Visual Word Learning in Good and Poor Readers

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Abstract

Forty students from regular, grade five classes were divided into two groups of twenty, a good reader group and a poor reader group, on the basis of their reading scores on Canadian Achievement Tests. The subjects took part in four experimental conditions in which they learned lists of pronounceable and unpronounceable pseudowords, some with semantic referents, and responded to questions designed to test visual perceptual learning and lexical and semantic association learning. It was hypothesized that the good reader group would be able to make use of graphemic and phonemic redundancy patterns in order to improve visual perceptual learning and lexical and semantic association learning to a greater extent than would the poor reader group. The data supported this hypothesis, and also indicated that, although the poor readers were less adept at using familiar sound and letter patterns, they were more dependent on such patterns as an aid to visual recognition memory and semantic recall than were the good readers.

It was postulated that poor readers are in a double-bind situation of having to choose between using weak graphemic-semantic associations or grapheme-phoneme associations which are also weak and which have hindered them in developing automaticity in reading.

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CHAPTER ONE

Introduction

Reading is only one of the many skills which most people are fortunate enough to be able to take for granted. However, reading is an extremely complex skill involving the coordination of many processes during a very short period of time. Children and adults who have difficulty in mastering this skill will be severely handicapped both in and out of school, since living a successful and satisfying life in modern society demands an increasingly high level of literacy. There are very few jobs that do not demand at least the minimum basic reading skills necessary in order to understand and respond to written instructions. For people with reading problems, road signs and shop signs may be indecipherable, and filling in forms can be an impossible task. Most computerized processes do not help the reading-disabled because they require the ability to read on-screen instructions and instruction manuals.

In order to be better able to help those who have problems with reading, we need to further our understanding of the processes involved in reading. In recent years, many studies have been carried out and several theories have evolved which attempt to describe the processes that take place during the act of reading, some by using formalisms of information processing approaches, such as flow charts.

Some of these studies examine the differences between good and poor readers, indicate areas of potential difficulty for poor readers, and show how good and poor readers differ in their ability to employ appropriate strategies for reading tasks. This information should be useful to those involved in helping poor readers to acquire some of the skills that good readers instinctively use.

The purpose of the present study was to compare the strategies spontaneously employed by a group of good readers with those spontaneously employed by a group of poor readers in tasks involving the learning of lists of new words. Semantic referents were provided for some of the words in order to investigate group differences in the use of semantic coding. Strategies which were of particular interest in this study were those using visual coding, phonemic encoding, and cross-modal transference involving the phonemic and/or semantic recoding of visual stimuli.

A word-learning task was used to make the comparisons. The words used were from a study by Massaro, Venezky and Taylor (1979) and were based on letter-sound patterns found in approximately twenty thousand English word types. There were four conditions in the experiment: a visual condition, using unpronounceable pseudowords without meanings; a visual and phonetic condition, using pronounceable pseudowords without meanings; a visual, phonetic and semantic condition, using pronounceable pseudowords with meanings;

and a visual and semantic condition, using unpronounceable pseudowords with meanings.

A word-learning task was used because of the importance of word learning to the reading process. Fast, automatic word recognition has been recognized as an essential component of fluent reading (Stanovich, 1980; Laberge & Samuels, 1974). Problems in word learning would lead to difficulties in word recognition, and such problems may be an underlying factor in reading failure. In this study, a word-learning task was used in order to examine some of the differences between good and poor readers with respect to the strategies and encoding methods used when learning new words.

CHAPTER TWO

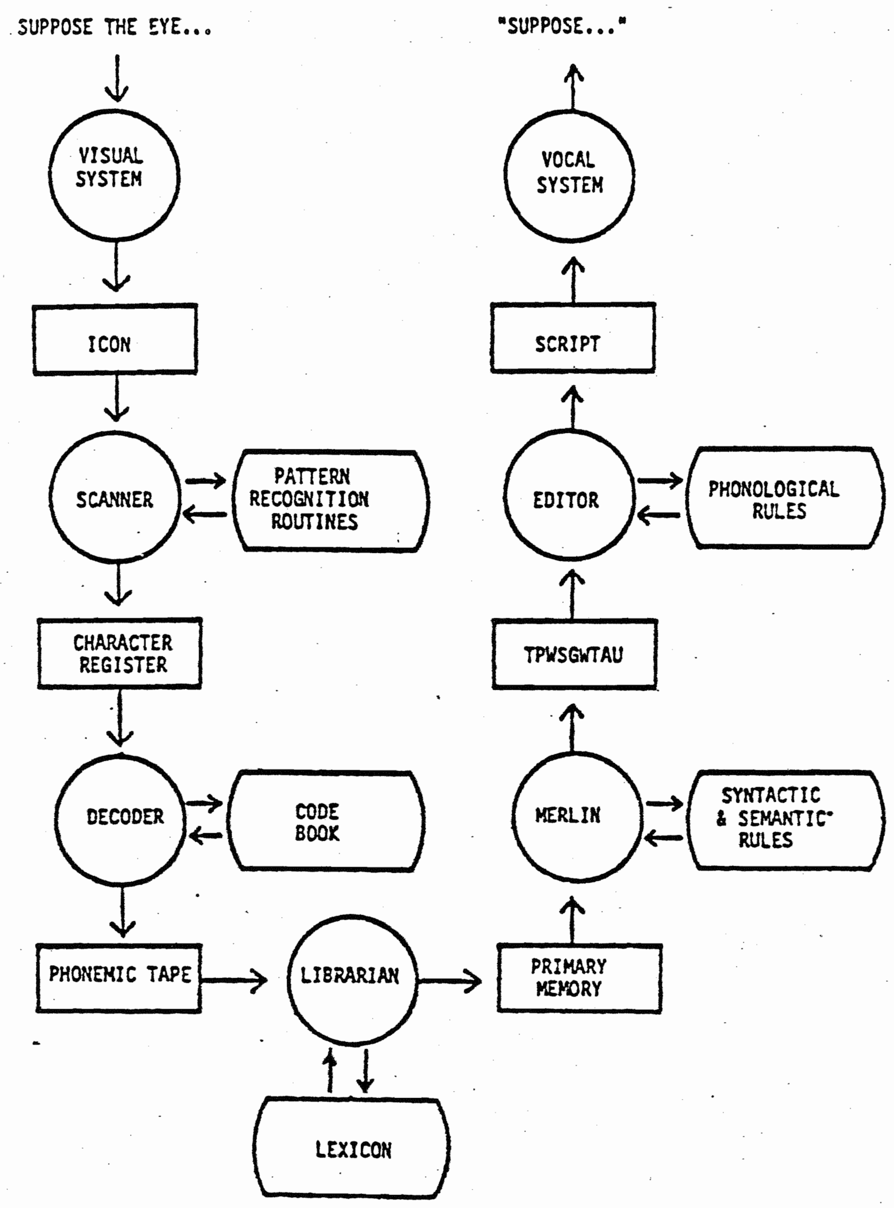
A Review of the Literature

In the last two decades, several theories have been advanced which attempt to describe the processes that take place during the act of reading by using flow chart models. Gough's (1972) model, shown in Figure 1, suggests that people read letter by letter, and that letters are processed and word meanings located in rapid succession. A phonemic representation of new input is matched up by the librarian with previously learned words in the lexicon (mental dictionary). This model presumes the existence of a cognitive representation of previously learned words. The reading process is a serial, letter by letter, word by word, analysis of the input string. This is called a bottom-up model, and is criticised because it does not allow for higher processes having an effect on lower levels of processing.

Smith (1971) suggests that the fluent reader engages in hypothesis testing as he proceeds through the text, and that he verifies his hypotheses by stimulus analysis, going from higher level to lower level processes. The success of the reader in generating hypotheses would, presumably, be dependent on the richness of the lexicon of previously learned words. This model is called a top-down model,

FIGURE 1

Gough's Model of Reading



because the flow of information is going from high level processes (semantics) to lower level processes (stimulus analysis).

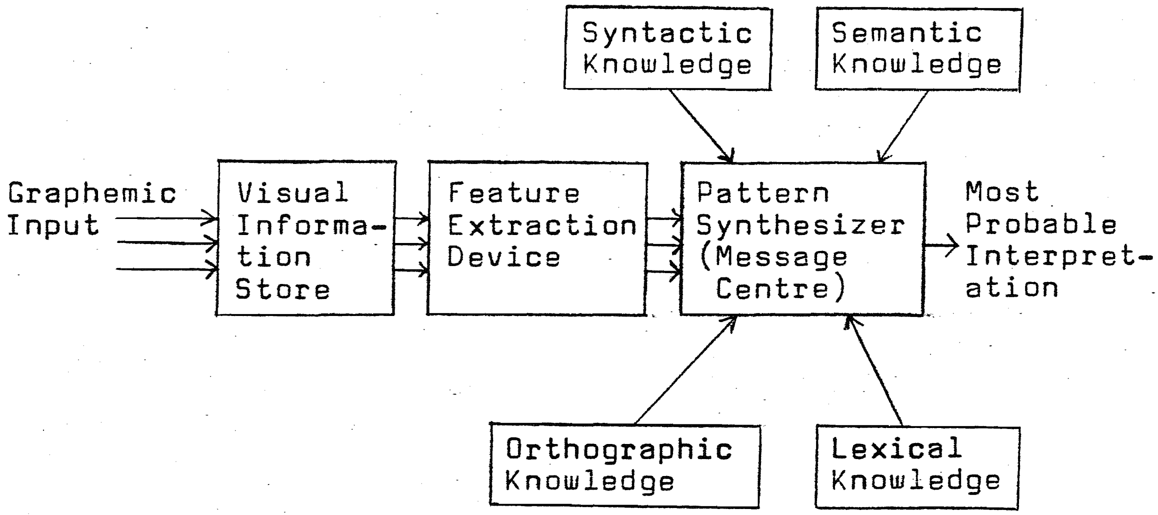
There are problems with both of these models. The bottom-up model cannot account for empirical findings about the reader's ability to make use of word, syntactic and semantic context effects (Rumelhart, 1977). The top-down model founders on consideration of the relative speeds of the processes involved. The generation of hypotheses about a subsequent word would probably take longer than a good reader would need in order to recognize the word from visual information alone (Stanovich, 1980).

A third model was developed by Rumelhart (1977) to deal with the above problems. This is the interactive model shown in Figure 2, which allows for the simultaneous application of various processes and sources of knowledge in order to achieve the "most probable interpretation" of the graphemic input. In this model, lexical knowledge, i.e., information concerning previously learned words, would be used by the pattern synthesizer, as would syntactic, semantic, and orthographic knowledge, in order to interpret the input of visual information.

Stanovich (1980) extended this third model by proposing an interactive-compensatory model which would account for individual differences in reading ability. This model is based on the assumption that a deficit in any knowledge

FIGURE 2

Rumelhart's Interactive Model



source results in a heavier reliance on other knowledge sources. According to this theory, perceptual and cognitive processes take place simultaneously during the act of reading, and are integrated to produce comprehension. A deficiency in one of these processes may be compensated for by a greater reliance on another process. At the word learning stage, this theory could account for the tendency of poor readers to use processes and strategies which are slower and less efficient than those used by good readers. This model has been used in attempts to explain developmental changes in reading ability, and differences between good and poor readers. General comprehension strategies and rapid, context-free word recognition are the processes cited by Stanovich (1980) as most clearly distinguishing good from poor readers.

The interactive-compensatory model is consistent with the Laberge and Samuels (1974) model in stressing fast, automatic word recognition as an important component of fluent reading. The latter model also places a great deal of emphasis on the role of attention. In reading, attention is divided between decoding and comprehension. The beginning reader has to switch his attention back and forth from decoding to comprehension in order to make sense of what he is reading. In the fluent reader, decoding is automatic, and the reader's attention is free to deal with the task of comprehension. For the poor reader, the attentional demands of decoding are greater because word recognition is slower. Automatic word recognition cannot be attained without efficient word learning. In word learning, as in reading, attention is divided between decoding and comprehension, as the learner has to attend to visual, phonetic, and semantic features of new words.

The processes of attention, perception and memory can all be considered as aspects of one information-processing or cognitive system which is referred to in the literature as "processing resource" or "working memory." The term "working memory" has evolved from the concept of short term memory. Short term memory is envisaged as a temporary storage space, where items are held briefly until they are processed and transferred to long term memory. The concept of working memory also incorporates processing functions. It is assumed that working memory has a limited capacity which is shared by storage and processing functions (Baddeley & Hitch, 1974). A trade-off between processing and storage demands may account for some of the differences between good and poor readers in word learning, with good readers needing less processing space because of the speed and automaticity of their decoding operations, and therefore having more space available for storage and comprehension.

Craik and Lockhart (1972) proposed a levels of processing framework for memory research as an alternative to multistore theories. They related depth of analysis to the strength of the memory trace, with greater degrees of semantic or cognitive analysis leading to stronger, longer lasting traces. The processing levels were seen as a continuum of analyses from sensory to semantic. According to this view, when different orienting tasks are used, incidental recall should be higher for words in a condition requiring semantic processing than for words in conditions requiring structural or phonetic processing. Processing capacity is believed to be limited, and limitations of storage are held to be a direct consequence of this more fundamental limitation. It is assumed that in deeper processing, knowledge of different kinds can be brought into use, and, therefore, processing will be more efficient and more material will be retained. When attention is diverted, information is believed to be lost at a rate appropriate to the level of processing, with slower rates for deeper levels. The implications of this theory for word learning are that the memory trace should be stronger and, therefore, recognition should be faster and more accurate when the attention of the learner is directed toward semantic associations than when the attention of the learner is directed toward structural or phonetic features of words.

In experiments carried out by Simon and Craik (1979), recognition of auditorily-presented digits declined as, simultaneously, visually presented words were classified at sensory, phonemic, and semantic levels of processing.

Incidental retention was highest for semantically processed words. In a further experiment involving divided attention, retention after a semantic orienting task was reduced. When difficult orthography was used, in a third experiment, context cues were no more effective than phonemic cues. It appeared that semantically elaborate, or deep, processing could be disrupted by difficult orthography or divided attention conditions. Deeper (semantic) processing, then, normally results in better recall performance. However, difficult orthography and divided attention conditions can reduce this effect, indicating that associations between semantic and visual codes may contribute to the superior recall and recognition memory scores associated with words learned in conditions involving semantic orientation.

The assumption of the existence of a unitary mechanism of working memory responsible for both processing and storage functions has been questioned. Richardson (1984) proposed an alternative view of working memory as a system of interrelated mechanisms controlled or activated by a central executive processor. According to this theory, the strategy selected by an individual for use on a specific task, such as word learning, would be a function of his skill in selecting an appropriate strategy and also of the efficiency of the working memory mechanisms at his disposal. Impairment of a mechanism could lead to the use of a less efficient strategy than would otherwise be employed. Performance on memory tasks such as those involved in reading and word learning, could, therefore, be expected to relate as much to the ability to select an appropriate strategy as to the efficiency of specific mechanisms.

The study of patients with localized cerebral lesions has indicated that short-term memory may be selectively impaired without any evidence of impairment in long-term memory tasks. Vallar and Baddeley (1984) studied a thirty-year-old Italian woman who had suffered a stroke which left her with a grossly defective auditory span and striking auditory/visual dissociation. When tested, this patient did not show the usual effects of articulatory suppression and word length on span, indicating that she was not using subvocal rehearsal. Since her speech was fluent, and she was able to articulate rapidly, these results were interpreted as indicating that subvocal rehearsal as a strategy was of little use to this patient because of her damaged phonological store, and that she, therefore, relied instead on visual storage. It may be then, that children with some impairment in verbal functioning might fail to use strategies such as subvocal rehearsal which would assist them in word learning and in forming associations between visual and phonemic codes. They, too, might rely instead on visual storage and elaboration alone, and would, consequently, perform poorly in tasks of word learning and reading.

Another possible reason for using ineffective or inappropriate strategies could be lack of knowledge about more efficient strategies. Reisberg, Rappaport and O'Shaughnessy (1984) demonstrated that subjects were able to increase their digit spans by up to 50% when they were taught to use a finger-loop strategy. In a study involving second grade good and poor readers, Torgesen and Goldman (1977) found that the demonstration and facilitation of verbal rehearsal strategies led to the improvement of the recall scores of poor readers so that they were no longer significantly different from those of the good readers. This suggests that poor readers could be taught to use verbal rehearsal and other strategies used by good readers in word-learning tasks.

The verbal-deficit hypothesis (Vellutino, 1977) relates reading problems to dysfunction in the semantic, syntactic or phonological aspects of language resulting from a basic deficiency in verbal processing. Vellutino (1977) suggests that impaired readers may have a specific disorder in one or more aspects of language which leads to problems in reading, whereas fluent readers make efficient and selective use of all their linguistic and cognitive skills. More specifically, he states that poor readers have been found to have difficulties in semantic processing, word encoding, visual-verbal association learning, and word-retrieval. They have problems both in linguistic coding of incoming information, and in the retrieval of linguistic referents associated with given stimuli. According to this theory, the availability of new ways of encoding words, i.e., by the provision of phonemic and semantic cues, during word learning tasks, could be expected to be more beneficial to good readers than to poor readers, as the poor readers would lack the linguistic skills needed in order to make use of the additional information.

Snowling's (1980) study investigated the development of grapheme-phoneme conversion ability in normal and dyslexic readers. In this study, the increasing efficiency in grapheme-phoneme translation, or decoding, shown by normal readers was not observed in dyslexics. It seemed that the dyslexics were not decoding visual material into phonetic form at all, and that, for them, increase in reading age was due to an increase in sight vocabulary. The performance of the dyslexics in this study was compared to that of the phonemic dyslexics described by Patterson and Marcel (1977). These were adult aphasics with acquired dyslexia involving selective impairment of the grapheme-phoneme route. This was interpreted to mean that the reading difficulties of dyslexics may be the manifestation of an underlying language deficit, as suggested by Vellutino (1977). The specific difficulties in grapheme-phoneme conversion found in dyslexics in Snowling's (1980) study, would, presumably, make it difficult for them to make use of phonemic cues when learning new words.

Simon (1979) found that the relative importance of phonemic, semantic, and contextual factors varied as a function of age and experimental manipulation. Phonemic cues were the most effective retrieval aids for older people and, when encoding time was restricted, for younger people also. She concluded that phonemic features have an importance that is not generally recognized in levels of processing theory. Older people, and young people under conditions of restricted encoding, may be forced to rely on more superficial processing strategies such as phonemic cues, when deep, semantic processing is limited by restricted encoding time, or by age-related deficiencies in cognitive processing. During word-learning tasks, the slower decoding processes of poor readers might have the same effect as restricted encoding time or age-related decrements in cognitive processing capacity, i.e., the effect of an overload of information, resulting in a reliance on phonemic features because they do not have time to process semantic features.

Perfetti and Lesgold (1977) proposed that the efficiency of the reading process depends critically on the efficiency of phonological code access, and that poor readers are deficient in some area of the processing involved in accessing phonological codes from memory. The precise nature of this deficiency has not been clearly defined, and could relate either to selective impairment of verbal functioning, or to inefficient learning strategies. A deficiency in accessing phonological codes from memory would, however, make the task of learning new, visually-presented words by means of associating the words with familiar phonemes, a slower and more difficult task for poor readers.

Salasoo, Shiffrin and Feustel (1985) suggested that a unitized memory code might provide automatic access to an identification response. According to their model, feedback from codes and episodic images in memory may facilitate letter processing by means of codification, i.e., the development of a single memory code that responds as a single unit to a set of features and serves to label, code, name or identify those features. Such a code could be triggered even by fragmented input information. The formation of such a unitized memory code when learning a new word would depend on between-code associations at the time of encoding between visual, phonemic, semantic and contextual or episodic codes. The word could then be retrieved or accessed via any one of, or any combination of, these routes.

The concept of a unitized memory code can be related to commonly used mnemonic systems based on imagery (Luria, 1967). Paivio (1969) has contributed much of the research on the effect of imagery on paired-associate learning. He argued that the stimulus member of a pair served as a "conceptual peg" to which its associate was hooked, and suggested that imagery could serve a mediating function and contribute to the formation of a compound image of stimulus and response. The stimulus would then serve as a cue that could reinstate the compound image from which the response component could then be retrieved. In word-learning tasks, the provision of semantic referents that are familiar to the subjects should assist them in the formation of these images.

The hypothesis that the stimulus-response association is stored as a new mental unit has been discussed in the literature on associative symmetry (Asch, 1968; Horowitz & Prytulak, 1969) and in a theoretical analysis by Estes (1976). The basis of this theory is the gestalt concept that the most important process in paired-associate learning is the formation of associations between the stimuli and the responses. The central claim of the gestalt theory is that association is a form of cognitive organization rather than an elementary process (Frijda, 1972). According to this view, the formation of associations between words, or between codes, would be a function of some kind of central processor as suggested by Richardson (1984).

Wagner (1983) argued that the tendency of disabled readers to engage in single code processing rather than to employ dual code processing when learning new reading vocabulary should be regarded as a major factor in the etiology of dyslexia. He found that, instead of developing associations between visually encoded information and auditory and/or semantic codes, the disabled readers appeared to concentrate on visual perceptual learning. When reading-disabled children were encouraged to focus on the sounds associated with some of the graphemes contained in the artificial words they were asked to learn, their recall scores improved, but there was no corresponding increase in their recognition scores. Apparently, there was an improvement in their use of auditory code processing, but they did not make use of this auditory information to improve their visual recognition performance, indicating no increase in dual code, or between-code, processing. It was suggested that the facilitation effects obtainable by means of using orienting instructions may be restricted in reading-disabled children, either by limitations in central processing capacity, or by difficulties in understanding and acting on verbal instructions.

In a study involving children of normal ability from a grade 3 classroom, Hof (1985) found that the provision of potentially new ways of encoding visually-presented words did not necessarily result in subjects using the new encoding operations. When new encoding operations were employed, the distribution of learning across encoding domains was found to be uneven.

According to Wagner's (1985) theory, visual word learning requires visual feature learning and lexical association learning, and these two types of learning can both facilitate and interfere with one another. The present study was designed to test this theory.

Study

The purpose of the present study was to compare the word-learning strategies spontaneously employed by a group of good readers with those spontaneously employed by a group of poor readers. Strategies which were of particular interest in this study were those using visual coding, phonemic encoding, and cross-modal transference involving the phonemic and/or semantic recoding of visual stimuli. A comparison was made of the extent to which the two groups were engaging in visual perceptual learning and lexical and semantic association learning.

A word-learning task was used in which good and poor readers were asked to learn lists of pseudowords. Pseudowords were used in order to eliminate the effects of prior knowledge of the words. The words used were from a study by Massaro, Venezky and Taylor (1979). Subjects were asked to learn four lists, each containing ten pseudowords. Two lists were made up of pronounceable pseudowords and, two lists were made up of unpronounceable pseudowords. Meanings were supplied for one of the lists of pronounceable pseudowords and for one of the lists of unpronounceable pseudowords. After studying each list, students were given a test list and were asked to indicate if words had been changed (visual recognition memory), to read the pronounceable words (read response), and to recall the meanings that had been provided (cued recall of meaning).

The four conditions of the experiment were designed to offer different ways of encoding. Condition 1 was a visual condition, using unpronounceable pseudowords, Condition 2 was a visual and phonetic condition, using pronounceable pseudowords, Condition 3 was a visual, phonetic and semantic condition, using pronounceable pseudowords with meanings, and Condition 4 was a visual and semantic condition, using unpronounceable pseudowords with meanings.

Comparisons of the scores for the dependent variables of visual recognition memory, read response, and cued recall of meaning were used as an indication of the encoding operations employed by the subject groups, and as a measure of the extent to which they were engaging in visual perceptual learning and lexical and semantic association learning.

Hypotheses

1. Visual Perceptual Learning. It was hypothesized that the good readers would be more accurate in recognizing pronounceable pseudowords in Condition 2 than unpronounceable pseudowords in Condition 1, as the former would enable them to take advantage of graphemic and phonemic redundancy patterns in language.

Poor readers also were expected to be more accurate in recognizing pronounceable pseudowords than unpronounceable pseudowords, but the difference in their visual recognition scores was expected to be less than that demonstrated by the good readers.

2. Lexical and Semantic Association Learning. It was hypothesized that the addition of meaning by providing seman-

tic categories for the pseudowords in Conditions 3 and 4 would make the task more demanding of processing resources, and would result in lower recognition scores. This effect was expected to be more apparent for the poor readers because of their less efficient strategies and/or processing dysfunctions or limitations.

In Condition 3, the pronounceability of the pseudowords was expected to significantly improve the scores of the good readers, and the scores of the poor readers also, but to a lesser extent. This result would imply the use of phonemic encoding, and the use of such encoding to access semantic information and as an aid in tasks of visual recognition by good but not by poor readers.

Assumptions

1. That the pseudowords in Conditions 1 and 4 are unpronounceable, or significantly more difficult to pronounce than the pseudowords in Conditions 2 and 3.

2. That higher scores on tests of visual recognition and semantic recall for pronounceable pseudowords than for unpronounceable pseudowords indicate that phonemic encoding has taken place, and is being used to facilitate visual recognition and access to semantic information.

Operational Definitions

The terms "dyslexic", "poor reader" and "disabled reader" are employed in this study to refer to children with severe reading problems not apparently attributable to below average intelligence, gross neurological disorder, peripheral sensory impairment, severe emotional disorder, inadequate home or school environments, or other extrinsic factors (Rabinovitch, 1959).

Visual recognition memory refers to the ability of the subject to detect changes in the words, and to distinguish between changed and unchanged words.

Read response refers to the ability of the subject to read the words, independent of his/her ability to detect changes to the visual structure of the words.

Cued recall of meaning refers to the ability of the subject to recall the semantic category provided for the word.

Visual perceptual learning refers to the amount of visual feature learning a subject has engaged in for a particular word, independent of the ability of the subject to read the word or to recall its meaning.

Lexical and semantic association learning refers to the ability of the subject to make either semantic-visual or phonemic-visual associations between the meaning of a word or the sound of a word and its visual configuration.

Cross-modal transfer, or between-code transfer, refer to the transmission of information from one modality, or code, to another, i.e., from visual to semantic, or from visual to phonemic.

Phonemic encoding refers to the association of the visual features of a word with its phonemic features, i.e., relating the grapheme (written or printed word or syllable) to the phoneme (sound).

CHAPTER THREE

Method

Subjects

The subjects were 40 students from regular grade 5 classes at two schools in the same neighbourhood of St. Catharines, Ontario. They were divided into two groups of 20 on the basis of their scores on recently completed Canadian Achievement Tests administered in the schools. The good reader group was made up of students who had achieved reading scores at or above a grade equivalent of 4.9, and the poor reader group was made up of students whose reading scores were at or below a grade equivalent of 3.9. The means of the grade equivalents were 6.58 (SD = 1.57) for the good readers, and 3.13 (SD = .62) for the poor readers. The mean total reading scores, comprising vocabulary and comprehension scores, were 46.80 (SD = 5.96) for the good readers, and 26.60 (SD = 5.16) for the poor readers. There were twelve girls and ten boys in each subject group. The mean age of the good readers was 10.65 (SD = .32) and the mean age of the poor readers was 10.70 (SD = .25). None of the stüdents had been identified by their teachers or·by school board personnel as having general learning problems or emotional or behavioral problems.

Conditions

1. Visual - subjects studied a list of 10 orthographically irregular, 6-letter, unpronounceable pseudowords.

2. Visual and phonetic - subjects studied a list of 10 orthographically regular, 6-letter, pronounceable pseudowords.

3. Visual, phonetic, and semantic - subjects studied a list of 10 orthographically regular, 6-letter, pronounceable pseudowords, and were provided with semantic categories for the words, e.g., this is a type of dog.

4. Visual and semantic - subjects studied a list of 10 orthographically irregular, 6-letter, unpronounceable pseudowords and were provided with semantic categories for the words.

Stimuli

The stimuli consisted of 4 lists, each containing 10, 6-letter words, and 4 tests. Each word list and test was typed on a 21.6 x 27.9 cm sheet of paper, using lower-case, pica letters and double spacing. Two of the word lists were made up of pronounceable pseudowords that were orthographically regular, such as 'matser' or 'siflet'. The other two word lists contained unpronounceable pseudowords such as 'tpsrii' and 'rdgera'. Meanings were provided for one of the lists of pronounceable pseudowords, and for one of the lists of unpronounceable pseudowords. Each of the 4 tests was made up of the words from one of the lists. The words were in a different order, and half of the words on each test sheet had been altered by changing the middle two letters. These alterations did not affect the pronounceability or unpronounceability of the words that were used in the tests.

Procedures

The tests were administered individually as follows:

1. An auditory recall test was administered. Two lists of ten words were presented orally. Each list was read in one minute, the words were read at two second intervals, and each word was read twice. After listening to each list, the students were allowed to rest for one minute during which they were engaged in casual conversation. They were then asked to repeat as many of the words as they could remember.

2. Before presentation of each condition, a sample list consisting of 3 words of the type contained in that condition was shown to the subjects. They were told that these words were similar to some they were going to be asked to learn, and that they were not real words but made-up words. For Conditions 1 and 2, they were told that the words had no meanings. For Conditions 3 and 4, they were told that the words were the names of certain types of thing, and that they were going to be asked to learn the words and to remember what each word was the name of.

3. In each condition, the subject was shown the list of words and instructed to try to learn the words so that he would recognize them when he saw them again. Where meanings were provided, these were read to the subject by the experimenter before the list words were revealed. The subjects were allowed to study each list for 1.5 minutes.

4. The list was removed, and subjects were engaged in casual conversation for one minute.

5. The subjects were then shown the test list, and were asked the following questions:

a. Has this word been changed? Subjects were told that the test list was made up of the same words that they had just learned, but that they were in a different order and some of them had been changed. They were instructed to answer "yes" if the word was changed and different or if they did not recognize it as a list word, and "no" if the word was unchanged and was the same as it had appeared on the list.

b. Read the word. The subjects were asked to read the pronounceable words only. In the case of words that had already been identified as having been changed, subjects were asked to, "Read it, anyway."

c. What is this word the name of? This question was asked only for words for which meanings had been provided. In the case of words that had already been identified as having been changed, subjects were asked, "What would this word have been the name of?"

The conditions were presented in random order with a one minute rest between each condition.

Scoring

The number of correct responses with respect to visual recognition (question a), read response (question b), and cued recall of meaning (question c) were recorded.

Auditory recall scores were based on the mean for the two tests.

Mean raw scores for visual recognition memory were 6.30 (SD = 1.75) for the good readers and 6.55 (SD = 1.57) for the poor readers in Condition 1, 8.75 (SD = 1.02) for the good readers and 7.95 (SD = 1.93) for the poor readers in Condition 2, 7.40 (SD = 1.43) for the good readers and 7.20 (SD = 1.51) for the poor readers in Condition 3, and 6.55 (SD = 1.36) for the good readers and 6.45 (SD = 1.70) for the poor readers in Condition 4.

The raw scores for visual recognition memory were converted to d' scores (Swets, 1964) as these are more accurate measures of sensory retention unbiased by decision aspects than are total correct scores, i.e., they correct for guessing. In signal detection theory, d' is a measure of the distance between the means of the two distributions of hits and false alarms scaled in z units with the common variance used as the metric. When this measure is used in cognitive psychology experiments, the signal to be detected is the memory trace. The correct positive identification of an item is scored as a 'hit', an incorrect positive identification is scored as a 'false alarm', a correct rejection of an item is scored as a 'correct response', and an incorrect rejection of an item is scored as a 'miss'.

The mean raw scores for the read response were 8.95 (SD = 1.12) for the good readers and 8.25 (SD = 1.18) for the poor readers in Condition 2, and 9.10 (SD = 1.14) for the good readers and 8.50 (SD = 1.50) for the poor readers in Condition 3.

The mean raw scores for cued recall of meaning were 1.55 (SD = 1.20) for the good readers and 1.30 (SD = 1.05) for the poor readers in Condition 3, and 1.55 (SD = 1.50) for the good readers and .90 (SD = 1.18) for the poor readers in Condition 4.

In the statistical calculations for read response and cued recall of meaning scores, only scores relating to unchanged pseudowords were taken into account, as subjects had not studied the changed words. It was noted, however, that, in the case of scores for cued recall of meaning, when the total correct scores were compared, the good readers' scores were higher than those of the poor readers, suggesting that they may have been better at associating a learned meaning with an altered stimulus.

Design

A factorial design was used, made up of the two subject groups and the four conditions. Analyses of variance were carried out for each of the three dependent measures of visual recognition, read response, and cued recall of meaning. Correlations were computed between the variables of auditory recall, visual recognition memory, read response, and cued recall of meaning in the four conditions.

The four conditions are described in Table 1. The order of presentation of the conditions was randomized. Each subject took part in all four conditions of the experiment, thereby acting as his/her own control.

TABLE 1

Conditions

Condition 1 - Visual

- unpronounceable pseudowords without meanings.

Condition 2 - Visual and phonetic

- pronounceable pseudowords without meanings.

Condition 3 - Visual, Phonetic, and Semantic

- pronounceable pseudowords with meanings.

Condition 4 - Visual and Semantic

- unpronounceable pseudowords with meanings.

CHAPTER FOUR

Results

The mean scores and standard deviations for both subject groups are summarized in Table 2.

Visual Recognition Memory

The mean d' scores for visual recognition memory are ported graphically in Figures 3 and 4.

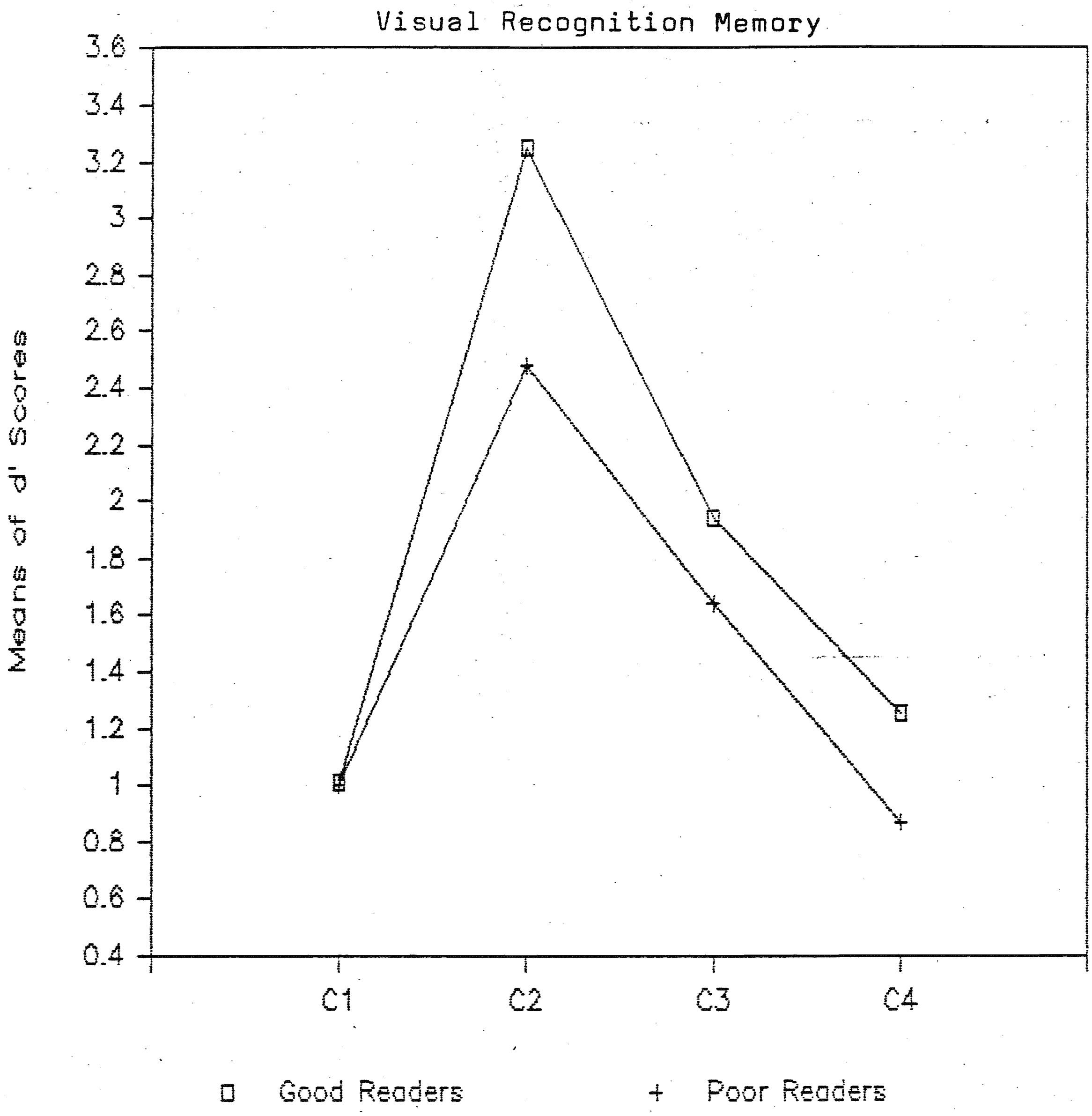
An overall analysis of variance was performed on the d' scores. The between subjects F ratio was not significant, indicating that the visual recognition memory scores of the two subject groups did not differ significantly in any of the four conditions. However, the within subjects F ratio was found to be significant, $F(3,38) = 20.72$, $p < .01$. Analyses of variance showed significant differences in visual recognition memory scores for both subject groups between Conditions 1 and 2, i.e., unpronounceable pseudowords versus pronounceable pseudowords, $F(1,19) = 60.61$, $p < .01$, for good readers, and $F(1,19) = 9.07$, $p < .01$, for poor readers. Significant differences were also found for both subject groups between Conditions 2 and 4, i.e., pronounceable pseudowords without meanings versus unpronounceable pseudowords with meanings, $F(1,19) = 48.36$, $p < .01$, for good readers, and $F(1,19) = 10.99$, $p < .01$, for poor readers. For good readers only, significant differences were also found between Conditions 1 and 3, i.e., the unpronounceable versus pronounceable

TABLE 2

Mean Scores

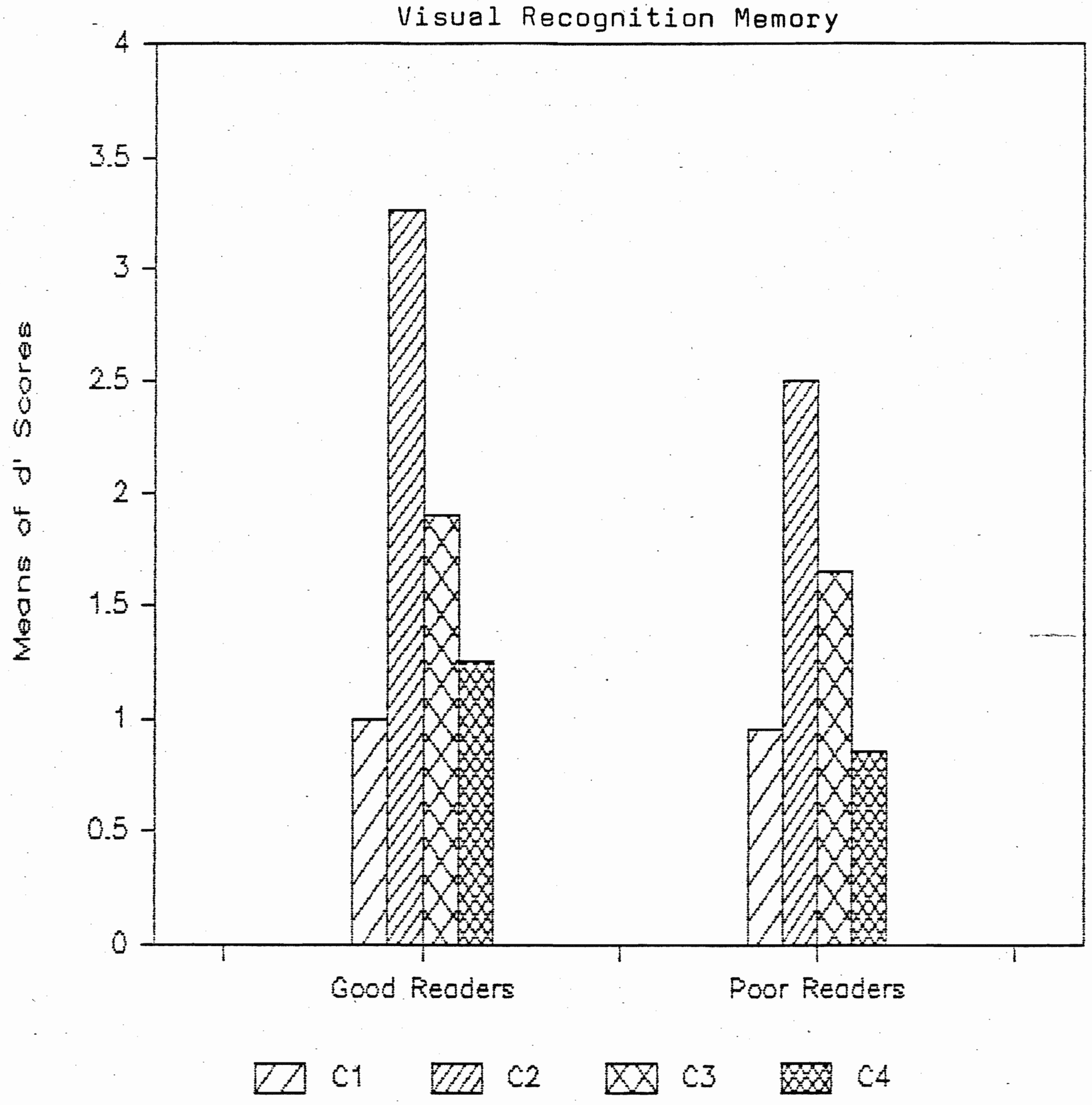
	Visual Recognition Memory (d')	Read Response (Out of 5)	Cued Recall of Meaning (Out of 5)
Condition 1			
Good Readers	1.01 (SD = 1.33)		
Poor Readers	1.00 (SD = 1.06)		
Condition 2			
Good Readers	3.25 (SD = .99)	4.25 (SD = .89)	
Poor Readers	2.48 (SD = 1.81)	3.95 (SD = .97)	
Condition 3			
Good Readers	1.94 (SD = 1.28)	4.45 (SD = .80)	.95 (SD = .74)
Poor Readers	1.64 (SD = 1.14)	3.90 (SD = 1.00)	1.00 (SD = .95)
Condition 4			
Good Readers	1.25 (SD = .99)		.90 (SD = 1.30)
Poor Readers	.87 (SD = 1.45)		.40 (SD = .58)
Auditory Recall			
Good Readers - 5.38 (SD = 1.06)			
Poor Readers - 5.13 (SD = .77)			

FIGURE 3



C1 - Unpronounceable Pseudowords without Meanings
C2 - Pronounceable Pseudowords without Meanings
C3 - Pronounceable Pseudowords with Meanings
C4 - Unpronounceable Pseudowords with Meanings

FIGURE 4



C1 - Unpronounceable Pseudowords without Meanings
C2 - Pronounceable Pseudowords without Meanings
C3 - Pronounceable Pseudowords with Meanings
C4 - Unpronounceable Pseudowords with Meanings

pseudowords with meanings, $F(1,19) = 7.89$, $p < .05$, and between Conditions 2 and 3, i.e., pronounceable pseudowords without meanings versus pronounceable pseudowords with meanings, $F(1,19) = 37.22$, $p < .01$.

Cued Recall of Meaning

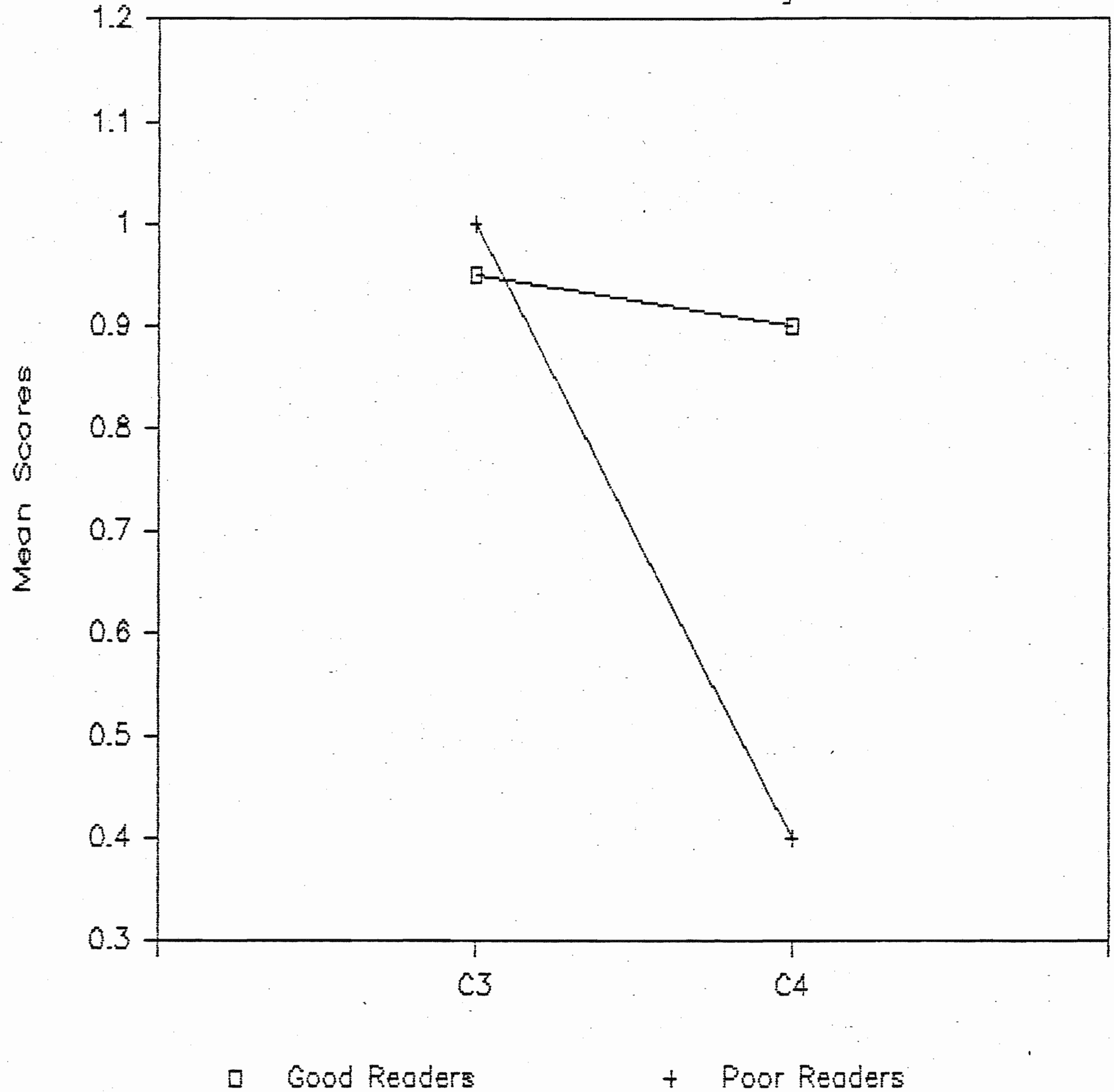
An overall analysis of variance revealed no significant differences between the cued recall of meaning scores of the two groups. However, the within subjects F ratio was found to be significant, $F(1,38) = 4.25$, $p < .05$. Analyses of variance showed that the cued recall of meaning scores of the poor readers in Group B improved significantly, $F(1,19) = 10.69$, $p < .01$, in Condition 3, i.e., when the pseudowords were pronounceable, in comparison to Condition 4 in which the pseudowords were unpronounceable. The performance of the good readers showed only a slight, nonsignificant improvement in Condition 3 over Condition 4. These results are reported graphically in Figures 5 and 6.

Read Response

The mean scores for the read response are shown graphically in Figure 7. In comparing scores for Condition 2, i.e., pronounceable pseudowords without meanings, with scores for Condition 3, i.e., pronounceable pseudowords with meanings, it was found that the scores of the good readers improved slightly when meaning was added, whereas the scores of the poor readers decreased slightly. However, an analysis of variance indicated no significant differences between the two groups, or between the two conditions for either group.

FIGURE 5

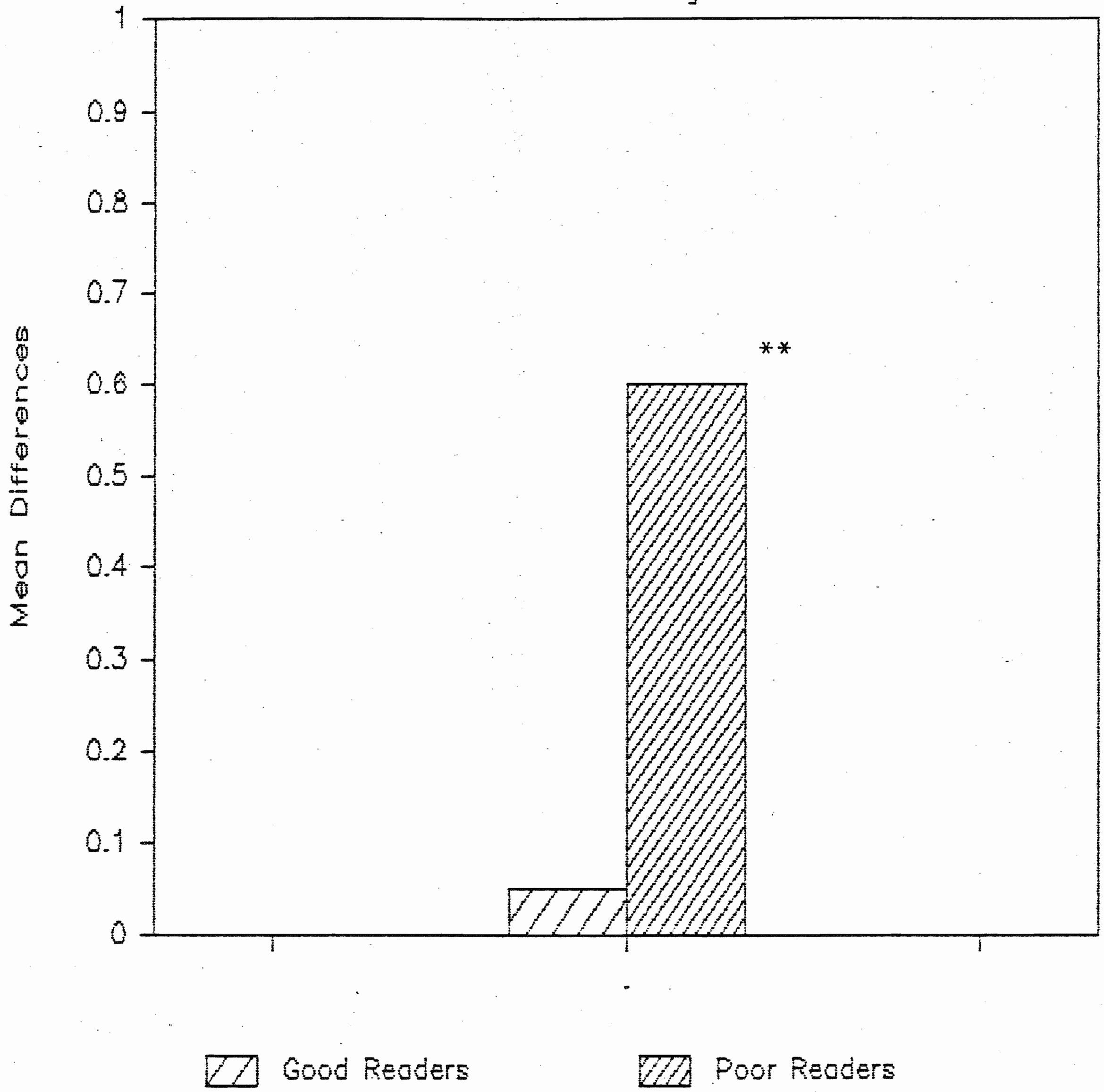
Cued Recall of Meaning



C3 - Pronounceable Pseudowords with Meanings
C4 - Unpronounceable Pseudowords with Meanings

FIGURE 6

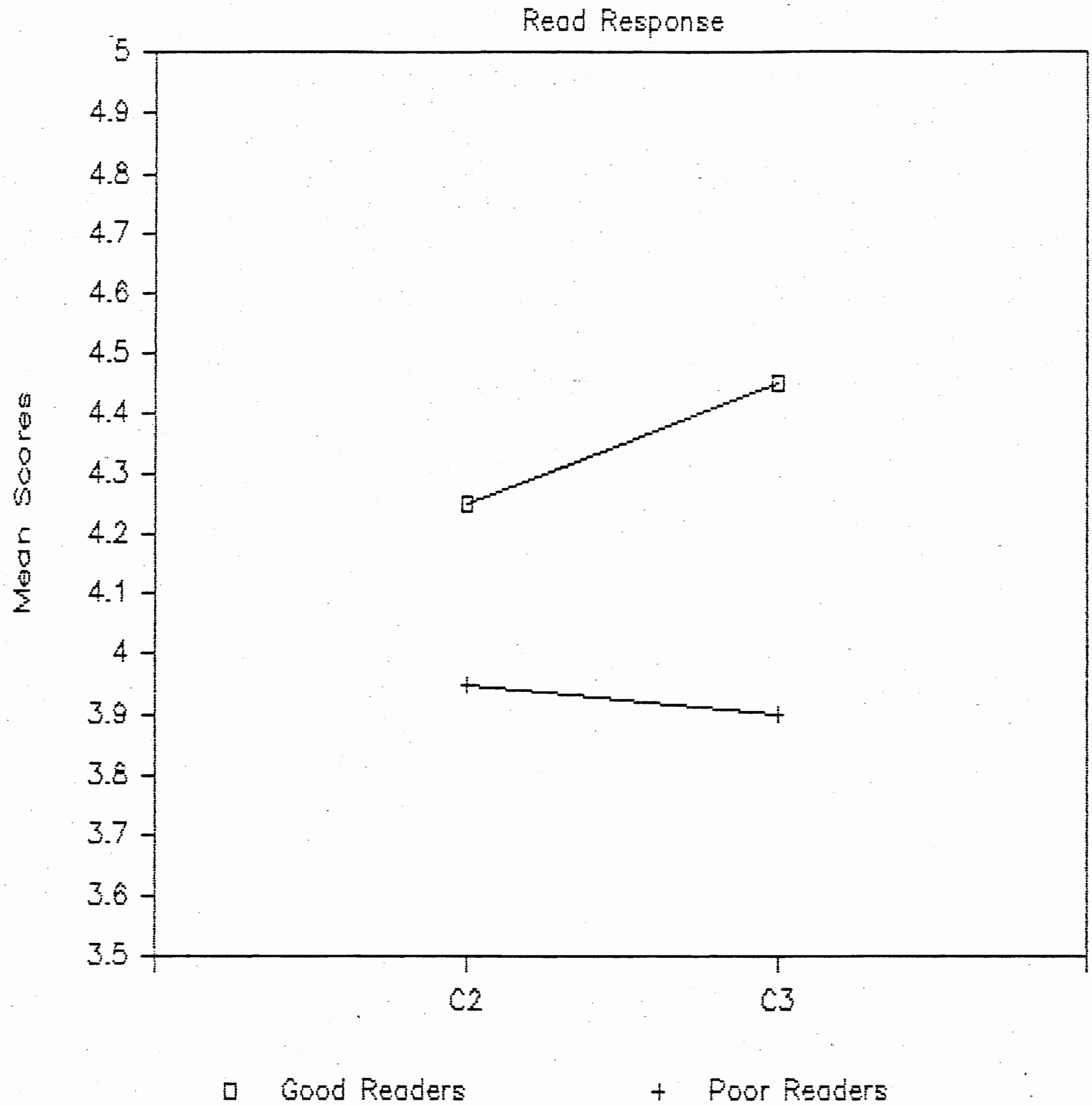
Cued Recall of Meaning — C3 vs C4



C3 - Pronounceable Pseudowords with Meanings
C4 - Unpronounceable Pseudowords with Meanings

** Significant ($p < .01$)

FIGURE 7



C2 - Pronounceable Pseudowords without Meanings
C3 - Pronounceable Pseudowords with Meanings

Auditory Recall

An analysis of variance was performed to compare the auditory recall scores of the two subject groups. There was no significant difference between the two subject groups in this respect. The mean scores were 5.38 ($SD = 1.06$) for the good readers, and 5.13 ($SD = .77$) for the poor readers.

Analyses of variance were also carried out comparing auditory recall scores with scores for cued recall of meaning and read response. Significant differences were found between auditory recall scores and scores for cued recall of meaning for both subject groups. For Condition 3, the F ratios were $F(1,19) = 107.37$, $p < .01$, for the good readers, and $F(1,19) = 50.19$, $p < .01$, for the poor readers. The F ratios for Condition 4 were $F(1,19) = 54.79$, $p < .01$, for the good readers, and $F(1,19) = 191.40$, $p < .01$, for the poor readers. Significant differences were also found between auditory recall scores and read response scores. For Condition 2, the F ratios were $F(1,19) = 58.96$, $p < .01$, for good readers, and $F(1,19) = 32.79$, $p < .01$, for the poor readers. The F ratios for Condition 3 were $F(1,19) = 64.03$, $p < .01$, for the good readers, and $F(1,19) = 48.44$, $p < .01$, for the poor readers.

Correlations

Table 3 summarizes the results of correlations computed between the following variables:

1. Auditory Recall Scores versus Cued Recall of Meaning Scores. These results are shown graphically in Figure 8. For

TABLE 3

Correlations

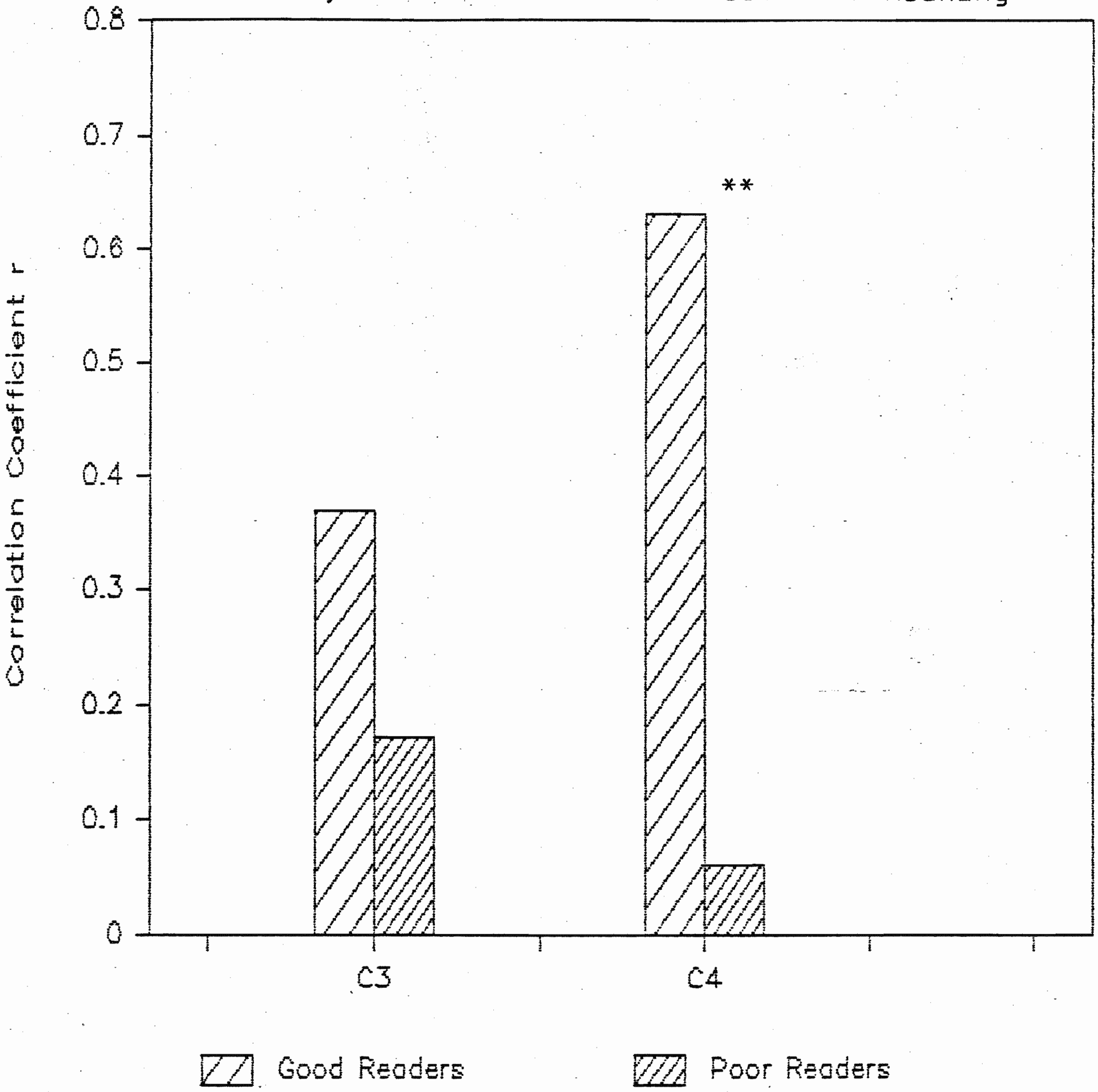
	C2 Read Response	C3 Read Response	C3 Cued Re-call of Meaning	C4 Cued Re-call of Meaning
Auditory Recall				
Good Readers	.30	.01	.37	.63**
Poor Readers	-.02	.57	.17	.06
C2 Visual Recognition				
Good Readers	.30			
Poor Readers	.12			
C3 Visual Recognition				
Good Readers		.28	.26	
Poor Readers		.56**	.20	
C3 Cued Recall of Meaning				
Good Readers				.51*
Poor Readers				.54*
C4 Visual Recognition				
Good Readers				.29
Poor Readers				-.27

* significant ($p < .05$)
** significant ($p < .01$)

C1 - Unpronounceable Pseudowords without Meanings
C2 - Pronounceable Pseudowords without Meanings
C3 - Pronounceable Pseudowords with Meanings
C4 - Unpronounceable Pseudowords with Meanings

FIGURE 8

Auditory Recall versus Cued Recall of Meaning



C3 – Pronounceable Pseudowords with Meanings
C4 – Unpronounceable Pseudowords with Meanings

** Significant ($p < .01$)

good readers, there was a significant correlation (r = .63) between auditory recall scores and scores for cued recall of meaning for unpronounceable pseudowords. For poor readers, the correlation was close to zero (r = .06).

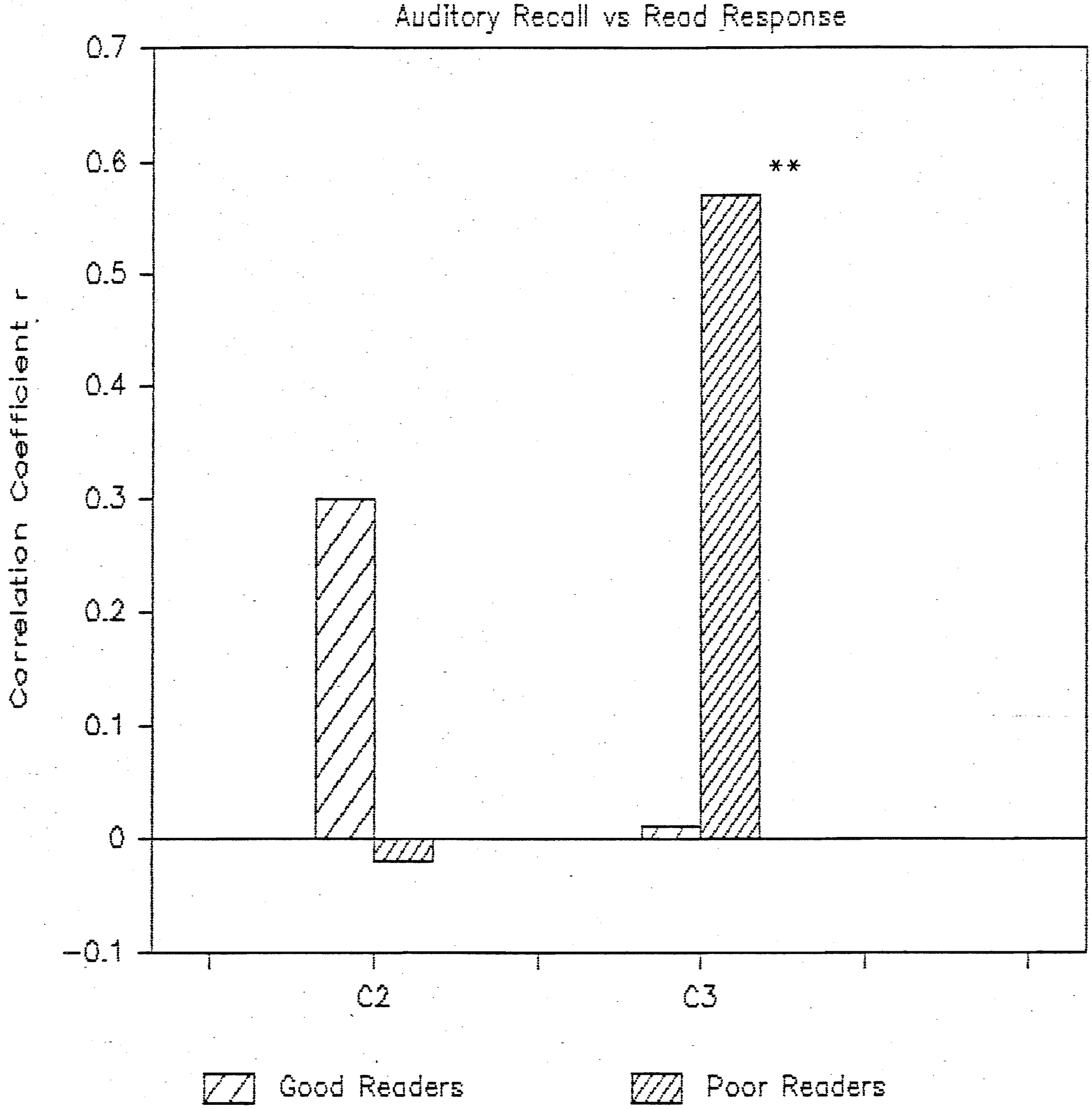
2. Auditory Recall Scores versus Read Response Scores. These results are shown graphically in Figure 9. For poor readers, there was a significant correlation (r = .57) between auditory recall scores and scores for the read response for pronounceable pseudowords with meanings. For good readers the correlation was close to zero (r = .01).

3. Read Response Scores versus Visual Recognition Memory Scores. These results are shown graphically in Figure 10. For poor readers, a significant correlation (r = .56) was found between visual recognition memory scores and read response scores in Condition 3, i.e., pronounceable pseudowords with meanings. For good readers, the correlation coefficient was nonsignificant (r = .28).

4. Cued Recall of Meaning Scores for Pronounceable Pseudowords versus Cued Recall of Meaning Scores for Unpronounceable pseudowords. As shown in Figure 11, significant correlations (r = .51 and r = .54 for good readers and poor readers respectively) were found between these two sets of scores for both subject groups.

5. Cued Recall of Meaning Scores versus Visual Recognition Memory Scores. Figure 12 illustrates a trend toward a positive correlation (r = .29) for the good readers, and to-

FIGURE 9

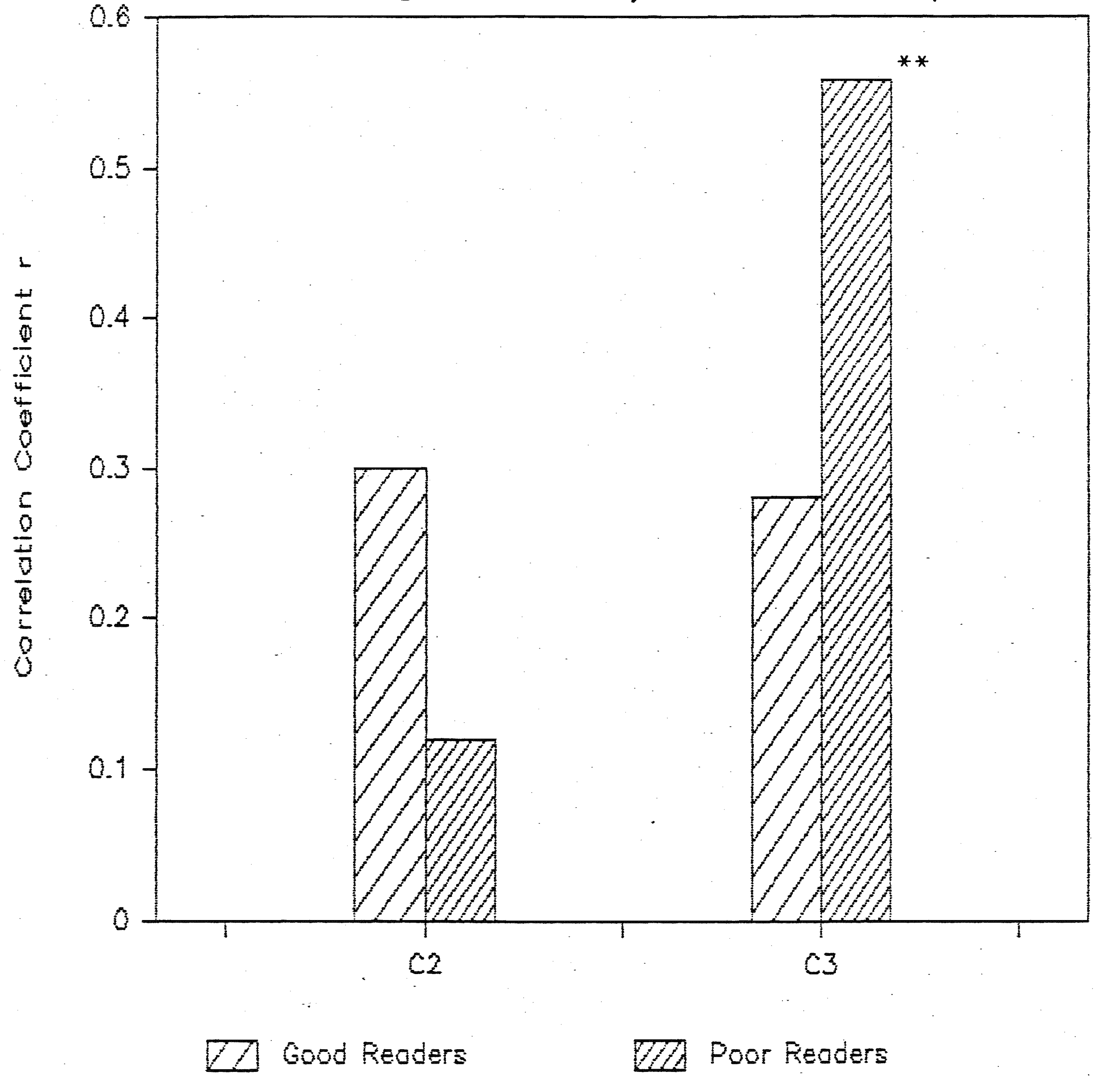


C2 - Pronounceable Pseudowords without Meanings
C3 - Pronounceable Pseudowords with Meanings

** Significant ($p < .01$)

FIGURE 10

Visual Recognition Memory versus Read Response

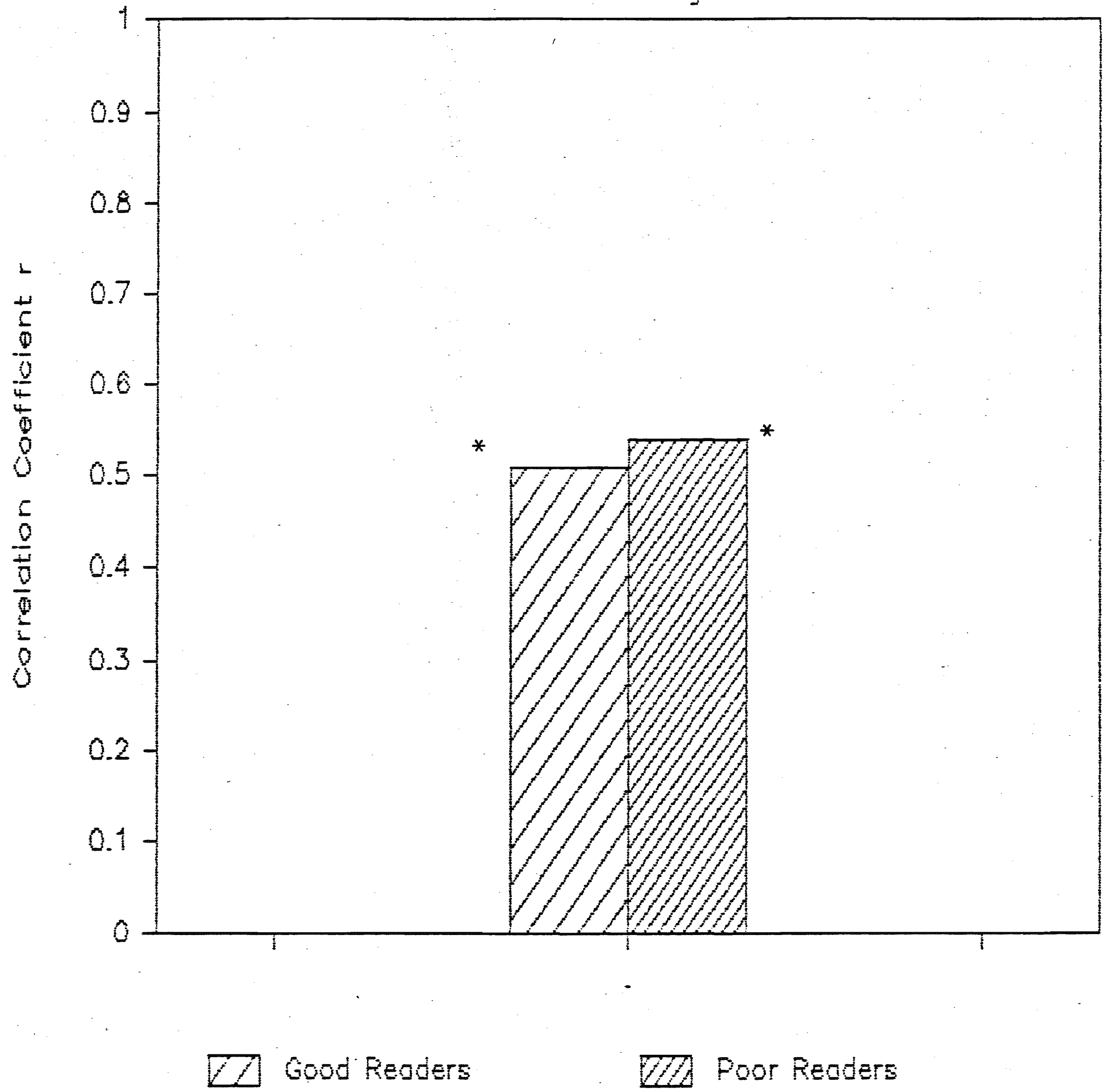


C2 - Pronounceable Pseudowords without Meanings
C3 - Pronounceable Pseudowords with Meanings

** Significant ($p < .01$)

FIGURE 11

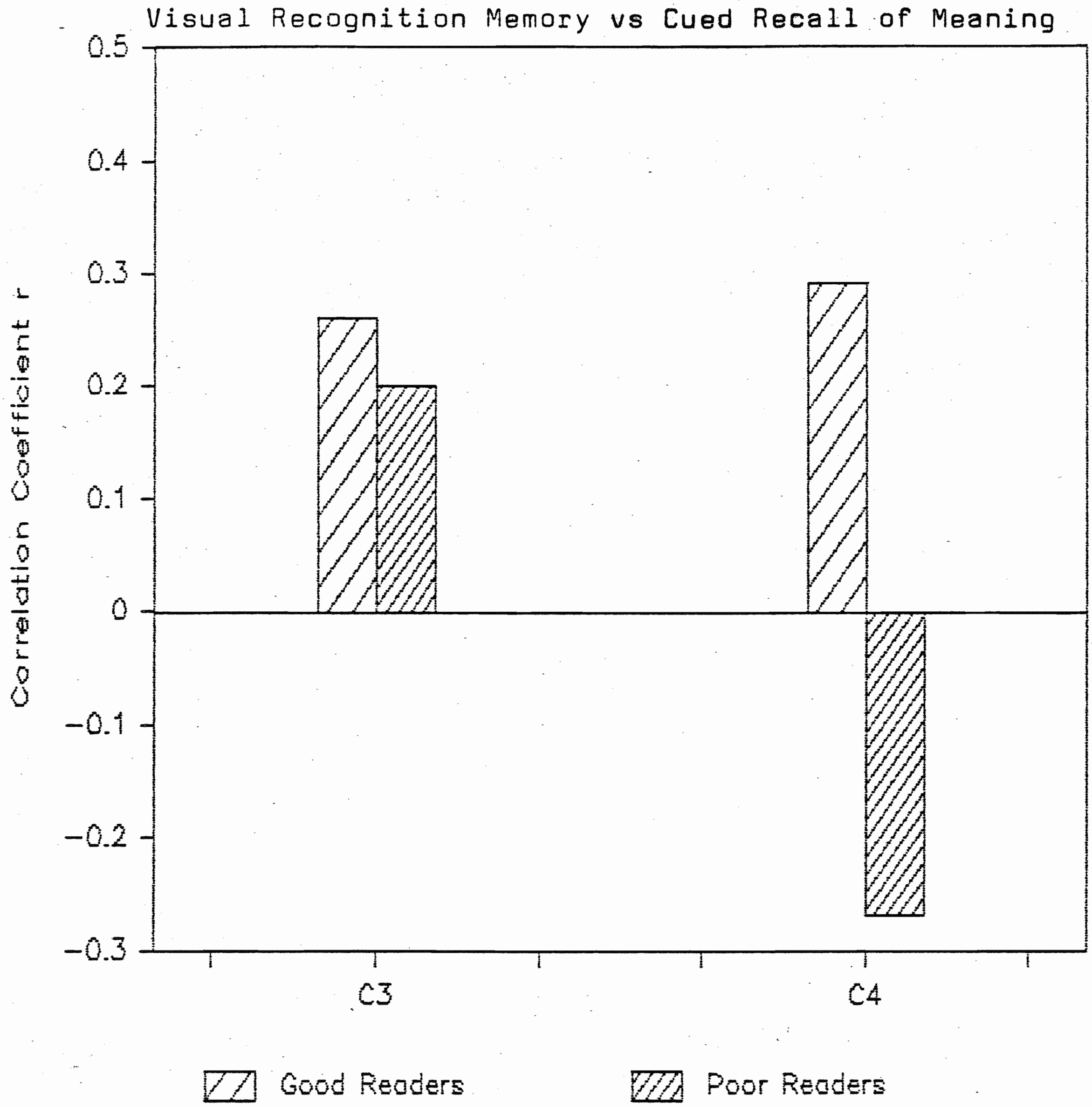
Cued Recall of Meaning – C3 vs C4



C3 – Pronounceable Pseudowords with Meanings
C4 – Unpronounceable Pseudowords with Meanings

* Significant ($p < .05$)

FIGURE 12



C3 – Pronounceable Pseudowords with Meanings
C4 – Unpronounceable Pseudowords with Meanings

ward a negative correlation for the poor readers ($r = -.27$). However, the correlation between these two sets of scores was not significant for either subject group.

Discussion

1. Visual Perceptual Learning. As shown in Figures 3 and 4, both groups were significantly more accurate in recognizing the pronounceable pseudowords of Condition 2 than the unpronounceable pseudowords of Condition 1, and the difference was greater in the case of the good readers although not significantly so. The good readers, apparently, benefitted more from phonemic clues than did the poor readers. However, the familiar sound and letter patterns of the orthographically regular, pronounceable pseudowords made them easier to recognize for both subject groups.

The provision of meanings for the pronounceable pseudowords in Condition 3 resulted in a drop in visual recognition scores for both groups. However, this drop was significant only for the good readers, indicating that they were, perhaps, sacrificing a degree of visual discrimination learning in order to attend to meaning.

In Condition 4, subjects were required to attend to meaning and the words were unpronounceable. This resulted in a further drop in visual recognition memory scores for both subject groups, but the drop was not significant for either group. When performance in Condition 4 is compared to performance in Condition 1, both of which use unpronounceable pseudowords, it is interesting to note that the visual recognition memory scores of the good readers improved with the addition of meaning, whereas the scores of the poor readers deteriorated. Although these differences were not significant, they could be taken as an indication that the extra attention paid by good readers to meaning aids visual recognition when unfamiliar letter patterns are involved and when familiar phonemic clues are not available to them. The poor readers, apparently, did not use the familiar meanings to help their visual discrimination learning, and the additional cognitive load of trying to remember meanings as well as what the words looked like, resulted in lower scores for them on tests of visual recognition memory. Another possibility may be that the good readers were simply better at establishing semantic-visual associations.

In comparing visual recognition memory scores in Condition 3 with Condition 4, both subject groups were able to use the pronounceability of the pseudowords to improve their visual recognition scores. This indicates that both good and poor readers can use phonemic encoding as an aid to visual discrimination learning. The familiar sound and letter patterns of the pronounceable pseudowords appear to be helpful to both good and poor readers.

2. Lexical and Semantic Association Learning. The significant difference in the cued recall of meaning scores

for poor readers between Conditions 3 and 4, i.e., pronounceable versus unpronounceable pseudowords, indicates that poor readers are more heavily dependent on familiar sound and letter patterns as an aid to meaning recall than are good readers. See Figures 5 and 6.

Figure 7 shows that the read response scores of the good readers improved with the addition of meaning, whereas the scores of the poor readers decreased. This is a non-significant trend similar to that already observed in the visual recognition memory scores for unpronounceable pseudowords, and indicates that good readers appear to be able to make better use of semantic associations than do poor readers.

3. Cross-modal Correlations. As shown in Figure 8, for good readers, there was a significant correlation between auditory recall scores and scores for cued recall of meaning for unpronounceable pseudowords in Condition 4. This could be interpreted as indicating that the good readers were able to make associations between visual, phonemic and semantic codes, even when the letter and sound patterns were unfamiliar. For the poor readers, auditory recall scores were not related to scores for cued recall of meaning, indicating that they were not using, or were less efficient in using, phonemic encoding as an aid to meaning recall. It is possible that the attentional demands of association learning are too heavy for the poor reader and that associations between sound and letter patterns and meaning are weak.

There was no significant difference in auditory recall scores for the two subject groups, mean scores being 5.38 (SD = 1.06) for the good readers, and 5.13 (SD = .77) for the poor readers. The differences noted between the two groups in their use of phonemic encoding could not, therefore, be explained by differences in auditory recall ability. Poor readers appear to be less efficient than good readers at establishing between-code associations, and this could relate either to inadequate strategies or to limitations in processing resources on the part of poor readers.

Figure 11 shows significant correlations between cued recall of meaning for pronounceable pseudowords and cued recall of meaning for unpronounceable pseudowords for both groups, indicating that both groups used similar strategies for dealing with these two tasks.

The more efficient strategies of the good readers allowed them to improve their visual recognition scores in Condition 4 over Condition 1, i.e., when familiar meanings were provided for unpronounceable pseudowords. For poor readers, the additional cognitive load resulted in lower visual recognition scores. Figure 12 shows a trend toward a positive correlation between visual recognition scores and scores for cued recall of meaning for good readers, and a corresponding trend toward a negative correlation for the poor readers. This indicates that for good readers, the extra processing demands of deeper, semantic processing result in stronger between-code associations. Poor readers, however, appear to expend extra processing capacity on simultaneous encoding of graphemic and semantic information without accruing the benefits of cross-modal, or between-code, transference of information.

As shown in Figures 9 and 10, for poor readers only, significant correlations were found between read response scores and scores for visual recognition and auditory recall in Condition 3, i.e., pronounceable pseudowords with meanings ($r = .56$ and $r = .57$ respectively). This suggests that poor readers may be more reliant than good readers on familiar graphemic, phonemic and semantic patterns. The fact that similar correlations were not found in Condition 2 in which the pseudowords were pronounceable but without meanings, suggests that the addition of meaning, requiring a deeper level of processing, may have helped the poor readers to make useful, between-code associations. This finding would be supportive of the levels of processing theory (Craik & Lockhart, 1972).

CHAPTER FIVE

Conclusions

The purpose of this study was to compare the strategies spontaneously employed by a group of good readers with those spontaneously employed by a group of poor readers in tasks involving visual perceptual learning, and lexical and semantic association learning.

The results of the study indicate that both good readers and poor readers alike use phonemic coding as an aid to visual and semantic recall. In comparing visual recognition performance under Conditions 1 and 2, i.e., unpronounceable pseudowords without meanings versus pronounceable pseudowords without meanings, it is apparent that the mean scores for both groups were significantly higher in Condition 2. Figures 3 and 4 show that the mean scores of the two groups were very close for condition 1, but that the performance of the good readers was noticeably, although not significantly, better than that of the poor readers under Condition 2. This indicates that, when familiar sound and letter patterns are provided, the good readers are more adept than the poor readers at using this graphemic and phonetic redundancy in order to improve their visual recognition scores. However, when meanings were added to the pronounceable pseudowords in Condition 3, the visual recognition scores of the good readers dropped significantly, indicating that they were diverting more of their attention to the meanings than were the poor readers. The scores of the poor readers dropped too, but not significantly.

A further drop in scores for both groups occurred in Condition 4, in which familiar meanings were provided, but in which the words were unpronounceable, thus providing no familiar sound or letter patterns. This drop in scores reflects the extra attentional effort required in order to process unfamiliar sound and letter patterns in addition to attending to meaning.

In comparing visual recognition memory scores for Condition 4 with those for Condition 1, i.e., unpronounceable pseudowords with meanings versus unpronounceable pseudowords without meanings, it is interesting to note that the scores of the good readers improved in Condition 4, whereas the scores of the poor readers deteriorated. This suggests that, in a situation in which there were no familiar sound or letter patterns to rely on, the good readers were able to improve their visual recognition memory scores when familiar semantic referents were provided, whereas the scores of the poor readers dropped, either as a result of the additional effort expended on semantic processing, or because the poor readers were more dependent than the good readers on familiar sound and letter patterns, or for both of these reasons.

The easiest condition for both groups with respect to visual discrimination learning was Condition 2, in which there were familiar sound and letter patterns, but no demand for semantic processing. Between this condition and Condition 4, in which semantic processing was required and there were no familiar sound and letter patterns, there was a significant drop in performance for both groups. This drop indicates that, for both subject groups, familiar sound and letter patterns can be used as an aid to visual discrimination learning, and that the demand for semantic processing requires extra attentional effort which may be provided at the expense of visual discrimination learning.

Condition 4 was the most difficult task for the poor readers, because in this condition they were required to cope with the attentional demands of semantic processing while simultaneously processing visual information without the aid of familiar sound and letter patterns. For good readers, Condition 1, in which there were no familiar patterns of either sound, letter or meaning, was the most difficult. The good readers were, apparently, able to cope with the extra attentional demands of semantic processing, and to use associations between semantic and visual codes in order to improve their visual discrimination learning.

Between Condition 1, unpronouceable pseudowords without meanings, and Condition 3, pronounceable pseudowords with meanings, there was a significant improvement for good readers. This indicates that the good readers were using associations between visual, phonemic, and semantic codes as an aid to visual discrimination learning. The scores of the poor readers improved also, but not significantly. The poor readers were, apparently, able to use familiar sound and letter patterns in order to form associations between visual and phonemic codes, and to use these between-code associations as an aid to visual discrimination learning. However, the addition of meaning detracted from their visual discrimination learning rather than aiding it, so that their net gain was less than that demonstrated by the good readers. The effect of semantic processing on visual discrimination learning then, appears to be beneficial to good readers and detrimental to poor readers. This effect could be explained by weak, between-code associations (Wagner, 1983), inadequate strategies (Torgesen & Goldman, 1977), or limitations of verbal processing resources (Vellutino, 1977), on the part of poor readers.

The cued recall of meaning scores, as shown in Figures 5 and 6, indicate that, for the poor readers, this task was significantly more difficult in Condition 4 when the pseudowords were unpronounceable than in Condition 3 in which the pseudowords were pronounceable. For the good readers, there was very little difference in the scores for these two tests.

This is supportive of Simon's (1979) theory that less skilled readers are more dependent on phonemic clues than are good readers.

The read response scores for pseudowords without meanings in Condition 2 versus pseudowords with meanings in Condition 3 are shown in Figure 7. Although the differences were not significant for either group, the trend was for the scores of the good readers to improve when familiar meanings were provided, and for the scores of the poor readers to drop. This would seem to indicate that, for good readers, the advantages of deeper, semantic processing, outweigh the costs in terms of attention diverted from other factors, whereas for poor readers, either the costs, i.e., the processing demands, are too heavy and outweigh the advantages, or the advantages of between-code transference of information are not used, or are less efficiently used, by poor readers. The first possibility would relate to levels of processing theory (Craik & Lockhart, 1972), and the second could be explained either by Torgesen and Goldman's (1977) theory of inadequate strategies in reading-disabled children, or by the verbal-deficit theory of Vellutino (1977) and the work of Vallar and Baddeley (1984), both of which would suggest that the choice of inappropriate or less effective strategies might be the result of some basic impairment in verbal processing.

Although it is not yet possible to pinpoint the exact cause, it does seem apparent that, as suggested by Wagner

(1983), poor readers are less efficient in transferring information between codes than are good readers. Poor readers also appear to be in a double bind situation, in that they rely heavily on visual and phonemic clues while at the same time being less proficient than good readers at using such clues.

No significant difference was found between auditory recall scores for the two subject groups, indicating that differences between them could not be explained by poor auditory recall on the part of the poor readers. Figure 8 shows a correlation between auditory recall scores and scores for cued recall of meaning for unpronounceable pseudowords on the part of good readers only. This might indicate that good readers were able to make associations even when the stimuli were unfamiliar.

Figure 9 shows a significant correlation between auditory recall scores versus read response scores for pronounceable pseudowords with meanings in the case of poor readers. This supports the view that poor readers rely heavily on phonemic clues that are less important to more skilled readers. As shown in Figure 10, a correlation was also found in the case of poor readers between visual recognition and read response in Condition 3, i.e., pronounceable pseudowords with meanings. The deeper level of processing required for dealing with meanings may have helped the poor readers to begin to make associations between codes.

It seems that poor readers are initially less efficient than good readers at using phonemic encoding. This initial problem makes it more difficult for them to develop automaticity in reading and to strengthen the direct graphemic-semantic relationships which ultimately provide good readers with an alternative route to meaning. The poor readers, therefore, have to choose between relying on weak graphemic-semantic relationships, as suggested by Snowling (1980), or on the slower route from grapheme to phoneme to meaning, a route which is also more difficult for them than for the good readers. Their problems are, therefore, compounded, and they are in the double bind of being unable to adopt an efficient strategy because the usual route to such a strategy is an area of weakness for them, and of having to rely instead on weak associations that they are unable to bypass.

An interesting area for future research would be to attempt to make a distinction between phonemic and graphemic factors. Where there are familiar sound patterns there are usually familiar letter patterns, and so it is not clear whether the poor reader is relying on a familiar sound pattern or on a familiar letter pattern, i.e., phonemic or visual encoding, to help him out. It would also be helpful to study response latencies, as this could help to clarify the differences between good and poor readers, particularly in tasks involving different levels of processing.

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APPENDIX 1

Auditory Memory Tests

Test 1	Test 2
boy	dress
chicken	toy
bat	girl
yellow	apple
train	dog
desk	runner
night	blue
sun	day
book	bag
pants	stars

APPENDIX 2

Pre-test Familiarization Lists

Condition 1

tpcraa

lyysfr

sscrii

Condition 2

luber

pilin

nonip

Condition 3

rasmit = type of house

palter = type of meat

gustel = type of train

Condition 4

ndferr = type of dog

smnibc = type of hat

gfsdba = type of fruit

APPENDIX 3

Pseudoword Lists and Tests

CONDITION 1 - LIST

igerdb

ctecpa

tpsrii

ylelra

efcfoi

rrentu

esrefu

rdgera

nsseoa

lsocho

CONDITION 1 - TEST

ylsmra

ctrnpa

rrfstu

rdykra

esrefu

lsplho

nsseoa

efcfoi

igerdb

tpsrii

CONDITION 2 - LIST

remond

siflet

matser

sinald

genold

nagred

firden

ramfer

boudel

tecird

CONDITION 2 - TEST

matser

remond

genold

sirold

boudel

nabled

tepord

sithet

firden

rasker

CONDITION 3 - LIST

golben = type of horse

manout = type of boat

samolt = type of game

acoint = type of fish

tasmer = type of pen

sardep = type of car

nigles = type of ball

socend = type of pop

surtel = type of shoe

podier = type of candy

CONDITION 3 - TEST

talber

nimbes

sabelt

acoint

suchel

sardep

manout

gospen

podier

socend

CONDITION 4 - LIST

rsemmu = type of cereal

ylelav = type of cat

rdfaai = type of plane

pperaa = type of monkey

rreaiv = type of bike

ettrbe = type of puzzle

ncntao = type of flower

enhcca = type of soap

ollrda = type of jacket

lwefol = type of cookie

CONDITION 4 - TEST

olcbda

ncpiao

rscbmu

lwefol

enhcca

rdzeai

rruoiv

pperaa

ettrbe

ylelav