	19.97	18.88	19.50	19.82
		SD	5.17	4.88	3.89	5.00
≥5.8	Ms	M	25.64	24.90	22.97	24.67
		SD	3.88	3.85	3.94	3.60
	Ps	M	25.31	24.15	22.86	24.65
		SD	3.81	4.22	3.96	3.41

Appendix C

Results of ANOVAs Comparing Monosyllabic (Ms) and Polysyllabic (Ps) Real Word and Phonic Transfer Scores of Normal and Untreated Poor Decoder Groups

		F-Statistic			
		Real Word		Phonic Transfer	
Effect	df	Ms	Ps	Ms	Ps
Group	1, 1841	22.52**	7.84*	101.62**	32.95**
Inst. Lev.	8, 1841	695.56**	962.79**	484.62**	706.21**
Group x Inst. Level (IL)	8, 1841	1.47	2.58*	1.45	2.72*

Note: Explanation of Significant Group Effects:

Real Ms: Scores of normal decoder group are higher than those of poor decoder group.

Real Ps: Scores of poor decoder group are generally higher than those of normal decoder group. Group by Instructional Level effect is signficant. T-test comparisons at each Instructional Level are shown in Appendix D.

PTms: Scores of normal decoder group are higher than those of poor decoder group.

PTps: Scores of normal decoder group are generally higher than those of poor decoder group. Group by Instructional Level effect is signficant. T-test comparisons at each Instructional Level are shown in Appendix D.

* $p < .01$

** $p < .001$

Appendix D

T-test Comparisons of Mean Polysyllabic Real Word (Realps) and Polysyllabic Phonic Transfer (PTps) Scores of Normal and Untreated Poor Decoder Groups, at Each Instructional Level (IL)

IL	df	t-value Realps	t-value PTps
1.8	175	-3.25**	-1.30
2.3	268	-1.40	0.1.8
2.8	207	-1.45	0.69
3.3	152	0.16	3.14**
3.8	125	-1.53	2.59**
4.3	209	0.18	3.08**
4.8	214	0.60	3.31**
5.3	227	0.49	1.67
≥5.8	265	-1.19	2.03*

Note: Positive t-values indicate that means of the normal decoder group are higher than those of the poor decoder group.

*p < .01

**p < .001

Appendix E

Results of ANOVAs Comparing Monosyllabic (Ms) and Polysyllabic (Ps) Real Word and Phonic Transfer Scores of Normal and One-Year Treated Poor Decoder Groups

		F-Statistic			
		Real Word		Phonic Transfer	
Effect	df	Ms	Ps	Ms	Ps
Group	1, 1656	43.66**	1.32	125.54**	32.43**
Inst. Lev.	8, 1656	698.04**	963.77**	467.44**	695.60**
Group x Inst. Level (IL)	8, 1656	1.50	1.46	1.63	2.31*

Note: All significant Group effects indicate that scores of the normal decoder group are higher than those of the poor decoder group. When Group by Instructional Level interaction is significant, t-test comparisons for scores at each Instructional Level are shown in Appendix F.

*$p < .01$

**$p < .001$

Appendix F

T-test Comparisons of Mean Polysyllabic Phonic Transfer Scores of Normal and One-Year Treated Poor Decoder Groups, at Each Instructional Level (IL)

IL	df	t-value
1.8	134	0.69
2.3	241	-0.05
2.8	221	1.71
3.3	97	2.01*
3.8	103	0.70
4.3	159	2.29*
4.8	228	3.61**
5.3	196	0.70
≥5.8	278	4.68**

Note: Positive t-values indicate that means of the normal decoder group are higher than those of the poor decoder group.

*$p < .01$

**$p < .001$

Appendix G

Results of ANOVAs Comparing Monosyllabic (Ms) and Polysyllabic (Ps) Real Word and Phonic Transfer Scores of Normal and Two-Year Treated Poor Decoder Groups

		F-Statistic			
		Real Word		Phonic Transfer	
Effect	df	Ms	Ps	Ms	Ps
Group	1, 1147	23.72**	1.46	58.67**	11.20**
Inst. Lev.	8, 1147	483.46**	756.53**	317.61**	499.52**
Group x Inst. Level (IL)	8, 1147	2.66*	1.78	1.07	1.06

Note: All significant Group effects indicate that scores of the normal decoder group are higher than those of the poor decoder group. When Group by Instructional Level interaction is significant, t-test comparisons for scores at each Instructional Level are shown in Appendix H.

*$p < .01$

**$p < .001$

Appendix H

T-test Comparisons of Mean Monosyllabic Real Word Scores of Normal and Two-Year Treated Poor Decoder Groups, at Each Instructional Level (IL)

IL	df	t-value
1.8	69	0.94
2.3	140	3.79**
2.8	112	0.85
3.3	70	1.17
3.8	82	1.25
4.3	125	2.06*
4.8	158	1.62
5.3	147	1.74
≥5.8	245	0.39

Note: Positive t-values indicate that means of the normal decoder group are higher than those of the poor decoder group.

*$p < .01$

**$p < .001$

Appendix I

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and Untreated Poor Decoder Groups, Using Subtest 1 Raw Score Range Categories (RSC) to Classify Subjects by Word Recognition Level

Multvariate effect	F^a	df	p	Univariate effect	F	df	p
Group	80.65	2, 3650	<.001	PTIms	156.25	1,3651	<.001
				PTIps	63.21	1,3651	<.001
Raw Score	277.02	14, 7298	<.001	PTIms	272.21	7,3651	<.001
Range (RSC)				PTIps	508.73	7,3651	<.001
Group	2.44	14, 7298	<.01	PTIms	1.62	7,3651	n.s.
x RSC				PTIps	1.28	7,3651	n.s.

[a]Hotellings statistic

Appendix J

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and One-year Treated Poor Decoder Groups, Using Subtest 1 Raw Score Range Categories (RSC) to Classify Subjects by Word Recognition Level

Multtvariate effect	F^a	df	p	Univariate effect	F	df	p
Group	69.07	2, 2387	<.001	PTIms	79.97	1,2388	<.001
				PTIps	81.99	1,2388	<.001
Raw Score	252.08	14, 4772	<.001	PTIms	56.43	7,2388	<.001
Range (RSC)				PTIps	111.68	7,2388	<.001
Group	1.84	14, 4772	<.05	PTIms	1.74	7,2388	n.s.
x RSC				PTIps	1.08	7,2388	n.s.

Note. Significant Group effects indicate that scores of the normal decoder group are higher than those of the poor decoder group.

[a]Hotellings statistic

Appendix K

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and Two-Year Treated Poor Decoder Groups, Using Subtest 1 Raw Score Range Categories (RSC) to Classify Subjects by Word Recognition Level

Multvariate				Univariate			
effect	F^a	df	p	effect	F	df	p
Group	52.00	2, 1530	<.001	PTIms	104.07	1, 1531	<.001
				PTIps	24.59	1, 1531	<.001
Raw Score	153.17	14, 3058	<.001	PTIms	163.45	7, 1531	<.001
Range (RSC)				PTIps	277.60	7, 1531	<.001
Group	1.87	14, 3058	<.05	PTIms	2.51	7, 1531	<.001
x RSC				PTIps	.91	7, 1531	n.s.

Note. Significant Group effects indicate that scores of the normal decoder group are higher than those of the poor decoder group.

[a]Hotellings statistic

Appendix L

T-test Comparisons of Mean Monosyllabic Phonic Transfer Indices of Normal and Two-Year Treated Poor Decoder Groups, at Each Raw Score Range Category (RSC)

RSC	t-value	df	p
32-41	3.20[a]	53.2	<.01
42-51	4.99	160	<.001
52-61	2.44	134	<.05
62-71	1.20	86	n.s.
72-81	4.76	133	<.001
82-91	3.55	196	<.001
92-101	5.62	287	<.001
102-110	4.31	431	<.001

Note. Positive t-values indicate that means of the normal decoder group are higher than those of the poor decoder group.

[a]Separate variance estimates were used to compute t-value when the probability of the F statistic for the homogeniety of variance test was $p < .10$.

Appendix M

Results of ANOVA Comparing Instructional Level Scores of Normal and Untreated Poor Decoder Groups, Using Subtest 1 Raw Score Range Categories (RSC) to Classify Subjects by Word Recognition Level

Effect	df	F
Group	1, 3887	571.05*
Raw Score Range (RSC)	7, 3887	2584.71*
Group x RSC	7, 3887	12.10*

Note: Significant Group effect indicates that scores of the normal decoder group are higher than those of the poor decoder group.

*p < .001

Appendix N

Results of ANOVA Comparing Instructional Level Scores of Normal and One-Year Treated Poor Decoder Groups, Using Subtest 1 Raw Score Range Categories (RSC) to Classify Subjects by Word Recognition Level

Effect	df	F
Group	1, 2433	184.01*
Raw Score Range (RSC)	7, 2433	1931.76*
Group x RSC	7, 2433	5.24*

Note: Significant Group effect indicates that scores of the normal decoder group are higher than those of the poor decoder group.

*p < .001

Appendix O

Results of ANOVA Comparing Instructional Level Scores of Normal and Two-Year Treated Poor Decoder Groups, Using Subtest 1 Raw Score Range Categories (RSC) to Classify Subjects by Word Recognition Level

Effect	df	F
Group	1, 1534	81.51*
Raw Score Range (RSC)	7, 1534	1441.58*
Group x RSC	7, 1534	2.77*

Note: Significant Group effect indicates that scores of the normal decoder group are higher than those of the poor decoder group.

*$p < .001$

Appendix P

Mean Monosyllabic (Ms) and Polysyllabic (Ps) Phonic Transfer Indices of Treated Poor Decoders Who Were Above Average Responders to Treatment

		1-year treated		2-year treated	
IL		Ms	Ps	Ms	Ps
2.3	M	.33	.17	—	—
	SD	.21	.22		
	n	24			
2.8	M	.43	.32	—	—
	SD	.21	.27		
	n	32			
3.3	M	.48	.40	—	—
	SD	.23	.23		
	n	34			
3.8	M	.59	.50	.53	.39
	SD	.15	.20	.16	.18
	n	28		23	
4.3	M	.61	.56	.63	.52
	SD	.13	.17	.17	.18
	n	51		24	
4.8	M	.69	.66	.70	.69
	SD	.15	.16	.18	.17
	n	98		43	
5.3	M	.77	.72	.74	.72
	SD	.12	.12	.14	.14
	n	64		29	

(Appendix P continues)

Appendix P (continued)

IL		1-year treated		2-year treated	
		Ms	Ps	Ms	Ps
≥5.8	M	.81	.80	.85	.83
	SD	.12	.12	.10	.10
	n	65		27	

Appendix Q

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and One-Year Treated Poor Decoders Who Were Above Average Responders to Treatment

Multvariate effect	F^a	df	p	Univariate effect	F	df	p
Group	34.88	2, 1194	<.001	PTIms	69.46	1,1195	<.001
				PTIps	25.32	1,1195	<.001
Instructional	92.64	14, 2386	<.001	PTIms	111.55	7,1195	<.001
Level (IL)				PTIps	169.25	7,1195	<.001
Group	1.20	14, 2386	n.s.	PTIms	1.95	7,1195	n.s.
x IL				PTIps	.65	7,1195	n.s.

Note. Significant Group effects indicate that scores of the normal decoder group are higher than those of the poor decoder group.

[a]Hotellings statistic

Appendix R

Results of MANOVA Comparing Monosyllabic and Polysyllabic Phonic Transfer Indices (PTIms and PTIps) of Normal and Two-Year Treated Poor Decoders Who Were Above Average Responders to Treatment

Multvariate effect	F[a]	df	p	Univariate effect	F	df	p
Group	16.71	2, 725	<.001	PTIms	30.51	1,726	<.001
				PTIps	20.60	1,726	<.001
Instructional	44.73	8, 1448	<.001	PTIms	50.78	4,726	<.001
Level (IL)				PTIps	83.01	4,726	<.001
Group	1.93	8, 1448	n.s.	PTIms	.94	4,726	n.s.
x IL				PTIps	2.40	4,726	<.05

Note. Significant Group effects indicate that scores of the normal decoder group are higher than those of the poor decoder group.

[a]Hotellings statistic

References

Backman, J., Bruck, M., Hébert, M., & Seidenberg, M. S. (1984) Acquisition and use of spelling-sound correspondences in reading. Journal of Experimental Child Psychology, 38, 114-133.

Baddeley, A. D., Logie, R. H., & Ellis, N. C. (1988). Characteristics of developmental dyslexia. Cognition, 29, 197-228.

Badian, N. A., McAnulty, G. B., Duffy, F. H., & Als, H. (1990). Prediction of dyslexia in kindergarten boys. Annals of Dyslexia, 40, 152-169.

Baron, J. (1979). Orthographic and word specific mechanisms in children's reading of words. Child Development, 50, 60-72.

Beech, J. R., & Awaida, M. (1992). Lexical and nonlexical routes: A comparison between normally achieving and poor readers. Journal of Learning Disabilities, 25, 196-206.

Beech, J. R., & Harding, L. M. (1984). Phonemic processing and the poor reader from a developmental lag viewpoint. Reading Research Quarterly, 19, 357-366.

Bowey, J. A., & Hansen, J. (1994). The development of orthographic rimes as units of word recognition. Journal of Experimental Child Psychology, 58, 465-488.

Bradley, L. (1988). Making connections in learning to read and spell. Applied Cognitive Psychology, 2, 3-18.

Bradley, L., & Bryant, P. E. (1983). Categorizing sounds and learning to read--a causal connection. Nature, 301, 419-421.

Bradley, L., & Bryant, P. E. (1985). Rhyme and reason in reading and spelling. Ann Arbor: University of Michigan Press.

Brady, S. A., & Shankweiler, D. P. (1991). Phonological processes in literacy. Hillsdale, NY: Lawrence Erlbaum.

Brown, I. S. & Felton, R. H. (1990). Effects of instruction on beginning reading skills in children at risk for reading disability. Reading and Writing, 2, 223-241.

Brown, G., & Watson, F. (1991). Recent development in dyslexia: A connectionist approach. In M. Snowling & M. Thomson (Eds.), Dyslexia: Integrating theory and practice (pp. 165-182). London: Whurr.

Bruck, M. (1990). Word-recognition skills of adults with childhood diagnoses of dyslexia. Developmental Psychology, 26, 349-354.

Bruck, M. (1992). Persistence of dyslexics' phonological awareness deficits. Developmental Psychology, 28, 874-886.

Bruck, M., & Treiman, R. (1992). Learning to pronounce words: The limitations of analogies. Reading Research Quarterly, 27, 374-388.

Byrne, B. (1992). Studies in the acquisition procedure for reading: Rationale, hypotheses, and data. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), Reading acquisition (pp. 1-34). Hillsdale, NJ: Lawrence Erlbaum Associates.

Catts, H. W. (1991). Early identification of reading disabilities. Topics in Language Disorders, 12 (1), 1-16.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), Strategies of information processing (pp. 151-216). London: Academic Press.

Coltheart, V., & Leahy, J. (1992). Children's and adults' reading of nonwords: Effects of regularity and consistency. Journal of Experimental Psychology, 18, 718-729.

Conners, F. & Olson, R. (1990). Reading comprehension in dyslexic and normal readers: A component skills analysis. In D. A. Balota, G. B. Flores d'Arcais, & K. Rayner (Eds.), Comprehension processes in reading (pp. 587-589). Hillsdale, NJ: Erlbaum.

Cunningham, A. E. (1990). Explicit versus implicit instruction in phonemic awareness. Journal of Experimental Child Psychology, 50, 429-444.

DiBenedetto, B., Richardson, E., & Kochnower, J. (1983). Vowel generalization in normal and learning disabled readers. Journal of Educational Psychology, 75, 576-582.

Ehri, L. C. (1987). Learning to read and spell words. Journal of Reading Behavior, 19, 5-31.

Ehri, L. C. (1989). The development of spelling knowledge and its role in reading acquisition and reading disability, Journal of Learning Disabilities, 22, 356-365.

Ehri, L. C. (1992). Reconceptualizing the development of sight word reading and its relationship to recoding. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), Reading acquisition (pp. 107-143). Hillsdale, NJ: Lawrence Erlbaum Associates.

Ehri, L. C., (1994). Development of the ability to read words: Update. In R. Ruddell, M. Ruddell, & H. Singer (Eds.), Theoretical models and processes of reading. Newark, DE: International Reading Association.

Ehri, L. C., & Robbins, C. (1992). Beginners need some decoding skills to read words by analogy. Reading Research Quarterly, 27, 13-16.

Ehri, L. C., & Saltmarsh, J. (1995). Beginning readers outperform older disabled readers in learning to read words by sight.. Unpublished manuscript.

Ehri, L. C., & Wilce, L. S., (1985). Movement into reading: Is the first stage of printed word learning visual or phonetic? Reading Research Quarterly, 20, 163-179.

Ehri, L. C., & Wilce, L. S. (1987). Cipher versus cue reading: An experiment in decoding acquisition. Journal of Educational Psychology, 79, 3-13.

Ellis, N., & Large, B. (1987). The development of reading: As you seek so shall you find. British Journal of Psychology, 78, 1-28.

Felton, R. H. (1993). Effects of instruction on the decoding skills of children with phonological processing problems. Journal of Learning Disabilities, 26, 583-589.

Felton, R. H. & Brown, I. S. (1989). Phonological processes as predictors of specific reading skills in children at risk for reading failure. Reading and Writing, 2, 3-23.

Felton, R. H. & Wood, F. B. (1992). A reading level match study of nonword reading skills in poor readers with varying IQ. Journal of Learning Disabilities, 25 , 318-326.

Foorman, B., & Liberman, D. (1989). Visual and phonological processing of words: A comparison of good and poor readers. Journal of Learning Disabilities, 6, 349-355.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall, & M. Coltheart (Eds.), Surface dyslexia. London: Routledge & Kegan Paul.

Gaskins, I. W., Downer, M. A., Anderson, R. C., Cunningham, P. M., Gaskins, R. W., Schommer, M., & The Teachers of Benchmark School (1988). A metacognitive approach to phonics: Using what you know to decode what you don't know. Remedial and Special Education, 9 (1), 36-41.

Glushko, R. J. (1979). The organization and activation of orthographic knowledge in reading aloud. Journal of Experimental Psychology: Human Perception and Performance, 5, 674-691.

Goldman, R., Fristoe, M., & Woodcock, R. W. (1974). The GFW Sound-Symbol Test. Circle Pines, MN: American Guidance Service.

Goswami, U. (1986). Children's use of analogy in learning to read: A developmental study. Journal of Experimental Child Psychology, 42, 73-83.

Goswami, U. (1988). Orthographic analogies and reading development. Quarterly Journal of Experimental Psychology, 40 (a), 239-268.

Goswami, U. (1990). A special link between rhyming skills and use of orthographic analogies by beginning readers. Journal of Child Psychology and Psychiatry, 31, 301-311.

Goswami, U. (1991). Recent work on reading and spelling development. In M. Snowling & M. Thomson (Eds.), Dyslexia: Integrating theory and practice (pp. 108-121). London: Whurr.

Goswami, U. (1993). Toward an interactive analogy model of reading development: Decoding vowel graphemes in beginning reading. Journal of Experimental Child Psychology, 56, 443-475.

Goswami, U., & Bryant, P. (1992). Rhyme, analogy, and children's reading. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), Reading acquisition (pp. 49-63). Hillsdale, NJ: Lawrence Erlbaum Associates.

Goswami, U., & Mead, F. (1992). Onsets and rime awareness and analogies in reading. Reading Research Quarterly, 27, 152-162.

Gough, P. B., & Hillinger, M. L. (1980). Learning to read: An unnatural act. Bulletin of the Orton Society, 30, 179-196.

Harris, A. J., & Jacobson, M. D. (1972). Basic elementary reading vocabularies. New York: Macmillan.

Holligan, C., & Johnston, R. (1988). The use of phonological information by good and poor readers in memory and reading tasks. Memory and Cognition, 16, 522-532.

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. Journal of Educational Psychology, 80, 437-447.

Juel, C., Griffith, P. L., & Gough, P. B. (1986). Acquisition of literacy: A longitudinal study of children in first and second grade. Journal of Educational Psychology, 78, 243-255.

Kirtley, C., Bryant, P., Maclean, M., & Bradley, L. (1989) Rhyme, rime, and the onset of reading. Journal of Experimental Child Psychology, 48, 224-245.

Kochnower, J., Richardson, E., & DiBenedetto, B. (1983). A comparison of the phonic decoding ability of normal and learning disabled children. Journal of Learning Disabilities, 16, 348-351.

Kay, J., & Marcel, A. (1981). One process, not two, in reading aloud: Lexical analogies do the work of non-lexical rules. Quarterly Journal of Experimental Psychology, 33 (a), 397-413.

Laxon, V. J., Coltheart, V., Keating, C. (1988) Children find friendly words friendly too: Words with many orthographic neighbors are easier to read and spell. British Journal of Educational Psychology, 58, 103-119.

Laxon, V., Smith, B., & Masterson, J. (1995). Children's nonword reading: Pseudohomophones, neighbourhood size, and priming effects. Reading Research Quarterly, 30, 126-144.

Lesgold, A., & Resnick, L. (1982). How reading difficulties develop: Perspectives from a longitudinal study. In J. Das, R. Mulcahey, & A. Wall (Eds.), Theory and research in learning disabilities (pp. 155-187). New York: Plenum Press.

Liberman, I. Y., & Liberman, A. M. (1992). Whole language versus code emphasis: Underlying assumptions and their implications for reading instruction In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), Reading acquisition (pp. 343-366). Hillsdale, NJ: Lawrence Erlbaum Associates.

Liberman, I. Y., Shankweiler, D., Liberman, A. M., Fowler, C., & Fischer, F. W. (1977). Phonemic segmentation and recoding in the beginning reader. In A. S. Reber and D. I. Scarborough (Eds.), Toward a psychology of reading. Hillsdale, NJ: Lawrence Erlbaum Associates.

Lovett, M. W., Ransby, M. J., Hardwick, N., Johns, M. S., & Donaldson, S. A. (1989). Can dyslexia be treated? Treatment-specific and generalized treatment effects in dyslexic children's response to remediation. Brain and Language, 37, 90-121.

Lovett, M. W., Warren-Chaplin, P. M., Ransby, M. J., & Borden, S. L. (1990). Training the word recognition skills of reading disabled children: Treatment and transfer effect. Journal of Educational Psychology, 82, 769-780.

Lundberg, I., Olofsson, A., & Wall, S. (1980). Reading and spelling skills in the first school years predicted from phonemic awareness skills in kindergarten. Scandinavian Journal of Psychology, 21, 159-173.

MacLean, M., Bryant, P., & Bradley, L. (1987). Rhymes, nursery rhymes and reading in early childhood. Merril-Palmer Quarterly, 33, 255-282.

Manis, F. R., & Morrison, F. J. (1985) Reading disability: A deficit in rule learning? In L. S. Siegel & F. J. Morrison (Eds.), Cognitive development in atypical children (pp. 1-26). New York: Springer-Verlag.

Manis, F. R., Szeszulski, P. A., Holt, L. K., & Graves, K. (1988). A developmental perspective on dyslexic subtypes. Annals of Dyslexia, 38, 139-153.

Manis, F. R., Custodio, R., & Szeszulski, P. A. (1993). Development of phonological and orthographic skill: A 2-year longitudinal study of dyslexic children. Journal of Experimental Child Psychology, 56, 64-86.

Marsh, G., Desberg, P., & Cooper, J. (1977). Developmental strategies in reading. Journal of Reading Behavior, 9, 391-394.

Marsh, G., Friedman, M. P., Desberg, P., & Saterdahl, K. (1981). Comparison of reading and spelling strategies in normal and reading disabled children. In P. Friedman, J. P. Das, & N. O'Connor (Eds.), Intelligence and learning (pp. 363-367). New York: Plenum Press.

Marsh, G., Friedman, M. P., Welch, V., & Desberg, P. (1980). A cognitive-developmental approach to reading acquisition. In G. E. MacKinnon & T. G. Waller (Eds.), Reading Research: Advances in theory and practice (Vol. 3, pp. 199-221). San Diego, CA: Academic Press.

Olson, R., Wise, B., Conners, F., Rack, J., & Fulker, D. (1989). Specific deficits in component reading and language skills: Genetic and environmental influences. Journal of Learning Disabilities, 22, 339-348.

Perfetti, C. A. (1985). Reading ability. New York: Oxford University Press.

Peterson, M. E., & Haines, L. P. (1992). Orthographic analogy training with kindergarten children: Effects on analogy use, phonemic segmentation, and letter-sound knowledge. Journal of Reading Behavior, 24, 109-127.

Rack, J. P., Snowling, M. J., & Olson, R. K. (1992). The nonword reading deficit in developmental dyslexia: A review. Reading Research Quarterly, 27 (1), 29-53.

Richardson, E. (1985). The reliability, validity, and flexibility of the Decoding Skills Test. In D. B. Gray & J. F. Kavanagh (Eds.), Biobehavioral measures of dyslexia (pp. 279-296). Parkton, MD: York Press.

Richardson, E., & DiBenedetto, B. (1985). The Decoding Skills Test. Los Angeles: Western Psychological Associates.

Richardson, E., & DiBenedetto, B. (1989). The Linguistic Pattern Series. Mount Vernon, NY: ISM Teaching Systems.

Richardson, E., & DiBenedetto, B. (1991). Acquiring the linguistic code for reading: A model for teaching and learning. In J. F. Kavanagh (Ed.), The Language continuum: From infancy to literacy (pp. 63-113). Parkton, MD: York Press.

Richardson, E., DiBenedetto, B., & Adler, A. (1982). Use of the Decoding Skills Test to study differences between good and poor readers. In K. D. Gadow & I. Bialer (Eds.), Advances in learning and behavioral disabilities (pp. 25-74). Greenwich, CN: JAI Press.

Shankweiler, D., Crain, S., Brady, S., & Marcuso, P. (1992). Identifying the causes of reading disability. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), Reading acquisition (pp. 275-305). Hillsdale, NJ: Lawrence Erlbaum Associates.

Share, D., Jorm, A., MacLean, R., & Matthews, R. (1984). Sources of individual differences in reading acquisition. Journal of Educational Psychology, 76, 1309-1324.

Siegel, L. S., & Ryan, E. B. (1988). Development of grammatical sensitivity, phonological, and short-term memory skills in normally achieving and learning disabled children. Developmental Psychology, 24, 28-37.

Snowling, M. J. (1981). Phonemic deficits in developmental dyslexia. Psychological Research, 43, 219-234.

Snowling, M. & Thomson, M. (Eds.). (1991). Dyslexia: Integrating theory and practice. London: Whurr.

Sonday, W. (1991). The road to reading: Basic skills to college allowances. In M. Snowling & M. Thomson (Eds.), Dyslexia: Integrating theory and practice (pp. 283-292). London: Whurr.

Stanback, M. L. (1992) Syllable and rime patterns for teaching reading: Analysis of a frequency-based vocabulary of 17,602 words. Annals of Dyslexia, 42, 196-221.

Stanovich, K. E. (1988a). The right and the wrong places to look for the cognitive locus of reading disability. Annals of Dyslexia, 38, 154-177.

Stanovich K. E. (1988b). Explaining the difference between the dyslexic and the garden-variety poor reader: The phonological-core variable-difference model. Journal of Learning Disabilities, 21, 590-612.

Stanovich, K. E. (1991). Word recognition: Changing perspectives. In P. D. Pearson (Ed.) Handbook of reading research (Vol. 2, pp. 418-452). White Plains, NY: Longman.

Szeszulski, P. A., & Manis, F. R. (1987). A comparison of word recognition processes in dyslexic and normal readers at two reading age-levels. Journal of Experimental Child Psychology, 44, 364-376.

Taraban, R., & McClelland, J. L. (1987). Conspiracy effects in word pronunciation. Journal of Memory and Language, 26, 608-631.

Treiman, R. (1985). Onsets and rimes as units of spoken syllables: Evidence from children. Journal of Experimental Child Psychology, 39, 161-181.

Treiman, R. (1986). The division between onsets and rimes in English syllables. Journal of Memory and Language, 25, 476-491.

Treiman, R. (1992). The role of intrasyllabic units in learning to read and spell. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), Reading acquisition (pp. 65-106). Hillsdale, NJ: Lawrence Erlbaum Associates.

Treiman, R., Goswami, U., & Bruck, M. (1990). Not all nonwords are alike: Implications for reading development and theory. Memory and Cognition, 18, 559-567.

Treiman, R. & Hirsh-Pasek, K. (1985). Are there qualitative differences in reading behavior between dyslexics and normal reader? Memory & Cognition, 13, 357-365.

Treiman, R., & Zukowski, A. (1991). Levels of phonological awareness. In S. A. Brady & D. P. Shankweiler (Eds.), Phonological processes in literacy (pp. 67-83). Hillsdale, NJ: Lawrence Erlbaum Associates.

Peterson, M. E., & Haines, L. P. (1992). Orthographic analogy training with kindergarten children: Effects on analogy use, phonemic segmentation, and letter-sound knowledge. Journal of Reading Behavior, 24, 109-127.

van Daal, V. H. P., Reitsma, P., & van der Leij, A. (1994). Processing units in word reading by disabled readers. Journal of Experimental Child Psychology, 57, 180-210.

Vellutino, F. R., & Scanlon, D. M. (1987). Phonological coding, phonological awareness, and reading ability: Evidence from a longitudinal study. Merril-Palmer Quarterly, 33, 321-363.

Venezky, R. L. (1970). The structure of English orthography. The Hague: Mouton.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. Psychological Bulletin, 101, 192-212.

Wise, B. W., Olson, R. K., & Treiman, R. (1990). Subsyllabic units in computerized reading instruction: Onset-rime versus postvowel segmentation. Journal of Experimental Child Psychology, 49, 1-19.

Wylie, R. E., & Durrell, D. D. (1970). Elementary English, 47, 787-791.

Zecker, S. G. (1991). The orthographic code: Developmental trends in reading-disabled and normally-achieving children. Annals of Dyslexia, 41, 178-192.