The Performance and Strategies of Adolescents in Learning to Read Artificial Words

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Abstract

The present study explored processing strategies used by individuals when they begin to read a script. Stimuli were artificial words created from symbols and based on an alphabetic system. The words were presented to Grade Nine and Ten students, with variations included in the difficulty of orthography and word familiarity, and then scores were recorded on the mean number of trials for defined learning variables. Qualitative findings revealed that subjects learned parts of the visual and auditory features of words prior to hooking up the visual stimulus to the word's name. Performance measures which appear to affect the rate of learning were as follows: auditory short-term memory, auditory delayed short-term memory, visual delayed short- term memory, and word attack or decoding skills. Qualitative data emerging in verbal reports by the subjects revealed that strategies they perceived to use were, graphic, phonetic decoding and word reading.

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CHAPTER ONE

INTRODUCTION

In today's early reading instruction, whole language is the dominant theory. Within the framework of whole language instruction, whole word reading is important. Although some word analysis skills are taught in whole language programs, there is a high probability that the child will be attempting to read words which he or she has written wholistically.

There is a lack of theoretical models that describe how a word might be learned and read wholistically. In examining research literature, it became apparent that a model of paired associate learning might tell more about the whole word learning process. Therefore, a decision was made to create a whole word learning task that seemed to simulate whole word learning in the initial stages. A simulated task with an artificial alphabet was used in an attempt to control for possible alphabetic knowledge and use of word analysis skills in the reader. This study is not concerned with the whole process of reading, but is more focused on a simulation of very early word learning.

BACKGROUND TO THE STUDY

This research is concerned with the processing that an individual engages in when a new word is being learned, and the strategies used throughout the learning process. Although other factors such as grammatical development and comprehension skills have been shown to contribute to reading development, the focus of this study is on the processing that is employed when a new word is learned.

It is argued here that the acquisition of new reading words is highly significant in determining success in reading ability. Unfortunately, however, this type of learning has not been given detailed attention in the reading research. A number of studies have been done on the movement into reading, with a debate on whether beginning to read is natural (Goodman & Goodman, 1979) or requires special skills to process print (Gough & Hillinger, 1980; Ehri, 1987; Ehri & Wilce, 1985), and a number of theories have attempted to identify the component skills required in learning to read (Ehri, 1987; Wagner, 1983; Wagner, 1985; Vellutino & Scanlon, 1987) or the specific stages involved in learning to read(Ehri, 1987; Lomax & McGee, 1987 ; Gough & Hillinger, 1980). However, few if any of these studies have attempted to specify the processes

involved in the acquisition of new reading words apart from the identification of general skills such as phonics or context analysis which are related to word acquisition only at certain stages of reading development. Put another way, although such general skills have been identified and studied, these skills have not been fit into a model of word learning that deals with the total acquisition process for a given word.

In contrast, verbal learning theory has given considerable attention to the problem of specifying how a single item such as a word might be acquired. One particular theory put forth by Greeno, James, DaPolito and Polson (1978) might have something to offer in the form of a hypothesis if the initial stages of visual word learning are similar to those in visual-verbal paired associate learning. Gough & Hillinger (1980) have suggested that reading begins as a child forms an association between a printed word and its spoken form in the same way that a college student learns paired associates. They are not suggesting that a child gradually acquires all words automatically by rote, but rather that beginning reading is a matter of selective learning. Greeno, et al. (1978) explain that this selective learning occurs when the learner seeks an attribute of a stimulus which will distinguish it from other similar stimuli. Therefore, if the reader were

learning the new word "dog", he or she might notice that it begins with a "d", that there is a circle in the middle, or that there is a tail at the end. The attribute chosen must be successful at the next attempt of reading that word or the reader will either choose another attribute or select additional attributes for that word.

The present study set out to delve deeper into the processing that does occur when an individual learns to read words. By breaking up the learning process into the coding processes that have been hypothesized to occur and then examining the strategies that students use to learn words, it should be possible to gain further insights into word learning and reading tasks.

Purpose of the Study

Given the importance of word learning to reading development, there is a need to examine the word learning process carefully. In the past, however, much word learning research has assessed only the ability to decode words (i.e., split words into syllables, take away the first sound, etc.). These studies have demonstrated how readers decode words and sounds that they already know. This study, in contrast, attempted to gain insight into the early stages of learning to identify words and the strategies used in visual word reading. By looking at word learning in its initial

stages, it may be possible to identify some of the basic acquisition skills and to identify points at which learning difficulties occur. As well, it may be possible to determine which reading related performance measures seem to be most related to word reading.

Specifically, then, the purpose of this study was to gain insight into the word learning process by examining the relationship between performance measures and the processes used in visual word learning. This study looked at reading ability in relation to a paired associate learning task which mimicked word learning with a within subject manipulation of: 1) orthographic difficulty (stimulus meaningfulness manipulation) and, 2) response familiarity (response meaningfulness manipulation). This study also attempted to show relationships between basic learning processes and reading related skills performance.

Significance of the Study

The relevance of this study to the area of reading is in the examination of the processing an individual engages in while participating in a word learning task. This information may be of importance in determining word identification performance and reading ability. This study is also significant because it examines reading related skills and their relationship to these learning processes.

Overview of Study

This study will review the research on beginning reading, focusing on studies that have looked at stages of developing reading and the coding processes and skills required to learn how to read words.

The background chapter will provide insight into past research on development of stages in reading, skills required to learn how to read, and the learning required to establish codes for reading.

Overall, reading seems to require learning of the visual features of words, the word's name, and a hook-up of the visual features to the word's name (Wagner, 1985). The learning of these codes was tested by using a dual code learning process, where an individual must learn some visual features and the name of the word and then connect them. This dual code learning process was examined, in this study, by a test that incorporated some principles of the Greeno et al. (1978) model of learning which examines paired-associate learning. This study assumes that the process of learning to read words is like a paired-associate task where an individual learns a stimulus and a response and learns to hook them up.

In addition, this study examines the coding processes that individuals seem to use in learning to read words and, also, the deficits in reading related

skills or performance measures skills that seem to show a relationship to the ability to learn words.

Finally, all of the results were assembled into a model that outlines a potential progression of stages in learning how to read words. All of this prior research will be explained and expanded in the following chapter.

Important Terms

This section will deal briefly with some of the terms specific to this type of research.

Visual within code learning is usually referred to as visual discrimination or visual feature learning (Gibson, 1969) and involves identifying and encoding features which may be used to identify the word in the future. Please note that in this study the terms of visual discrimination learning, visual feature learning and stimulus encoding will all be synonymous. The visual stimulus will also be sometimes referred to as visual orthography or orthographic structure. This terminology is necessary due to the different uses by authors in describing processes related to their studies. In addition, the terms lexical association learning, association learning and name retrieval will all be used to denote the same process. Free recall of words, which in this study refers to the simple recall

of the name of the word, will also be called response learning. Free recall means to only recall the auditory name without connection to the visual features. In addition, any skills that have been found in past research to be related to learning to read will be referred to as reading related skills or performance measures which appear to be related to learning to read. Although many articles have termed them as reading subskills, it was determined that it was not clear whether these were all subskills or not; therefore, subskills did not seem to be an adequate description. These terms will be explained more fully and given operational definitions in the following sections.

CHAPTER TWO

Literature Review

This literature review examines the research related to the processes involved in visual word learning and the strategies used by individuals to solve the various problems of visual word learning.

Word Learning Theories

Most word learning theories fall under one of two categories: non-analytic correspondence and analytic correspondence (Brooks, 1978). Some theorists such as Goodman & Goodman (1979) claimed that beginning to read is natural and that it occurs through encounters with print in the environment. This would be related to a very elementary form of theory similar to non-analytic correspondence where the stimulus (or visual orthography) is hooked up to the response (word name) on the basis of a single overall similarity measure rather than a series of individual correspondences between components of stimulus and response. On the other hand, discussions regarding analytic correspondence often take one of the two extreme positions: reliance on specific-stimulus learning or complete reliance on rules (Rozin & Gleitman, 1977). Theories stressing that words are assessed for the main

part by visual features of letter groups also admit that there is a certain amount of specific phonological coding. The other extreme position is that the reader uses either implicit or explicit knowledge of spelling rules to convert the visual form of a word into a phonological form so he/she can use names that are part of his/her spoken vocabulary. A reader who becomes proficient at this task should be able to read words in his/her spoken vocabulary that he/she has not seen in writing before (Brooks, 1978). These analytic correspondence theories appear to follow a two-stage process of specific learning required prior to the stimulus-response hook-up, whereas the non-analytic correspondence theories bypass a first stage of initial learning prior to direct whole word learning.

Gough and Hillinger (1980) have suggested that the first stage of reading consists of paired-associate learning, which they called code learning. In this stage, they say, a distinctive visual feature of the stimulus (e.g., a zig-zag line in one of the letters or a contour of the spelling) is selected and associated arbitrarily with the word response. They describe the following possible sequence of paired-associate learning: to begin, the individual is presented with a visual word and is told its name. He/she chooses some aspect or attribute and stores the association in memory. When the individual next sees that attribute

(whether it is the correct stimuli or another stimuli that shares that same attribute), he/she will retain the attribute-word association. If it is incorrect, on the other hand, he/she will choose another attribute. Gough and Hillinger (1980) suggest that a child learns to read his/her first words in much this manner. For example, when presented with the word "dog", the child may note an attribute (i.e., begins with d, has a circle in the middle, or a tail on the end) and associate it with the spoken word in memory.

Gough and Hillinger (1980) make several observations related to their selective hypothesis. First, they feel that with the selective hypothesis, the first few words will come easily, as long as there is one distinctive cue. For example, children will recognize "McDonald's" or "Pizza Hut" in their distinctive fonts long before they can read "dog" or "house" from a book. This also lends some explanation to some errors early readers make in not noticing all letters in words or even their order. For example, they may read any word beginning with "d" as "dog" or may write "stop" as "tops". This also can offer some explanation as to why children read a word correctly once and then read it incorrectly the next time. In addition, the selectional hypothesis explains why inconsistent results have occurred to date in the search for cues children use. Gough and Hillinger

(1980) stress that it is doubtful that any particular attribute is used consistently. children will use whatever is successful for them. For example, some children may feel more success using the first couple of letters for some words, and double letters for other words, or a distinctive letter which reminds them of the word (i.e., that word is dog because the "g" looks like a tail).

Gough and Hillinger (1980) do note one problem with the paired-associate approach, and that is the increase in difficulty of learning to recognize a word with each additional word given to the child. When someone is faced with two words, any cue used to distinguish the two could be acceptable. However, as the vocabulary increases, many more similar words will be included and the cues or attributes used to distinguish them will become increasingly complex. Therefore, Gough and Hillinger (1980) suggest that the end of the associationist stage comes gradually as the frequency of errors and confusion increases. They do not claim that the child completely discards the skills of choosing attributes for all words since many words in the English language could be mastered in no other way due to their irregular spellings.

Ehri (1987) termed this learning <u>cue learning</u> so as not to mix it with decoding since there is no decoding at this stage. While cue learning may be used by

beginners to read up to 40 or so words, the system breaks down when the amount of visual feature information available for distinguishing among words is exhausted. At this point it is argued that learners shift to a second stage, called cipher reading, where they begin to use letter-sound relations to read words. Ehri (1985) found evidence that suggested that movement into reading requires children to process print in a qualitatively different manner than prereaders. Her research found that prereaders read differently than readers, where prereaders seem to be using a cue reading and readers usè cipher reading. Kindergarteners (prereaders) learned to read visual spellings more easily than phonetic spellings, while novice and veteran readers learned phonetic spellings more easily. These findings suggested that when children move into reading (cipher reading) they change from a visual cue processing of words to phonic cue processing. Phonetic processing skills require recognizing and remembering some associations between letters in spellings and sounds in pronunciations.

Ehri (1985) reported some evidence that cipher reading begins quite early in the learning to read process. She found that letter-sound processing is what beginners do at the outset of learning. Even when they are able to identify a small number of words, they do this by accessing phonetic associations stored in

memory. Children appear to use what Ehri terms _letter-sound recognition memory mechanism_. In order to use this system, children must be familiar with letters and their names or sounds. Also, when they see and hear spellings paired with pronunciations of words, they must pay attention to how some of the letters symbolize phonetic units detected in pronunciation. For example, when they see "jail" and hear "jail", they may associate the "j" and "l" with pronunciation. When reading begins, children's phonetic analysis of spellings are partial and incomplete because they know only some letter-sound correspondences. Words with similar letters are easily mistaken. They use mainly associations between consonant letters and sounds to remember spellings, not vowel-letter sound associations which are more complex and variable (Venenzky, 1970). Although this begins poorly, as children's knowledge of letter-sound mapping relations expands, their knowledge of different spellings as symbols for pronunciation becomes more complete and they will remember more letter-sound associations. What does not appear in this particular explanation is a discussion of how children get to the point where they can recognize a couple of words. It might be, for example, that they do not abandon one coding strategy for another, but rather that they integrate and build upon each other throughout the learning process.

In this respect, it can be argued that words are coded in terms of visual, auditory, semantic and episodic information (Craik & Tulving, 1975). It is important to note that a task may involve more than one type of coding, however. For example, a phonetic orienting task may have the stimulus word presented visually while the subject makes a decision regarding its sound. Coding as referred to above is the "abstract internal representation in memory of events and relations between events: it relates to the structure of memory, its components and their organizations within a system" (Haines & Leong, 1983, p. 67).

Coding Processes Related to Reading

A number of studies have examined coding abilities or processes as they are related to reading (e.g., Brooks, 1978; Leong, 1986; Manis, Savage, Morrison, Horn, Howell, Szeszulski & Holt, 1987; Vellutino & Scanlon, 1987; and Whyte & Harland, 1984). According to Vellutino and Scanlon (1987) both name retrieval and alphabetic mapping are important skill determinants for word identification and deficiencies in either skill will lead to reading disability. With this notion in mind, the above- mentioned studies all incorporated stimuli constructed with artificial symbols in a word learning task similar to paired associate learning, where the symbols mimicked an alphabetic or word

system. As Savage (1983) stressed, the use of artificial novel stimuli eliminates the need to control for frequency of past exposure. This implies that all individuals will be involved in the task at a very primitive level since they have no prior experience with the symbols used in the stimuli. Thus, they all begin with an equivalent lack of knowledge and experience. Any differences in performance, then, can be more attributable to their actual learning of the task rather than their previous experience with the stimuli to be learned.

It is necessary to explore the learning required to establish codes for words. Gibson (1969) has provided a model for the learning of a word's visual code. According to Wagner (1985), however, current theories of reading say little about how this code is organized with the auditory and semantic codes during visual word learning. The word learning process seems to require both within code elaboration learning and between code association learning. Wagner (1985) applied this concept to reading by assuming that within code learning is confined to the visual domain and between code learning involves the establishment of an auditory-visual link between the word's name and its visual features. However, Vellutino and Scanlon (1987) have also found that the ability to code the name of the word in memory is important and a separate skill

from an alphabetic mapping of the visual features. Therefore, it appears that remembering the name in memory may comprise a within code learning for the auditory domain as well.

Underwood (1963) made a very important statement regarding stimulus encoding by distinguishing between the nominal stimulus (event presented by the experimenter) and the functional stimulus (mental representation of event). The functional stimulus is what becomes associated with the response. This process is referred to as it pertains to reading, as was defined above, as visual feature learning or visual discrimination (Gibson, 1969; Gibson & Levin, 1975). This visual feature learning is viewed as involving the identification and encoding of a set of features which can be used to identify the stimulus. Gibson's definition (1969) also implied that the more stimulus features an individual has stored in long-term memory, the greater probability that the critical features needed for a recognition task will be available. It is important to note that this process of visual feature learning in no way implies that associations are made with the response.

Along with visual feature learning, another singular process occurs: name retrieval learning. This process occurs when a word's name is associated to some part of the stimulus. As was previously inferred,

materials in paired-associate experiments do not always form whole single elements. For example, in an experiment like Wagner's (1983), subjects were required to connect words constructed from artificial word symbols to an auditorily presented response. In this case the artificial words were constructed of four symbols each. Greeno et al. (1978) have explained that this type of task is more complicated than connecting a single element with another single element. The artificial words discussed above contain four elements or a four element list. In these cases, not only is there a process of learning the stimulus and response, but also a process of response/stimulus integration may be required.

Samuels (1973) stated that the assumption can be made that the learner must develop an association between the part of the lexical structure of a logogen that will be a response and any additional visual features. This process may involve a linkage of the auditory representation or name of the word with new visual features. However, it is not clear whether there are any documented reasons to reject the use of semantic or phonetic features of a word in this kind of association as well, provided that these features are linked to the response (Wagner, 1985).

At this time, it must be emphasized that the processes of visual discrimination and the ability to

recall the name of a word freely are assumed to be independent. Vellutino and Scanlon (1987) found strong evidence that the ability to remember the name of a printed word (free recall) as an intact unit and the ability to analyze the internal structures of the spoken and written counterparts of that word are different skills but that both are necessary for word identification. In addition, they found that the skill of being able to recall the name of the word was necessary in order to learn to read the words. It follows that different sequences of stages are possible.

Possible Sequence of Learning to Read Words

One possible sequence can be outlined as follows. First, as Vellutino and Scanlon (1987) have suggested, the individual will learn the name of the word. Then, as Wagner (1985) suggested, it is possible that the individual may initially develop an association between the name of a word and the first letter of the visual stimulus. On the next 10 exposures, the individual may choose to strengthen the above-mentioned association rather than adding new letters. However, this strategy would only be possible in reading tasks where the word can be identified by the first letter only. In tasks where further discrimination must be made, Wagner (1985) hypothesized that this process may begin with

the development of an association between the name of the word and the first letter of its visual representation. It is assumed that the name must be retrieved from long-term memory and held in short-term memory at this time (Greeno et al., 1978; Nairne, 1983) and that the word's name is associated with a component visual stimulus, such as a letter, and stored in long-term memory. The next time the visual stimulus is encountered, the representation is retrieved and the word's name is the response and a second letter is associated with the response. This process could then continue until learning is sufficient in relation to the requirement of discriminating the stimulus from visually similar distractors in a given response environment. Wagner (1983) found evidence that poor readers may only associate the name of the word to one letter and then learn the rest of the visual features without linking them to the word's name. While they did not appear to have difficulties in forming initial associations, their difficulties became more pronounced as words had to be read in context where they could not discriminate them by one or two visual features or letters.

With these points in mind, it is necessary to stress that Vellutino and Scanlon (1987) found that whole word identification is especially dependent on free recall of the word's name. As such, it appears

that learning of the response or the name of the word must in some sense be completed prior to proper word identification. On the other hand, learning of the internal structure of alphabetic mapping of a word, as it is referred to by Vellutino and Scanlon (1987), does not necessarily have to be totally complete for the association to be successful. Vellutino and Scanlon (1987) explained alphabetic mapping as being the ability to map component letters of words to sound.

Theories such as those proposed by Wagner (1983, 1985) suggest that the following processing may be involved in the acquisition of reading vocabulary: visual discrimination learning; visual serial learning; auditory discrimination learning; semantic and syntactic feature learning; and associative learning. In examining findings regarding these processes, Wagner (1985) formed the hypothesis that learning new words may consist of a dual processing requirement which involves visual discrimination learning and associative learning (i.e., the formation of a connection between the word's name and its visual features), and which may be much more difficult than focusing on either visual feature learning or associative learning on their own. Vellutino and Scanlon (1987) also found that associative learning is more difficult than learning alphabetic mapping or free recall of the name of the word on its own. Wagner (1985) concluded that if an

individual is holding a word's name in working memory while incorporating new visual information with the word's name, this may require more attention than if the individual is simply identifying new visual information or associating the name with previously learned features. Laberge (1973) also found that the amount of attention required may increase as related to the difficulty of the visual feature learning of the items or the unfamiliarity of the word's name.

Paired Associate Model of Learning

It appears that the association of the visual features and word's name is the most difficult part of learning to read. As previously noted by Gough and Hillinger (1980), the association process resembles what occurs in paired-associate learning models. Greeno, James, DaPolito, and Polson (1978) have done extensive research on a paired associate model of learning, which proposes there are two stages to such learning. They have also extensively examined studies that attempt to show the learning stages. Their theory of two-stage learning is as follows: State "U" is the unlearned stage prior to the hook-up of a name to the stimulus. Variable "a" is the first stage of learning or is the first hook-up of the stimulus to the appropriate stimulus set. Stage "I" is the middle stage which occurs due to the process of a variable "a".

Variable "c" is how long it takes to get out of "I" or the number of trials to criterion. State "L" is the final stage of learning where learning is complete. An alternate route was also suggested where the stimuli bypass state "I" and immediately learn the stimulus-response hook-up.

Greeno, et al. (1978) stated that the use of the two-stage model is not confined to any specific psychological ideas about the process of learning or what information is stored during the two stages. A major task in paired-associate learning is to organize stimulus and response into an integrated unit. The cognitive view stated by Polson, Restle and Polson (1965) is that acquiring the association precedes the visual discrimination of the stimulus. This could mean that in the final learning, the stimulus difficulty would be a significant factor. On the other hand, the older, associationist view argues that acquiring the connection between the stimulus and response occurs late. Response learning was seen as preceding learning a connection based on grounds that a response cannot be connected to a stimulus if the response has not yet been learned. Therefore, a major question was to determine if the early stages of learning focus on only encoding response information or if information about the stimulus-response pair is involved from the outset.

Humphries (as referenced in Greeno et al, 1978) hypothesized that if the first stage is mainly a process of acquiring responses, then difficulty of learning in the first stage should be due mainly to different kinds of responses used (i.e., meaningful vs non-meaningful, or familiar vs unfamiliar). On the other hand, if the first stage involves storing information about the stimulus-response pair, then it would be expected that both stimuli and responses would influence difficulty of the first stage. These hypotheses are based on the assumption that one can measure the difficulty of learning in two stages separately.

Humphries' results showed that both stimulus and response variables affected the difficulty of the first stage of learning. Results were also consistent that the second stage depended mainly on properties of the stimuli. The interpretation of these results can be that storage of a stimulus-response connection occurs in the first stage and the association is made more retrievable through stimulus discrimination in the second stage.

As Humphries has suggested that both stimulus and response variables affected the difficulty of the first stage of learning, the nature of the stimulus and response must also be examined. Saltz (1971), in his discussion of the effects of meaningfulness on

paired-associate learning, reviewed the effects of stimulus and response meaningfulness. He reported that results in studies have been consistent that increased word frequency is related to better recall. In other words, words that are heard more frequently in the language, are remembered more easily. Saltz and Modigliani (1967) proposed that high meaningful or highly familiar stimuli lead to somewhat faster learning than unfamiliar stimuli. In real word learning, for an individual who is looking at a word, this study proposes that the stimuli is the visual orthography of the word and the response is the verbal name of the word.

Relating the Model to Word Learning

A major step, of course, is to determine how to relate this type of model to word learning and to discover which additional forms of learning have been suggested as necessary in learning to read words. When an individual participates in typical paired-associate learning tasks, the following learning appears to be going on when there are two words which the individual must associate (e.g., ball and road). These words provide an easy visual stimulus and easy auditory response in that the subject is usually familiar with both words and will be able to read them. As such, that part of learning (visual discrimination and word

recall) is often completed prior to the experiment. For both words (ball and road) the student must remember visually and verbally what each word is. Since these words are already in their oral language and reading vocabularies, the learning for them will mainly consist of beginning to form a hook-up between the stimulus and response since this strategy is necessary to the task of remembering paired-associates. Even when nonsense words are used in such a task, if letters of the alphabet are used, the individual will have only to decode the word and not totally learn to read the symbols. This learning is, for the most part, based on between code learning where the individual is engaged in associating the stimulus to the response.

On the other hand, for learning to read words, as based on the above model, there are some differences. when an individual is beginning to read, the symbols (or letters) may not be learned to the point where they are automatically recognized. Furthermore, even if the subject is familiar with the graphemes of the word, a certain amount of serial learning may be required in order to master the letter order pattern that differentiates the word from other words with similar letters. The individual will have a considerable amount of learning to do: 1) What do the symbols sound like? 2) What does the word sound like? 3) What do symbols stand for? (associate symbols to names or sounds).

Therefore, prior to or along with forming the hook-up, they will have to learn the symbols and remember the words; this task requires within code learning for the visual discrimination, learning of the orthography, and within code learning for the name. These things must be learned as well as forming associations between the visual and verbal stimulus. This means that there may be some extra steps that are not required in the paired-associate model of Greeno et al. (1978). Therefore, learning a new reading word is not simply learning to associate a stimulus (visual orthography to a response [name retrieval]), but rather may require strategies for learning the visual orthography, the name of the word, and the hook-up of the two factors.

The writer feels that in the above theoretical explanation, there are some vague and troublesome areas regarding visual feature learning. First of all, it appears that in visual feature learning, it is the functional stimulus, as defined by Underwood (1963) that is associated with the response. In addition, as Wagner (1985) stated, in the notion of linkage of the auditory representation or the name of a word with new visual features, it is not possible to reject the possibility that semantic of phonetic features of a word are used in this association. These two factors appear to point to the question of what type of coding occurs when a subject is presented with a pattern of

symbols to read. What types of strategies do they use in determining their own functional stimulus? The stages of reading acquisition literature may provide us with some important clues as to the strategies individuals may use and how they appear to change as learning takes place.

Stages of Reading Acquisition

Studies by Ehri and Wilce (1985) and Ehri (1987) appear to support several conclusions. It appears that prereaders do not acquire graphic skill by learning to read labels and signs in the environment; rather, a mastery of the alphabetic symbol system is necessary. Prereaders tend to use pictorial or sentence context cues to identify words. However, as soon as they move into reading (master the letter system), they shift to letter-sound cues. In analyzing this finding in terms of the categories of analytic and non-analytic correspondences reviewed by Brooks (1978), Ehri appears to be arguing that children may be employing specific stimulus learning at first and, as they master the letter system, they shift to using their explicit knowledge of the spelling rules. (Note that these are both analytic type correspondences).

The process of learning to read words was broken down into a sequence of stages by Lomax and McGee (1987) when they studied young children's concepts

about print and reading. They found the following model to fit their data: It measured print concepts and word reading in five stages. 1) The first component included measures of children's awareness of oral and written language units. 2) The second component was the graphic awareness process which was composed of evaluations of children's attention to the graphic or visual features of printed letters and words. 3) The third component, phonetic awareness included measures of children's awareness of phonemes and their similarities and differences. 4) The fourth component was grapheme-phoneme corrèspondence knowledge which included an assessment of the children's ability to read isolated words. Goodman and Goodman (1979) proposed a two-component model where the above-mentioned components 1-4 represent a unified wholistic component of knowledge of the process of reading. This model did not appear to fit the research findings by Lomax and McGee (1987) as well as the five-stage model did.

<u>Skills Related to Learning to Read</u>

One question still remaining is how the factors and strategies defined above relate to reading ability. The difference in reading performance between good and poor or disabled readers has been studied extensively. Stanovich (1986) reviewed the past research which has

attempted to explain the variance in reading ability in terms of psychological processes and discovered the following relevant information: First of all, he stated that word decoding ability accounts for a very large proportion of the variance of reading ability.

It was also found that short-term memory deficits often are found in individuals with reading difficulties (Stanovich, 1986). Jorm (1983) and Brady (1986) have presented reviews of the literature regarding short-term memory/working memory and reading ability. Jorm (1983) stressed that the body of evidence shows that children who are poor readers perform poorly on certain memory tasks. More specifically, Brady (1986) suggested that there seemed to be a significant relationship between phonetic processes and verbal memory span, but not between phonetic processes and non-verbal memory. They also found evidence in studies about children with reading problems that they are less accurate at phonetic encoding than are good readers and that their performance on phonetic tasks correlates with verbal memory span abilities. Vellutino and Scanlon (1986) found some strong evidence that poor readers are deficient in phonological coding when they found that poor readers had more difficulty memorizing nonsense words, at an ability which relies on a student's ability to store and retrieve phonetic information.

Stanovich (1986) also identified comprehension deficits which were less related to word decoding than the above-discussed skills and may also have been due to syntactic and metacognitive abilities. Vellutino and Scanlon (1986) provided some insight into why comprehension may not be as much of a problem. It has been found that poor readers are more attuned to meaning than to structural components of words they see. Therefore, comprehension should not be a factor that causes major differences due to word learning tasks.

The above-mentioned skills will be taken into consideration when testing data are collected on students to be compared with their visual word learning performance.

It appears that auditory short-term memory and phonetic analysis skills may set an upper limit on the ability to learn words or the speed at which they are learned. In addition, as Saltz (1971) has indicated, stimulus and response difficulty can affect the rate at which things are learned. Therefore, a word with a difficult orthography or one whose name is unfamiliar to the learner would be more difficult to learn. In addition, a word with both a difficult orthography and an unfamiliar name should be the hardest to learn to read. These factors should be kept in mind throughout the description of the learning to read process.

Summary

In summary, as Vellutino and Scanlon (1987) suggested, it is expected that the student will first learn the names of words presented; however, most children learning to read are already familiar with many of the names of words they are reading. Therefore, this skill will be developed in children for most words they will be learning to read. Next, as Lomax and McGee (1987) stressed, graphic information was used initially in learning to read words. Ehri (1985) also suggested that possibly individuals initially use visual/context clues before they have a knowledge of spelling rules. Brooks (1978), in his discussion of analytic correspondences, listed that both specific/stimulus and the implicit/explicit knowledge of spelling start with analyzing the visual codes. This would also fit well with Gough and Hillinger (1980) who stressed that code learning relied on visual information.

An analysis of the visual information would be a requirement for alphabetic mapping. In an implicit alphabet, which is what is being analyzed in this study, individuals would have to analyze the visual symbols before they would be able to map the symbols to sounds. Therefore, alphabetic mapping as referred to by Vellutino and Scanlon (1987) probably can be said to include both analysis of visual features and mapping of

some symbols to the name of the word. As Wagner (1985) stressed, associative learning, where an individual attempts to hook up part of the stimulus to the word name begins early in learning. Ehri (1987) stated that it starts at the outset of learning as soon as the individual has some phonetic knowledge stored in memory and it occurred as an intermediate stage between cue learning and cipher learning. In addition, Lomax and McGee (1987) also found that children begin to become aware of phonemes and later analyze them into grapheme-phoneme correspondences.

Finally, as the stimulus and response or the orthographic structure and word's name are combined in memory, the first stage of Greeno et al. (1978) is possibly reached since Humphries found that the initial hook-up occurred in the first stage. Since acquiring this stimulus-response association precedes stimulus discrimination as the individual moves to the second stage of strengthening the hook-up, it is possible that the stimulus or orthography is not fully learned. Gough and Hillinger's (1980) findings also support this since they suggest that it is possible that only a single attribute is initially selected for a particular word and, if it is unsuccessful, then the individual may add to the attribute list or choose another attribute. In addition, by this second stage where learning is complete, the word's name must be fully learned since

Vellutino and Scanlon (1987) found that free recall of the word's name was the most necessary step prior to fully learning whole words.

Assumptions

At this time, it is necessary to review assumptions stated by Wagner (1985), in addition to outlining other assumptions on which this study is based. It is assumed that a printed word can be coded in terms of visual, auditory, semantic and episodic information (Craik & Tulving, 1975). It is assumed that visual word learning requires both within code elaboration learning (or the learning of visual, auditory, or semantic features of a word) and between code association learning (the forming and strengthening of auditory-visual, semantic-visual, and auditory-semantic associations) (Wagner, 1985). The dual processing strategy that an individual engages in while performing visual feature learning and association learning simultaneously requires more cognitive effort than either process alone.

In addition, the following assumptions are made: It is assumed that individuals will treat the artificial word stimuli as a symbolic-code system. The verbal reports of strategy use, in the least will be interpreted as symbolic of strategies the individuals

consciously feel they are using. Finally, the paired-associate type artificial word learning task mimics, at perhaps a very elementary level, what may occur in learning to read new words. It is hoped that, at the very least, this research may help to explain deficient processes in readers.

Scope

The scope of this research is to study the learning process in a paired-associate task within an experimentally controlled setting. It should be kept in mind that the results of this study must be limited to adolescents who have wide vocabularies and reading skills. Any assumptions based on other age groups should require specific additional experimentation.

It must also be stressed that this study is on learning strategies and should not be taken as a promotion for the use of paired-associates as a teaching strategy for teaching reading. It serves here as an experimental tool which allows for control when investigating the learning process.

Limitations

There are limitations to this type of research. First of all, adolescents have a fairly well

established vocabulary and experience with reading. In addition, although an artificial word system is being used, these individuals already possess an entire symbol system including all of the rules of symbol-sound correspondence. This limits assumptions being made for prereaders who have no previous knowledge of these rules when they undertake the process of learning to read.

In regards to verbal reports of strategy use, it will not be possible to propose which strategies seemed to be most successful because transfer of the knowledge was not tested on new stimuli. Therefore, it is not possible to report on whether an alphabetic decoding or strictly visual discrimination strategy will be more successful in the process of reading. Any results must be taken in the context of the task itself. An additional problem which occurs with verbal reports is that the reported information is not necessarily representative of what is going on in memory. They are only a conscious estimate of strategies the individual feels they are using in solving the problem.

Another limitation of this study is that transfer effects to new words were not obtained from this particular study but are being tested in further studies by Wagner.

CHAPTER THREE

METHOD

This chapter will outline the method of this study. It will begin with a description of the subjects. Then it will describe all tests and other assessment tools used in the study. A description of the procedures followed, including special instructions given to subjects, is next. The chapter concludes with an explanation of the special methods and procedures used for data scoring and analysis.

Subjects

Thirty Grade 9 & 10 students served as participants. These students were chosen by teachers to participate in a larger university study. The subjects were chosen from different groups of students in the high school population in order to include a cross section of reading abilities for the study. Students were chosen from the following programs: Enrichment, Advanced English, General, Basic, and Special Education Programs. It was arranged so that students would fit on a continuum from well above average readers, down to very poor readers. Poor readers does not necessarily refer here to dyslexics. It is a general term including

dyslexics and "garden variety poor readers" who Stanovich (1989) defined as having low IQ and reading abilities. Therefore, the poor readers in this study may have specific reading disabilities or general learning disabilities.

The students chosen formed a fairly normally distributed group in terms of reading skills as they were assessed by reading tests in the study. The reading test scores can all be found in Table 1 in the Results chapter 4. The students presented a variety who may be encountered in an educational setting. It is hoped that by using a continuum of skills, some useful information will be found to assist the classroom teacher. This goal became especially important following exposure to a quote from Ellis (1985, p. 401) where he discussed his feelings that dyslexia is not analogous to a condition like measles (where you are afflicted or not) but rather, more to obesity. He stated that for all people, no matter what their age or height, there will be a continuum from "painfully thin" to "inordinately fat". He feels that it is arbitrary where we draw the line between "normal" and "obese", but feels,"that does not prevent obesity being a real and worrying condition, nor does it prevent research into the causes and cures of obesity being both valuable and necessary". Therefore, in a given population, it is not simply a matter of categorizing

an individual as dyslexic or normal. Instead, there will be a continuum of readers from very poor to above average. As expressed above, this does not diminish the importance of research; however, it does complicate it drastically. There is not a single cause for dyslexia and there is not a simple cure.

Research dealing with a continuity of reading abilities is very important. In order to provide results for the classroom teachers and other resource people, who encounter an endless variety of reading abilities, it is important that some of the research examine which strategies seem to be most important in learning to read and which skills seem to diminish as reading ability decreases.

The ages at first testing session ranged from 14.3 to 17.7. (Please note the higher end of the range was due to the fact that some subjects were chosen from special education settings). The mean age was 14.9. Eleven subjects were female and 19 male.

Parent permission was required for students' participation in the large university study and students were told they might leave at any time if they were uncomfortable with the setting. No students left the testing sessions. The study began with thirty-four subjects; however, four were lost due to chronic absenteeism or school changes.

Materials

In the following section, all tests administered during the sessions will be outlined. Standardized tests will be described as to their specific use in this study and the word learning test that was created for this study will be outlined in detail.

The reading tests were given to the whole group to ensure that the subjects represented a continuum from well above average readers down to poor readers. The following tests were used as the basis for assessing the subjects on a number of reading and performance measures which appear related to reading:

1) Boder Test of Reading and Spelling Patterns (1982). This measures students' abilities to read based on words which are appropriate to grade levels. This test was used because it measured word reading levels for both phonetic and irregular words. Since the task to be used in this study was a word reading task, it was thought that this test would prove valuable in comparing word reading level with performance on the task. The number of phonetic and irregular words read on the Boder were recorded together as well as separately in order to determine if performance on the experimental measures relies more on an ability to read phonetic or, the more difficult irregular, words.

2) GORT-R (Gray Oral Reading Test - Revised (1986)). The comprehension scores measure the ability to remember the story and answer questions about it. The Gray Oral Reading Test - Revised was used because it covered both decoding and comprehension scores and the GORT-R measured the speed and accuracy of reading words in context.

3) LET (Learning Efficiency Test) (1981). This measures the following types of short term memory performance:

Auditory unordered immediate memory
Auditory unordered short-term memory
Auditory unordered delayed short-term memory
Auditory ordered immediate memory
Auditory ordered short-term memory
Auditory ordered delayed short-term memory
Visual unordered immediate memory
Visual unordered short-term memory
Visual unordered delayed short-term memory
Visual ordered immediate memory
Visual ordered short-term memory
Visual ordered delayed short-term memory

All of these memory scores are based on the ability to remember letters. This test was chosen since it provided more thorough measures of auditory and visual memory than other tests by including immediate, short-term and delayed short-term memory and providing

different scores for ordered and unordered memory. In addition, it has been suggested by Stanovich (1986) that memory for letters is more apt to determine reading problems than memory for other objects.

4) IPAT (Culture Fair Intelligence Test (1970)). This test measures non-verbal performance IQ. This test was used to measure the visual-spatial reasoning abilities. It was chosen because in the initial stages of reading, visual discrimination may be important and may rely heavily on visual strategies.

5) Woodcock Word Attack Subtest (1973) This test measures the phonetic analysis skills.

6) Word Learning Measure. This test was created for the study. The artificial words used as the stimuli in this experiment were based on an alphabetic system. Each symbol corresponded to a letter in the English alphabet. For example, an "l" sound in "fall" and "heel" always had the same symbol. The artificial word learning test contained the following materials: First, there were eight sentences which contained one artificial word each (see Appendix I). These sentences all defined the word meaning by their context in order to aid the subjects with the learning task.

Second, there were three test sets constructed which contained the artificial word and two distractors, one with letter item changes and one with letter order changes (see Appendix II for stimuli

sets). The other stimulus sets were identical except the order of the test words was rotated so that the subjects would not be able to identify the correct word simply by remembering the position on the test cards.

The order of presentation of both the stimulus sentences and the test cards was randomized between trials. As indicated in Appendix III, the words were classified according to whether their orthographic structures were easy (fall, heel, bipp, and coom) or harder (rain, star, pung, and wark) to learn. There was both clinical and psychological evidence that the double letter words were easier to remember, probably because of the saliency and redundance of the repeated letter pattern. Many researchers have found that event repetitions are remembered easier than patterns with different letters. For example, EEEE would be remembered more easily than KVUR (Jones, 1974; Jones & O'Hara, 1973; Myers, 1970; and Vitz & Todd, 1969). Therefore, the easy words were determined to be those with double letters included.

As indicated in Appendix IV, the stimulus sentences included four familiar name words (fall, heel, rain, and star) and four unfamiliar name words (bipp, coom, pung, and wark). The unfamiliar words were chosen due to their infrequent use in the language. None of the subjects had ever heard any of these low frequency words before, therefore, ensuring the words were not

part of their vocabulary and also controlling for exposure. The words were chosen from the game Balderdash (1984) which guaranteed that all of the words that were used are found in at least one English Dictionary and are real. These words were pretested on ten adults in higher education who all reported they had never heard the words before and had no idea what the words meant.

Design and Procedure

This study had a within subjects design. The testing took part during school scheduled sessions in testing rooms assigned to the tester in the high schools. The first session was used to collect standardized information and the second session was used to collect the artificial word learning data and protocol analysis of strategies. Each session averaged about 45 minutes to one hour. Two additional subjects were used in pilot tests. Although the artificial word learning task had been previously used in a Reading Clinic setting, it was important to pilot test this particular group and help to perfect administration procedures since the testing was taking place in a different setting and at different time intervals. In addition, the standardized tests have been used along

with the artificial word learning data in previous trials in a Reading Clinic setting.

Tests administered during first session

Tests described in the materials section were administered by the tester to assess the reading performance measures which appear related to the ability to learn to read (Stanovich, 1986). Word reading was assessed by the GORT-R and Boder tests. The GORT-R comprehension section was also administered. The LET was chosen due to the fact that it tests both the auditory and visual modalities and the stimuli are verbal (letters) which, as previously reported, would show deficits for reading more consistently than digit span tests (Perfetti,1985). In addition, Bradley and Bryant (1978) suggested that disabled readers have specific difficulties in organizing sounds and the LET allows an examination of their ordered and unordered letter recall throughout immediate, short-term and delayed short-term memory. Phonetic analysis skills which are said to be related to the short-term memory scores, were tested by the Woodcock Word Attack Subtest (1973). Finally, the IPAT was used to assess visual-spatial reasoning abilities or as a measure of non-verbal (performance) IQ which it was hypothesized might be related to the subjects' visual discrimination learning. The order of administration of these tests

was randomized among subjects in order not to bias results. In addition, the order of presentation of the visual and auditory tests of the LET were alternated across subjects.

Tests administered during second session

For the artificial word learning task, the entire procedure was first described briefly to the individuals. They were told that the task was like a game or puzzle. In addition, it was explained to them that the writer was interested in finding out how people first begin to read words and that their experience with the artificial symbols would be similar to what they experienced when they first saw words.

The sequence of events for this task was very specific for all subjects. The following sequence was followed on the first trial: 1) The sentences were read by the tester and shown to the subject at the same time. It was ensured they knew what all the words meant based on the context clues in the sentence. For example, for the sentence "I put a bipp on my cut finger", the student would say it is a bandage or a bandaid and the experimenter would say he or she was correct. 2) Next, subjects were shown the sentences one-by-one and were asked to read the sentence out loud. 3) Then they were presented with the word in isolation (written in the artificial symbols) and were

asked to give a verbal report of their strategies in the following manner: They were asked "How did you remember the word? Was there anything specific you remembered about it?" Their verbal reports were documented on a sheet beside each stimulus word. 4) The next step was to show the individuals the sentences again and have them read the sentences out loud. If they did not feel comfortable reading the entire sentence out loud, it was suggested that they read the sentence to themselves and simply repeat the artificial word out loud. 5) Following this, the words were covered for one minute, after which the individuals were asked to recall any of the artificial words they could remember by name. 6) Then they were shown the stimulus sets which contained distractors and were asked to choose one which looked familiar. They were instructed that only one word was contained on each card. They were asked to guess which word it was (verbal recall) and point to the word on the stimulus set cards and read it.

On the subsequent trials, the first step in the above sequence was omitted and Steps 2 through 6 were followed until criterion was reached (where they chose correct word visually from amongst distractors and said the correct word name as they pointed) or until the sixth trial was reached. The sixth trial was chosen as a cut off point due to distractions in a regular school

day (i.e., breaks and class changes for students) which made it impossible to complete more trials in a single session. In addition, fatigue became too intense after this point in some pilot test subjects and their performance decreased drastically.

Data Scoring

The following describes the dependent variables in this within subjects design that were chosen based on the literature reviewed on beginning reading:

Visual Discrimination

This is the ability to learn visual features of words. Gibson (1969) and Gibson and Levin (1975) elaborated on how this skill is of importance in learning to read words. Also, this skill is important based on theories on cue (code) and cipher learning (Gough & Hillinger, 1980; Ehri, 1987; and Ehri & Wilce, 1985). Two measures were taken here: 1) visual discrimination to first correct was taken in order to discover how long it takes for an individual to identify features he/she can rely on, and 2) visual discrimination to criterion was taken to find out how long it takes to elaborate the identification of visual features to the point where he/she can remember enough visual features to correctly identify words and not

make any errors following correct identification. Two measures were taken because: a) the first correct identification measure may be due to guessing, and b) non readers can read signs like, "stop" or "McDonalds" by remembering the whole pattern of the sign they are written on, but they require much more extended visual feature learning to identify words that are not embedded in a similar context.

Name Retrieval

This skill may be partly a function of visual discrimination learning and partly a function of response familiarity where the name of the word is associated with the visual stimulus. This measured the initial stages of learning the stimulus where, as Gough and Hillinger (1980) have explained, the word's name may first become associated with possibly the first one or two letters of the visual stimulus. Two levels were also taken of this variable. The first was name retrieval to first correct - to measure the first correct cued recall of the word. At this point, the individual first begins to associate the name of the word to some part of the visual stimulus. He/she chooses the correct stimulus set, but not necessarily the correct stimulus. The second level was name retrieval to measure the point at which an individual

associates the name of the word to the correct stimulus set without making any further errors.

Free Recall

This measure was based solely on the individual's ability to recall the words without being given any visual cues. Two measures were again taken: 1) free recall to first correct, and 2) free recall to criterion, where no errors were made following this measure.

Word Reading

Word reading occurred when the individual pointed to the correct word and read it correctly. Two measures were taken: 1) word reading to first correct (where errors could follow); and 2) word reading to criterion (where no errors follow).

For these learning data from the artificial words, the scoring was completed by taking a criterion point and calculating how many trials per word each individual took to criterion and then calculating and recording the mean number of trials. For example, if the criterion was the first correct visual discrimination, the trials would be counted per word for the first time an orthographic structure was correctly identified from the distractors.

In summary, the following eight dependent variables were examined:

1) mean number of trials to first correct visual discrimination of visual orthography.

2) mean number of trials to criterion of visual discrimination where correct orthographic structure is chosen for the remainder of the testing.

3) mean number of trials to first correct name retrieval (where the correct stimulus set is chosen but the student does not necessarily point to the correct orthographic pattern).

4) mean number of trials to criterion of name retrieval (same as 3 but learned to criterion).

5) mean number of trials to first correct word reading (correct orthographic pattern is chosen and correct name is called).

6) mean number of trials to criterion of word reading.

7) mean number of trials to first free recall of word.

8) mean number of trials to criterion of free recall of word.

In addition, for each of the above measures, the following four separate total scores were calculated:

1) words with familiar names (fall, heel, star, rain);

2) words with unfamiliar names (bipp, coom, pung, wark);

3) words with easy orthographies (fall, heel, bipp, coom); and,

4) words with difficult orthographies (star, rain, pung, wark).

As an example, the trials to criterion would be recorded for each of star, rain, pung, and wark and then the mean score would be recorded. It should be noted that criterion meant that a correct response had been achieved and no mistakes were made after that.

The verbal reports of strategy use were coded by letters or symbols. The codes were reported in the results chapter since distinguishing the code was part of the qualitative analysis. This is how the codes were scored. For example, if an individual stated that a symbol looked like something, that code was given one point and if he/she said that three codes reminded him/her of something, that was given three points. It was decided that this was the only method where each strategy could be given equal weight.

The coding decisions were based on Lomax and McGee (1987). The verbal reports of codes used were examined and an attempt was made initially to fit them into the appropriate strategy category. Then two additional categories were formed and added based upon the nature of the verbal reports. It was reasoned that a strategy which incorporates both graphic features as well as the concept of the word (see conceptual coding below) was too sophisticated to be coded simply as graphic associative. In addition, since this study included

words which students would be aware of the spellings and other words where they would not be sure of spellings, it was necessary to add a category of (labelled) grapheme-phoneme decoding. If an individual knew the spelling, it was assumed he/she was using grapheme-phoneme correspondence. However, if he or she were unsure of the spelling, reading would not be accomplished by a direct grapheme-phoneme correspondence, but rather by a decoding of the graphemes into phonemes.

The six coding categories were labelled as follows:

1) Graphic awareness: Lomax and McGee stated that this occurred when children paid attention to the graphic details of printed letters and words. (i.e., I remember that symbol or word).

2)Graphic associative: memory strategy where one associates symbols with something they look like (i.e., that symbol looks like a man standing on his head). This is a graphic awareness (Lomax & McGee, 1987) with a more sophisticated strategy use. This seems to be a precursor to grapheme-phoneme correspondence based on Ehri's (1987) work and suggests subjects are thinking that the symbols stand for something.

3) Conceptual coding: Ellis and Daniel (1971) termed this was associating the concept of the word to a response (this word is pung and it means sled and that symbol looks like a sled. That is how I guessed

pung). This is like Graphic Associative at a more complex level. It appears that this occurs where the visual and semantic features were combined to create a very strong and successful code. This was split into a separate category from Graphic Associative (even though it was not included in Lomax and McGee (1987)) because it seemed to be a stronger code that requires more cognitive effort and would prove very successful in remembering because it is associated to something so concrete.

4) Grapheme-phoneme correspondance: Lomax and McGee suggested this is where `students associate symbols to sounds they know. This reading was applied only to words whose response was familiar since students would already know how to spell them.

5) Grapheme-phoneme decoding: This is a slight variation of Grapheme-phoneme correspondence, where unfamiliar words are decoded through a symbol sound analysis.

6) Whole word learning: The students can read the whole word (I just know how to read it or I remembered all the symbols or letters).

Data Analysis

Two types of analyses were performed on the model data. First of all, paired t-tests were performed

comparing easy orthography trials to hard orthography trials on all eight dependent variables. Paired t-tests were also used to compare familiar and unfamiliar responses for all eight dependent variables.

In addition, an analysis was done to check the effect of the independent reading variables on the students' abilities to perform in relation to the eight model variables. Initially, a multivariate analysis of variance was planned. However, upon fitting data to normal curves, it was determined that the data resembled a normal distribution, more than two distinct reading groups. Therefore, in order not to distort the data by creating two groups , an alternate procedure was chosen which provided an outcome similar to ANOVA. However, the procedure took into account the distribution of reading abilities across all of the subjects. The procedure was taken from Draper and Smith (1966) and involved taking regression values and performing t-tests on the beta values. Regressions were performed as in the following example: If the number of trials to criterion in the visual discrimination factor of easy orthographies and hard orthographies were to be compared based on the reading abilities of the students (for example the Woodcock Word Attack scores), then the regression analysis would be constructed with the dependent variable of easy orthographies and the independent variable of Word

Attack. A second regression analysis would then be entered with the dependent variable of hard orthographies and the independent variable again of Word Attack.

The next step was to employ the following formula:

$$t = \frac{(b1 - b10)}{(est\ se\ (b1))}$$

Where the beta of the easy orthographies regressed by Word Attack substituted for "b1" and the estimated standard error was recorded for (est se (b1)) and the beta of hard orthographies regressed by Word Attack substituted for B10.

This procedure was used to all eight Model Variables regressed by the four reading independent variables: Woodcock Word Attack, Boder Reading Quotient, GORT passage score, and GORT comprehension score.

For the qualitative data, mean scores were found for all six categories as described earlier. This was completed for three trials because after the first three trials most good readers had completed the task and the strategy reports were representative of those used only by the poorer readers.

Results of these analyses are presented in Chapter Four.

CHAPTER FOUR

Results

Means were calculated for all independent variables. These values can be found in Table 1 along with minimum and maximum scores. These data describe the average scores of the subjects.

The mean trials to learning for the dependent variables were as follows: visual discrimination first correct (*M*=1.86); visual discrimination to criterion (*M*=2.59); name retrieval first correct (*M*=2.03); name retrieval to criterion (*M*=2.53); word reading first correct (*M*=2.62); word reading to criterion (*M*=3.03); free recall first correct (*M*=1.48); and, free recall to criterion (*M*=1.96).

The mean number of trials to learning for the dependent variables split into familiar/unfamiliar words and easy/hard orthographies can be found in Figures 1 and 2.

Reading Model Related Data

Visual Discrimination. Visual Discrimination, as previously noted, has been hypothesized as the child's ability to find something in the orthography of the stimulus that he/she can recognize.

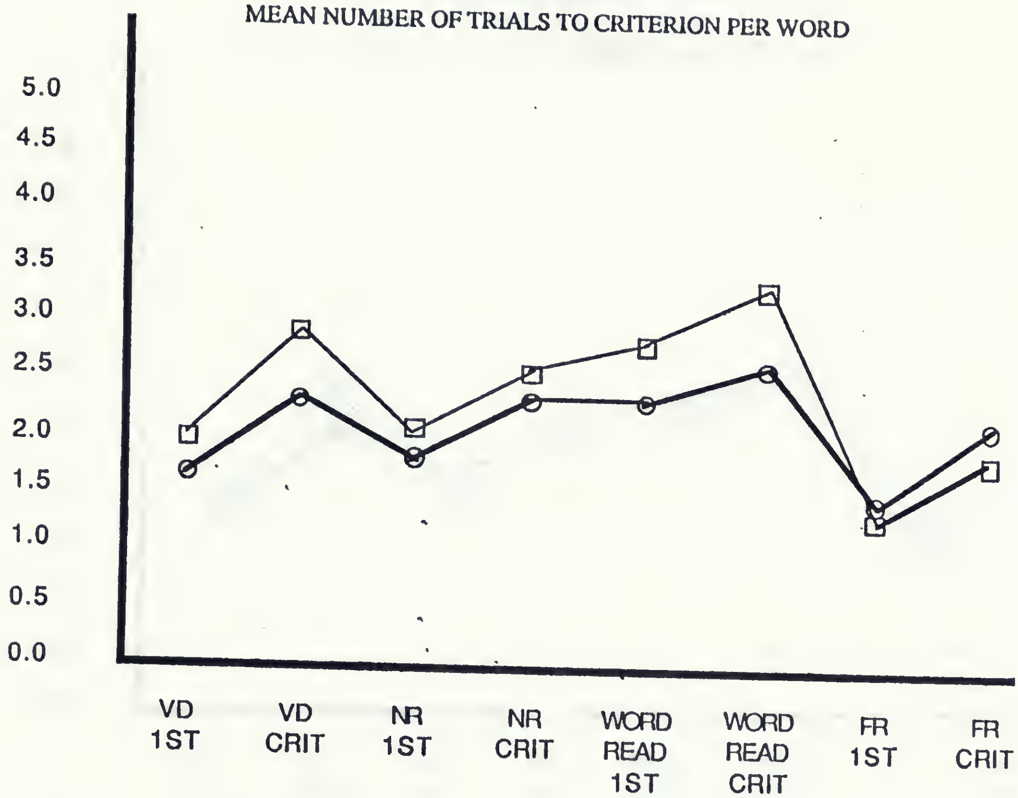
Table 1

Mean, Minimum, and Maximum Values for Independent Variables

Variable	Mean	S.D.	Min.	Max.
Age	14.86	.79	14	17
Grade	9.37		9	10
GORT-R Comprehension	10.30	2.84	6	17
GORT-R Passage	9.33	3.78	2	18
Phonetic words read on Boder	96.20	21.39	42	126
Non-phonetic words read on Boder	94.83	20.73	42	126
LET				
Visual Ordered Immediate Memory	9.70	3.41	5	16
Visual Ordered Short Term	7.97	4.51	1	17
Visual Ordered Long Term	7.87	4.68	1	18
Visual Unordered Immediate	10.77	4.08	1	19
Visual Unordered Short Term	10.67	3.78	3	19
Visual Unordered Long Term	10.07	4.27	1	19
Auditory Ordered Immediate	9.60	3.67	4	16
Auditory Ordered Short Term	8.27	4.45	1	15
Auditory Ordered Long Term	8.30	5.24	1	18
Auditory Unordered Immediate	10.63	4.26	3	19
Auditory Unordered Short Term	10.17	4.42	1	16
Auditory Unordered Long Term	10.10	4.46	0	18
IPAT Percentile	46.46	27.53	10	96
Reading Quotient	46.53		2	99
Woodcock Word Attack	123.67	14.57	101	151

FIGURE 1

MEAN VALUES FOR DEPENDENT VARIABLES
SPLIT BY ORTHOGRAPHIC DIFFICULTY

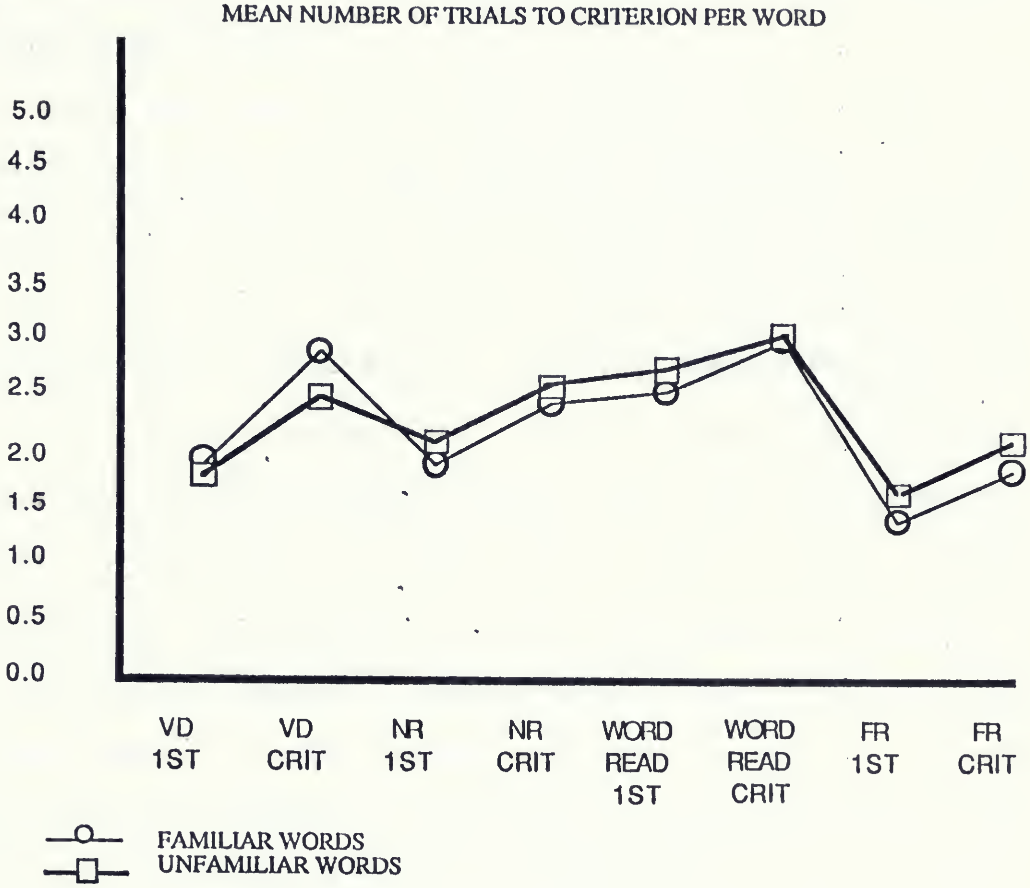


—O— EASY ORTHOGRAPHY
—□— HARD ORTHOGRAPHY

VD 1ST	VISUAL DISCRIIMINATION 1ST CORRECT
VD CRIT	VISUAL DISCRIMINATION TO CRITERION
NR 1ST	NAME RETRIEVAL 1ST CORRECT
NR CRIT	NAME RETRIEVAL TO CRITERION
WORD READ 1ST	WORD READING 1ST CORRECT
WORD READ CRIT	WORD READING TO CRITERION
FR 1ST	FREE RECALL 1ST CORRECT
FR CRIT	FREE RECALL TO CRITERION

FIGURE 2

MEAN VALUES FOR DEPENDENT VARIABLES SPLIT BY FAMILIARITY OF WORD



VD 1ST	VISUAL DISCRIIMINATION 1ST CORRECT
VD CRIT	VISUAL DISCRIMINATION TO CRITERION
NR 1ST	NAME RETRIEVAL 1ST CORRECT
NR CRIT	NAME RETRIEVAL TO CRITERION
WORD READ 1ST	WORD READING 1ST CORRECT
WORD READ CRIT	WORD READING TO CRITERION
FR 1ST	FREE RECALL 1ST CORRECT
FR CRIT	FREE RECALL TO CRITERION

a) The first measure used was the number of trials to first correct visual discrimination (where the student first pointed to the correct word when it was shown with distractors). This variable was not included in the Greeno model.

There was no significant difference as found by t-tests between the easy and hard orthography or the familiar and unfamiliar words on this measure. However, on the regression analysis, where the beta values (slopes) were compared by t-tests, the slope of the line for easy orthographic words was significantly different from the slope found for hard orthographic words $t(28)=2.23$, $p<.05$, when Word Attack test performance was employed as the independent variable.

The relationship of easy orthographic words to Word Attack was not significant so there was not a linear relationship. However, the hard orthographic words did show a linear relationship to Word Attack $F(1,)=7.22$, $p<.02$. This implies that the lower a subject's ability to phonetically decode the pseudowords employed on the Word Attack test, the more trials were required to the first correct visual discrimination on the hard orthographic stimulus words.

b) For the visual discrimination to criterion, t-tests indicated an effect for orthographic difficulty but not for name familiarity. The t-test for orthography showed that hard words ($M=2.93$) took

significantly longer than easy words (*M*=2.34) to learn them to criterion $t(29)=-3.06$, $p<.005$.

In addition, there were reading ability effects in the t-tests between slopes of the regressions of easy/hard orthographies by Boder Reading Quotient $t(28)=2.37$, $p<.05$ and by GORT Passage scores $t(28)=2.57$, $p<.02$. These results imply that a small change in the reading measures leads to a larger change in number of trials to criterion on words with hard orthographies than in words with easy orthographies.

Therefore, it seems that getting to criterion in visual discrimination learning, or finding enough information to correctly identify the visual orthography of a new word is defined by the difficulty of the orthography, where it takes longer to get to criterion for hard words. In addition, the two reading measures of Boder Reading Quotient and GORT Passage scores had slopes that indicated that higher reading scores lead to less trials to criterion, especially when the orthographies are more difficult.

<u>Name Retrieval</u>. Name retrieval, as previously noted, occurs when an individual reads the correct name of the word when presented with the word in a set with two distractors, regardless of which item in the set he/she points to.

a) As previously mentioned, there were some effects expected due to response familiarity in this measure, but not stimulus difficulty. In general, t-tests did not find differences for the first correct name retrieval, However, when reading ability was taken into consideration, the Word Attack measure showed effects in the relationship of word familiarity and phonetic decoding ability $t(28)=5.26$, $p<.001$. The larger slope for unfamiliar words indicates that a small change in phonetic decoding ability led to a larger change in the number of trials to criterion for unfamiliar words. This measure seems to be related more to familiarity of response than stimulus difficulty as was expected.

b) Getting name retrieval to criterion did not show differences for hard/easy orthography or word familiarity.

Word Reading. Word reading, as previously mentioned, occurs when an individual recognizes the correct visual orthography and associates this with the correct name of the word.

a) For the reading variable (between code learning of the association of visual discrimination and name retrieval) the first correct reading had an effect for orthography where the hard orthography ($M=2.83$) took significantly longer than the easy orthography ($M=2.29$), $t(29)=2.47$, $p<.02$. In terms of response

familiarity, there were no general differences between familiar and unfamiliar words in the mean number of trials to criterion. However, the GORT Passage score showed that there was a significant difference in the regression slopes between easy and hard orthographies regressed on reading ability $\underline{t}(28)=2.13$, $\underline{p}<.05$. The slope for hard words was steeper than for easy words indicating decreases in performance on the GORT passage scores resulted in increases in number of trials to criterion.

It is important to note that there were both visual discrimination and name retrieval effects for this whole word reading variable. Therefore, there was evidence that orthographic difficulty effects learning to read words.

b) As far as attaining criterion was concerned, only stimulus factors had an effect, as was predicted. The t-tests indicated that words with hard orthographies took significantly more trials to learn to criterion than words with easy orthographies $\underline{t}(29)=2.75$, $\underline{p}<.01$. In addition, there was an effect due to reading ability as measured by GORT Passage scores. The t-test of beta values of easy orthographies regressed by GORT Passage scores and hard orthographies regressed by GORT Passage scores shows the slopes are significantly different $\underline{t}(28)=2.15$, $\underline{p}<.05$. Since the slope of hard orthographies was steeper than the slope

of easy orthographies, it can be argued that the less reading ability an individual has, the more trials to criterion he/she will require in learning words with hard orthographies.

Free Recall. As previously stated, the free recall measure is not a part of the Greeno et al. (1978) model. It measures the free recall of words learned and is not directly related to cued name retrieval. However, it may be an important variable due to evidence that learning disabled children have difficulties keeping words in their short-term memories long enough to learn them.

Since this was a purely recall measure, only name familiarity should have an effect. The name familiarity variable did show differences. First, there was a t-test significant result between familiar words (M=1.28) and unfamiliar words (M=1.67) where $t(29)=-2.41$, $p<.025$. In addition, for three reading variables there was a significant difference found in the relationships between familiar and non-familiar words regressed by reading variables. These results are as follows: Boder Reading Quotient $t(28)=4.51$, p.01; Woodcock Word Attack $t(28)=4.45$, $p<.01$; and GORT Comprehension $t(28)=3.33$, $p<.01$. These results provide strong support to evidence that unfamiliar words are initially more difficult to remember than familiar

words and that this difficulty is clearly related to reading ability as defined by the above tests.

Finally, the recall to criterion showed only one significant effect. In the t-tests between beta values of word familiarity and unfamiliarity regressed by Boder Reading Quotient $\underline{t}(28)=2.65$, $p<.05$.

In general, these results seem to indicate that in the initial stages of learning, as defined by Greeno et al. (1978), there are more errors in words with unfamiliar response components. This was partly reflected in the fact that the unfamiliar words were more difficult to recall.

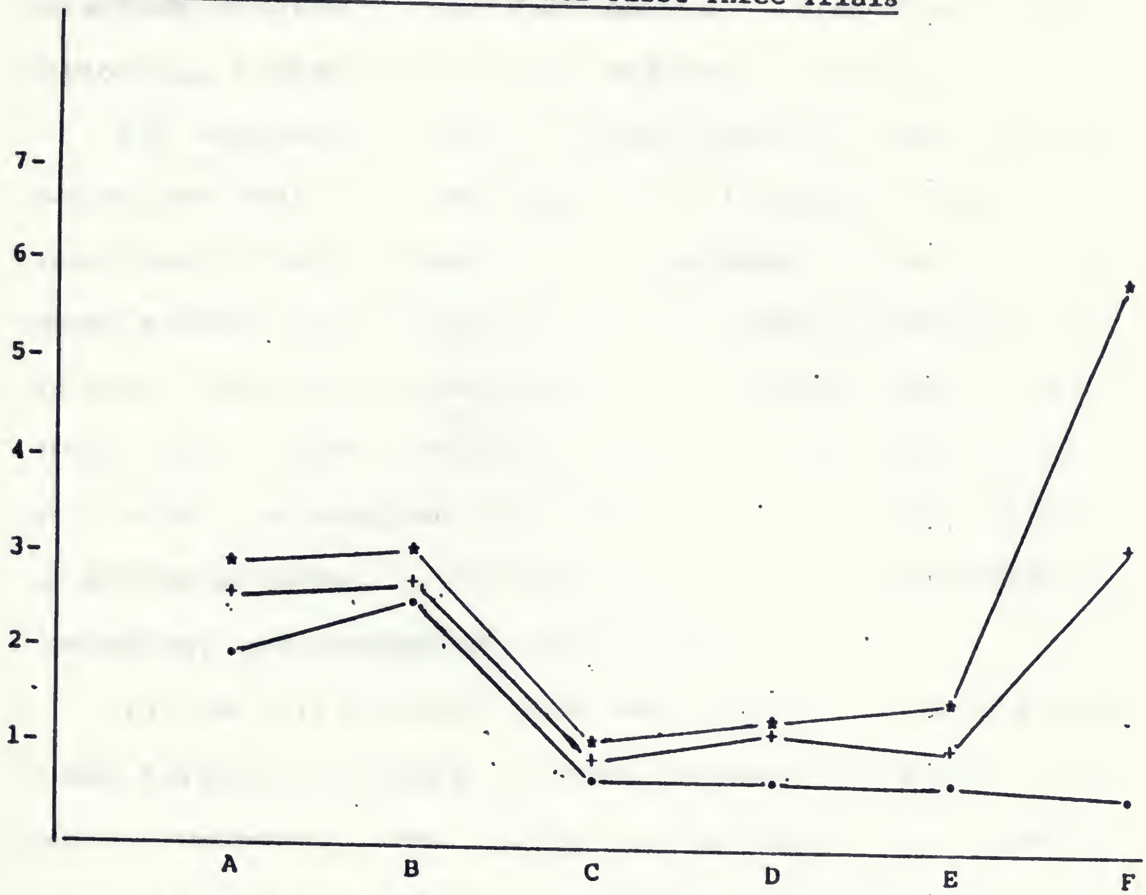
In the second stage of learning the difficulty is defined by the orthographic structure. It seems that the ability to read words is affected mainly by the difficulty of the orthographic structure as defined by the stimuli used in this experiment.

Qualitative Data on Strategy Use

These data provide some very rich insights into strategy use. The six coding schemes were used in producing the means shown in Figure 3 for the first trial. In the first trial of learning, the most popular strategies were graphic awareness (where students pay attention to graphic details of the symbols) followed by graphic association (where students associate symbols to something they look like in order to

FIGURE 3

Means of Qualitative Data for First Three Trials



A- Graphic Associative
B- Graphic Awareness
C- Conceptual Coding
D- Grapheme/Phoneme Correspondence
E- Grapheme/Phoneme Decoding
F- Word Reading

• Trial 1
+ Trial 2
* Trial 3

remember them better). These were followed by grapheme-phoneme correspondance, grapheme-phoneme decoding, conceptual coding, and word reading.

For the second trial, the six codes had mean values which are reported in Figure 3. It appears that the whole word reading was the most popular. However, the mean average use of the two mainly visual strategies of graphic awareness and graphic association were still high, even higher than they were on the first trial. All other strategies increased also in the order: grapheme-phoneme correspondance; grapheme-phoneme decoding; and conceptual word coding.

In the third trial, the mean values of strategies used follows in Figure 3. Word reading increased even more. However, the visual strategies of graphic association and graphic awareness decreased in use. Conceptual coding also decreased. On the other hand, the grapheme-phoneme correspondance and grapheme-phoneme decoding scores increased. By this point in learning, individuals seem to be able to recognize whole words and rely on more sophisticated and successful coding.

The qualitative verbal report of strategies used was also analyzed for how well they fit with the non-analytic or analytic correspondance theories.

First of all, it is important to note that none of the individuals reported recognizing the whole word on

the first trial without reporting use of graphic or phonetic strategies. Therefore, none of the students reported using a non-analytic correspondance strategy in which they go directly to knowing the whole word without analyzing the components. The first stage, therefore, appeared to involve the use of graphic/phonetic strategies in some combination.

All students in the study reported using graphic strategies on the first trial. Over the three trials the following strategy combinations were noticed: Using only graphic strategies for all three trials continued for 43% of the students. The amount of students using mostly graphic with some phonetic was 32%. A total of 14% of the students used an equal amount of graphic and phonetic strategies. Finally, 11% of the students used graphic strategies initially which were changed to phonetic strategies.

Tables 2.1 through 2.3 provide examples of the verbal reports placed under the various strategy categories. Table 2.1 includes all graphic reports: graphic associative, graphic awareness, and conceptual coding. Table 2.2 includes grapheme-phoneme correspondance and grapheme-phoneme decoding. Table 2.3 indicates the whole word strategies that were used. In examining the choices of verbal reports, the following observations are documented:

Table 2.1

Verbal Reports of Graphic Strategies

1) Graphic Strategies

Word	Letters Stressed	Comments made by students
star	s	recognize the 1st symbol
	t	remember the shape
	st	remember two symbols
		1st two symbols
fall	f	remember symbol
	a	recognize symbol
	fa	remember symbols
	ll	know last two
	fll	know 1st and last two
rain	r	remember 1st symbol
		remember this sign
		familiar symbol
	n	know this mark
		little symbol
		this squiggly line
		remember this line
heel	h	remember 1st symbol
		this symbol or mark
	ee	remember symbols

(Table continues)

		two symbols in middle
	hee	these symbols are familiar
bipp	b	1st symbol
	pp	remember these things
		they show up a lot
	ipp	last three
coom	c	1st symbol
	oo	know these symbols
	coom	know first three and the
		last symbol helped me make
		the correct choice
pung	p	1st symbol
		remember symbol
	pu	front two symbols show up most
	ug	remember these two
wark	w	1st symbol
	wk	remember 1st and last symbols

2) <u>Graphic Associative</u>

star	s	looks like a bunny
		the question mark
	t	looks like a loop
		looks like a "t"

(Table continues)

		I remember the fish hook
		looks like an "8"
		remember the fish
	a	recognize the triangle
	r	there's the seesaw
		that looks like a swing set
	st	the "7" and "8"
fall	f	looks like the thing you cut
		corn with
		because of the sideways
		hockey stick
	ll	the slides
		because of the triangles
		those hills
		if you turn these around
		they look like l's
		I remember that roof
		look like trees
rain	r	because it looks like an
		upside down swing set
	i	looks like a whip
	n	the crowbar
		because of this hook
	in	because of the swivelled "i"
		and flat "n"

(Table continues)

heel	h	that is a backwards "h"
	l	tipped over "l"
	ee	the candy canes
		look like backwards "r's"
		those hooks
		these look like "l's"
bipp	pp	I remember the rakes
		the two dots
		those look like school flag
		poles
		I remember the houses
		these look like a person
		upside down
coom	c	backwards "c"
	oo	hangman
		the triangles
		look like "k"
		I remember the lines and
		triangles
pung	p	the dot
		person upside down
		looks like a "y"
	u	looks like a "u" with a line
		looks like an "s"

(Table continues)

		question mark
	n	that seems to be a miniature
		"n"
		there's the nose
wark	w	upside down "w"
		looks like an "n"
	a	upside down "a"
	r	looks like "w"
	k	looks like electricity
		lightening
		looks like symbol for pain
		or shock
	ar	parts of two shapes make a "w"
3) <u>Conceptual Coding</u>		
star	s	looks like a shepherd's cane
		who saw the star
	t	looks like a star
fall	a	looks like its falling down
	ll	look like trees , trees fall
	fall	everything points down
rain	a	arrow points down like rain
	i	looks like a raindrop
	ra	lines go down like rain

(Table continues)

heel	ee	look like heels
		look like foot, word is heel
		upside down legs
bipp	i	looks like finger - you put bandaids on fingers
pp		look like bandaids
coom	oo	triangles look like a car and the line is the coom (dust)
pung	u	looks like "s"- pung means sled
	n	looks like bottom of a sleigh

Table 2.2

Verbal Reports of Phonetic Strategies

1) Grapheme-Phoneme Correspondence

Word	Letters	Verbal Report
star	s	know "s"
	t	know "t"
	a	know "a"
	ar,sr,tar	know they are these letters
fall	f	know "f"
	ll	there are the "l's"
		those are the double "l's"
		I think of them as "l's"
	all, fll	remember these letters
		(they name them)
rain	r	"r" is in wark too
	a	that symbol is an "a"
	ra,an	I know (name letters)
heel	l	I know "l", the roof is "l"
	ee	double "e's", same letter "e"
	eel	I know e e l

2) Grapheme-Phoneme Decoding

bipp	b	know its a "b"

(Table continues)

	pp	two letters at end stuck in my mind
		"p" is in another word
		those are "p's"
coom	oo	sounds like double "o", know the "o's"
	coo	know letters (name them)
pung	n	I write my "n" like that
	pu pg	I know these (name)
wark	w	remember "w"
	k	must be "k", knew ar and figured out "k"
	wa	know "w" and "a"

Table 2.3

Whole Word Learning Strategies

Word	Strategies
star	all of them , all symbols, just picked it
fall	all symbols, all letters, four letters
rain	knew whole thing, all letters, know alphabet
heel	whole thing I guess, know alphabet, everything
bipp	all letters, whole thing
coom	whole thing
pung	all symbols
wark	whole pattern, all letters, looks like it, looks like nervous,nous, remember symbols

1) Graphic Awareness: The majority of times, the individual chose the first symbol or last symbol except where there are some double letters. Then the double letters took priority.

2) Graphic Associative: The focus was on various letters in the word. There seemed to be no clear preference for first or last letters. Where there were double letters, they again took priority.

3) Conceptual Coding: This measure was strongly dependent on how letters looked: if they looked like the concept of the word or if the student could make a symbol remind them of the word's meaning.

4) Grapheme-Phoneme Correspondance: Various symbols were associated with their proper alphabetic letter. There did not seem to be a first or last letter preference but double letters again took priority.

5) Grapheme-Phoneme Analysis: Students chose various letters to decode and priority was given to double letters.

6) Whole Word: Various statements were uttered that all suggested the subjects knew the whole word as can be seen in Table 2.3.

Independent Variables Effects on Learning Variables

All of the experimental variables were tested first by using a correlational analysis with all of the independent variable scores. For the correlational

analysis, significant variables are listed in order of significance for each experimental variable in Tables 3.1 to 3.8. On each table, one learning variable is listed with the correlational values of the independent variables. Beside each correlational value is a rank given where the most highly correlated variable is given (1) and they are ranked through to (19).

In addition to these correlational analyses, a step-wise regression was also performed to provide more in depth analysis of the same data. The correlations were added to the analysis to show to what degree of significance various independent variables were related to the word learning variables used in this study.

For the step-wise multiple regression on Visual Discrimination First Correct, the independent variable entered on step one was the Auditory Unordered Short-term Memory $F(1,28)=17.21$ $p<.0005$. This accounted for 38% of the variance. The variable entered on step two Auditory Unordered Delayed Short-term Memory $F(1.28)=12.73$ $p<.0002$. Together, Auditory Unordered Short-term Memory and Auditory Unordered Delayed Short-term Memory accounted for 48% of the variance in Visual Discrimination to first correct.

For Visual Discrimination to Criterion, Auditory Unordered Short-term Memory was entered on step one $F(1,28)=16.58$ $p<.0005$ and accounted for 37% of the variance. Word Attack was entered on step two

Table 3.1

Correlations of Visual Discrimination First Correct With All Independent Variables

Correlations:	Visual Discrimination 1st correct	Rank
Reading Quotient	-.3640	13
IPAT (Visual Spacial Reasoning)	-.4484*	4
GORT-R Comprehension	-.2409	16
GORT-R Passage	-.2736	15
Phonetic words read on Boder	-.3679	11
Nonphonetic words on Boder	-.3534	14
Visual Ordered Immediate Memory	-.2084	17
" " STM	-.4128	6
" " Delayed STM	-.3883	8
Visual Unordered Immediate Memory	-.3743	9
" " STM	-.4030	7
" " Delayed STM	-.3663	12
Auditory ordered Immediate Memory	-.4621*	3
" " STM	-.1907	18
" " Delayed STM	-.1000	19
Auditory Unordered Immediate Memory	-.4444*	5
" " STM	-.6170**	1
" " Delayed STM	-.3732	10
Woodcock Word Attack	-.4886*	2

1-tailed significance: *- .01 **- .001

Table 3.2

Correlation of Visual Discrimination to Criterion

With All Independent Variables

Correlations:	Visual Discrim to crit.	Rank
Reading Quotient	-.5220*	7
IPAT	-.5323*	6
GORT-R Comprehension	-.3907	14
GORT-R Passage	-.4162	13
Phonetic words on Boder	-.5709**	3
Nonphonetic words on Boder	-.5567**	4
Visual Ordered Immediate Memory	-.3534	17
STM	-.4945*	8
Delayed STM	-.4282*	12
Visual Unordered Immediate Memory	-.4808*	9
STM	-.3812	16
Delayed STM	-.3871	15
Auditory Ordered Immediate Memory	-.5345*	5
STM	-.3326	18
Delayed STM	-.2224	19
Auditory Unordered Immediate Memory	-.4762*	10
STM	-.6099**	1
Delayed STM	-.4563*	11
Woodcock Word Attack	-.5950**	2

1-tailed significance: *.01 **.001

Table 3.3

Correlation of Name Retrieval First Correct

With All Independent Variables

Correlations: Name Retrieval 1st Correct		Rank
Reading Quotient	-.5499**	6
IPAT	-.4552*	10
GORT-R Comprehension	-.3329	14
GORT-R Passage	-.4331*	12
Phonetic words on Boder	-.5785**	3
Nonphonetic words on Boder	-.5763**	4
Visual Ordered Immediate Memory	-.3881	13
STM	-.2678	17
Delayed STM	-.2772	16
Visual Unordered Immediate Memory	-.5046*	8
STM	-.4869*	9
Delayed STM	-.4413	11
Auditory Ordered Immediate Memory	-.5763**	4
STM	-.2957	15
Delayed STM	-.2396	18
Auditory Unordered Immediate Memory	-.5526**	5
STM	-.6491**	1
Delayed STM	-.5130*	7
Woodcock Word Attack	-.6295**	2

1-tailed significance: *.01 **.001

Table 3.4

Correlation of Name Retrieval to Criterion

With All Independent Variables

Correlations: Name Retrieval to Criterion		Rank
Reading Quotient	-.5098*	10
IPAT	-.4469*	12
GORT-R Comprehension	-.3544	17
GORT-R Passage	-.4259*	13
Phonetic words on Boder	-.5538**	5
Nonphonetic words on Boder	-.5503**	6
Visual Ordered Immediate Memory	-.3970	15
STM	-.3966	16
Delayed STM	-.4036	14
Visual Unordered Immediate Memory	-.5389*	8
STM	-.5436**	7
Delayed STM	-.5264*	9
Auditory Ordered Immediate Memory	-.5953**	2
STM	-.2624	18
Delayed STM	-.2069	19
Auditory Unordered Immediate Memory	-.5751**	4
STM	-.6695**	1
Delayed STM	-.5015*	11
Woodcock Word Attack	-.5762**	3

1-tailed significance: *.01 **.001

Table 3.5

Correlation of Word Reading First Correct

With All Independent Variables

Correlations: Word Reading First Correct		Rank
Reading Quotient	-.5517**	3
IPAT	-.5332*	7
GORT-R Comprehension	-.3803	17
GORT-R Passage	-.4503*	13
Phonetic words on Boder	-.5397*	5
Nonphonetic words on Boder	-.5244*	8
Visual Ordered Immediate Memory	-.4082	15
STM	-.4122	14
Delayed STM	-.4075	16
Visual Unordered Immediate Memory	-.5068*	10
STM	-.5220*	9
Delayed STM	-.5037*	11
Auditory Ordered Immediate Memory	-.5351*	6
STM	-.3014	18
Delayed STM	-.1997	19
Auditory Unordered Immediate Memory	-.5400*	4
STM	-.6459**	1
Delayed STM	-.4717*	12
Woodcock Word Attack	-.6082**	2

1-tailed significance: *.01 **.001

Table 3.6

Correlation of Word Reading to Criterion

With All Independent Variables

Correlations: Word Reading to Criterion		Rank
Reading Quotient	-.5229*	7
IPAT	-.4695*	12
GORT-R Comprehension	-.3803	17
GORT-R Passage	-.4497*	14
Phonetic words on Boder	-.5818**	3
Nonphonetic words on Boder	-.5646**	5
Visual Ordered Immediate Memory	-.3840	16
STM	-.4643*	13
Delayed STM	-.4408*	15
Visual Unordered Immediate Memory	-.5115*	8
STM	-.5009*	10
Delayed STM	-.5035*	9
Auditory Ordered Immediate Memory	-.5677**	4
STM	-.3200	18
Delayed STM	-.2193	19
Auditory Unordered Immediate Memory	-.5591**	6
STM	-.6703**	1
Delayed STM	-.4869*	11
Woodcock Word Attack	-.6004**	2

1-tailed significance: *.01 **.001

Table 3.7

Correlation of Free Recall First Correct

With All Independent Variables

Correlations: Free Recall First Correct		Rank
Reading Quotient	-.4740*	7
IPAT	-.4735*	8
GORT-R Comprehension	-.3472	17
GORT-R Passage	-.4134	12
Phonetic words on Boder	-.4632*	9
Nonphonetic words on Boder	-.4476*	10
Visual Ordered Immediate Memory	-.3853	14
STM	-.2884	18
Delayed STM	-.2278	19
Visual Unordered Immediate Memory	-.3908	13
STM	-.5021*	3
Delayed STM	-.5126*	2
Auditory Ordered Immediate Memory	-.4390*	11
STM	-.5663**	1
Delayed STM	-.4753*	6
Auditory Unordered Immediate Memory	-.4864*	4
STM	-.3792	15
Delayed STM	-.3781	16
Woodcock Word Attack	-.4327*	5

1-tailed significance: *.01 **.001

Table 3.8

Correlation of Free Recall to Criterion

With All Independent Variables

Correlations: Free Recall to Criterion		Rank
Reading Quotient	-.5478**	8
IPAT	-.5062*	10
GORT-R Comprehension	-.4509*	14
GORT-R Passage	-.4566*	15
Phonetic words on Boder	-.5679**	4
Nonphonetic words on Boder	-.5546*	6
Visual Ordered Immediate Memory	-.4924*	12
STM	-.3362	17
Delayed STM	-.2747	19
Visual Unordered Immediate Memory	-.4998*	11
STM	-.5821**	3
Delayed STM	-.5651**	5
Auditory Ordered Immediate Memory	-.5498**	7
STM	-.4494*	16
Delayed STM	-.3223	18
Auditory Unordered Immediate Memory	-.5919**	2
STM	-.6000**	1
Delayed STM	-.4903*	12
Woodcock Word Attack	-.5123*	9

1-tailed significance: *.01 **.001

$F(1,28)=12.25$ $p<.0005$ and together these variables accounted for 48% of the variance.

The Name Retrieval First Correct found that Auditory Unordered Short-term Memory was entered first $F(1,28)=20.39$ $p<.0002$ and accounted for 42% of the variance. Word Attack entered next, had a value of $F(1,28)=15.59$ $p<.0001$ and together with Auditory Unordered Short-term Memory accounted for 54% of the variance.

Auditory Unordered Short-term Memory was also entered on the first step for Name Retrieval to Criterion $F(1,28)=22.74$ $p.0002$ and accounted for 45% of the variance. Visual Unordered Delayed Short-term Memory regressed by Name Retrieval to Criterion had a significance of $F(1,28)=14.78$ $p<.0001$. Together these two variables accounted for 52% of the variance.

For the Word Reading First Correct, Auditory Unordered Short-term Memory was again entered on the first step $F(1,28)=20.04$ $p<.0002$ and accounted for 42% of the variance. Then Word Attack was entered $F(1,28)=14.43$ $p<.0002$. Together these two independent variables accounted for 52% of the variance.

For the Word Reading to Criterion, Auditory Unordered Short-term Memory $F(1,28)=22.84$ $p<.0002$ accounted for 45% of the variance. Word Attack was entered on the second step $F(1,28)=15.47$ $p<.0001$ and

together with Auditory Unordered Short-term Memory accounted for 53% of the variance.

For the Recall First Correct measure, Auditory Ordered Short-term Memory was entered on the first step $F(1,28)=13.21$ $p<.0002$ and accounted for 32% of the variance, followed by Auditory Unordered Short-term Memory $F(1,28)=10.12$ $p<.001$. Together 43% of the variance was accounted for by these variables.

Finally, for the Recall to Criterion, Auditory Unordered Short-term Memory $F(1,28)=15.75$ $p<.001$ and Auditory Ordered Short-term Memory $F(1,28)=14.42$ $p<.0002$ which together accounted for 52% of the variance. Therefore, it appears that Auditory Short-term Memory ability was the most significant skill effecting both recall measures.

CHAPTER FIVE

CONCLUSIONS AND DISCUSSION

This chapter will discuss the findings as they relate to previous research. In addition, it will assemble information to form a possible sequence of learning and provide some insight on the educational implications related to this research.

It appears that for the number of trials to first correct on the visual discrimination measure, neither stimulus factors, response factors, nor reading ability were related to performance. This suggests that finding a discriminable feature in a new reading word does not present a problem to students of various reading abilities.

The fact that the easy orthography words were not linearly related to Word Attack scores, but that hard orthography words were, suggests that phonological decoding ability seems to be related to performance in terms of fewer trials to criterion. This ability did not appear to have a relationship in visually recognizing words with a simple pattern (i.e., double letters); however, when visual discrimination became more difficult, there was a phonological decoding effect. Perhaps double letters may only require learning of three separate features as opposed to four.

In fact, a learning of the double letters may be enough, in some cases, for a first correct visual discrimination. This suggests that students who have phonetic decoding problems may find it harder to visually discriminate words with more difficult orthographies. These effects may not show up on words with simpler orthographies.

As expected, results from the t-tests did show that there was a general difference for orthographic difficulty, suggesting that the ability to learn hard orthographies to criterion is more difficult for all readers. In addition, the relationship of this factor to the Reading Quotient and GORT Passage scores provides evidence for the Vellutino and Scanlon's (1986) observation that the poorer the reader, the more trouble he/she will have in orthographic coding. Therefore, real words with more difficult orthographies may be harder to learn. In addition, the fact that there were differences between hard and easy orthography conditions, but no differences between familiar and unfamiliar names, provided some evidence that visual discrimination learning may be a separate factor from the ability to recall the word's name. It also appears that some visual discrimination learning takes place prior to the beginning of between code learning. Between code learning must start at some point where visual discrimination and name retrieval

are learned well enough to choose features of both to associate.

It seems that by comparing scores of visual discrimination first correct and visual discrimination to criterion, that the real problem may be in completing the visual picture. It appears that elaborating or completing the visual discrimination learning may be what separates the good from the poor reader. As noted earlier, in addition to finding visual discrimination learning to be a possible independent factor, the data also showed that name retrieval was independent of orthographic difficulty. Therefore, the results were consistent with previous research that provided support for the claim that familiarity with word response should affect only name retrieval (Wagner, 1985; Vellutino & Scanlon, 1987).

The position that holds that some response learning may occur prior to the hook-up of stimulus and response seems to have some support here. The trials to criterion mean score for name retrieval was less than that of word reading to first correct. This implies that the person may have to retrieve the name prior to associating it with the orthographic features of a word. Furthermore, response familiarity appeared to have no effect as there were no differences between familiar/unfamiliar words on name retrieval.

The results also implied that name retrieval was not generally a difficult task for the students. Although there were reading ability effects for the first correct name retrieval, there were none for the name retrieval to criterion. This suggests that once an individual retrieves the correct name, it is not significantly more difficult to retrieve familiar or unfamiliar words based on reading ability. All of the students in the study seemed to have an equal chance at retrieving familiar and unfamiliar words regardless of their reading ability.

The part of learning called name retrieval in this study appears to be too simple to be the first stage of learning that Greeno et al. (1978) described. There is no true association between the orthography and name retrieval since the individual may be pointing to an incorrect orthographic structure that he/she remembered because it was on the same card of responses. There is no direct link of stimulus to response since the correct stimulus may not be chosen: One of the distractors may be pointed to instead. It appears that the Greeno et al. (1978) model's stimulus-response association could be analogous to the orthographic structure being linked to the correct word name. What occurred in this stage seemed to be the learning that takes place prior to that hook-up. This stage is more related to Ehri's (1987) description of the initial

stages of attempting to find letter-sound correspondences.

In the first correct whole word reading, the process occurring seems closest to what Wagner (1985) described as the development of an association between the name of the word and the first letter of its visual representation. It is probable that for the name retrieval task, only one letter needed to be recognized to choose the correct stimulus set and this would not prove to be an exceptionally difficult task for poor readers. It is when there are more letters to process that students with reading disabilities begin to have increasing difficulties. This information seems to point to the whole word first correct as most closely resembling the learning referred to by Greeno et al. (1978) as Stage 1 learning. This appears to be the stage where the response is learned but the stimulus response hook-up is not fully established. Therefore, in this stage as Humphries (in Greeno et al., 1978) argued, both stimulus (orthography and response name) should influence learning in this stage. This is the only point at which both orthographic difficulty and name familiarity appeared to have some effect. It also appeared that by this time in learning to read the stimuli, the only reading skills that were related to performance were those necessary in obtaining the GORT

Passage scores which is a reading test where students must read stories orally.

These data also provided support for the hypothesis that whole word identification is especially dependent on the ability to recall the word's name (Vellutino & Scanlon, 1987). The fact that learning went on within codes prior to association learning also supports their argument that the ability to retrieve a name and analyze the orthographic structures are different skills but both necessary for word identification.

The following conclusions appear warranted with regard to the data collected on the experimental factors: By an analysis of the mean values of all of the variables of learning tested (visual discrimination first correct, visual discrimination to criterion, name retrieval to first correct, name retrieval to criterion, free recall to first correct, free recall to criterion, word reading to first correct, word reading to criterion) the following sequence of learning is proposed: (Please keep in mind that this is a very rough proposal based solely on ordering the mean number of trials to criterion from least to most). This analysis assumes that if a task took less trials to criterion that it may be learned more thoroughly first. Figure 4 presents a diagram of the following description of a potential sequence of learning.

Figure 4

A Possible Sequence of Learning

Step 1 Subject begins to remember names of the words

Step 2 Subject begins to recognize the graphic pattern of words independent of associating them with word name

-followed closely by-

Subject can remember all names of words without error

Step 3 Subject begins to associate one or more symbols to word's name independent of recognition of whole graphic pattern

Step 4 Subject recognizes graphic patterns without error; and,

Subject associates one or more symbols to word's name without error - may choose a distractor or word spelled similarly

Step 5 Initial hook-up of the visual word with correct name (enough features are known to not choose a distractor or similarly spelled word)

Step 6 Complete hook-up of visual word with name

Free recall to first correct took the least mean trials to criterion so this was probably the first learning occurring. In other words, subjects were able to begin to remember some of the names of the words first. This was followed by visual discrimination first correct and free recall to criterion, implying that the individuals began to analyze the graphic features before they thoroughly learned to recall all the words' names. Next, the word retrieval to first correct was achieved, implying that, at this time, individuals began to attempt to associate possibly one or two of the symbols to the name of the word.

The next phase of learning may involve the following processes: First, name retrieval to criterion is followed closely by visual discrimination to criterion. Subjects were able to retrieve the correct word based on the stimulus set in almost the same number of trials as it took them to be able to make the same choice based on graphic features. At this point, learning of the word's name in association with at least one letter of the stimulus occurred. Not enough letters were known to correctly distinguish the word from distractors so there was still not a direct hook-up between stimulus and response. Also, visual discrimination to criterion includes pointing to the correct stimulus but not necessarily giving correct responses. Therefore, at this point, the stimulus was

learned well enough to choose it as the word learned but not to the point where it was associated with the correct response. In other words, a subject can point to the correct word but is not always sure of the name of that word. These above-mentioned learning factors were all completed to criterion prior to the complete hook-up of stimulus to response. This implies there was some independent learning of the word's name, visual orthography, and trial and error of hook-ups of the word's name to the orthography before a complete stimulus-response hook-up occurs.

Then the learning moved into the Greeno et al. (1978) model where the initial hook-up of stimulus and response occurred. Between this initial hook-up and the learning of the association of stimulus and response to criterion, there were some errors made, meaning that this was probably initial learning. Finally, the hook-up was completed in the second stage as predicted by Greeno et al. (1978). At this point, subjects knew enough about the visual and auditory features of the word to be able to choose the correct word and read it correctly every time.

The qualitative data also showed some evidence concerning possible sequences of learning. As was suggested by McGee and Lomax (1987), the visual strategies were the most popular in the first trial. Then, in later trials grapheme-phoneme correspondence

and analysis and, finally, whole word reading became popular strategies.

These findings correspond to the research that follows. They provide support to Gough and Hillinger (1980) who suggested that a mainly visual strategy is used first. However, the Ehri and Wilce (1985) theory appears to have been supported also. Prereaders (in this study they were only prereaders of the specific script used in experimental tests) may start with visual cue processing and then move into phonetic cue processing since in the first trial visual graphic material was most popular. Analysis of later learning which will measure transfer of skills would be necessary in order to test Ehri's proposal that moving from prereader to reader, one uses different strategies. As the individual moved into a reader of this alphabetic system, he/she would be using more phonetic strategies based on Ehri's findings.

In this particular study, where only eight words were to be learned, the students appeared to begin to analyze words as Gough and Hillinger (1980) suggested in their description of code learning. Students reported beginning to identify words by using a distinctive feature of the visual stimulus such as a zig-zag line or contour and associating it with the response. Students associated the visually distinctive feature by stating what it looked like (that symbol

looks like a man standing on his head; I remember that symbol; or, that symbol looks like a sled and the word pung means sled). The students initially focused on the double letters or the first or last symbol in the Graphic Awareness stage. They progressed to Graphic Associative and Conceptual coding and then the double letters or letters with distinctive features took priority.

As some of the students began to use phonetic strategies, the pattern could follow Gough and Hillinger (1980) or Ehri (1987). Gough and Hillinger felt that cue learning breaks down when the amount of visual features available to distinguish words from each other is exhausted. Therefore, in this study when readers ran out of distinguishing visual features for each word, they began to use phonetic strategies on some words. This stage, called cipher reading, did not appear to be relied on totally by the subjects, perhaps because they were not tested far enough into learning or because they were using both visual and phonetic strategies in reading. Thus, they did not totally shift to cipher reading but moved into it and mixed cipher and code reading strategies. As previously reviewed, Ehri (1987) suggested a similar process where pre-readers use visual or context cues to identify words and as soon as they move into reading and master the letter system they shift to letter sound cues.

However, Ehri and Wilce (1985) also argued that even when they can identify only a few words, they can use letter-sound processing. This is what appeared to be happening in this study when some students began to use phonetic strategies early in learning by analyzing sounds in a few words. By analyzing verbal reports, it is also important to note that again, as Brooks (1977) suggested, students chose the distinctive features of the double letters if they occurred and focused on various letters they remembered in other words. At this time it must be noted that it was very exciting that the results matched these theories. On the other hand, this study would have to be repeated with real words and real prereaders to determine how quickly they acquired the letter-sound relationships.

In terms of the stimuli employed in this study, what appears to be happening is that visual discrimination of graphic features occurs first. Then, later in learning, when a pattern of visual features is matched to sounds, grapheme-phoneme correspondence is used; however, graphic strategies are not abandoned. Then, as learning progresses, it reaches the point where individuals recognize some whole words. One of the most important findings is that as individuals appeared to move on to different strategies, they still used some of their previous strategies. For example, if someone started with graphic strategies and then used

some grapheme-phoneme correspondence strategies, they continued to use some graphic strategies. In addition, when students began to recognize words as wholes, they still used some graphic and grapheme-phoneme strategies on words. Therefore, there does not appear to be a clear cut distinction of stages, but rather a development of strategies that build on each other and enhance learning. This is also suggested by the nature of the verbal reports of whole word types of strategies. Where some words were reported to have been learned because the student remembered all letters or all symbols or they knew the alphabet (suggesting phonetic decoding, other words were reported to have been learned because they recognized the word as a whole or knew the pattern - suggesting graphic decoding. Therefore, it appears that students use strategies which are most effective for them and may be selective as to which strategies are effective for specific words. It is possible that prereaders may remember words by using various strategies and may in fact use more than one strategy on a single word.

Since learning was only reported over three trials, the information regarding strategy use should be treated with caution. For example, for the most popular use of graphic strategies only, it is not clear what would be reported after the third trial of learning. Also, we can not be sure if other strategies are being

used and not reported because the student is doing so unconsciously. On the other hand, the results proved to be very interesting regarding uses of analytic correspondence. It does appear that students used analytic correspondence more often than non-analytic correspondence. Stimulus-specific correspondence was the most popular strategy and the students used graphic strategies or mostly graphic with some phonetic strategies. An equal use of graphic and phonetic strategies was the next popular combination and graphic changed to phonetic (which corresponds to analytic correspondence with reliance on rules) was the least popular, but was still used. Therefore, it appears that students who are just learning to read words with an alphabet do not just recognize words without analyzing parts. Instead, they break them up and learn in a two-stage process where features are learned first through graphic and phonetic analysis and then when enough information is analyzed, they can be recognized as a complete pattern.

In terms of reading skills which determined performance on the experimental variables, the results provided support for Stanovich's (1986) claim that individuals with reading difficulties have problems in word decoding and short-term memory. As Brady (1986) found, this was particularly true for verbal memory

span. Since the LET uses only letters in the test, it was indeed verbal memory being tested.

A factor of interest is that Auditory Unordered Short-term Memory proved to be more closely related to scores on the Word Learning Tests than the Auditory Ordered Short-Term Memory. Remembering auditorily presented words in order is a more difficult task than just remembering all of the letters whether they are perfectly in order or not. The results indicate that the skill of remembering all of the letters, not necessarily in order, is more of an indicator of performance on these tasks and that it did not have to be perfected to remembering them all in order. These results could be further explained by Wagner (1985) who suggested that when an individual begins to learn words, he/she begins to associate one letter of the word to the name of the word. The amount of letters associated would increase with trials until enough letters were remembered to discriminate that word from distractors. Since this does not necessarily require remembering all letters in order, it would follow that Unordered Auditory Short-Term Memory might be more related to this ability. The importance of this variable also suggests that auditory short-term memory may play a critical role in the acquisition of new reading words. Wagner (1985), for example, has argued for a model in which the name of a word (or its

phonemes) must be held in auditory short-term memory while the individual is engaging in learning the visual features of the word's orthography. This factor is seen as necessary in order for grapheme-name or grapheme-phoneme associations to be formed. Individuals with poor auditory short-term memory performance may be prone to maintaining the name or phonemes of a word in short-term storage for only brief periods of time (30 seconds for example) while engaging in visual discrimination learning, whereas good readers may be capable of maintaining verbal rehearsal for a longer period of time (i.e., two minutes). As a result, the poor reader may disengage from learning a new word before much of the orthography has been learned and associated with the word's name.

It is important to note that for each experimental variable, different independent variables were entered for mean number of trials to first correct and mean number of trials to criterion. This could mean one of two things: First correct response occurred by chance or that first correct response required different skills than learning to criterion. If the latter is true, it could follow Ehri's (1985) and Gough and Hillinger's (1980) suggestions that as individuals move into reading they use different skills. Perhaps as a group, the initial skills necessary to find a first correct response were particular to that part of

learning. Moving to criterion is a much more difficult task and is perhaps a determining factor in reading ability. However, before any of these speculations can be taken into consideration, more research in this area of necessary skills for the stages of reading is essential. Although important research regarding the necessary skills for reading has been done, this study implies that there may be other important skills which are important determiners of learning to read in the initial stages. Further research in this area is necessary. It may bring forth new information that will assist children who are first being exposed to print. If we are able to reach these children early, they may have less trouble learning later on.

Summary and Conclusions

The following conclusions can be reached through findings based on past research and new information discovered in this study:

First of all, it appears that the ability to remember the words' names occurred first. Perhaps this occurred because we become familiar with hearing language before we begin to read. The name of the word in this study was a single bit of information to remember while the orthography consisted of four bits of information (symbols) to remember. Auditory Ordered

and Unordered Short-term Memory were the major factors which affected this learning. Also, since it was learned first, it may be a factor that is most important to learn thoroughly in order to continue the process of learning to read words.

Next, the students began to analyze visual orthographies of words. In addition, they reported using graphic strategies first. In the initial stages of visual discrimination to first correct, the Auditory Unordered Short-Term Memory and Auditory Unordered Delayed Short-Term Memory were the skills that determined performante. However, as visual discrimination was more fully learned, Auditory Unordered Short-Term Mèmory and Word Attack became important indicators of learning performance.

Name retrieval to first correct started soon after visual discrimination to first correct and these two skills developed together. Subjects began to analyze the letters in the words and remember visual orthographies as separate skills, since the orthographic difficulty only affected the visual discrimination scores and the name familiarity only affected the name retrieval scores. From the qualitative data, grapheme-phoneme correspondence and analysis also developed soon after graphic awareness and analysis. These verbal reports tended to coincide with the trends of the experimental learning variables.

Name retrieval to first correct was affected by Auditory Unordered Short-Term Memory and Visual Unordered Delayed Short-Term Memory.

Finally, for word reading first correct, both orthographic difficulty and word name familiarity affected learning at the first stage. By the second stage, the word's name was fully learned and the orthography still had an effect; therefore, orthography does not have to be fully learned in order to learn to read the words. Only the amount required for specific tasks needs to be learned. The students seemed to choose letters to focus on based on the strategies they were using and how these letters were particularly distinctive to the decoding strategy. Very distinctive features, in this case double letters, were most often used first in decoding. The skills of Auditory Unordered Short-Term Memory and Word Attack were the most important for the first correct and measures to criterion.

In evaluating the findings, it is also necessary to note that this study did not test transfer effects where these words were put into different context or new words based on the same alphabetic system were used. These studies could provide additional insight into how students use some knowledge of word learning. However, it is exciting that the results in this study did appear to follow trends of past research. Much more

work is necessary in this area to provide more insight on how to assist children in learning how to read and what causes some of their difficulties in different stages of learning.

Limitations of this Study

There are limitations to this type of research. Although the experimental design provides a well controlled environment and precise data gathering procedures, there are some factors that place limits on the ability to generalize to a normal classroom setting.

The testing created for this study was based on extensive research; however, it is not a standardized test. This is the reason why such a rich collection of performance measures related to learning to read were used. The correlated performance measures helped to explain what was occurring during the learning of the artificial words.

The testing group itself was not "normal" of a beginning reading group. This group was best for a preliminary testing on these stimuli since the individuals are more aware of reading strategies and it was assumed that they would be able to provide more rich verbal descriptions of strategies they felt they used. In addition, it was much easier to obtain

standardized results to compare with the artificial word testing on an adolescent group than a prereader group. Adolescents have a fairly well established vocabulary and experience with reading. In addition, although an artificial word system was used, these individuals already possess an entire symbol system including all of the rules of symbol-sound correspondence. This limits assumptions being made for prereaders who have no previous knowledge of these rules when they undertake the process of learning to read.

In regards to verbàl reports of strategy use, it will not be possible to propose which strategies seemed to be most successful because transfer of the knowledge was not tested on new stimuli. Therefore, it is not possible to report on whether an alphabetic decoding or strictly visual discrimination strategy will be more successful in the process of reading. Any results must be taken in the context of the task itself. An additional problem which occurs with verbal reports is that the reported information is not necessarily representative of what is going on in memory. They are only a conscious estimate of strategies the individual feels he/she are using in solving the problem.

Another limitation of this study is that transfer effects to new words were not tested. This research is presently being done at Brock University by Dr. Wagner.

Information obtained from this research could provide excellent insights to use of strategies and the transfer of learning in students based on their reading abilities.

In regards to the strategies used, it must be noted that the training procedure used was in effect a whole word approach and did not involve alphabetic code or phonics pretraining. Therefore, the results of this study, especially those regarding the verbal reports of strategies used, should only be thought of in the context of whole word learning. Also, there was a lack of story context training prior to testing which again places limits on the ability to generalize results to a normal classroom study.

Despite the limitations stated above, this was a well controlled experimental study which provided some very valuable results that could be used in future studies. This study also provided some very significant insights possible beginning reading strategies.

Educational Implications

The results of this study provide some implications for reading instruction. Today's early reading instruction is based on the whole language theory. Within the framework of whole language instruction, whole word reading is important. This study examined

strategies that may be used in attempting to read words wholistically.

When a word that is spoken orally is not a familiar word to an individual, that individual will make more errors in identifying it initially. If the individual's word decoding ability is low, he/she will make more errors. This will be particularly true when the word that is spoken is unfamiliar and the visual features of the word are difficult. Therefore, to make a response more familiar, the teacher should work with students on the oral word by introducing it as part of their language for quite a period of time prior to expecting them to learn to read it. This procedure might significantly reduce the number of trials to initial learning (as was suggested by Saltz (1971)). This is especially true for the poorer readers. Proof of this occurs in the recall to criterion trial where there were only significant differences based on the Boder test. For the most part, all readers had equally learned to recall easy and hard orthography words by the criterion trial. In this study it may have been fairly easy to recall the unfamiliar words due to the obvious context clues. All readers figured out the meaning of the unfamiliar words early in the learning.

For complete learning of words, a child has to master the hard orthographies. It appears that the obvious way to master these is through more exposure to

the word. More practice is necessary in the classroom and at home through visual and auditory exposure to words with hard orthographies.

There is danger in not being aware of these factors. If teachers do not take these factors into account, they can assume that words with hard orthographies and unfamiliar names are fully learned when they are not. Children may not be able to distinguish the word from others that look similar if the orthography is not fully learned. Therefore, teachers must be aware of the potential errors: 1) Teachers may not check or assume the students are familiar with words prior to learning (especially true for English as a Second Language); or 2) they may assume a word is learned before learning is complete.

In addition, some of Ehri's (1989) suggestions for instruction are very appropriate in reference to these research findings. Ehri's first suggestion was that beginning readers be taught most of the letter shapes and names or sounds before they are taught to read words. This seems to correspond to the findings in the present study where visual discrimination of orthography, name retrieval, and recall were necessary skills for learning to read and they started prior to the association or word reading. These skills are necessary, as Ehri indicated, so they will see letters when they look at words, use the sounds symbolized by

letters, and use the information to store associations in memory.

The second suggestion Ehri (1989) made was that children need to begin very early to develop some knowledge of the spelling system. Phonics programs attempt this, but a beginning reader is often frustrated by the difficulty of sounding out words when he/she lacks knowledge of spelling. Therefore, she suggests a technique which has become very important in the whole language programs: invented spelling.

Invented spelling, where students are taught to invent phonetic spellings of words, has been found by Ehri to begin sooner during literacy development than sounding out and blending. Before children start to read words, they can use letter names or sound information to invent their spellings of words. Once they get this idea, teachers can work on filling in the gaps and correcting spellings for the children. A learning system that is found easier by more children is likely to benefit more children. A critical factor in using invented spellings is that children do at some point learn how to spell correctly if they are not frustrated along the way. Ehri has pointed out that such knowledge gained in using invented spelling may be a key to learning correct spellings of words. Also, as was previously mentioned, it may be the easiest way to help beginners to learn about letters. These skills are

under a teacher's power to teach and as the children progress further into reading and invented spelling, some will pick up correct spellings on their own and others will need help. The teacher has the power to expand invented spellings, which often initially contain mostly consonants, to include vowels and also to correct way-out spellings. The information a teacher gathers from invented spellings can be used to plan instruction in areas where students are having the most problems.

It must be noted here that Ehri's research is extremely valuable because of its practical suggestions. This is the type of work that encourages teachers and curriculum planners to make use of research findings. Too much important research remains untouched by many because it is too difficult to interpret. When the researcher, like Ehri, does take research findings and then relate them to the real world of teaching, this action may lead to more applied use of important discoveries.

The instructional implications arising from this study lend support to Ehri's suggestions and this in itself gives them some credence. Additional research is needed, however, to investigate word learning further, as well as to relate findings on word learning to other factors associated with reading development.

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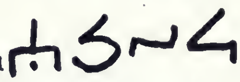
Appendix I

Sentences for Experiment

She put a  (bipp) on her cut finger.

The sun came out after the  (rain).

The horse pulled us through the snow on a  (pung).

In the  (fall) the leaves turn colours.

He felt a  (wark) in his sprained ankle.

The north  (star) is very bright.

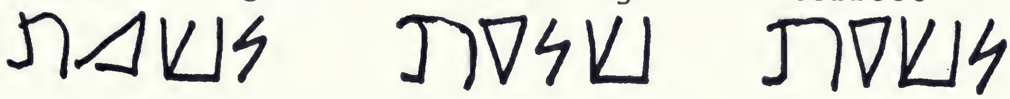
She broke the  (heel) on her shoe.

A cloud of  (coom) followed the car down the dirt road.

Appendix II

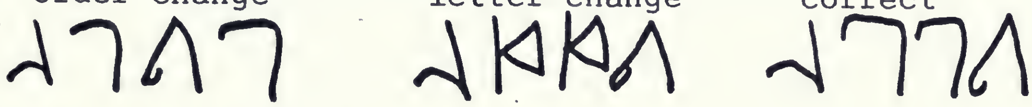
Words With Distractors to Choose

letter change | order change | correct



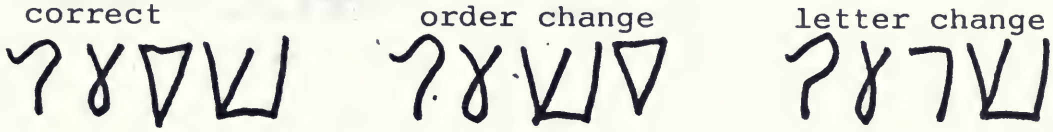
wark

order change | letter change | correct



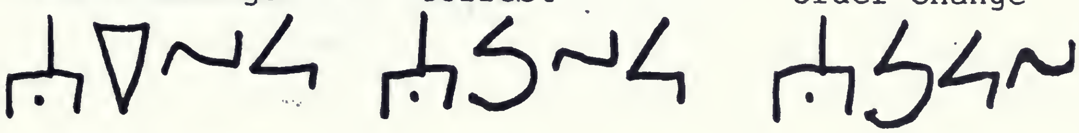
heel

correct | order change | letter change



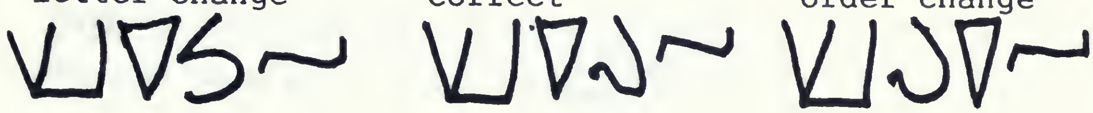
star

letter change | correct | order change



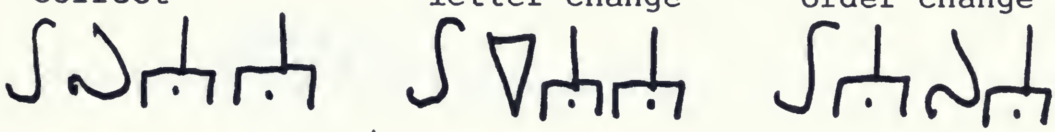
pung

letter change | correct | order change



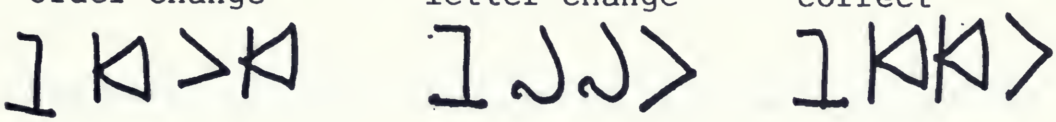
rain

correct | letter change | order change



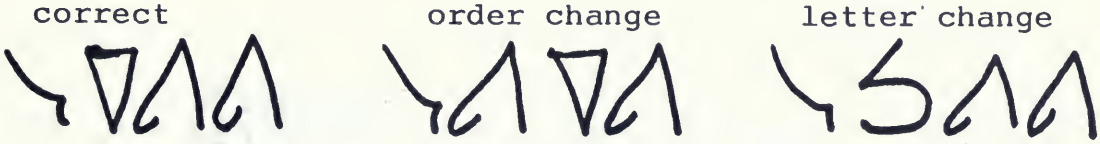
bipp

order change | letter change | correct



coom

correct | order change | letter change



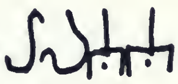
fall

Appendix III
Splitting Sentences According to Orthography:
Easy/Hard Stimulus Difficulty

Easy Orthography (Double letters)

A cloud of  followed the car down the dirt road.
coom

In the  the leaves turn colours.
fall

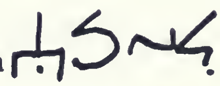
She put a  on her cut finger.
bipp

She broke the  on her shoe.
heel

Hard Orthography (No double letters)

The sun came out after the .
rain

The north  is very bright.
star

The horse pulled us through the snow on a .
pung

He felt a  in his sprained ankle.
wark

Appendix IV

Splitting Sentences According to Word Familiarity

Familiar Words

The sun came out after the .
rain

The north  is very bright.
star.

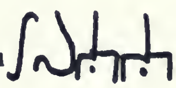
In the  the leaves turn colours.
fall

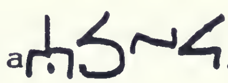
She broke the  on her shoe.
heel

Unfamiliar Words

A cloud of  followed the car down the dirt road.
coom

He felt a  in his sprained ankle.
wark

She put a  on her cut finger.
bipp

The horse pulled us through the snow on a .
pung

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