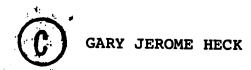THE UNIVERSITY OF ALBERTA

THE RELATIONSHIP BETWEEN READING

ACHIEVEMENT AND AWARENESS OF

ENGLISH ORTHOGRAPHIC STRUCTURE

by

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A THESIS

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ABSTRACT

This study was designed to examine students'
familiarity with English orthographic structure in an
attempt to determine if any differences exist in the
ability of achieving and non-achieving readers in each of
Grades two, three and four to select and differentiate
permissible sequences of letters from non-permissible
sequences of letters in word-like structures. The
relationship of this ability and reading achievement was
also investigated. The differences between these groups
in their ability to correctly read the word-like structures
chosen was also examined.

Ten achieving and ten non-achieving readers in each of
Grades two, three and four were selected from two schools
in the Edmonton Separate School System. They were selected
on the basis of achievement or non-achievement in reading
as measured by the silent reading comprehension test of the
Gates-MacGinitie Reading Test. These subjects were tested
individually on their ability to select and construct
permissible sequences of letters in word-like structures
of English orthography. An interview was held to determine
the basis of the subjects'discrimination and selection of
these permissible structures. All testing was completed
by the researcher and a trained assistant by May, 1972.

The data which had been collected was analyzed by means

ACKNOWLEDGEMENTS

of correlations, an analysis of variance, a Kolmogorov-
Smirnov two-sample test and an APL program. A discussion
of student performance was done in a non-statistical manner.

No significant difference was found between the mean
scores of the achieving and non-achieving readers at each
grade, although the Grade two non-achieving readers
correctly identified fewer permissible letter sequences,
resulting in their performance differing significantly from
both the third and fourth graders. Little significant
correlation was found between this ability and reading
achievement, except for the Grade two and four non-achieving
readers.

In constructing permissible sequences of letters,
only the performance of the Grade four achieving and
non-achieving readers differed significantly. Similarly,
the Grade two and four achieving readers and the Grade
two and three non-achieving readers were found to differ
significantly in building permissible letter sequences.
No significant correlations existed with reading achievement.

Certain items were found to yield a significant
difference in the choices selected for word-like structures
by the reading groups.

Increasing accuracy in identifying the non-permissible
word-like structure accompanied increasing grade level.
Similarly, the older children were more able to correctly
identify and name the non-permissible sequence in these
structures.

Significant differences were found to exist in the ability of achieving and non-achieving readers to correctly read their choice for a permissible word-like structure in several of the items. Non-achieving readers were found to make more errors than the achieving readers.

The theory that students are able to identify permissible sequences of letters in word-like structures was supported as it was investigated in this study.

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THE PROBLEM

BACKGROUND TO THE PROBLEM

Fundamental to the process of reading is realizing the correspondence between written symbols and elements of spoken language (Williams and Levin, 1967). In fact, Ausubel (1967) states:

> "Learning to read is essentially a matter of
> learning to perceive the potential in written
> messages and then relating the perceived
> potential meaning to cognitive structure so
> as to comprehend it." (p.545)

This has left researchers with the problem of discovering the basis with which the reader recognizes and responds appropriately to printed matter. The process of word recognition has been the subject of research for many years. Several researchers have attributed the recognition of words to the graphic cues inherent in the word. Tinker and Patterson (1940) hypothesized that overall geometric shape, outline or configuration serve as cues for word recognition. Others have postulated that certain letters provide the necessary cues. Wilson and Fleming (1938) claimed dominant letters, such as ascending or descending letters, were important. Levin and Watson (1963) have claimed that initial and terminal letters provide the necessary cues.

Other researchers have studied the role of grapheme-phoneme correspondences in the perception of words. From recent studies, it appears that clusters of letters have invariant relationships with sound patterns (Hockett, 1963; Venezky, 1967; Hanna et al, 1966). In other words, the combination of graphemes to represent English phonemes is based on regularity and consistency. However, these same researchers emphasize that the correspondence exists in clusters or groups of letters rather than individual phonemes and graphemes.

Money (1966) hypothesized that experience in reading, writing and spelling provides the learner with a "conceptual feel" of how written language should look. Gibson and her colleagues have conducted research to determine the effects of grapheme-phoneme correspondences on the perception of word-like structures composed of such correspondences. Gibson hypothesized that these correspondences are assimilated by the skilled reader and have an effect of organizing units for perception. Experiments have tested this hypothesis (Gibson, Pick, Osser and Hammond, 1962; Gibson, Osser and Pick, 1963). The results have shown that skilled readers perceive with greater accuracy word-like structures that follow invariant grapheme-phoneme correspondences.

Smith's (1971) model of reading includes two processes of word identification: mediated and immediate. These processes, particularly the latter, depend upon a number

of factors, including knowledge,that the reader has
acquired through experience, of the way words and letters
occur together in a language. Because printed English is
not a random sequence of letters, constraint or redundancy
exists in the sequence of symbols which compose the
language (Carson, 1961). Smith (1969) conducted research
to determine the effect of redundancy in the perception
of words and found knowledge of word structure resulted
in more accurate perception of words.

The work of these researchers seems to indicate that
the visual perception of words is facilitated when readers
have discovered the invariant letter patterns in words
and also, that readers are very sensitive to the predict-
ability of letter sequences. It is anticipated that this
study may provide some information regarding the role of
grapheme-phoneme correspondences in the perception of
words in reading.

PURPOSE OF THE STUDY

The purpose of this study was to examine students'
familiarity with English orthographic structure in an
attempt to determine if any differences exist in the
ability of achieving and non-achieving readers in each of
Grades two, three and four to select and differentiate
permissible combinations of letters from non-permissible
combinations of letters in word-like structures.

STATEMENT OF THE PROBLEM

This study, designed to investigate the role of grapheme-phoneme correspondences in the perception of words, will indicate whether, in these groups of readers, permissible sequences of letters in word-like structures are selected rather than non-permissible sequences of letters. It will also determine whether this is significantly related to the reading achievement of the children used in this study. It will also determine if any significant difference exists in the performance of achieving and non-achieving readers in Grades two, three and four.

SIGNIFICANCE OF THIS STUDY

Confusion exists concerning grapheme-phoneme correspondences and their utility in reading instruction. Recent research studies have indicated that nonsense words following the rules of grapheme-phoneme correspondences are read easier and with more accuracy than psuedo-words that are not orthographically correspondent (Gibson et al, 1962; Gibson, Osser and Pick, 1963).

Vernon (1971) hypothesizes that difficulty in the reading of words might be avoided if in the early stages of reading instruction, children were exposed to the regularities that exist in clusters of letters as opposed to single letters which have little grapheme-phoneme

relationships. If words bearing grapheme-phoneme correspondences are perceived and selected with greater accuracy, the classroom teacher may have another method to utilize in the teaching of reading. If differences exist between the groups and grades, further studies can explore the possibility of improving the child's word recognition ability by improving his perception and familiarity with permissible letter sequences of English orthography.

DEFINITION OF TERMS

Phoneme

The phoneme is a feature of spoken language structure and in this study refers to an element in the sound system of the English language having a characteristic set of interrelationships with each of the other elements in this system (Gleason, 1966).

Grapheme

The grapheme is a feature of the written language structure and in this study refers to one graphic shape in the writing system of the English language representing some portion of the structure of the spoken language (Gleason, 1966).

Grapheme-phoneme Correspondences

Grapheme-phoneme correspondences refer to the inter-relationship of the oral and written system of the English language so that a letter or grapheme group in a particular

graphic environment results in the utterance of a specific sequence of phonemes. In this study, only invariant grapheme-phoneme correspondences are considered. These refer to a letter or cluster of letters in a given graphic position within the written word, which bears an invariant relationship with a phonemic pattern (Gibson et al, 1962).

Permissible Sequences of Letters

A permissible sequence of letters refers to letter sequences of English orthography that are capable of being generated by the rules of grapheme-phoneme correspondences of that language.

Non-permissible Sequences of Letters

A non-permissible sequence of letters refers to letter sequences of English orthography that are incapable of being generated by the rules of grapheme-phoneme correspondences of that language.

Word-like Structure

A word-like structure is a sequence of letters, either permissible or non-permissible in English orthography, separated from any other word-like structure by spaces.

Redundancy

Redundancy refers to a type of knowledge which reduces the uncertainty of a letter or word (Smith, 1971). In this study, the term refers to the non-random order of letters in English words. Awareness of the redundancy of written language is considered in this study to be measured by the Test of Letter Familiarity.

Test of Orthographic Structure

This examiner-constructed test consists of three word-like structures, two of which are comprised by permissible sequences of letters and one of a non-permissible sequence of letters. Of the two word-like structures made of permissible sequences of letters, one of the structures was a real word. The digram and trigram frequency of these two word-like structures was such that while one was reported as having a high frequency of occurrence, the other had a low frequency of occurrence. This test was designed to measure students' awareness of permissible letter sequences in word-like structures of English orthography.

Test of Letter Familiarity

This examiner-constructed test consists of a word having a blank to represent one deleted letter in the word-like structure. Three choices are provided for the deleted letter. Of the three choices, two of the letters would build a permissible sequence of letters while the remaining one would build a non-permissible sequence of letters in English orthography. Of the two permissible choices, one is of high frequency and the other of low frequency. This test was designed to measure students' ability to construct permissible letter sequences in word-like structures of English.

Achieving Readers

These were ten readers at each of Grades two, three and four who obtained a standard score that was one half

standard deviation or more above the mean score on the silent reading comprehension section of the <u>Gates-MacGinitie Reading Test</u> .

Non-Achieving Readers

These were ten readers at each of Grades two, three and four who obtained a standard score that was one half standard deviation or more below the mean score on the silent reading comprehension section of the <u>Gates-MacGinitie Reading Test.</u>

HYPOTHESES

The following hypotheses were formulated for testing in this study:

(1) There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four in their ability to select permissible combinations (sequences) of letters in word-like structures on:

> (a) the <u>Test of Orthographic Structure</u>
>
> (b) the <u>Test of Letter Familiarity</u>

(2) There is no significant relationship between reading achievement scores for achieving and non-achieving readers in each of Grades two, three and four and their ability to select permissible combinations (sequences) of letters in word-like structures on:

> (a) the <u>Test of Orthographic Structure</u>
>
> (b) the <u>Test of Letter Familiarity</u>

(3)   There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four on their performance on:

        (a) the <u>Test of Orthographic Structure</u>

        (b) the <u>Test of Letter Familiarity</u>

(4)   There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four in their ability to select permissible sequences of letters which cannot occur in English orthography on the <u>Test of Orthographic Structure</u>.

(5)   There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four in their ability to correctly pronounce or read their choice of a real word on the <u>Test of Orthographic Structure</u>.

DESIGN OF THE STUDY

Sample

The sample used in this study consisted of twenty students in each of Grades two, three and four from two mid-socioeconomic schools in the Edmonton Separate School System.

Procedure

(1)   The sample was selected from a population of 127 children in Grade two, 100 children in Grade three and 124 children in Grade four. For this sample, the silent

reading comprehension score on the <u>Gates-MacGinitie Reading Test</u> was considered. The researcher administered the <u>Gates-MacGinitie Survey D</u> to the Grade four population but used the results of the <u>Gates-MacGinitie Primary B</u> and <u>C</u> that had been administered to the Grade two and three population in January, 1972.

(2) The subjects were selected from the population on the basis of their performance on the silent reading comprehension section of the reading test. Those subjects who placed at a half standard deviation or more above the mean were selected as achieving readers. Those subjects who placed at a half standard deviation or more below the mean score on this test were selected as non-achieving readers.

(3) Ten achieving and ten non-achieving readers at each grade level were randomly selected to participate in this study.

(4) Each of these children were seen individually by the researcher and a trained assistant when the following tests were administered:

(a) a test of the subjects' awareness of permissible sequences of letters in word-like structures as constructed by the researcher.

(b) a test of the subjects' ability to construct permissible letter sequences in word-like structures of English. This test was also constructed by the researcher.

(5) Several questions were directed to the children

in an effort to discover the basis of discrimination and selection of permissible (and non-permissible) sequences of letters in word-like structures.

All testing was conducted by the researcher and his assistant during the latter part of April and the beginning of May, 1972. The data were analyzed at the Department of Educational Research Services, University of Alberta and interpreted by the researcher. Informal analysis of the results obtained in the study was also done by the researcher.

LIMITATIONS OF THE STUDY

(1) The researcher realizes that the test items were constructed on the basis of the reported frequency of occurrence of single items, digrams and trigrams in a twenty thousand word list. A number of these words may have contained letter sequences that the children had not been exposed to. Similarly, although the twenty thousand words are representative of all English words, the frequency counts of the letter groups are relative to these words.

(2) The researcher also realizes that the task of each examiner-constructed test required the children to select only one answer, whereas the items on each test had two choices comprised of permissible sequences of letters. By making the children select one answer, limitations were being placed on their responses and

behavior. Furthermore, since two answers were considered acceptable, the chance factor of selecting a correct response was increased.

(3) The researcher was concerned with the perception of permissible sequences of letters in word-like structures by achieving and non-achieving readers who had been defined as such for this study. If there had been more children in the population from which the sample was drawn, more precise criteria might have been used to determine achievement or non-achievement in reading. That is, the definition of achievement or non-achievement might have been changed to include only those scoring a standard deviation or more, above or below the mean score on the reading test. Under those conditions, the results might have varied considerably from those obtained in this study.

SUMMARY

This chapter has provided an overview of the research conducted by the investigator. The problem was presented and discussed. Five null hypotheses were formulated to investigate the problem. A research design was established to collect and analyze the necessary data to test these hypotheses. The sample, the examiner-constructed tests and the testing procedures were outlined. The limitations of the study were acknowledged and the possible significance of the study was presented.

CHAPTER II

REVIEW OF SELECTED RESEARCH

INTRODUCTION

For many years a controversy has existed over the
relationship between sounds (phonemes) of English speech
and the symbols (graphemes) which represent these sounds
in writing. In recent years, opinion and research in the
area of linguistics appears to indicate that large numbers
of words contain highly consistent grapheme-phoneme corres-
pondences.

Considerable research has been conducted in discover-
ing the role of grapheme-phoneme correspondences in the
perception of words. Vernon (1971) suggests that "...dif-
ficulty in analyzing word sounds and resynthesizing letter
sounds might be avoided, if in the early stages of reading,
groups or clusters of letters were utilized rather than
single letters." (p.52) Research that is concerned with
the perception and recognition of words with consistent
or invariant grapheme-phoneme correspondences is pertinent
to this study.

Furthermore, research that examines the nature of
grapheme-phoneme correspondences, both in terms of spelling-
to-sound correlations and redundancy of English letter
sequences, are also relevant to this study.

This chapter contains a review of recent research findings of the nature of grapheme-phoneme correspondences, the role of grapheme-phoneme correspondences in the visual perception of words; and the influence of pronounceability, meaningfulness, letter frequency and redundancy on the perception of words.

THE NATURE OF GRAPHEME-PHONEME CORRESPONDENCES

Ausubel (1967) has stated that learning to read does not involve learning a completely new symbolic code, but rather, the written equivalent of a familiar spoken one whose phonemes, morphemes and syntax have already been mastered. In learning to read, the first problem faced by the reader is the conversion of written words into spoken words. This is done on the basis of grapheme-phoneme correspondences.

English writing is an alphabetic system whereby each alphabet character (grapheme) represents a unit speech sound (phoneme) (Bloomfield, 1942). Sometimes two characters combine to form one speech sound. This is represented by the fact that there are 26 graphemes but 38 or more English phonemes (Gibson, Osser and Pick, 1963). The combination of graphemes to represent English phonemes is not done in a haphazard method. On the contrary, there is some regularity and consistency in English orthography.

Fries (1962) emphasizes the fact that throughout

English spelling history, single letters have never matched single sound features. However, written English has word patterns represented by spelling patterns. These spelling patterns consist of sequences of phonemes and are not as irregular as spelling traditionalists have maintained. Fries concludes that although there is no one-to-one correspondence of individual phonemes and graphemes, the regularity lies in basic spelling patterns. These basic patterns, to Fries, consist of one syllable words spelt regularly with a very simple pattern such as (c)vc where c stands for consonant or consonant cluster; v for a vowel or diphthong; and the brackets refer to being optional.

The importance of letter grouping was also emphasized by Bloomfield (1942), although the exact nature of grapheme-phoneme correspondences was not explored in his writings. However, he did provide guidelines for teaching beginning reading by emphasizing that phonemes of letters vary less when the letters are associated in trigrams or monosyllables. Because these groupings are regular, Bloomfield suggests that the beginning reader be exposed to syllables, even senseless syllables, rather than be confronted with the irregularities of spelling.

The correspondence between written English and spoken English has been demonstrated by Hockett (1963). He classified English monosyllables according to letter arrangements and in terms of their pronunciation. The aim of this classification was to discover rules by which pronunciation

can be predicted from spelling. He states that the rules for pronunciation are formulated by what precedes and follows each grapheme in the graphic monosyllable.

Hanna _et al_ (1966) quotes Moore (1951) as having conducted research which demonstrated that eighty per cent of the 12,546 phonemes comprising the three thousand most frequently used American-English words are spelt consistently. Because of the criticism directed at the corpus size in Moore's study, Hanna _et al_ (1966) analyzed the grapheme-phoneme correspondences in a 17,310 word list. The computer program classified the grapheme-phoneme correspondences according to three kinds of frequency and percentage tabulations. A mere frequency and percentage tabulation of the correspondences, irrespective of phonological factors, yielded a percentage of 83.99 for the thirty consonant phonemes and 62.27 for the twenty-two vowel phonemes. When positional constraints of initial, medial and final were considered, the percentages increased to 74.65 for the vowel phonemes and 87.14 for the consonant phonemes, although a slight decline was noted in the final position for consonant phonemes. When the amount of stress given to the syllables is included, the percentage of correspondence for the vowel phonemes increases to 78.17 per cent and to 89.95 per cent for the consonant phonemes.

Thus, when other factors such as stress and positional constraint or environment are considered, the percentage of correspondence between the grapheme and the phoneme

increases. Hodges (1971), one of the researchers of the Hanna et al (1966) study, writes that the degree of correspondence can achieve and slightly exceed an eighty per cent criterion when monosyllabic syllables and/or words are considered. This is much higher than the degree of correspondence between single graphemes and phonemes.

Venezky (1967) reports the results of his computer program done in 1963 to derive and tabulate spelling-to-sound correspondences in the 20,000 most common English words. He concluded that spelling-to-sound rules should not be based upon individual letters or graphemes but upon functional spelling units. Positional effects, morpheme boundaries and phonotactical influences must be considered in determining the grapheme-phoneme correspondence of a spelling unit. Since good readers can pronounce a high percentage of new words encountered, Venezky hypothesizes that they are generalizing and formulating rules of spelling-to-sound correspondences.

Carroll (1964) agrees with Venezky that correspondences between grapheme and phoneme are more regular than irregular as evidenced by computer programs translating printed text into phonemes with better than 95 per cent accuracy. Similarly, he purports that even young children are capable of grasping the rules of spelling by generalizing rules and classes of correspondence through frequently encountering such grapheme-phoneme correspondences. If this is true, then words containing such correspondences should be recognized

more easily than words that are considered to be highly
irregular, that is, having little grapheme-phoneme corres-
pondence.   There is considerable evidence to support this.
Several research studies by Gibson and her associates have
demonstrated that invariant grapheme-phoneme correspondences
are more accurately perceived than their unpronounceable
counterparts.

THE ROLE OF GRAPHEME-PHONEME CORRESPONDENCES IN THE PERCEPTION OF WORDS

Several studies in reading research have attempted to
investigate the reader's acquisition of word recognition
skills.   This ability requires the reader to realize the
correspondence between written symbols and the elements of
spoken language. (Bloomfield, 1942; Ausubel, 1967; Carroll,1964)
Gibson (1970) states: "The heart of the matter is surely the
process of decoding the written symbols to speech (p.139)."

Similarly, Levin and Biemiller (1968) analyzed oral
reading into the process of decoding and matching to auditory
memory.   They found that the harder a word is to pronounce,
the longer the interval from exposure to oral response.
According to this interpretation, correct recognition of a
word depends upon decoding written material to sound.

The graphic code is related to the speech code by rules
of correspondence. (Fries, 1962; Hockett, 1963; Venezky, 1967)
Reading, then, according to Gibson's definition, involves
discovering the grapheme-phoneme correspondences.   Since the

correspondence between graphemes and phonemes is greatest with clusters of letters occurring in a given position within a word, these are considered to be critical units for perception (Williams and Levin, 1967; Gibson, 1970).

Gibson et al (1962) calls this critical unit a higher order unit that is "...constituted by spelling-to-sound correlations (p. 554)." The unit is not a single grapheme since it does not correspond consistently with speech. As early as 1885, Cattell showed that whole words can be perceived as easily as single graphemes. Other tachistoscopic experiments have demonstrated that the number of unconnected letters recognized is well below the number of letters recognized when they are grouped into familiar words (Newman, 1966; Miller, 1956).

Thus, the higher-order unit is a spelling pattern defined as "...a cluster of graphemes in a given environment which has an invariant pronunciation according to the rules of English (Gibson, 1965, p. 1071)." Gibson hypothesized that these correspondences have been assimilated by the skilled reader of English and serve to organize units for perception. In other words, sequences of letters conforming to the rules of English orthography would be perceived more easily than sequences which do not conform to these rules. The research studies that have been conducted to test this hypothesis will be reviewed in depth.

Gibson, Pick, Osser and Hammond (1962) compared the perceptibility of two sets of letter strings, all pseudo-words,

which differed in their grapheme-phoneme correspondences.
One list, called 'pronounceable', contained twenty-five
words with a high spelling-to-sound correlation. Each word
had (1) an initial consonant spelling having a single,
regular pronunciation; (2) a final consonant spelling having
a single, regular pronunciation; and (3) a vowel spelling
placed between the two consonant spellings and having a
single regular pronunciation in the environment of the given
initial and final consonant spelling. The twenty-five words
in the second list, called the 'unpronounceable' list, had
low grapheme-phoneme correspondence. These words were con-
structed from the words in the first list by reversing the
initial and final consonant spellings while leaving the medial
vowel unchanged. The length of the words was held constant
for each pronounceable and unpronounceable string in an item,
but varied in length from four to eight letters over the
entire test .

The words were projected tachistoscopically on a screen
in random order in five successive presentations. The 25
college students were instructed to write down what they had
seen. The mean percentage of pronounceable words correctly
perceived was consistently and significantly better than the
mean percentage of unpronounceable words (at a .01 level for
all exposure times). Errors tended to increase with the
length of the word.

The experiment was repeated with the same material but
requiring a different type of response to minimize the effect

of 'response-bias'. In this experiment, after the pseudo-word was exposed, it was followed by a multiple-choice list of four items, one of which was correct while the other three were the most common errors produced in the previous experiment. The 60 college students were instructed to choose the word they thought they had previously seen. Again, the mean number of pronounceable pseudo-words correctly perceived significantly surpassed the unpronounceable mean number.

Thus, Gibson et al (1962) concluded that pseudo-words constructed according to rules of invariant grapheme-phoneme correspondences are perceived more accurately under conditions of tachistoscopic viewing.

Would the results be different if the tachistoscopic conditions were removed? At what stage of development have these grapheme-phoneme correspondences been assimilated? Questions such as these were the problems of further research in this area.

In another experiment, Gibson, Osser and Pick (1963) studied the development of the perception of grapheme-phoneme correspondences. This experiment was designed to discover the age at which children respond to spelling-patterns as units. Twenty-four subjects (12 boys and 12 girls) who had just completed Grade one and three were compared in their ability to recognize familiar three-letter words, pronounceable trigrams and unpronounceable trigrams. The three letter words were taken from the first-grade reading list and each word chosen was broken into meaningless trigrams, both a

pronounceable and an unpronounceable one. Twenty four-and five-letter pseudo-word combinations (half pronounceable and half unpronounceable) were selected from the previous experiment of Gibson et al (1962).

The words and pseudo-words were presented tachistoscopically to individual children who were required to spell them orally. All the first-graders and the third grade boys read the familiar three-letter words more accurately than the non-word trigrams. The pronounceable trigrams were read significantly more accurately than the unpronounceable ones by the same children. The third-grade girls read all three-letter combinations with high and equal accuracy, but perceived the pronounceable four- and five-letter pseudo-words more often correctly than their unpronounceable counterparts. The longer words were seldom read accurately by first-graders and there was no significant difference between pronounceable and non-pronounceable. But the third-graders were found to have an increased span and the difference between the pronounceable and unpronounceable items accurately perceived was significant.

This led Gibson and her associates to conclude that a child in the early stages of reading reads in short units but has already assimilated certain regularities of grapheme-phoneme correspondences which facilitate in the perception and recall of words containing such correspondences.

Rosinski and Wheeler (1972) chose 16 subjects in each of Grades one, three and five. There was an equal number of boys and girls. Twenty pseudo-words of three-to-six letters in

length were used from the Gibson *et al* (1962, 1963) study. The words were typed in upper-case letters on five by eight inch cards, and the subjects were asked to select the one that was more like a real word. The results indicated no significant difference for sex, so a two-way analysis of variance (Grade by word length) was conducted. Only the effect of Grade was significant. Their experimental results report the performance of the first-grade children to be at chance levels, whereas the performance of the third-and fifth-graders ranged between 69 per cent and 80 per cent. A Newman-Keuls analysis of the effect of grade revealed that the performance of the first-graders differed from both the third- and fifth-grade levels (at a level greater than the .01 level of significance). This led the researchers to conclude that extraction of invariant grapheme-phoneme correspondences occurs between grades one and three.

While Rosinski and Wheeler attempted to determine the basis for the word-like structures chosen by asking each individual how they had decided which sequence of letters were more word-like, they posed the question after all 20 words had been shown. Although this provided a global or generalized response, it did not account for the possibility that a different basis for the choice of each word-like structure may exist. Thus, it was decided that this study would attempt to determine the basis for choosing each word-like structure.

Gibson attempted to discover if meaningfulness or

pronunciation were factors in the subjects' choice rather than orthographic structure. These effects will be discussed.

The Effect of Pronounceability and Meaningfulness

One of Gibson's main purposes in her research was to discover the unit-forming principles in reading activity. She considered the basis to be either the same as the unit-forming principles in speech, that is, pronounceability or morphological usage; or orthographic rules that are learned in reading.

To discover if pronounceability was a prime factor in the more accurate perception of invariant grapheme-phoneme correspondences (which were also more pronounceable), Gibson, Shurcliff and Yonas (1968) repeated the Gibson et al (1962) study with 34 deaf subjects and 34 hearing subjects. The results showed that although the deaf subjects made more errors than the hearing subjects, the difference in the error score of pronounceable and non-pronounceable pseudo-words was just as significant for both groups. This led Gibson to conclude that pronounceability is not the main cause of the units. The deaf subjects profited just as much from reading as the hearing subjects did. However,this could indicate that deaf subjects rely more upon visual cues or some other factor in the perception of words.

However, as the Gibson et al (1962) study showed, words that conform to the rules of invariant grapheme-phoneme correspondences are more pronounceable . To confirm this, Gibson et al (1962) had 165 college students rate the test words on a nine-point scale for pronounceability. The

pronounceable list was rated in all cases as being easier to pronounce. After this had been done, Gibson had 16 subjects read the words aloud. The invariance of pronunciation was better for the pronounceable list. A positive correlation of 0.85 was found between both sets of scores.

Thus, it seems that although pronounceability may aid in the accurate perception of grapheme-phoneme correspondences, it alone cannot account for the formation of units. Gibson (1962) states that it is the frequency of experiencing the grapheme-phoneme correspondence that leads to skilled recognition.

Vernon (1971) reports that these studies seem to indicate that pronounceable trigrams and pseudo-words are processed as single unitary structures, whereas the less pronounceable and unpronounceable had to be perceived letter by letter before they could be recognized. Thus, it appears that pronounceable grapheme-phoneme units are assimilated in chunks. Miller (1956) showed that a 'chunk' of information could be perceived as rapidly as a single item. Newman (1966) found that restricting the span of letters exposed radically reduced the speed at which material could be read. In fact, to read a passage easily and with 96 per cent accuracy, a string or span of eight letters was required for each eye fixation.

Gibson, Bishop, Schiff and Smith (1964) compared three types of trigrams in a study to determine the effects of meaningfulness and pronounceability as grouping principles in the perception and retention of verbal material. The

three types of trigrams included a pronounceable one con-
structed by grapheme-phoneme correspondences; a meaningful
trigram having a semantic reference; and a control trigram
that was low in both pronounceability and meaningfulness.
The pronounceable trigrams were found to require the lowest
perceptual threshold for accurate perception and recall of
tachistoscopically presented trigrams. Meaningful trigrams
followed and the control trigrams required the highest
perceptual threshold. Thus, Gibson et al (1964) concludes
that letter-groups which have an invariant grapheme-phoneme
correspondence form functional units for reading.

Although the words used in these studies were rated for
pronounceability, the ratings and reading were done by subjects
other than those used in the study. Also, the rating and
reading was done by college students, whereas the words were
sometimes used with elementary students. Thus, it seems
necessary to determine if the words selected by students are
read with an invariant pronunciation.

The Effect of Letter Frequency

Anisfield (1964) commented on the research of Gibson
et al (1962) and raised an alternate point in discovering
that although the letter frequency of the test items was
controlled, the frequencies of bigrams and trigrams were not.
Ainisfield found (except for three items) that the word with
a higher bigram frequency had a higher recognition score than
the correspondent word with a lower bigram frequency. A

Wilcoxon test indicated that the difference was significant

beyond the .01 level. Thus, he concluded that bigram

frequency can predict the differences in recognition.

Gibson (1964) replied to Ainisfield's comments indicat-

ing that because the test items varied in length, the longer

words would have greater summed frequency. Mere sums would

give a bias toward a negative correlation. Using the mean

summed trigram and digram frequency for each item and

correlating it with the number of correct perceptions yielded

no significance.

However, Ainisfield's point does raise a purpose for

further investigation. Given two invariant grapheme-phoneme

correspondences with differing summed bigram and trigram

frequencies, would the pseudo-word containing the higher

summed frequency be chosen?

Postman and Rosenzweig (1957) conducted research that

dealt with conditions that determine the perceptual recognition

of verbal stimuli. One aspect of the research was concerned

with the correlation between visual recognition thresholds,

word frequency and trigram frequency. No relationship was

found between recognition thresholds and trigram frequency.

However, word frequency was found to lower the recognition

threshold.

Mayzner and Tresselt (1962) studied college students'

ability to rank letter pairs and single letters to match

digram and single-letter frequency counts that were based on

word length and letter-position. The results indicated that

the subjects were able to successfully rank the frequency
with which digrams and single-letters occur in the language.

This led Biederman (1966) to study the recognition of
tachistoscopically presented five-letter words as a function
of digram frequency. With the 16 college students, Biederman
found that for words of high frequency, there was no difference
in the ease of recognition between high digram frequency
words and low digram frequency words. However, for words of
low frequency, high digram frequency words were recognized in
fewer trials than low digram frequency words.

This research seems to indicate that given words of
low frequency, or perhaps even pseudo-words with a no-word
frequency value, the words comprised of high digram or trigram
frequency would be recognized more often than a lower digram
or trigram frequency based word. The present study will
attempt to test this hypothesis in a non-statistical manner.

THE ROLE OF REDUNDANCY IN THE PERCEPTION OF WORDS

Bruner, as reported in Hörmann (1971), has stated that
learning a coding system is like classifying in which the
learner must draw the similarities and differences to learn
the system. Furthermore, he postulates that by allowing
language to happen, man makes use of his freedom to link the
randomness of reality with the laws of probability.

Postman and Rosenzweig (1957), in their study of pre-
recognition errors, found that their subjects had a tendency
to complete partially discriminable items, if the items were

of high frequency. Thus, once a subject had recognized two letters, he was able to supply the missing letter and to reconstruct the word. Postman and Rosenzweig conclude:

> "In the language of communication theory, it would appear that after training, each letter carries a smaller amount of information; the stimulus pattern has become more redundant." (p.252)

Miller (1951), in discussing rules for using symbols, states:

> "So long as language contains fewer symbols than there are things to be symbolized, the symbols must be arranged in patterns. Thus every symbol occurs in a context of other symbols, and its symbolic role changes as the context changes." (p.103)

Thus, in English, letters should not be considered in isolation but rather in the context of other letters. The role of the letter can be changed with a new context or environment of letters and a positional change within the word.

Miller reports that when a person reads a familiar sequence of letters, the central activity of the brain can run slightly ahead of the stimulus sequence and so lead the reader to expect certain stimuli before they occur.

Thus, linguistic events are redundant. Redundancy is not a characteristic of a single event, but of a sequence of events. Garner (1962) attributes the redundancy in printed English to the intraword constraints. Could this be why tachistoscopic experiments have demonstrated that the number of letters recognized when they are grouped into familiar

words or sequences exceeds the number of unconnected letters recognized?

Schiffman (1971) reports that sometimes readers only need to perceive certain familiar letter groups, dominant letters, or just the initial or final part of the word for accurate recognition. Smith (1969b) proposes that identification is the result of testing a sufficient number of features, that is, elements of the visual configuration, so that alternative responses are eliminated and the uncertainty is reduced. His research (Smith, Lott and Cronnell, 1969) found evidence to support the hypothesis that disruption of 'total word form' does not interfere with the identification of words unless the discriminability of the elements in a word are disrupted. The 216 college subjects searched for words in passages of text that varied from normal text to alternating type size and upper-and lower-case type. Relative size of alternate letters rather than the alternation of case accounted for the disruption of discriminating the feature sets needed to identify the word. This led Smith to conclude that a reader is sensitive to sequential dependencies among features rather than among letters and this permits him to identify letters in words which he cannot identify in isolation.

Smith (1967) hypothesized that the number of features to be discriminated for a sequence of letters to be identified varies inversely with the amount of redundancy within the sequence. The experimental results obtained by controlling

the intensity level of the stimulus sequence indicated that several parts, called distinctive features, were analyzed simultaneously and that the number of features required vary with the redundancy of the sequence as a whole and with the probability of the sequence being a word.

Thus, a reader is sensitive to sequential dependencies (or redundancy) within a sequence of letters. For example, sequential redundancy determines that the final letter of an English sequence "an_" is probably "d,t, or y."

The ability to make use of sequential redundancy should be based on an acquired implicit knowledge of word structure. Smith and Lott (1970) studied how children in Grades one and four developed adult-like skills in the use of sequential redundancy in the recognition of familiar three-letter words. A stimulus word or letter was projected at below contrast threshold and the contrast intensity of the projected light was gradually increased until the subjects responded to the stimulus. All groups tended to identify letters within words at a lower light intensity level than the level at which they were able to identify letters in isolation. They found that children appeared able to use sequential redundancy in the identification of letters in the familiar three-letter words even in Grade one, and by Grade four achieved an adult level of performance. It led them to conclude that information from one part of a word facilitates the identification of other parts or letters of that word.

Thus, as Foote and Havens (1965) reported - configuration

plays a significant role as a response determinant of tachistoscopic presentations since it reduces the uncertainty and also provides cues for distinguishing the features that Smith reports are used in word recognition. In addition to this, there appears to be an awareness of the sequential distribution or redundancy of letters that can occur together. It could be this factor that caused Foote and Havens' subjects to try to find words to fit the configuration, and the words chosen were usually of high frequency of occurrence, thus contributing to their being more redundant.

This result is in agreement with the results of Miller and Selfridge (1950). Their experiment was designed to show that meaningful material is easier to retain because it contains, to a greater degree than nonsense material does, the "transitional probabilities" or sequential redundancy of everyday language. Likewise, Gibson postulated that pronounceable, invariant grapheme-phoneme correspondences are perceived more accurately than variant correspondences. This could be because readers have acquired a knowledge of the transitional probabilities in their language and can transfer this knowledge to the solution of a new task (recognition of words).

Similarly, Miller, Bruner and Postman (1954) found increased accuracy in recall and recognition of letter groups and words that had greater or closer approximation to English. The researchers estimated the redundancy

value of these letter groups to be 43 per cent. Again, the number of letters identified correctly increases when the stimulus sequence is more redundant.

Wallach (1963) exposed nonsense words with varying degrees of approximation to English to Grade five pupils. Good spellers were able to recognize words of a higher order approximation significantly faster than poor spellers. Thus, it would appear that good spellers have acquired a knowledge of the transitional probabilities of written English.

To determine the letter sequence habits of children, Amster and Keppel (1968) compared Grade two, five and college students in their ability to complete a word with the letter which would best follow. The data showed an increasing ability with age to make meaningful units or words, as well as providing a letter which most frequently follows in orthographic structure.

Thus, it would appear that younger children have acquired an awareness of orthographic structure and are aware of sequences of letters that can occur together. To determine which part of a word conveys more information, Bruner and O'Dowd (1958) worked with 16 college students in their ability to recognize words in which typographical reversals were inserted at the beginning, middle or end of the whole word. The results indicated that the beginning of the word is more informative than the end, and the end is more informative than the middle. Experiments done by Carson (1961) and Broerse and Zwaan (1966) agree with the

results obtained by Bruner and O'Dowd.

SUMMARY

From the research reviewed here, it can be concluded that invariant grapheme-phoneme correspondences are identified more accurately than their variant counterparts. It would appear that the invariance is based upon units that have a consistent spelling-to-sound correlation. These correspondences appear to be assimilated by the reader at a very early stage of reading development. The orthographic structure of the word, rather than its pronunciation or meaningfulness, seems to be the factor involved in the accurate recognition of words containing such grapheme-phoneme correspondences.

Few of the studies have been done without tachisto-scopic presentations or light controlled intensity levels. None have required the subjects to read, as a unit, each word chosen. Only one of the studies attempted to determine the basis of individual discrimination. No study has tried to determine if there are any differences in the ability of achieving and non-achieving readers to select the invariant grapheme-phoneme correspondences.

CHAPTER III

THE EXPERIMENTAL DESIGN

INTRODUCTION

In this chapter, the experimental design of the study
is described. Information regarding the selection of the
sample, the test instruments used, and the procedure used in
the administration and scoring of the tests will be included.
For the examiner-constructed tests, it was necessary to run
a pilot study. The results of this pilot study have been
summarized. A description of the treatment of the data by
statistical procedures will also be discussed in this
chapter.

SAMPLE

Two schools, in a mid-socioeconomic area of Edmonton,
were originally designated by the officials of the Edmonton
Separate School System for this research. According to
Blishen's Occupational Class Scale (Blishen, Jones, Naegele
and Porter, 1961, pp.477-485), the majority of subjects in
this 'mid'category would come from homes of skilled and
semi-skilled workers. This means the subjects would belong
in category four or five on this scale although, drawing
from a normal distribution, there would be some deviations
above or below these categories. Few children in these two
areas came from non-English speaking homes.

The students selected for this study were from Grade 2, 3 and 4 classrooms in the Edmonton Separate School System. The students had been taught reading by a basal reader approach. The actual sample consisted of the 127 children registered in Grade 2, 100 children in Grade 3 and 124 children in Grade 4 in the two schools in this system. Twenty-five children (7.1 per cent of the population) were excluded during the sampling procedure because they were able to speak a second language.

Individual interviews were held with students purporting to speak a second language. The investigator was assisted by a person conversant with French and Ukranian, the two predominant second languages spoken in these school areas. A conversation between the investigator's assistant and the individual was used to determine the fluency with which the individual spoke the second language. Those who were able to converse quite fluently were eliminated from the study. For those who spoke a language other than French and Ukranian, the individual was required to translate orally, sentences from English to their second language. This method was used rather than relying upon the information in the cumulative cards in the schools.

SELECTION OF SAMPLE

After the exclusion of the children who were able to speak two languages, the remainder of the population (119 children in Grade 2; 92 children in Grade 3 and 115 children in Grade 4) was classified as achieving and non-achieving

readers on the basis of the results of the silent reading
comprehension standard scores of the Gates-MacGinitie
Reading Tests, Form 1 (1965).

During the last two weeks of January, all the children
in grades two and three of the Edmonton Separate School
System are administered this test. The Primary B Form is
administered to those in Grade two, and the Primary C Form
to the Grade three children. The investigator administered
Survey D, 1M to the Grade four children in April. All forms
of the Gates-MacGinitie Reading Test have two subtests –
Vocabulary and Comprehension. Only the silent reading
comprehension subtest scores were considered for the purposes
of this study. The norms of this test were established on
a sample of 40,000 children. The mean standard score of the
test is 50 and the standard deviation was established as
10 (Technical Manual, 1965, p.2).

The mean and the standard deviation was computed on the
1972 reading comprehension subtest scores of the population.
The results indicated a Grade 2 mean of 49.0 with a standard
deviation of 8.32. The Grade 3 mean was 50.3 with a stan-
dard deviation of 7.69. The Grade 4 mean was 50.37 with a
standard deviation of 7.58.

Using these means and a half-standard deviation, groups
of achieving and non-achieving readers for each of the three
grade levels were established. A table of random numbers
was employed to select the test sample of ten achieving and

ten non-achieving readers from each grade.

Achieving readers in Grade 2, 3 and 4 were selected from those children scoring above 53.70, 54.14 and 54.16, respectively, on the silent reading comprehension test. Thus, achieving readers in all three grades were children who scored .5 or more standard deviations above the mean.

Non-achieving readers in Grade 2, 3 and 4 were selected from those children scoring below 44.38, 46.46 and 46.58, respectively, on the silent reading comprehension test. Non-achieving readers in all three grades were children who scored .5 or more standard deviations below the mean.

In the selection of the sample, no consideration was given to the sex of the subjects. The distribution of male and female subjects was thus a random outcome. As Table I reveals, the mean age of both groups within each grade was very close.

TEST INSTRUMENTS

Standardized Tests

Gates-MacGinitie Survey D, Form 1M - This test was designed for use in Grades four through six and provides a measure of speed, vocabulary and comprehension. Each of these is administered as separate tests and is interpreted separately by standard scores, percentile rankings and grade scores.

Only the silent reading comprehension subtest was administered to the population. In this test, the student

TABLE I

SUMMARY OF TEST SAMPLE

Grade	Group	SEX			Mean Age	Standard Deviation	Mean Reading Score	Standard Deviation
		Male	Female	Total				
2	Achieving	5	5	10	92.7	3.88	57.7	3.62
	Non-Achieving	6	4	10	96.5	4.72	38.4	4.27
3	Achieving	4	6	10	106.9	2.66	61.0	2.31
	Non-achieving	8	2	10	104.0	4.19	41.0	3.09
4	Achieving	6	4	10	115.9	3.44	57.0	1.83
	Non-achieving	3	7	10	115.7	3.13	40.9	3.51
	TOTAL	32	28	60				

indicated his choice of answer by marking the appropriate box. He was instructed to do the best that he could.

The comprehension subtest measures "... the child's ability to read and understand passages (Manual, p.1)." It contains 21 passages in which a total of 52 blank spaces have been distributed. For each blank space the child had to choose,from five, the one which best conforms to the meaning of the whole passage.

The Gates-MacGinitie Reading Test, Survey D replaces the Gates Reading Survey. This new, revised edition appears to be more up-to-date. The scoring of the tests has been sim- plified. The norms for the Gates-MacGinitie Reading Tests are based upon a new, nationwide standardization. (Technical Manual, 1965)

Test of Orthographic Structure

Since the purpose of this study was to discover whether achieving and non-achieving readers are familiar with the orthographic structure of words, it was necessary to construct a test to measure this. A copy of this test is to be found in Appendix A.

All of the real words used in this fifteen-item test appeared in Hockett's (1963) list of spelling words comprised of invariant grapheme-phoneme correspondences. Words from this list were chosen because Hockett had classified these monosyllables according to their letter arrangement and pronunciation. Hockett had found them to be consistent in spelling-to-sound correspondences.

Since it was decided to minimize the effects of meaning-
fulness, the words were checked for frequency of occurence
in the Teacher's Word Book of 30,000 Words (Thorndike, 1944).
Only those words that occured less than five times per
million were retained as possible test items. It was decided
that these should be meaningless to the students in the
sample. The words to be used in this study were randomly
selected by placing all the words in a container and drawing
the number of words required.

The words selected were checked for frequency of
occurence in the Word Frequency Book (Carroll et al, 1971).

The words selected were checked for frequency of
occurrence in the Word Frequency Book (Carroll et al, 1971).
This book gives a total frequency count. In addition to this,
the word frequency count in a range of material for each of
grades three through nine is presented. The words were found
not to be used, or used infrequently, in material typically
exposed to the grades participating in this study.

Digram and trigram frequency of each real word was
analyzed according to the frequency tables of Mayzner and
Tresselt (1965). This study presented tables, based on a
sample of 20,000 English words, which show single-letter
to pentagram frequency counts for all word-length and letter-
position combinations, for three to seven letter words.
The summed or total frequency count for all word-length and
letter-position combinations bears a high degree of corres-
pondence with the Underwood and Schulz tables (1960). For
example, a Spearman rank-difference correlation yields a
value of .97 between single-letter counts of the two

tables (Mayzner and Tresselt, 1965, p.13).

The digram and trigram count of each real word was considered because some consonant clusters appear to function as digrams whereas trigrams form pronounceable syllables (Postman and Rosenzweig, 1956). An example of the frequency count computation and consideration is:

	Digram count considering LP and WL	Total digram and trigram
scurf	sc - 7 cu - 0 ur - 8 rf - 1	sc - 41 urf - 50

(LP - Letter Position
WL - Word Length)

Since one of the purposes of this study is to discover whether letter frequency affects the basis of an individual's choice, it was necessary to build a distractor containing invariant grapheme-phoneme correspondences.

The following criteria were used to build this distractor:

(1) The total digram and trigram count of the real word was considered to be either highly frequent or of low frequency. This decision was relative to the frequency count of other digrams and/or trigrams beginning with the same letter. If the real word was considered to be of high frequency, then the distractor would be made of letters of the lowest possible digram and trigram counts. If the real word was considered to be of low frequency, then the distractor would be made of letters having the highest possible digram and trigram frequency counts.

(2) The distractor was built by beginning with the same letter as the real word but by selecting the digram and/or trigram having a frequency count that was opposite in value to the frequency count of the same number of letters in the real word.

(3) The distractor was comprised by an invariant grapheme-phoneme correspondence. The letter sequences generated by the investigator were classified according to the arrangement of letters and were compared to Hockett's list of spelling words having consistent spelling-to-sound correspondences.

(4) Word length was held constant within each item.

These four criteria ensured that these two items would be of opposite digram and trigram frequency counts while maintaining an invariant grapheme-phoneme correspondence.

A third distractor was constructed for each item. This distractor was to contain a non-permissible sequence of letters, that is, the letters could not be generated according to the rules of English orthography. This distractor was included to determine if students were able to discriminate between permissible and non-permissible sequences of letters in English orthography. The pronunciation of the distractor was awkward and unnatural according to English phonological rules.

The following criteria were used to build the non-permissible distractor:

(1) This distractor was to begin with the same initial

letter as the other two words.

(2) This distractor was to contain a sequence of letters that cannot occur in English orthography. The non-permissible combination was randomized to be in initial, medial or final positions (or a combination of any two positions).

(3) The length of the distractor item was to be in agreement with the length of the other items in that entry. Thus, length was held constant for each test item.

The test was constructed so that each item would have three choices. The three choices were typed in lower-case letters with primary type on a three by five inch card. The order for each card was randomly determined.

An example of an item is:

<div align="center">

brin   bnel   bleb

</div>

Each student was interviewed individually by either the investigator or the trained assistant. The student was asked the following sequence of questions for each of the fifteen items presented (with one item per card):

(1) Which one of these three groups of letters is more like a real English word?

(2) Why did you choose that one?

(3) Could you read the word for me?

(4) Which of these three groups of letters could not be a real English word?

(5) Why did you choose that one?

If the response to Question two contained any evidence of the child having previously seen or heard the word, the following questions were asked:

(1) Can you remember where you saw (or heard) the word before?

(2) What does the word mean?

If the child gave no response to Question Two, it was decided that the following questions would be asked:

(1) Have you ever seen or heard that word before?

(2) Does that word remind you of any other word that you know?

The responses were noted on a scoring sheet. A copy of the scoring sheet is to be found in Appendix A. The scoring procedure generated the following information:

(1) Total number of permissible sequences of letters chosen over the non-permissible combinations.

(2) Whether the response for a real word was an item of high or low frequency.

(3) The basis of discrimination for each item selected as permissible and non-permissible.

(4) The pronunciation of each real word chosen.

(5) The total number of non-permissible sequences of letters correctly identified as being non-permissible.

Arrington's Formula ($\frac{2A}{2A+D}$) was used to determine the reliability coefficient of this test (Fiefel and Lorge, 1950). To use this formula, it was necessary to do a test-retest

of the sample used in the pilot study. This was carried
out by the investigator two weeks after the initial testing.
The reliability coefficient was computed at .67 for the
Grade 2 sample; .74 for the Grade 3 sample and .90 for the
Grade 4 sample. Responses that were the same on both test
and retest were recorded as agreements while responses that
were different were recorded as disagreements. The number
of agreements and disagreements for each group of readers
within each grade are described in Table II. As the results
indicate, there was a consistently higher number of agree-
ments amongst the achieving readers as opposed to the non-
achieving readers, except in the Grade 4 responses to the
real word. Similarly, as the grade level increased, there
was an increase in the number of agreements. This could
mean that at the lower grades and amongst the non-achieving
readers, there is less consistency of response and may mean
that in these groups there was more guessing.

Test of Letter Familiarity

It was decided to construct this test to determine if
the students were aware of permissible letter combinations
within a particular word. It was believed that this test
would provide a measure of the child's awareness of letter
redundancy.

The test consisted of twenty real words chosen in the
exact manner that words were chosen for the Test of Ortho-
graphic Structure. The words appeared in Hockett's (1963)
list of regularly spelt words. The frequency of occurence

TABLE II

SUMMARY OF RESULTS OF RESPONSE AGREEMENTS
AND DISAGREEMENTS IN RETEST OF
TEST OF ORTHOGRAPHIC STRUCTURE

Grade	Response Category	Achieving Readers Agree	Disagree	Non-Achieving Readers Agree	Disagree
2	Real Word	20	10	7	23
	Non-permissible	17	6	9	13
3	Real Word	19	11	18	12
	Non-permissible	23	7	10	20
4	Real Word	20	5	23	7
	Non-permissible	28	2	23	7

of the words was checked in the Teacher's Word Book of 30,000 Words (Thorndike, 1944) and the Word Frequency Book (Carroll et al, 1971). The frequency of occurrence of these words was less than five times per million. The digram and trigram frequency of each real word was analyzed according to the tables of Mayzner and Tresselt (1965). A copy of this test is to be found in Appendix B.

For this test, it was decided to delete one letter from the sequence of letters comprising the real word. For the deleted letter, three one-letter choices would be provided. The student was asked to select the best letter to make a word and to write that letter in the blank.

As much as possible, the criteria used in selecting the one-letter choices for each of these items was the same as that used for items on the Test of Orthographic Structure.

The three choices for each item consisted of:

(1) the missing letter from the real word;

(2) a permissible sequence whose digram or trigram frequency count value was opposite to the real missing letter; and

(3) a non-permissible letter or one that could not occur within that letter environment according to the rules of English orthography.

An example of an item from this test is:

s__og   (l w g)

The twenty items were typed on one test sheet. Each student completed the test individually. The order of the

three one-letter choices was randomized. Three choices followed each test item.

To discover the basis of the subjects discrimination and selection of one letter, it was decided to ask each student the following questions about four of the test items:

(1) How did you decide which letter would best fit in the blank to make a real English word?

(2) Can you read the word?

The four test items had been preselected by a table of random numbers (Glass and Stanley, 1970).

Again, the reliability was determined by Arrington's Formula $\left(\frac{2A}{2A+D}\right)$ in using a test-retest of the entire test sample. The number of agreements and disagreements for each group of readers within each grade was calculated. Table III presents a summary of this information. The reliability coefficient for the Grade two sample was .68; for the Grade three sample it was .71; and for the Grade four sample it was computed as .76. The reliability coefficient across grades is more agreeable for this test. The achieving readers' responses were more consistent than the non-achieving readers' responses except at the Grade 3 level where the achieving readers had nine less agreements.

PILOT STUDY

A pilot study was conducted in the middle of April to test the effectiveness of the two examiner-constructed tests. The two tests were administered to twelve children from one

TABLE III

SUMMARY OF RESULTS OF RESPONSE AGREEMENTS
AND DISAGREEMENTS IN RETEST ON
TEST OF LETTER FAMILIARITY

Grade	Achieving Readers		Non-Achieving Readers	
	Agree	Disagree	Agree	Disagree
2	110	90	86	94
3	101	79	110	90
4	124	56	110	90

school assigned to the investigator by the Edmonton Separate School System. The school was in a mid-socioeconomic area.

The children selected for this pilot were from a Grade two, three and four classroom in this school. On the basis of teacher judgements and tests, two children at each grade level were identified as achieving and two were identified as non-achieving readers.

Each of these children were then seen individually by the investigator and an observer who was being trained to assist in the final collection of data. The following tests were administered in a random order:

    (1) the <u>Test of Orthographic Structure</u>.

    (2) the <u>Test of Letter Familiarity</u>.

The responses to all questions asked on the <u>Test of Orthographic Structure</u> were tape-recorded and hand-written on a scoring sheet.

Revisions and changes were made in each of the two tests on the basis of the pilot study. The <u>Test of Orthographic Structure</u> was found to be too long to sustain the attention of the younger children in the sample. The number of items was therefore reduced from twenty to fifteen on this test. Two of the items were deleted because they were found to be meaningful and recognizable to some of the children. The final fifteen items for the test were selected from the remaining eighteen by using a table of random numbers.

In conducting the pilot study, a number of questions

were asked of each child about the basis of their dis-
crimination and selection of answers. For the final
collection of data, these questions were structured to
be asked in conjunction with each item on the Test of
Orthographic Structure.

The results of the responses of the children indicated
that few based their selection on orthographic structure.
Rather, the children seemed to search for meaning or would
misread their choice so that it became a real word that had
a similar structure. Table IV shows how many words were
read incorrectly at each grade level.

TABLE IV

NUMBER OF WORDS READ INCORRECTLY
ON THE TEST OF ORTHOGRAPHIC STRUCTURE

Grade	Words Read Incorrectly	Words Read With Substitution type error	Total Words Read Incorrectly
Grade 2			
Achieving	8	8	16
Non-achieving	10	14	24
Grade 3			
Achieving	7	2	9
Non-achieving	13	9	22
Grade 4			
Achieving	2	5	7
Non-achieving	11	3	14

The investigator attributed the search for meaning to
the possibility that since there were two choices represented

by invariant grapheme-phoneme correspondences, the child
might be forced to search for meaning to discriminate and
select.

To determine if this was so, a second pilot was con-
ducted using the Revised Test of Orthographic Structure.
The revised test consisted of fifteen test items, each item
having two choices. One choice was a real English word
with an invariant grapheme-phoneme correspondence. The other
was a non-permissible sequence of letters in English
orthography.

The Revised Test of Orthographic Structure was piloted
to a total of six students in Grades 2, 3 and 4. Again, on
the basis of teacher judgement and tests, both an achieving
and non-achieving reader were identified for each grade.
The results showed little difference. Table V summarizes
these results. The children still seemed to search for

TABLE V

NUMBER OF WORDS READ INCORRECTLY ON
THE REVISED TEST OF ORTHOGRAPHIC STRUCTURE

Grade	Words Read Incorrectly	Words Read With Substitution Type Error	Total Words Read Incorrectly
Grade 2			
Achieving	4	5	9
Non-achieving	4	8	12
Grade 3			
Achieving	1	2	3
Non-achieving	6	5	11
Grade 4			
Achieving	2	0	2
Non-achieving	0	3	3

meaning. Thus, it was decided to use the <u>Test of Ortho-graphic Structure</u> as it had originally been designed.

In the first pilot run, the <u>Test of Letter Familiarity</u> was tried. The twenty items were divided into two sets of ten items with each set being tried with a different set of questions. This was to determine if different results would be obtained according to the set of directions given. The order of the two sets of directions were varied so that one set was asked for questions one to ten first, and with the next child, they were asked on questions eleven to twenty.

The two sets of questions were:

<u>Set One</u>:   Look carefully at each word below. In each word one letter is missing. Following the word, three letters are given. Pick the letter which you think would best fit in the blank to make an English word, even though you may not know the word or its meaning. Write the best letter in the blank.

<u>Set Two</u>:   Look carefully at each word below. In each word one letter is missing. Following the word, three letters are given. First, circle the letter which you think would not fit in the blank to make an English word. (PAUSE)
Now, from the remaining two, pick the letter which you think would best fit the blank to make an English word, even though you may not know the word or its meaning. Write the best letter in the blank.

The total number of permissible responses for each set of directions are recorded in Table VI. The results indicated that there was no significant difference in responses when the directions were varied. Thus, it was decided that Set One would be used for ease of administration.

On the basis of the performance of the children, it was decided to change four of the test items. More than half of

TABLE VI

NUMBER OF PERMISSIBLE RESPONSES ACCORDING TO TWO SETS
OF DIRECTIONS ON TEST OF LETTER FAMILIARITY

| Grade | Group | Directions | |
		Set One	Set Two
2	Achieving	15	16
	Non-Achieving	12	15
3	Achieving	18	18
	Non-Achieving	15	14
4	Achieving	17	18
	Non-Achieving	19	17
	TOTAL	96	98

the children had selected the non-permissible letter on these items in an attempt to make the word meaningful. Different non-permissible distractors were written for these four items.

It was also decided to double the space between the letters composing each test item to minimize discrimination difficulties that had been noted on one test item.

In an attempt to determine the basis of discrimination and selection, it was decided to randomly select four of the twenty items and to ask the child to explain how he chose a letter. Similarly, to determine if the child was able to read the word correctly, it was decided to ask for the pronunciation of each of the four items.

TESTING PROCEDURES

During the month of April, 1972, the Grade four subjects in both schools were tested on the <u>Gates-MacGinitie Survey D, 1M</u>. The results of the Edmonton Separate School System's <u>Gates-MacGinitie Primary B and C</u> for Grades two and three subjects in both schools were made available to the investigator. The sample of ten achieving and ten non-achieving readers for each of the three grades was completed from these scores.

The following tests were administered individually to the subjects either by the researcher or the trained assistant:

(1) the <u>Test of Orthographic Structure</u>.

(2) the <u>Test of Letter Familiarity</u>.

The administration of these tests was held constant.

All testing was completed by the beginning of May, 1972.

ANALYSIS OF DATA

All the tests administered to the subjects were hand scored by the investigator. The information obtained from the testing program for each child was coded, punched on data cards and processed by computer by the Division of Educational Research Services at the University of Alberta.

Correlations

Using the computer program Dest 02, correlations were obtained for the reading score and the total score of permissible letter sequences on the <u>Test of Orthographic Structure</u> and the <u>Test of Letter Familiarity</u>. These correlations were obtained for each grade and each group of readers within each grade.

One-way Analysis of Variance

By using the computer program ANOV10, the relationship of the ability of each grade to select permissible sequences of letters in each test was found.

Using the computer program ANOV15, the relationship of the ability of achieving readers for each grade, and the relationship of the ability of non-achieving readers in each grade to select permissible sequences of letters on each test was found.

Kolmogorov-Smirnov Two-sample Test

The Kolmogorov-Smirnov two-sample test was used to

determine whether the two groups had been drawn from the same population. This computer program NONPØ1 compared the number of responses for each item in each category of either high or low frequency or non-permissible sequence. The responses were compared within each grade using the two groups of readers. Furthermore, the responses of each group of readers was compared with the responses of the same type of group in another grade. The significance of the chi square was determined.

APL Program

The APL program CHISQ PROP was used to compare the types of responses for each item in the categories of either permissible or non-permissible sequences of letters. Each group of readers within a grade were compared as well as similar groups across the grades. The types of responses were compared for both tests. The significance of the z value was determined.

SUMMARY

Ten achieving readers and ten non-achieving readers in each of grades two, three and four were selected to constitute the test sample. The achieving readers were those who scored a half standard deviation or more above the mean score on the Gates-MacGinitie Reading Test on the silent reading comprehension subtest. The non-achieving readers were those who scored a half standard deviation or more below the mean score on this same test. The grade two,

three and four students used in this study were randomly
selected from a population that met the criterion of either
an achieving or non-achieving reader.

A pilot study was conducted by the investigator and an
assistant from the University of Alberta. Revisions were
made on the two examiner-constructed tests before the final
data collection occured. The investigator and the assistant
individually interviewed all student in the test sample and
administered the Test of Orthographic Structure and the
Test of Letter Familiarity.

The results were tabulated and data analysis was done
with the aid of the Division of Educational Research
Services at the University of Alberta.

CHAPTER IV

ANALYSIS OF
STUDENT PERFORMANCE ON THE TESTS

INTRODUCTION

This chapter will present the results of performance of the students on the three tests. No statistical analysis will be discussed in this chapter. Rather, data on student performance on the tests administered will be presented. In the first section, the results of the reading achievement tests will be discussed. The second section will present the results of the Test of Orthographic Structure and the third section will deal with the Test of Letter Familiarity.

STUDENT PERFORMANCE ON THE TESTS

Reading Achievement

The mean scores and the standard deviation on each of the tests of reading achievement for both achieving and non-achieving readers are presented in Table VII.

TABLE VII

STUDENT PERFORMANCE ON READING ACHIEVEMENT TESTS

Grade	Possible Standard Score	Achieving Readers Mean	St. Dev.	Non-Achieving Readers Mean	St. Dev.
2	72	57.7	3.62	38.4	4.27
3	75	61.0	2.31	41.0	3.09
4	75	57.0	1.83	40.9	3.51

The mean score for each group of readers reflects the design that was built into the sample selection. For the achieving readers, the mean standard score on the silent reading comprehension test is relatively high. The mean standard score of 57.0 for the Grade four achieving readers is the lowest of the achieving sample. However, a standard deviation of 1.83 on this test indicates that this group had less variation in performance than either the Grade two achieving readers with a standard deviation of 3.62 or the Grade three achieving readers with a standard deviation of 2.31 .

For the non-achieving readers, the mean standard score on the silent reading comprehension test ranges from 38.4 for the Grade two group to 41.0 for the Grade three group. The standard deviations of the non-achieving readers reflect a greater variation in performance than that of the achieving group for the same grade.

Test of Orthographic Structure

Table VIII shows the mean score and the standard deviation on the Test of Orthographic Structure, an examiner-constructed test.

This test was designed to measure students' awareness of the orthographic structure of English words. Since both the high frequency or low frequency choice in each item had correct orthographic structure, either answer was considered to be a permissible response. The performance

of the test sample , in terms of permissible responses on this test, is described in the following table and is discussed in the following paragraphs.

TABLE VIII

STUDENT PERFORMANCE ON
TEST OF ORTHOGRAPHIC STRUCTURE

Grade	Possible Score	Achieving Readers Permissible Responses	St. Dev.	Non-Achieving Readers Permissible Responses	St. Dev.
2	15	14.2	1.03	13.2	1.48
3	15	14.5	.71	14.4	.70
4	15	14.7	.48	14.4	1.07

Mean scores ranging from 14.2 to 14.7 for the achieving readers in the three grades reveals that they did not experience much difficulty in selecting permissible word-like structures on this test. The total possible score was fifteen. Similarly, mean scores ranging fron 13.2 to 14.4 for the non-achieving readers of the three grades indicates that this was not a difficult task for them either. The standard deviation scores for the non-achieving group reveals only a slightly greater variation in performance than the standard deviation scores for the achieving group except at the Grade three level, where the achievers' standard deviation score is .01 greater than the non-achievers.

The different types of responses made by each group of

TABLE IX

STUDENT PERFORMANCE ON THE
TEST OF ORTHOGRAPHIC STRUCTURE
TYPES OF RESPONSES

Grade	Group	High		Low		Non-Permissible	
		Frequency Total	Per Cent	Frequency Total	Per Cent	Total	Per Cent
2	Achieving	91	60.67	51	34.0	8	5.33
	Non-Achieving	91	60.67	43	28.67	16	10.67
3	Achieving	95	63.33	50	33.33	5	3.33
	Non-Achieving	101	67.33	43	28.67	6	4.0
4	Achieving	96	64.0	51	34.0	3	2.0
	Non-Achieving	110	73.33	34	22.67	6	4.0

readers revealed in Table IX. For all grades and
groups, the responses classified as high frequency
(according to tables, Mayzner and Tresselt, 1965) were
chosen more frequently than any other type of response.
For all grades and groups, high frequency responses were
chosen at least 60 per cent of the time. Grade three
and four non-achieving readers selected high frequency
responses 4.0 per cent and 9.33 per cent, respectively, more
than the achieving readers of the same grade. For the
non-achieving readers of all three grades, the number of
high frequency responses were more than double the number
of low frequency responses selected.

The number of non-permissible responses selected
decreased with increasing grade level. The non-achieving
readers at each grade selected a greater percentage of
non-permissible responses than did the achieving readers of
the same grade. The greatest difference between groups was
at the Grade two level where achieving readers selected the
non-permissible response 5.33 per cent of the time compared
with 10.67 per cent of the time by the non-achieving readers.
Beyond Grade two, non-permissible responses were selected
less than 5 per cent of the time by either group of readers.

The number of responses mispronounced for each item are
presented in Table X. The total number of responses pro-
nounced incorrectly was 409 of the 900 possible. This
represented 44.33 per cent of the number of responses
that were pronounced.

note

The Grade two non-achieving readers made the greatest number of errors, having mispronounced 125 (or 83.33 per cent) of the 150 responses. Percentages of 54 per cent for the Grade three non-achievers and 56 per cent for the Grade four non-achievers revealed that both of these groups also experienced difficulty in pronouncing the word-like structures they had chosen. For all grades, the non-achieving readers mispronounced a greater number of words than did the achieving readers of the same grade.

For the achieving readers, the Grade two group made the greatest percentage of errors with 42.67 per cent mispronunciations while the Grade three and four readers mispronounced 23.33 and 13.33 per cent, respectively. Thus, for the achieving readers, increasing accuracy in the pronunciation of the word-like structures accompanied increasing grade level.

The type of error that was predominantly made was substitution of a real word for the word-like structure chosen and pronounced. All words that were counted as substitutions were real words that began with the same letter as the word-like structure chosen. Usually, the substituted word was similar in configuration to the word-like structure.

The greatest number of substitution errors were made by the Grade three non-achieving readers. Substitution errors constituted 72.34 per cent of this group's errors. The number of substitution errors made by the Grade two and

four non-achieving readers was 46.4 per cent and 53.57
per cent, respectively. Only Grade three and four non-
achieving readers had a higher percentage of substitution
errors than the achieving readers of the same grade.

For the achieving readers, the Grade three group had
62.86 per cent substitution errors while the Grade two
and four achieving readers both made substitution errors
only 50 per cent of the time. Thus the tendency to make
substitution errors was greatest among both groups at the
Grade three level.

Table X also indicates the total number of responses
mispronounced for each item. The number given does not
reveal the number of errors for each of the three choices
in each item. Rather, the number represents the total
number of word-like structures incorrectly pronounced per
item. Items 1, 3, 7, 10 and 11 were mispronounced more than
50 per cent of the time. Items 6, 9, 13, 14 and 15 were
mispronounced more than 40 but less than 50 per cent of the
time. These items seemed to cause the greatest difficulty
in the pronunciation of the word-like structures chosen.
Words were considered to be mispronounced when the oral
phonemes emitted by the children did not correspond to the
written graphemes in the word-like structure. For example,
the following cases were considered as mispronounced or
misread: "kas" for "sace"

                        "verd" for "heft"

                        "slard" for "shard"

Table XI reveals the words that were substituted most predominantly for the word-like structures selected in each test item. As the table reveals, the substitution-type errors were real words with very similar configuration to the word-like structure selected in the test item. It may be that the influence of meaningfulness rather than just orthographic structure had some effect in the selection of word-like structures on the Test of Orthographic Structure.

After selecting a word-like structure, the student was asked to indicate the basis for his selection of one structure. Table XII presents the types of reasons given by each group for selecting word-like structures. The responses were categorized into seven categories by the investigator. The response types and the category assigned to the responses are revealed below. Appendix C contains some sample responses.

(1) The word-like structure was selected because it contained an embedded real word known to the student. For example: 'cup' in 'scup'

(2) The word-like structure was associated with another real word that rhymed, such as 'face' and 'sace'; or had similar structure, such as 'swim' and 'swain'.

(3) No reason could be elicited from the student to indicate a basis for choice of a word-like structure.

(4) The word-like structure was perceived and identified as another real word that the student knew (substitution errors). For example: 'scarf' for 'scurf'. The

TABLE XI

WORDS MISREAD AND SUBSTITUTION ERROR
ON ITEMS ON TEST OF ORTHOGRAPHIC STRUCTURE

Item	Most Commonly Selected Test Word	Most Common Substituted Word
1	sace	space
2	dray	dry
3	scibe	scribe
4	yort	york
5		NPSW*
6	starsh	starch
7	scurf	scarf
8		NPSW*
9	squit	squirt
10	swain	swan
11	stong	strong
12		NPSW*
13	geft	gift
14	whorl	whirl
15	shunt	shut

*NPSW - No predominant substituted word

choice was affirmed by reading the word in response to the question for reason in selecting that structure.

(5)   This category was composed of numerous responses most of which were insignificant because the student claimed familiarity with the word-like structure but was unable to attach either meaning or reason to why the structure seemed familiar. These responses included claims to having seen or heard the word-like structure once before, but both meaning and occasion were unknown. Another response type was a decision that the choice was the best without reason to indicate why it was the best.

(6)   The word-like structure was selected because it was identified and read as part of a larger word. For example: 'instruct' for 'sruct'.

(7)   The word-like structure was chosen because it was said to be easier to read and pronounce.

As Table XII indicates, the reason given most often for selecting word-like structures was Category 5, responses claiming familiarity without a meaning or reason. This was given 55.44 per cent of the time. For 26 per cent of the responses, the children associated their choice for the best word-like structure with another real word that rhymed or had similar structure (category 2). Category five does not attribute the reason to orthographic structure. Rather, it appeared that the children were unable to define the basis for choice and were unable to be specific in

TABLE XII

CATEGORIZED REASONS FOR
WORD-LIKE STRUCTURES CHOSEN ON
TEST OF ORTHOGRAPHIC STRUCTURE

Grade	Group	Response Categories						
		1	2	3	4	5	6	7
2	Achieving	4 (2.67)	32 (21.33)	21 (14.00)	1 (.67)	79 (52.67)	2 (1.33)	11 (7.33)
	Non-Achieving	3 (2.00)	39 (26.00)	4 (2.67)	0 (0.00)	101 (67.33)	3 (2.00)	0 (0.00)
3	Achieving	11 (7.33)	50 (33.33)	9 (6.00)	0 (0.00)	75 (50.00)	4 (2.67)	1 (.67)
	Non-Achieving	18 (12.00)	54 (36.00)	6 (4.00)	0 (0.00)	65 (43.33)	0 (0.00)	7 (4.67)
4	Achieving	12 (8.00)	17 (11.33)	3 (2.00)	2 (1.33)	93 (62.00)	6 (4.00)	17 (11.33)
	Non-Achieving	2 (1.33)	42 (28.00)	10 (6.67)	4 (2.67)	86 (57.33)	1 (.67)	5 (3.33)
	TOTAL	50 (5.55)	234 (26.00)	53 (5.89)	7 (.78)	499 (55.44)	16 (1.78)	41 (4.56)

( ) indicates percentages

their reasons. Category two has some semblance of familiarity with orthographic structure. Thus, it appears that although t' students in this study were able to select permissible combinations of letters in word-like structures, they had difficulty in specifying the basis of their choice.

The next task required of the students was to select, from the remaining two choices, the one that had an orthographic structure that could not occur in English. The results in response to this task are presented in Table XIII. Achieving readers were able to correctly identify more non-permissible word-like structures than were the non-achieving readers of the same grade. The greatest difference between the two groups occurred at the Grade two level where the achieving readers identified 123 of the non-permissible structures whereas the non-achieving readers were able to correctly identify only 81 of these structures. The least difference occured at the Grade four level where the achieving readers correctly identified 129 compared with the 122 non-permissible structures correctly identified by the non-achieving group. The table indicates that increasing accuracy was experienced by all groups with increasing grade level.

The table also reveals that item 3 and 13 caused the greatest difficulty. The non-permissible structure of these items was correctly identified less than two-thirds

TABLE XIII

NUMBER OF CORRECT NON-PERMISSIBLE
WORD-LIKE STRUCTURES IDENTIFIED ON
TEST OF ORTHOGRAPHIC STRUCTURE

Item	Grade 2 Ach	NAch	Grade 3 Ach	NAch	Grade 4 Ach	NAch	TOTAL
1	10	6	9	8	10	9	52
2	6	5	10	6	10	9	46
3	6	5	9	3	9	7	39
4	9	4	10	9	10	7	49
5	10	6	9	6	10	9	50
6	7	5	8	7	8	7	42
7	8	8	7	8	5	7	43
8	8	6	9	10	10	9	52
9	10	5	9	9	9	9	51
10	9	5	8	9	10	9	50
11	7	4	9	10	10	7	47
12	7	5	8	8	8	8	44
13	7	3	7	4	10	7	38
14	9	6	10	8	10	8	51
15	10	8	10	10	10	10	58
TOTAL	123	81	132	115	139	122	712

of the time. The difficulty in identifying the non-permissible structure in these two items was experienced by the non-achieving reading group. The structure and choices of items 3 and 13 are shown below:

Item 3:   scitb   scibe   strop

Item 13:   gcot   grog   geft

After selecting the non-permissible orthographic structure, the student was asked to indicate the basis for choosing that structure. Table XIV presents the categorized reasons given by each group for selecting non-permissible orthographic structures. The responses were categorized into six categories by the investigator. The response and the category assigned to the responses are revealed below:

(1) The non-permissible structure was reported as being difficult to pronounce.

(2) The non-permissible structure was reported as being misspelled or having a peculiar spelling, but the children were unable to specify the error or the peculiarity.

(3) No reason could be elicited from the student for having selected this response.

(4) The reason reported for selecting the non-permissible response bore little significance to the orthographic structure of the word. Responses included claims to never having seen or heard that word before; or simply stating: "It's not an English word."

(5) The non-permissible sequence was correctly

identified and given as the reason to why this structure could not be an English word.

(6) The non-permissible sequence was not named, but the student would remove one letter and would report it as now being correct. For example: 'huf' for 'hzuf'.

As Table XIV reveals, in total, the category that included responses that bore little significance to orthographic structure (category 4) was used most often by the students. However, with increasing grade level this response category was used less frequently by either group. Thus, the more advanced students appeared more able to specify a more accurate and precise answer. The response category that accurately specified the non-permissible sequence (category 5) was the next most common response type, being reported 26.11 per cent of the time. However, this category was used seldom by the Grade two students (either group), but was used increasingly more often by the other grade levels. In fact, it was the response given 70 per cent of the time by the Grade four achieving readers. This could mean that older students are more aware of the nature of grapheme-phoneme correspondences and are able to specify, with more accuracy, non-permissible letter sequences in English orthography.

There was a difference in the types of responses made by the two groups of readers. For Grades two and three, the achievers reported the words as being difficult to pronounce or as being misspelt (category 1 and 2) more

TABLE XIV

CATEGORIZED REASONS FOR NON-PERMISSIBLE
STRUCTURES CHOSEN ON TEST
OF ORTHOGRAPHIC STRUCTURE

| Grade | Group | Response Categories | | | | | |
		1	2	3	4	5	6
2	Achieving	26 (17.33)	13 (8.67)	22 (14.67)	74 (49.33)	15 (10.00)	0 (0.00)
	Non-Achieving	8 (5.33)	3 (2.00)	4 (2.67)	122 (81.33)	13 (8.67)	0 (0.00)
3	Achieving	39 (26.00)	21 (14.00)	11 (7.33)	50 (33.33)	29 (19.33)	0 (0.00)
	Non-Achieving	16 (10.67)	14 (9.33)	13 (8.67)	74 (49.33)	33 (22.00)	0 (0.00)
4	Achieving	11 (7.33)	23 (15.33)	2 (1.33)	7 (4.67)	105 (70.00)	2 (1.33)
	Non-Achieving	11 (7.33)	49 (32.67)	4 (2.67)	44 (29.33)	40 (26.67)	2 (1.33)
	TOTAL	111 (12.33)	123 (13.67)	56 (6.22)	371 (41.22)	235 (26.11)	4 (.44)

( ) indicates percentages

frequently than the non-achieving readers of the same grade. For all three grades, reasons of insignificance (category 4) were given more frequently by the non-achieving readers than by the achieving readers of the same grade. Little difference existed in the use of category five, which was the most accurate and precise response since it indicated the exact non-permissible sequence, except at the Grade four level where the achievers used this category in 105 of the 150 responses compared to 40 of the 150 responses made by the non-achieving readers of this grade.

The reliability of this test as a measure of the awareness of orthographic structure of words was determined by Arrington's formula. The reliability coefficient was found to be .67 for the Grade two sample; .74 for the Grade three sample and .90 for the Grade four sample. This indicates less inconsistency in performance as grade level increased. Ferguson (1959) reports that when the same test is administered twice to the same group with a time lapse between the two administrations, some variation may occur. The reliability coefficient thus appears to be sufficiently high to accept this test as a reliable measure of the subjects' awareness of English orthographic structure (Ferguson, 1966, p.377)

Test of Letter Familiarity

Table XV contains the mean score and standard deviation for each group of readers at each grade level on the Test of Letter Familiarity. The total score possible for this examiner-constructed test was twenty.

TABLE XV

STUDENT PERFORMANCE ON
TEST OF LETTER FAMILIARITY

Grade	Possible Score	Achieving Readers Permissible Responses	St. Dev.	Non-Achieving Readers Permissible Responses	St. Dev.
2	20	15.5	3.47	13.6	2.76
3	20	16.3	2.75	16.1	1.45
4	20	18.6	1.27	15.4	1.58

This test was designed to measure students' awareness of redundancy in English orthography. As on the Test of Orthographic Structure, this test had two types of responses that were permissible according to the rules of English orthography. That is, two of the letter choices on each item could be correct since they formed sequences of letters that do occur in English orthography. These letters had been defined as either high digram/trigram frequency or low digram/trigram frequency according to the tables of Mayzner and Tresselt (1965). Either the high frequency or the low

frequency choice was considered to be a permissible response. The subjects performance on the Test of Letter Familiarity is explained first in terms of these permissible responses.

The greatest difference in performance between any two groups on this test occurred at the Grade four level. Here the Grade four achieving readers had a mean score of 18.6 while the non-achieving reader's mean score was only 15.4, a difference of 3.2 . The difference between the mean raw score of the Grade two achieving and non-achieving readers was 1.9, while a difference of .2 occurred between the mean raw score of the Grade three achieving and non-achieving readers. It would appear that none of these groups experienced great difficulty with the test. The variance in the performance of the achieving readers was greater than that of the non-achieving readers except at the Grade four level where greater variance existed among the non-achieving readers.

Thus, while the mean score of the achieving readers was greater than that of the non-achieving readers, the amount of variance in performance was greater among the achieving readers except at the Grade four level.

The Grade four achieving readers, with a mean score of 18.6, did better than the Grade two and three achieving readers with mean scores of 15.5 and 16.3, respectively. Among the non-achieving readers, the Grade three group had the highest mean score of 16.1 while the Grade two and

four non-achieving readers had mean scores of 13.6 and 15.4, respectively.

The different types of responses are reported in Table XVI. The results indicate that neither high frequency responses nor low frequency responses were predominantly selected by any group of readers. That is, no response type was chosen more than 50 per cent of the time by any one group. This may possibly mean that digram and trigram frequency was not a factor in the selection of a letter to build a word.

When the high frequency and low frequency responses are conflated to a permissible category, the results indicate that permissible responses were chosen more than 65 per cent of the time by all groups. The Grade two achieving readers selected permissible responses 77.5 per cent of the time compared with the non-achieving readers who selected permissible responses 68.5 per cent of the time. Percentages of 81.5 per cent for the Grade three achieving group; 80.5 per cent for the Grade three non-achieving group; 93 per cent for the Grade four achieving readers and 82 per cent for the Grade four non-achieving readers reveal that these groups are able to select permissible responses and thus appear to be aware of the redundancy of letter sequences in English orthography.

The non-achieving readers for each grade selected a greater proportion of non-permissible responses than the

TABLE XVI

STUDENT PERFORMANCE ON THE
TEST OF LETTER FAMILIARITY
TYPES OF RESPONSES

Grade	Group	High Frequency Total	Percent	Low Frequency Total	Percent	Non-Permissible Total	Percent
2	Achieving	75	37.5	80	40.0	45	22.5
	Non-Achieving	69	34.5	67	33.5	64	32.0
3	Achieving	95	47.5	68	34.0	37	18.5
	Non-Achieving	76	38.0	85	42.5	39	19.5
4	Achieving	88	44.0	98	49.0	14	7.0
	Non-Achieving	81	45.5	73	36.5	46	23.0

achieving group in the same grade. The number of non-permissible responses decreased for each grade with increasing grade level except for the Grade four non-achieving readers where a difference of 3.5 per cent existed over the Grade three non-achieving readers. Although the percentage is small, it may be that non-achieving readers at the Grade four level are less competent in skills than non-achieving readers in previous grade levels.

It may be that the influence of variables other than awareness of redundancy and digram/trigram frequency of letter sequences had some effect in creating a greater distribution of response types. On this test, the student was to choose one letter to complete a word. Rather than selecting a letter that would resemble a letter sequence in English orthography, it appeared to the investigator and his assistant that many of the children relied upon the pronunciation of the word-like structure being formed. Most of the children vocalized the auditory sequence represented by each letter choice before making the selection. Levin and Biemiller (1965) hypothesized that children rehearse decoded sounds to match an auditory schema or sound pattern that is familiar. Thus, it seemed that many of the students did not complete the visual image of the letter sequence without having first checked the sequence against his auditory memory for familiar words and/or sound patterns.

Each student was asked to pronounce four of the items

on this test. These four items were randomly selected.

Of the 240 responses read, 129 of these were read incorrectly.

This represents more than 50 per cent error in the oral

representation of the words completed by the students.

Table XVII indicates the number of errors made by each

group of readers.

TABLE XVII

NUMBER OF ERRORS IN ORAL REPRESENTATION
OF WORD-LIKE STRUCTURES FORMED ON
TEST OF LETTER FAMILIARITY

Grade	Group	Number of Oral Reading Errors	
2	Achieving	24	(60)
	Non-Achieving	36	(90)
3	Achieving	10	(25)
	Non-Achieving	27	(67.5)
4	Achieving	8	(20)
	Non-Achieving	24	(60)
	TOTAL	129	(53.75)

( ) indicates percentages

The number of errors decreased with increasing grade level.

The non-achieving readers made many more errors than the

achieving readers of the same grade.

Of the four random items, the students were asked to

indicate the basis for selection of a letter to make a word-like structure. Table XVIII presents the categorized reasons that were given for the 240 questions. The responses were categorized by the investigator and consisted of the following response types:

(1) The letter was selected because it 'sounded best' in that structure.

(2) The letter was selected on the basis of letter sequence, such as "q is usually followed by u".

(3) The letter was selected because it "looked best" in that structure.

(4) The letter was selected because it was perceived as making a real word that was familiar to the student. (This resembled the substitution errors on the <u>Test of Orthographic Structure</u>).

(5) The letter was selected because it was perceived as making an English word, although the word was not familiar or known to the student.

(6) No reason could be elicited for the selection of that letter.

As revealed by Table XVIII, response category 1, that is, 'the constructed word sounded best', was used most frequently, having been used 33.75 per cent of the time. The table also reveals increased use of this category by both groups with increasing grade level. The non-achieving readers used this response category more frequently than did the achieving readers of the same grade.

TABLE XVIII

CATEGORIZED RESPONSES FOR SELECTING LETTERS TO BUILD WORD-LIKE STRUCTURES ON SELECTED ITEMS ON TEST OF LETTER FAMILIARITY

Grade	Group	Categorized Responses					
		1	2	3	4	5	6
2	Achieving	3 (7.5)	4 (10.0)	1 (2.5)	6 (15.0)	18 (45.0)	8 (20.0)
	Non-Achieving	5 (12.5)	5 (12.5)	3 (7.5)	13 (32.5)	12 (30.0)	2 (5.0)
3	Achieving	9 (22.5)	9 (22.5)	1 (2.5)	4 (10.0)	11 (27.5)	6 (15.0)
	Non-Achieving	14 (35.0)	9 (22.5)	2 (5.0)	4 (10.0)	7 (17.5)	4 (10.0)
4	Achieving	19 (47.5)	10 (25.0)	2 (5.0)	6 (15.0)	2 (5.0)	1 (2.5)
	Non-Achieving	31 (77.5)	4 (10.0)	1 (2.5)	0 (0.0)	4 (10.0)	0 (0.0)
	TOTAL	81 (33.75)	41 (17.08)	10 (4.17)	33 (13.75)	54 (22.5)	21 (8.75)

( ) indicates percentages

Selecting the letter because it was perceived as making an English word, even though unfamiliar or unknown, was the next most frequently used response, having been given 22.5 per cent of the time. The use of this response type decreased for both groups with increasing grade level. The achieving readers at each grade, except Grade four, used this response more than the non-achieving readers of the same grade.

Awareness of letters that commonly occur together in a sequence (category 2) was verbalized as the basis for selection of letters in 17.08 per cent of the cases. This was followed by responses that indicated a substitution type of error being made by the children (category 4). This category was used 13.75 per cent of the time. There was no particular pattern for response categories used across the grades or groups, except for increased use of category 2 (naming letter sequences that occur together) by achieving readers of increasing grade level and decreased use of category 4 (making a familiar real word out of the constructed test word - in effect, a substitution error) by non-achieving readers of increasing grade level.

The information in this table seems to indicate that older students relied more upon the pronunciation of the word-like structures being formed, whereas the younger students could not specify the basis for selection of a letter to build a word. The pronunciation factor accounts for the selection of a non-permissible letter in some items,

such as : "dhews" read as "dues"; and "larkh" read as "lark". This seems to indicate that a variable, such as pronunciation, was operating in the selection of some letter choices.

Thus, it could be that the rehearsed acoustic representation of the visual stimuli played a greater role in the selection of a letter to make a word-like structure than did an awareness of redundancy of letter groupings.

Arrington's formula was used to determine the reliability coefficient of this test. The reliability coefficient was found to be .68 for the Grade two sample; .71 for the Grade three sample and .76 for the Grade four sample. While these reliability coefficients are not as high as those for the Test of Orthographic Structure, this test can be accepted as a fairly reliable measure of the students' performance.

SUMMARY

The mean scores on the Test of Orthographic Structure and Test of Letter Familiarity by achieving and non-achieving readers at each grade indicate that they did not experience much difficulty in selecting or building permissible word-like structures in either of these tests.

On the Test of Orthographic Structure, word-like structures of high frequency of occurrence were selected more frequently than were the low frequency or

non-permissible structures. Frequency did not seem to affect the choice of a letter on the Test of Letter Familiarity.

On the Test of Orthographic Structure, non-achieving readers were found to mispronounce or misread a higher percentage of the word-like structures they had chosen as an acceptable letter sequence in English orthography. The percentage of word-like structures incorrectly pronounced decreased per group with increasing grade level. The same results occurred in the oral pronunciation of randomly selected items on the Test of Letter Familiarity.

Reasons for the selection of word-like structures were categorized and recorded in tables in this chapter.

On the Test of Orthographic Structure, achieving readers at each grade were found to identify a greater number of non-permissible word-like structures than the non-achieving readers. However, the difference between the groups decreased with increasing grade level.

CHAPTER V

THE FINDINGS OF THE STUDY

This chapter will present the findings of the study in four main sections. In the first section, the results of the analysis of variance performed for hypothesis one will be presented. In the second section, the statistical analysis yielding correlation coefficients between the variables in this hypothesis will be discussed. Thirdly, the results of the Kolmogorov-Smirnov two-sample test performed for hypothesis three will be given. Finally, the results of the APL program yielding z scores to compare performance between groups in hypothesis four and five will be discussed. A summary of the findings will conclude this chapter.

THE FINDINGS WITH RESPECT TO

THE HYPOTHESES

Hypothesis One

There is no significant difference between achieving
and non-achieving readers in each of Grades two, three
and four in their ability to select permissible
combinations (sequences) of letters in word-like
structures on:
      (a) the Test of Orthographic Structure.
      (b) the Test of Letter Familiarity.

This hypothesis was analyzed by means of an analysis of variance technique discussed in Ferguson (1966, pp.281-323). The ANOV10 IBM360 computer program was used to determine the

differences between the two groups at each grade level.
A 't' test was used to test the significance of the
difference between the means of the two groups. Table
XIX reports the results of the tests of significance.

The ANOV15 IBM360 computer program was used to
determine the difference between the three groups of
achieving readers and the three groups of non-achieving
readers. A Scheffé test of Multiple Comparison of Means
was used to test the difference between the mean scores of
these groups. Ferguson (1966) describes this test as being
more rigorous than other multiple comparison methods.
Since the Scheffé procedure is more rigorous than others,
Ferguson (1966) reports that a .10 level of significance
can be used instead of the .05 level (p.297). This program
was used to determine if any significant differences
occured among the three grade levels in selecting permissible
word-like structures on the two examiner-constructed tests.

Comparison on the Test of Orthographic Structure

Table XIX indicates that on the Test of Orthographic
Structure, there was no significant difference between the
mean scores of the achieving and non-achieving readers at
the same grade level. The difference between the Grade
two achieving and non-achieving readers was the greatest,
yielding a 't' value of 1.76. However, this did not
attain the .05 level of significance. Thus, it would
appear that the achieving and non-achieving readers at

each grade do not differ in their ability to select

permissible letter sequences.

TABLE XIX

COMPARISON OF ACHIEVING AND NON-ACHIEVING READERS
ON TEST OF ORTHOGRAPHIC STRUCTURE

Grade	Achieving Readers Mean	Var.	St.Dev.	N-Achieving Readers Mean	Var.	St.Dev.	't' value	Level of Significance
2	14.20	1.07	1.03	13.20	2.18	1.48	1.76	ns
3	14.50	.50	.71	14.40	.49	.70	.318	ns
4	14.70	.23	.48	14.40	1.16	1.07	.81	ns

Table XX reveals that at each of the grade levels there

was no significance difference amongst the groups of

achieving readers. The mean scores in Table XIX indicated

only a very slight improvement with increasing grade level.

TABLE XX

PROBABILITY MATRIX FOR SCHEFFÉ MULTIPLE
COMPARISON OF MEANS ON
TEST OF ORTHOGRAPHIC STRUCTURE

Group	Grade	Two	Three	Four
Achieving Readers	2	1.00	.69	.37
	3		1.00	.85
Non-Achieving Readers	2	1.00	.08*	.08*
	3		1.00	1.00

* significant at .10 level recommended in Ferguson (1966)

Amongst the non-achieving readers, however, the second graders performance was found to differ significantly from both the third and fourth graders (See Table XX). The difference among the means of the permissible scores was significant below the .10 level suggested by Ferguson (1966). The performance of the Grade three and four non-achieving readers was found to be the same since they had the same mean score.

Comparison on the Test of Letter Familiarity

In comparing the difference between the mean scores of the achieving and non-achieving readers on the Test of Letter Familiarity, Table XXI indicates a 't' value of 5.00 for the Grade four readers. This was significant beyond the .001 level. The 't' values calculated between achieving and non-achieving readers at each of Grades two and three yielded probabilities that did not achieve significance.

TABLE XXI

COMPARISON OF ACHIEVING AND NON-ACHIEVING READERS
ON TEST OF LETTER FAMILIARITY

Grade	Achieving Readers Mean	Var.	St.Dev.	N-Achieving Readers Mean	Var.	St.Dev.	't' value	Level of Significance
2	15.50	12.01	3.47	13.60	7.60	2.76	1.36	ns
3	16.30	7.57	2.75	16.10	2.10	1.45	.20	ns
4	18.60	1.60	1.26	15.40	2.49	1.58	5.00	beyond .001

This table (XXI) reveals a greater variance in the performance of the achieving readers at Grades two and three.

The Scheffé Multiple Comparison between means (Table XXII) of the three groups of achieving readers revealed that the Grade four achieving readers were able to construct significantly more (at a .05 level) permissible combinations of letters than were the Grade two achieving readers. The differences between the mean scores of the Grade two and three achieving readers, and also between the means of the Grade three and four achieving readers were not significant.

TABLE XXII

PROBABILITY MATRIX FOR SCHEFFÉ MULTIPLE
COMPARISON OF MEANS ON
TEST OF LETTER FAMILIARITY

Group	Grade	Two	Three	Four
Achieving Readers	2	1.00	.80	.05**
	3		1.00	.17
Non-Achieving Readers	2	1.00	.04**	.16
	3		1.00	.74

** significant at .05 level

Table XXII also shows that amongst the non-achieving readers, the mean of the Grade two non-achieving readers was found to differ significantly from the mean of the

Grade three non-achieving readers. There was no signi-
ficant difference between the means of any other non-
acheiving readers at different grade levels on the Test of
Letter Familiarity.

Hypothesis Two

There is no significant relationship between reading
achievement scores for achieving and non-achieving
readers in each of Grades two, three and four and
their ability to select permissible combinations
(sequences) of letters in word-like structures on:
    (a) the Test of Orthographic Structure.
    (b) the Test of Letter Familiarity.

This hypothesis was analyzed by means of the "Pearson
product moment" technique, calculated by utilization of
the DEST02 IBM360 computer program.

The correlations between reading achievement scores
and each of the examiner-constructed test scores are
presented in Table XXIII.

Test of Orthographic Structure and Reading Achievement

On the Test of Orthographic Structure, Table XXIII
indicates that the correlation coefficient between the
reading scores of achieving readers in Grade two and their
permissible response scores was very low and not signif-
icant. Furthermore, the reading scores of the achieving
readers in each of Grades three and four indicated an
absence of any relationship at all.

When the non-achieving readers are considered, a
relatively high correlation, significant at the .05 level,
existed between the reading achievement scores and the

TABLE XXIII

CORRELATIONS BETWEEN READING ACHIEVEMENT SCORES AND
PERMISSIBLE RESPONSES ON THE TWO EXAMINER TESTS

Grade	Group	Test of Orthographic Structure Correlation Coefficient	Test of Letter Familiarity Correlation Coefficient
	Achieving Readers Scores	.15	.32
2	Non-Achieving Readers Scores	.70*	.33
	Total Scores	.51*	.39
	Achieving Readers Scores	0.0	.13
3	Non-Achieving Readers Scores	.05	.38
	Total Scores	.08	.10
	Achieving Readers Scores	0.0	0.0
4	Non-Achieving Readers Scores	.64*	.35
	Total Scores	.33	.74**

* significant at the .05 level

** significant at the .01 level

permissible response scores at the Grade two and Grade four levels, but not at the Grade three level. This may be attributed to the greater variance experienced by the Grade two and four non-achieving readers in their performance on this test.

When the performance of the achieving and non-achieving readers was combined for a total grade score, a healthy correlation, significant at the .05 level, existed only at the Grade two level between reading achievement and performance on the Test of Orthographic Structure.

Test of Letter Familiarity and Reading Achievement

Table XXIII shows that for both achieving and non-achieving readers at all grade levels, the correlation between reading achievement scores and the permissible responses on the Test of Letter Familiarity was very low, and failed to achieve a level of significance for any group at any grade level.

However, when the total grade performance was considered, by combining the performance of the achieving and non-achieving readers at each grade, a significant correlation was found to exist at the Grade four level.

Hypothesis Three

There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four on their performance on:
(a) the Test of Orthographic Structure.
(b) the Test of Letter Familiarity.

This hypothesis was analyzed by means of the

'Kolmogorov-Smirnov two-sample test' calculated by utilization of the NONP01 IBM360 computer program.

The Kolmogorov-Smirnov two-sample test (as described in Siegel, 1956, pp. 127-136) is used to determine whether two independent samples have been drawn from the same population. The two-sample test is concerned with the agreement between two sets of sample values, in this instance, the number of high frequency, low frequency or non-permissible choices selected by the two samples (the achieving and non-achieving readers) for each item. The test focuses on the largest deviation between the observed cumulative distributions of both samples. The Kolmogorov-Smirnov two-sample test (K-S) was used because Siegel (1956) claims that it is a more powerful test than the chi square test.

The K-S values for each item on the two examiner-constructed tests are presented for both the Test of Orthographic Structure and the Test of Letter Familiarity. The cumulative distribution of responses of achieving readers was compared with those of non-achieving readers at the same grade level. A further comparison was made among the three groups of achieving readers and the three groups of non-achieving readers.

Test of Orthographic Structure and Sample Performance

In comparing the distribution of responses for achieving and non-achieving readers at each grade for each item on the Test of Orthographic Structure, Table XXIV indicates

TABLE XXIV

KOLMOGOROV-SMIRNOV VALUES
COMPARING ACHIEVING AND NON-ACHIEVING READERS
RESPONSES ON EACH ITEM OF THE
TEST OF ORTHOGRAPHIC STRUCTURE

Item	Grade 2	Grade 3	Grade 4
1	.20	3.20	1.80
2	.20	0.0	.20
3	.20	0.0	1.80
4	7.20*	1.80	.80
5	.80	.20	.20
6	7.20*	3.20	.20
7	.20	1.80	.80
8	.20	1.80	3.20
9	.80	0.0	.20
10	.80	.80	.20
11	.80	0.0	0.0
12	.80	.20	0.0
13	1.80	1.80	.20
14	1.80	1.80	.20
15	1.80	.20	.80

* significant at value $> .05$

that only items 4 (yaws, yatw, yort) and 6 (smruth, smutch, starsh) had a K-S value that was significant and differentiated between achieving and non-achieving readers, and this significance was achieved only at the Grade two level. For both of these items, the difference was due to the non-achieving readers selecting the high frequency response 80 per cent of the time while the achieving readers selected this as their choice for 20 per cent of the responses. Since both the high frequency and low frequency responses were orthographically correct, the difference merely means that the two groups had different preferences for the permissible letter structure. On the remaining thirteen items, the K-S value for the Grade two sample was not large enough to be significant.

At the Grade three and four level, there were no significant K-S values for any of the test items. This seems to indicate that the achieving and non-achieving readers at the Grade three and four level did not differ significantly in the types of responses made on each item.

To determine if there were significant differences between the grade levels, the Kolmogorov-Smirnov two-sample test was repeated comparing the responses of the achieving readers and the responses of the non-achieving readers for the three grade levels (See Table XXV)

Significant differences were found in the responses of achieving readers on three items only. On item 3 (scitb, scibe, strop) the responses of the Grade two and Grade four

TABLE XXV

KOLMOGOROV-SMIRNOV VALUES
COMPARING ACHIEVING AND NON-ACHIEVING READERS
RESPONSES ON THE TEST OF ORTHOGRAPHIC STRUCTURE

Item	Grade	Achieving Readers Grade 3	4	Non-Achieving Readers Grade 3	4
1	2	.80	0.0	.80	1.80
	3		.80		5.00*
2	2	.80	.80	.80	.20
	3		0.0		.20
3	2	.20	5.00*	0.0	.20
	3		3.20		.20
4	2	7.20**	.20	1.80	3.20
	3		7.20**		.20
5	2	.20	.20	.80	.80
	3		0.0		.20
6	2	.80	7.20**	0.0	.20
	3		3.20		.20
7	2	0.0	1.80	.80	1.80
	3		1.80		.20
8	2	.80	.80	.80	.80
	3		.20		0.0
9	2	.20	0.0	.20	.20
	3		.20		0.0
10	2	.20	.80	.20	5.00*
	3		.20		3.20
11	2	.80	.80	0.0	0.0
	3		0.0		0.0
12	2	.20	3.20	3.20	7.20**
	3		1.80		.80
13	2	.80	.80	3.20	5.00*
	3		1.80		.20
14	2	3.20	1.80	.80	.20
	3		.20		1.80
15	2	0.0	.80	1.80	1.80
	3		.80		.20

  *   approaching significance at .05 level
  ** significant at a value > .05

achieving readers approached significance at the .05
level. Item 6 (smruth, smutch, starsh) significantly
differentiated between the Grade two and three achieving
readers. Item 4 (yaws, yatw, yort) differentiated between
the Grade two and three and also between the Grade three
and four achieving readers, but did not differentiate
between Grade two and four achieving readers. Again, the
difference was due to each group of readers selecting a
different proportion of high or low frequency responses,
both of which were orthographically permissible.

The responses of the non-achieving readers approached
significance on three items and differed significantly on
one. Items 10 (senpw, spere, swain) and 13 (gcot, grog,geft)
approached significance differentiating between the Grade
three and four readers, while item 12 (brin, bnel, bleb)
significantly differentiated between these two groups.
Item 1 (scup, spcu, sace) approached significance in
differentiating between the Grade three and four non-
achieving readers. The differences can be attributed to
the number of high or low frequency choices selected in
each of these items by the reading groups.

Test of Letter Familiarity and Sample Performance

Table XXVI indicates that on the Test of Letter
Familiarity, a significant difference was observed in the
responses of the Grade two achieving and non-achieving
readers for items 9 (s__og (l w g)) and item 13 (__litch
(h f g)). On item nine, the non-achieving readers selected

TABLE XXVI

KOLMOGOROV-SMIRNOV VALUES
COMPARING ACHIEVING AND NON-ACHIEVING READERS
RESPONSES ON EACH ITEM OF THE
TEST OF LETTER FAMILIARITY

Item	Grade 2	Grade 3	Grade 4
1	.20	3.20	.20
2	.20	1.80	.20
3	1.80	3.20	.20
4	3.20	1.80	.80
5	3.20	1.80	7.20*
6	.20	3.20	1.80
7	1.80	.80	3.20
8	.20	5.00	1.80
9	7.20*	.20	3.20
10	.20	5.00	.80
11	1.80	.20	1.80
12	1.80	.20	.80
13	7.20*	.80	.80
14	1.80	.20	.80
15	.80	.80	.80
16	1.80	.20	5.00
17	.20	.80	3.20
18	3.20	3.20	1.80
19	.80	.80	.80
20	.20	.80	.80

* significant at value > .05

the non-permissible letter to build a word-like
structure of English orthography. On item 13, the
difference was due to the different proportion of high
frequency and low frequency responses selected by the
two groups. The K-S values for these two items achieved
significance at a probability level greater than .05.
There were no significant differences between achieving
and non-achieving readers in Grade three on any test
items of the Test of Letter Familiarity. At the Grade four
level, only item 5 (tin__ (g p k)) significantly differ-
entiated between achieving and non-achieving readers. On
this item, the non-achieving readers selected the non-
permissible choice 60 per cent of the time while none of the
achieving readers selected the non-permissible choice.

To determine performance differences between grade
levels, the Kolmogorov-Smirnov two-sample test was repeated
for the Test of Letter Familiarity comparing the responses
of the achieving readers and the responses of the non-
achieving readers at each grade. Table XXVII reveals that
only two items showed a significant difference in the
responses of the achieving readers. On item 5 (tin__(g p k))
the Grade two and four achieving readers were found to
prefer a different proportion of high frequency and low
frequency choices, thus accounting for the significant
difference. Similarly, the difference on item 16 (scri__
(q p n)) was due to a different proportion of high frequency
and low frequency letter choices of the Grade three and

TABLE XXVII

KOLMOGOROV-SMIRNOV VALUES
COMPARING THE RESPONSES OF ACHIEVING READERS
ON THE TEST OF LETTER FAMILIARITY

Item	Grade	Grade 3	4	Item	Grade	Grade 3	4
1	2	.80	.20	11	2	.20	.20
	3		.20		3		.20
2	2	.20	.20	12	2	.80	.80
	3		.20		3		0.0
3	2	.80	.80	13	2	1.80	.20
	3		.80		3		.80
4	2	.20	.20	14	2	.80	1.80
	3		.80		3		.20
5	2	3.20	9.80**	15	2	1.80	.20
	3		1.80		3		.80
6	2	.80	3.20	16	2	.80	3.20
	3		.80		3		7.20*
7	2	1.80	.80	17	2	.80	.80
	3		3.20		3		3.20
8	2	.20	3.20	18	2	.80	0.0
	3		3.20		3		.80
9	2	.20	.20	19	2	.80	1.80
	3		.80		3		.20
10	2	3.20	.80	20	2	.20	.20
	3		.80		3		.80

** significant at value of .01

* significant at value $>$ .05

TABLE XXVIII

KOLMOGOROV-SMIRNOV VALUES
COMPARING THE RESPONSES OF NON-ACHIEVING READERS
ON THE TEST OF LETTER FAMILIARITY

Item	Grade	Grade 3	4	Item	Grade	Grade 3	4
1	2	1.80	.20	11	2	3.20	3.20
	3		3.20		3		.80
2	2	.80	1.80	12	2	3.20	1.80
	3		1.80		3		.20
3	2	.80	3.20	13	2	1.80	5.00*
	3		1.80		3		.80
4	2	.80	.80	14	2	.80	.80
	3		.20		3		.80
5	2	1.80	3.20	15	2	.20	.80
	3		1.80		3		1.80
6	2	1.80	.80	16	2	.20	.80
	3		.20		3		.80
7	2	.80	0.0	17	2	.80	.20
	3		.80		3		.80
8	2	3.20	0.0	18	2	.80	.20
	3		3.20		3		.20
9	2	5.00*	3.20	19	2	1.80	.20
	3		.20		3		1.80
10	2	.20	5.00*	20	2	.80	.20
	3		5.00*		3		.80

* approaching significance at .05 level

four achieving readers.

When the responses of the non-achieving readers were considered, the differences in responses on items 9 (knu__l (t r 1)); 10 (s__og (l w g)); and 13 (__litch (h f g)) approached significance but did not meet the required .05 level (See Table XXVIII). Non-achieving readers, whether at Grade two, three or four, do not seem to differ significantly in their responses to the Test of Letter Familiarity.

From the results of this analysis, it appears that there was not much difference in the performance of the readers in their choices for permissible letter sequences on either the Test of Orthographic Structure or the Test of Letter Familiarity.

Hypothesis Four

> There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four in their ability to select sequences of letters that cannot occur in English orthography on the Test of Orthographic Structure.

This hypothesis was analyzed by applying a test of the difference between two independent proportions (Ferguson, 1966, pp. 176-178). An APL program was used to test the difference between the two proportions. A critical value of $z = 1.96$ was necessary to obtain significance at the .05 level. The critical value increased to 2.58 in order to reach the .01 level of significance.

The results in Table XXIX indicate that significant

TABLE XXIX

z VALUES FROM TEST OF SIGNIFICANCE OF DIFFERENCES
BETWEEN ACHIEVING AND NON-ACHIEVING READERS CHOICES
FOR A NON-PERMISSIBLE SEQUENCE ON THE
TEST OF ORTHOGRAPHIC STRUCTURE

Item	Grade 2	Grade 3	Grade 4
1	2.236*	0.626	1.026
2	0.449	2.236*	1.026
3	0.449	2.739**	1.118
4	2.344*	1.026	1.879
5	2.236*	1.549	1.026
6	0.913	0.516	0.516
7	0.0	0.516	0.913
8	0.976	1.026	1.026
9	2.582**	0.0	0.0
10	1.952	0.626	1.026
11	1.348	1.026	1.879
12	0.913	0.0	0.0
13	1.789	1.348	1.879
14	1.549	1.491	1.491
15	1.491	0.0	0.0

* significant at the .05 level

** significant at the .01 level

differences existed between achieving and non-achieving readers for several of the test items but none of these items were common to all three grades. At the Grade two level, items 1 (scup, spcu, sace); 4 (yaws, yatw, yort); 5 (huzz, hzuf, heft) and 9 (surdq, squit, shard) differentiated between the achieving and non-achieving readers. On these items the achieving readers were able to select sequences of letters that could not occur in English orthography, whereas the non-achieving readers could not do this.

At the Grade three level, a significant difference was found between the achieving and non-achieving readers on item 2 (drdy, dreb, dray) and item 3 (scitb, scibe, strop). Again, the non-achieving readers had more difficulty in selecting the correct non-permissible letter sequence.

No significant differences were found between the achieving and non-achieving readers at the Grade four level in their ability to select non-permissible sequences of letters in word-like structures. It may be that by Grade four, readers have improved in their discrimination ability as well as their awareness of acceptable letter sequences in words. This may be a result of longer exposure to print.

The previous discussion analyzed differences at each grade level between achieving and non-achieving readers and their ability in dealing with unacceptable

TABLE XXX

z VALUES FROM TEST OF SIGNIFICANCE OF DIFFERENCES AMONG ACHIEVING AND NON-ACHIEVING READERS CHOICES FOR A NON-PERMISSIBLE SEQUENCE ON THE TEST OF ORTHOGRAPHIC STRUCTURE

Item	Grade	Non-Achieving Readers Grade 3	4	Achieving Readers Grade 3	4
1	2	0.976	1.549	1.026	0.0
	3		0.626		1.026
2	2	0.449	1.952	2.236*	2.236*
	3		1.549		0.0
3	2	0.913	0.913	1.549	1.549
	3		1.789		0.0
4	2	2.344*	1.348	1.026	1.026
	3		1.118		0.0
5	2	0.0	1.549	1.026	0.0
	3		1.549		1.026
6	2	0.913	0.913	0.516	0.516
	3		0.0		0.0
7	2	0.0	0.516	0.516	1.406
	3		0.516		0.913
8	2	2.236*	1.549	0.626	2.236*
	3		1.026		1.026
9	2	1.952	1.952	1.026	1.026
	3		0.0		0.0
10	2	1.952	1.952	0.626	1.026
	3		0.0		1.491
11	2	2.928**	1.348	1.118	1.879
	3		1.879		1.026
12	2	1.406	1.406	0.516	0.516
	3		0.0		0.0
13	2	0.469	1.789	0.0	1.879
	3		1.348		1.879
14	2	0.976	0.976	1.026	1.026
	3		0.0		0.0
15	2	1.491	1.491	0.0	0.0
	3		0.0		0.0

* approaching significance at .05 level
** significant at a value > .05

sequences of letters in English orthography. To determine whether there were any significant differences between the grade levels on this ability, the APL program was repeated for the three groups of achieving readers and for the three groups of non-achieving readers.

Table XXX shows that items 4 (yaws, yatw, yort); 8 (rin, ret, rlt) and 11 (stong, snogt, snath) significantly differentiated between Grade two and three non-achieving readers. The Grade two children could not identify as many non-permissible sequences of letters as could the Grade three children in these items. No significant differences occurred between the non-achieving readers in Grades three and four, and the remaining twelve items on the Test of Orthographic Structure were unable to differentiate significantly between any of the grade levels.

With the responses of the achieving readers, item 2 (drdy, dreb, dray) differentiated the achieving readers of Grades two and four. In all of these items, the Grade two achieving readers could not identify as many non-permissible sequences as did the Grade three and four achieving readers.

Hypothesis Five

> There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four in their ability to correctly pronounce or read their choice of a real word on the Test of Orthographic Structure.

This hypothesis was analyzed by applying a test of significance of difference between two independent proportions. This APL program, also used in hypothesis four, required critical z values equal to or greater than 1.96 and 2.58 to be significant at the .05 and .01 level, respectively. Tables XXXI and XXXII present the results of these analyses.

Table XXXI compares the achieving and non-achieving readers at each grade level. Eight of the fifteen items were found to differentiate between achieving and non-achieving readers at both the Grade two level and the Grade four level when the children were required to pronounce the word-like structure.

However, at the Grade three level, only two items significantly differentiated between the achieving and non-achieving readers. It would appear that the Grade two and four non-achieving readers are not as able to pronounce the word-like structures on the Test of Orthographic Structure.

The difference between grade levels of the three groups of achieving readers and the three groups of non-achieving readers in their ability to correctly pronounce the word-like structures was determined by this same APL program. The

TABLE XXXI

$\underline{z}$ VALUES FROM TEST OF SIGNIFICANCE OF DIFFERENCES
BETWEEN ACHIEVING AND NON-ACHIEVING READERS
CORRECTLY READING THE PERMISSIBLE RESPONSES ON
TEST OF ORTHOGRAPHIC STRUCTURE

Item	Grade 2	Grade 3	Grade 4
1	2.582*	1.348	3.578**
2	0.449	1.879	1.879
3	1.348	1.789	0.469
4	1.348	1.952	2.582**
5	4.045**	0.516	2.928**
6	2.247*	1.348	2.582**
7	2.236*	0.469	1.789
8	2.247*	1.879	1.879
9	2.928*	2.344*	2.928**
10	0.976	0.0	0.913
11	0.0	3.578**	2.344*
12	3.282**	1.118	2.344*
13	1.952	1.406	2.739**
14	0.469	1.348	0.516
15	2.739**	1.348	1.826

* significant at .05 level

** significant at .01 level

(from Ferguson, 1966, p.177)

results of this analysis are contained in Table XXXII.

A perusal of this table reveals that five test items (or one-third of the Test of Orthographic Structure) significantly differentiated the Grade two non-achieving readers from the non-achieving readers in Grade three. When these children were asked to pronounce the word-like structures which contained permissible letter combinations for English orthography, the Grade two non-achieving readers mispronounced the greater number of the test items. In most of the errors made, the Grade two non-achieving readers seemed to rely too heavily upon the initial letter in the word-like structures and neglected to look at the middle of the structure. This resulted in mispronounciation errors or substitution-type errors. In substitution-type errors, another real word was substituted for the permissible word-like structure. This real word began with the same letter and had a similar configuration.

Four of the test items also significantly differentiated between the Grade two and four non-achieving readers. The Grade two children again made the most errors. However, none of the items in the Test of Orthographic Structure were able to differentitate significantly between Grade three and Grade four non-achieving readers when the children were asked to pronounce the permissible letter combination sequence.

A comparison of the articulatory responses of the achieving readers indicated that the Grade two achieving readers differed significantly from the Grade three achieving

TABLE XXXII

z VALUES FROM TEST OF SIGNIFICANCE OF DIFFERENCES
AMONG ACHIEVING AND NON-ACHIEVING READERS
CORRECTLY READING THE PERMISSIBLE RESPONSES ON
TEST OF ORTHOGRAPHIC STRUCTURE

Item	Grade	Non-Achieving Readers Grade 3	4	Achieving Readers Grade 3	4
1	2	2.236*	1.026	0.913	1.952
	3		1.549		1.118
2	2	0.913	0.913	2.236*	2.236*
	3		0.0		0.0
3	2	0.0	0.0	0.469	0.894
	3		0.0		1.348
4	2	0.449	0.449	1.118	1.879
	3		0.0		1.026
5	2	3.282**	2.236*	0.626	1.026
	3		1.348		1.491
6	2	0.976	1.406	0.0	1.879
	3		0.449		1.879
7	2	1.879	1.879	0.0	1.348
	3		0.0		1.348
8	2	2.247*	2.247*	1.879	1.879
	3		0.0		0.0
9	2	2.236*	2.236*	1.549	2.236*
	3		0.0		1.026
10	2	0.976	1.406	0.0	1.348
	3		0.449		1.348
11	2	0.626	0.976	3.146**	3.146**
	3		1.549		0.0
12	2	3.282**	2.236*	1.118	1.118
	3		1.348		0.0
13	2	1.952	1.118	1.406	1.952
	3		0.913		0.626
14	2	0.469	1.789	1.348	1.826
	3		1.348		0.516
15	2	1.549	1.549	0.0	0.516
	3		0.0		0.516

* significant at .05 level   ** significant at .01 level

readers on only two items, but these Grade two achieving readers differed significantly from the fourth graders on three items.

Far fewer test items (Items 2 and 11) could differentiate significiantly between Grade two and Grade three achieving readers, whereas, more than twice that number (Items 1, 5, 8, 9 and 12) could differentiate between the Grade two and Grade three non-achieving readers.

The number of test items (three) which significantly differentiated between Grade two and Grade four achieving readers was similar to that which differentiated between Grade two and Grade four non-achieving readers (four).

As was the case with non-achieving readers, no test items on the <u>Test of Orthographic Structure</u> were able to significantly differentiate between the Grade three and Grade four achieving readers.

It may be that the inexperience of the Grade two children with English orthographic structure in relating sound and symbol can account for part of this difference between the Grade two and three and the Grade two and four, but not the Grade three and four achieving and non-achieving readers.

SUMMARY OF THE RESULTS

The computer analyses to test the null hypotheses formulated by the researcher yielded the following results:

Hypothesis One

Achieving and non-achieving readers in each of Grades two, three and four did not differ significantly in their selection of permissible letter sequences on the Test of Orthographic Structure. Among the non-achieving readers, the Grade two readers were found to select significantly fewer permissible responses than the third or fourth grade non-achieving readers.

On the Test of Letter Familiarity, only the achieving and non-achieving readers in Grade four differed significantly in constructing permissible letter sequences. Comparison across the grades revealed that the Grade two achieving readers differed significantly from the Grade four achieving readers in constructing permissible sequences of letters. The Grade two non-achieving readers also differed significantly from the Grade three non-achieving readers on this task. However, there were no significant differences between the Grade three and four achieving or non-achieving readers on this task.

Hypothesis Two

The correlation between the permissible letter sequence scores of the Grade two non-achieving readers on the Test of Orthographic Structure and their silent reading comprehension scores was found to be significant. There was also a significant correlation for the Grade four non-achieving readers on this same test. There were no significant

correlations with reading scores for any of the other
groups, that is, Grade two achieving readers, Grade three
achieving readers, Grade four achieving readers and Grade
three non-achieving readers. The correlation between the
scores for the entire Grade two sample on the Test of
Orthographic Structure and silent reading comprehension
for Grade two was significant.

On the Test of Letter Familiarity, only the performance
of the combined Grade four sample (achieving and non-
achieving readers) was found to be significantly correlated
with their reading achievement scores.

Hypothesis Three

The Kolmogorov-Smirnov two-sample test was performed
for each group of readers within and across the three grades.
The results indicated that on both tests constructed by
the investigator, only a few of the items differentiated
significantly between the achieving and non-achieving
readers.

On the Test of Orthographic Structure, significant
differentiation was mainly due to the selection of a
different proportion of high frequency or low frequency
responses by achieving and non-achieving readers. Both
the high frequency and low frequency responses were
considered permissible and orthographically correct.

Results of the Test of Letter Familiarity indicated
that responses which significantly differentiated between

achieving and non-achieving readers were mainly attributed to the fact that the non-achieving readers selected more non-permissible letter sequences to construct word-like structures.

Hypothesis Four

When the achieving and non-achieving readers were considered at each grade level, the APL program yielding z values indicated that the Grade two sample of achieving and non-achieving readers differed significantly in their choice of a non-permissible word-like structure on four items on the Test of Orthographic Structure. The Grade three groups differed significantly on only two items, while no significant differences existed between the Grade four achieving and non-achieving readers.

When achieving and non-achieving readers were considered across grade levels, the choices of the non-achieving readers revealed significant differences between the Grade two and three non-achieving readers on three of the items. The Grade two and three achieving readers differed significantly on only two items, while one item was able to differentiate between the Grade two and Grade four achieving readers. The Grade two achieving readers were less able than both the Grade three and the Grade four children to identify the non-permissible structure in these items.

Hypothesis Five

Upon comparing the groups and their correct pronunciation of the responses to the word-like structure, the performance of the Grade two achieving and non-achieving readers was found to differ significantly for more than half of the test items. Non-achieving readers mispronounced a greater number of their choices for permissible word-like structures than did the achieving readers.

The Grade three achieving and non-achieving readers differed significantly in their correct pronunciation of responses on only two of the items, while the Grade four achieving and non-achieving readers were found to make significantly more pronunciation errors in eight of the fifteen test items.

When the oral responses of the non-achieving readers to the permissible letter sequences were compared, the second grade children were found to make significantly more errors on four items than did the Grade three non-achieving readers.

Only three test items could significantly differentiate among the achieving readers when their oral response to a permissible sequence of letters was considered.

CHAPTER VI

SUMMARY, CONCLUSIONS, IMPLICATIONS AND
SUGGESTIONS FOR FURTHER RESEARCH

SUMMARY

This study investigated the ability of achieving and
non-achieving readers in Grades two, three and four to
select and construct permissible sequences of letters in
word-like structures of English.

A sample of ten achieving readers and ten non-achieving
readers in each of the three grades was randomly selected
from two designated schools in the Edmonton Separate School
System. In the sample selection process, the results of
the silent reading comprehension section of the Gates-
MacGinitie Reading Test were used as the basis of determining
achievement or non-achievement in reading. Achieving
readers were those who scored a half standard deviation or
more above the mean score on the Gates-MacGinitie Reading
Test used for that grade. Non-achieving readers were those
who scored a half standard deviation or more below the mean
score on the Gates-MacGinitie Reading Test used for that
grade.

Each of the sixty children was tested individually
by the researcher and a trained assistant, on the two tests
constructed by the examiner. The Test of Orthographic

<u>Structure</u> (Appendix A) measured the child's awareness of permissible letter sequences in word-like structures of English orthography. The <u>Test of Letter Familiarity</u> (Appendix B) was designed to measure students' ability to construct permissible sequences of letters in word-like structures of English. Several questions were posed to the children to determine the basis of their selection of a permissible letter sequence. Informal analysis of these questions and the errors on the two tests was reported. The data were analyzed and interpreted for each group of readers with respect to the five null hypotheses that had been formulated. A one-way analysis of variance was used to determine if there was a significant difference between achieving and non-achieving readers of the three grades in their ability to select and construct permissible letter sequences. Correlation coefficients were computed between reading achievement scores and the scores on the two examiner constructed tests. The Kolmogorov-Smirnov two-sample test was used to compare the performance of each group of readers on each item of the two tests. Further analysis compared the performance of each group of readers in (a) selecting non-permissible sequences of letters on the <u>Test of Ortho-graphic Structure</u>; and (b) correctly reading the permissible sequence of letters selected on the <u>Test of Orthographic Structure</u>.

MAIN FINDINGS AND CONCLUSIONS OF THE
NON-STATISTICAL ANALYSIS

A non-statistical analysis of student performance on

the two examiner-constructed tests was performed to

determine the types of responses and errors made on the

two tests.

Test of Orthographic Structure

On the Test of Orthographic Structure, the mean score

for any group of readers revealed that permissible sequences

of letters were selected at least 88 per cent of the time.

It appears that both achieving and non-achieving readers,

as defined in this study, at the Grade two, three and four

level, are able to identify permissible sequences of letters

in word-like structures.

High frequency responses (as determined by the tables of

Mayzner and Tresselt, 1965) were selected at least 60 per

cent of the time by all groups at all grade levels. Perhaps

the word-like structures composed of high frequency digrams

and trigrams, bear greater resemblance to English words, and

thus, serve as a factor in the selection of a permissible

sequence of letters. Miller, Bruner and Postman (1954)

found increased accuracy in the identification and recall

of sequences of letters that had greater approximation to

English orthographic structure.

A high percentage of error was found in the oral

pronunciation of the permissible word-like structures

chosen by the children. The non-achieving readers had a

greater percentage of oral reading errors, with the Grade
two non-achieving readers mispronouncing 83 per cent
of their choices for permissible sequences of letters.
Increasing accuracy in the oral reading of word-like
structures was experienced by the achieving readers with
increasing grade level, resulting in 86 per cent accuracy
by the Grade four achieving readers.

Substitution-type errors constituted over half of the
pronunciation errors made by the readers. A substitution-
type error occurred when another real word, beginning with
the same letter and having a similar configuration, was
read for the word-like structure selected by the reader.
It would appear that although children in this study were
able to visually select permissible sequences of letters
with great accuracy, the oral representation of word-like
structures bearing invariant grapheme-phoneme correspon-
dences is a more difficult task. The information obtained
in this study suggests that the ability of achieving
readers to accurately relate sound and symbol increases
with increasing grade level. However, for non-achieving
readers, an increase is experienced between Grade two and
three in the ability to correctly relate sound and symbol,
but a 'levelling-off' effect seems to occur after Grade three.
These results are in agreement with Levin and Biemiller
(1968) who hypothesized that reading a word aloud involves
rehearsing the sound pattern within the word to the
auditory memory and schema, finally emitting the word

with varying latencies and correctness (p. 106). Pseudo-
words were read more slowly and with greater error in
that study, and this was attributed to an unfamiliar
visual and sound pattern of these words.

The results of the present study also revealed a
tendency to read the pseudo-word as a real, familiar one.
It may be that the influence of other variables, such as
pronounceability, familiarity with words and meaningfulness,
rather than just orthographic structure had some effect
in the selection of permissible sequences of letters in
word-like structures.

The students in this study experienced difficulty in
verbalizing the basis for discrimination and selection of
permissible letter sequences. Each response was placed
into one of seven categories. The information revealed
by this categorization indicated that more than 50 per
cent of the responses of the total sample were in a
category claiming familiarity with the word-like structure
without any basis for the familiarity. In other words,
the students using this response claimed familiarity with the
word-like structure selected, but could not give either
a meaning or reason as to why the structure seemed familiar.
A greater percentage of the responses of the Grade four
subjects fit this category. This may be due to the
influence of a wider range of reading material being
exposed to children at this grade level. Many new words,
with unfamiliar meanings may be experienced by these students,

thus leading them to claim structural familiarity without an attachable meaning.

In identifying the non-permissible sequence of letters in each item, achieving readers were found to be more successful and accurate than the non-achieving readers at each grade level. The greatest difference between groups occurred at the Grade two level where the achieving readers correctly identified 42 more non-permissible structures than the non-achieving readers. Beyond the second grade, the non-achieving readers became more accurate in their identification of non-permissible sequences of letters so that by Grade three, it appears that children can distinguish word-like structures that do not obey the rules of English orthography.

As for verbalizing the basis for selection of the non-permissible sequence of letters, the Grade two readers were found to have difficulty in relating a reason of significance. In other words, their reasons or responses bore little relationship to the orthographic structure of the non-permissible sequences. However, by Grade four, the achieving readers were able to identify or locate, with 70 per cent accuracy, the exact error in the non-permissible sequence. Beyond the second grade, an increasing number of students reported the non-permissible sequence as being difficult to pronounce or as having a peculiar spelling, but these same students were unable to specify the nature of the difficulty.

It would appear that the ability to identify and verbalize the nature of the non-permissible sequence of letters develops with increasing grade level.

Test of Letter Familiarity

On the Test of Letter Familiarity, the achieving readers' mean score was greater than that of the non-achieving readers of the same grade. The mean scores indicated that the Grade two non-achieving readers were able to construct the least number of permissible sequences of letters, although they were able to construct them with 68 per cent accuracy.

The non-statistical analysis of the digram frequency of the letter selected (that is for example, 'st', 'sl' or 'sc' in __reed) to construct a word-like structure indicated no predominant pattern of responses. In other words, the number of high frequency digrams selected as opposed to the number of low frequency digrams selected to complete word-like structures did not differ significantly. Non-permissible responses were selected to build word-like structures for a greater proportion of the time as compared to this response being chosen on the Test of Orthographic Structure. It may be that other variables influenced the reader in his choice of a letter selection on this test. It appeared to the investigator that pronounceability of the sequence being completed, rather than the sequential redundancy of the sequence, played a role in the completion

of items on this test. Garner (1962) wrote that frequency of word usage can affect both visual and auditory thresholds in the recognition of words, suggesting a response effect rather than a perceptual effect.

In the oral representation of randomly selected items, the number of errors in pronouncing the word that was formed decreased per group with increasing grade level. The percentage of errors for each group was very similar to the percentage of error made by that group on the Test of Orthographic Structure. Thus, again it appears that although invariance is perceived and recognized, it is a more difficult task to give the auditory representation of the visual stimulus.

The pronounceability factor was found to play an increasing role (with increasing grade level) in the selection of a letter to construct a permissible sequence of letters. This factor was verbalized by the children as the basis for their selection of a letter to build a permissible word-like structure. An awareness of sequential redundancy, that is, letters that occur together in English orthography, was verbalized as the basis for the letter selection in less than 25 per cent of the responses by any one group of readers. Thus, it would appear that factors, other than sequential redundancy were variables in this test.

MAIN FINDINGS AND CONCLUSIONS ON THE

STATISTICAL ANALYSIS

Hypothesis One

There is no significant difference between achieving
and non-achieving readers in each of Grades two, three
and four in their ability to select permissible
combinations (sequences) of letters in word-like
structures on:
(a)   the Test of Orthographic Structure.
(b)   the Test of Letter Familiarity.

Summary and Conclusions of Hypothesis one - Achieving and

non-achieving readers in each of Grades two, three and four

did not differ significantly in their ability to select

permissible sequences of letters on the Test of Orthographic

Structure.

Among the three grades of achieving readers, there was

no statistically significant difference in their ability to

select word-like structures conforming to the rules of

English orthography. However, among the non-achieving

readers, the Grade two readers were found to select signi-

ficantly fewer permissible responses than either the third

or fourth grade non-achieving readers. Therefore, hypothesis

one (a) can only be rejected in part.

On the Test of Letter Familiarity only the achieving

and non-achieving readers in Grade four were found to differ

significantly in constructing permissible letter sequences.

Comparison across the grades revealed that the Grade two

non-achieving readers differed significantly from the
Grade three non-achieving readers; and the Grade two
achieving readers differed significantly from the Grade
four achieving readers on this task. Therefore, hypothesis
one (b) can only be rejected in part.

Readers thus appear to be able to visually select
permissible structures of English orthography, and a
progressive improvement in this ability occurs as the
readers gain more experience and exposure to the
orthographic structure of English.

These results are in agreement with those obtained by
Gibson, Osser and Pick (1963) and Rosinski and Wheeler
(1972). Their research dealt with the development of the
perception of grapheme-phoneme correspondences in elementary
school children. Rosinski and Wheeler (1972) concluded
that the extraction of invariant grapheme-phoneme corres-
pondences occurs between grades one and three. However,
the results indicated that, although the children in the
study were able to select permissible sequences of letters
in word-like structures, they experienced difficulty in
articulating or correctly pronouncing their choices for
acceptable word-like structures. Similarly, the children
appeared to have difficulty in explaining the basis for
their discrimination and selection of permissible letter
sequences.

It may be that constructing permissible word-like
structures involves factors other than those involved in

selecting permissible letter sequences. In fact, it seemed that the children relied upon the pronunciation of the word-like structure being formed rather than using visual cues of correct orthographic structure.

Hypothesis Two

There is no significant relationship between reading achievement scores for achieving and non-achieving readers in each of Grades two, three and four and their ability to select permissible combinations (sequences) of letters in word-like structures on:
  (a) the Test of Orthographic Structure.
  (b) the Test of Letter Familiarity.

Summary and Conclusions of Hypothesis two - The correlation between the permissible letter sequence scores of the Grade two and the Grade four non-achieving readers on the Test of Orthographic Structure and their silent reading comprehension scores was found to be significant. No significant correlation was found for any of the other reading groups. Therefore, hypothesis two (a) can only be rejected in part.

A significant correlation existed between the reading achievement scores and the permissible scores for the entire Grade two sample.

Correlations between reading achievement and the permissible sequence scores on the Test of Letter Familiarity failed to achieve significance for any of the groups of readers. Therefore, hypothesis two (b) could not be rejected.

However, when the performance of the combined groups was considered, the performance of the Grade four sample was found to be significantly correlated with their reading

achievement scores.

The present study went beyond the research done by Gibson and her associates in an attempt to determine whether the ability to select or construct permissible sequences of letters is related to reading achievement. The results of the analysis of this hypothesis indicated that these are not related except for non-achieving readers at the Grade two and four levels.

Hypothesis Three

There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four on their performance on:
(a) the Test of Orthographic Structure.
(b) the Test of Letter Familiarity.

Summary and Conclusions of Hypothesis three - Since significant differences were found only on some of the items on both the Test of Orthographic Structure and the Test of Letter Familiarity, hypothesis three (a) and three (b) can only be rejected in part.

With the significant differences found on some of the items on the Test of Orthographic Structure, the difference could be attributed to the different proportion of high frequency and low frequency responses selected by the achieving and non-achieving readers. Both the high frequency and the low frequency choices in each item of the test were permissible and orthographically correct. Thus, the difference existed in permissible choices selected.

However, on the Test of Letter Familiarity, the significant difference noted in many of the items was due to the non-achieving readers selecting a greater proportion of non-permissible letters to build an acceptable combination of letters in English orthography. The non-statistical analysis revealed that non-permissible letters were often selected because the reader thought that letter was necessary to build a familiar, pronounceable word.

Hypothesis Four

> There is no statistical difference between achieving and non-achieving readers in each of Grades two, three and four in their ability to select sequences of letters that cannot occur in English orthography on the Test of Orthographic Structure.

Summary and Conclusions of Hypothesis four - An analysis of the data showed that the Grade two achieving and non-achieving readers differed significantly on four items in their choice of a non-permissible structure. The Grade three achieving and non-achieving readers differed significantly on two items, while the Grade four achieving and non-achieving readers did not differ significantly on any items in their choice of unacceptable letter sequences.

The responses for non-permissible structures by the achieving readers differentiated significantly on one item for the Grade two and three readers and on two items for the Grade two and four readers. Among the non-achieving readers, three items significantly differentiated between

the Grade two and three non-achieving readers. Therefore, hypothesis four can only be rejected in part.

The results of this analysis seem to indicate that as experience is gained in reading, children seem to become more familiar with English orthographic structure and are better able to correctly identify non-permissible sequences of letters. In this study, non-achieving readers identified fewer of the non-permissible structures than did the achieving readers of the same grade.

In the investigator's search of related literature, it was discovered that none of the previous studies had examined the subjects' awareness of non-permissible word-like structures. This was included in the present study to determine whether or not the children were able to identify (1) the non-permissible structure; and (2) the letter sequencing error(s) in that non-permissible structure.

As the results of this study showed,only a few of the items were able to significantly differentiate between achieving and non-achieving readers. The Grade two readers were less able than either the Grade three or four children to identify the non-permissible sequence in these items.

The questions directed to the children in the study revealed that although the children could identify the non-permissible structure, they experienced difficulty in locating the exact error in that orthographic structure. However, by Grade four, the achieving readers were able to do this with 70 per cent accuracy.

Hypothesis Five

> There is no significant difference between achieving and non-achieving readers in each of Grades two, three and four in their ability to correctly pronounce or read their choice of a real word on the <u>Test of Orthographic Structure</u>.

<u>Summary and Conclusions of Hypothesis five</u> - The analysis of data on each item and for each group of readers revealed that several significant differences occurred in the correct pronunciation of the responses to the permissible word-like structure. The performance of the Grade two and four achieving and non-achieving readers differed significantly for more than half of the test items, while the Grade three achieving and non-achieving readers were found to differ significantly in their correct pronunciation of responses on only two of the items. Non-achieving readers mispronounced a greater number of their choices for permissible word-like structures than did the achieving readers.

The Grade two non-achieving readers were found to make significantly more errors on four items than did the Grade three and four non-achieving readers. Only three test items could differentiate significantly among the achieving readers when their pronunciation of the permissible sequence of letters was considered. Therefore, hypothesis five can only be rejected in part.

It would appear from the results of this analysis that although the children were able to select permissible letter sequences, they could not always correctly pronounce or read

their choices for a permissible word-like structure. It may be that the children experienced difficulty in relating the sound and symbol, or that they did not perceive the details of the word-like structure correctly. If the latter alternative was the case, the research conclusions of Gibson and her associates are subject to criticism and doubt.

The non-statistical analysis revealed that the least number of choices were pronounced correctly by the Grade two non-achieving readers, followed by the Grade four non-achieving readers. However, the difference between the Grade three and four non-achieving readers was very slight. Perhaps this indicates a 'levelling-off' of these abilities at the Grade three level. Amongst the achieving readers a constant increase in the total number of responses correctly pronounced was noticed. The greatest increase occurred between the Grade two and three groups while the increase between the third and fourth grade was not as large. This could mean that the greatest development of the ability to correctly relate sound and symbol for articulation occurs between the second and third grades.

The non-statistical analysis showed a tendency to substitute a real familiar word for the test word chosen on the Test of Orthographic Structure. These results agree with those of Postman and Rosenzweig (1957), who in their study of pre-recognition errors, found a tendency for subjects to construct words that were more familiar to them. This appeared to be a tendency of the children

in this study as well.

IMPLICATIONS OF THIS STUDY

This study has shown that there is no statistical difference in the ability of achieving and non-achieving readers in Grades two, three and four to select permissible sequences of letters in word-like structures. It would appear that in the course of learning to read, children extract the rules of grapheme-phoneme correspondences in the structure of English words, and are able to generalize these correspondences to aid in the identification of new words. Since this occurs in the early stages of reading, Gibson (1965) suggests that programming reading materials could enhance the opportunities for discovering the correspondences. Such programming would be based on the regularities in spelling and word patterns.

The many errors noted among the achieving and non-achieving readers of all grades in the oral pronunciation of their choice for a permissible sequence of letters would suggest that the ability to correctly associate the auditory counterpart of the visual symbol is not as well-developed as is the ability to visually recognize a permissible sequence of letters. Significant differences were found to exist between achieving and non-achieving readers on several items. The non-achieving readers may thus be able to improve their word recognition skills

through a training program in relating sound sequences to corresponding letter sequences on a printed page.

Thus, it might be that children exposed to groups of letters bearing invariant grapheme-phoneme correspondences, would acquire more awareness of the sound-symbol relationship of the letter combinations in monosyllabic words and syllables from which longer words are constructed. Fries (1962) and Gibson (1965) suggest that the discovery and mastery of these rules might be enhanced if spelling were coordinated with reading.

The majority of errors made in the oral pronunciation of chosen word-like structures was a substitution-type error. That is, a real word, beginning with the same initial letter and having a similar configuration, was substituted for the test word in the oral response stage. This would suggest a response bias based on familiar words. It may be that these readers need training in accurately perceiving the internal details of words and pseudo-words, and practice in relating the aural counterpart of the perceived stimulus.

The children in this study had difficulty in verbalizing the basis of their selection and discrimination of a permissible and non-permissible sequence of letters. Although the ability to verbalize may be a developmental factor, consideration should be given to the study of English orthography. Rather than mere emphasis on phonics or memorization of spelling patterns, factors of redundancy

or allowable sequences of letters in English orthography might be included in both spelling and reading instruction. The probability or predictability of letter sequences might be incorporated in such instruction to develop an awareness of the sequential dependencies among letters in the English language.

A great number of non-permissible sequences selected on the Test of Letter Familiarity and the reasons given for the construction of these sequences led the researcher to believe that the influence of sequential redundancy was not always a variable involved in the construction of a permissible word-like structure. Thus, it would appear that some readers require a program that examines the structure of English orthography. These readers may also require specific training in the construction of letter sequences that are likely ones to occur in the English language.

Such training might be conducted by presenting the child with two forms of letter sequences - both permissible and non-permissible sequences of letters. The distinctive features of each might be considered and analyzed in relation to English orthography. In this manner, an awareness of the sequential distribution of letters in English orthography might be developed.

SUGGESTIONS FOR FURTHER RESEARCH

The following problems arise out of this study as areas for consideration as further research:

(1) This study revealed a very low relationship between reading achievement and the ability to select and construct permissible sequences of letters on the two tests constructed by the examiner. Reading achievement was defined on the basis of performance on the silent reading comprehension section of the <u>Gates-MacGinitie Reading Test</u>. Since silent reading comprehension is only one aspect of the reading process, other variables, such as word-recognition ability, memory factors, phonics, etc. might be further assessed to determine if any relationship exists between those variables and selecting permissible sequences of letters on the examiner-designed tests.

(2) This study centred on the visual recognition and selection of permissible sequences of letters. Reading, however, involves a large auditory factor as well. The study of the role of grapheme-phoneme correspondences in the field of reading can be further investigated by a study of the relationship between the ability to correctly read or pronounce these correspondences and the ability to correctly perceive them. The present study focused on the differences between groups in the oral pronunciation of their choice of a permissible letter sequence.

(3) Differences in the performance of children within a group might be further investigated with a study of the

relationship between other variables, such as intelligence
or memory, and the ability to select permissible or non-
permissible sequences of letters in word-like structures
of English.

(4) A study might be undertaken to investigate the
decoding difficulties noted in the results of this research.
The findings imply a tendency to pronounce a pseudo-word
as a familiar, real word that resembles the structure of
the pseudo-words. Further research might investigate the
decoding of word-like structures having different degrees
of approximation to English, to determine the effects of
structure on the decoding difficulties of children. Perhaps
this will reveal that closer approximations to English
yield sound patterns of highly frequent and familiar words
and thus results in the substitution and mispronunciation
of the printed word.

(5) Since the Test of Letter Familiarity involved
constructing permissible sequences of letters, a study
might be centred on determining the relationship of
performance on this test and performance on a spelling
test.

(6) Since the results of this study suggested the
influence of pronounceability in the construction of a
permissible sequence of letters, a study might be undertaken
to investigate the effects of pronunciation on the
perception and pronounciation of word-like structures.
Gibson et al (1962) ran control experiments on

pronounceability , but the sample used to rate and read the pseudo-words were college students. No control on the pronounceability of each item choice existed in this study done by the investigator. Another study might be designed to include the investigation of the pronounceability of the word-like structures used in the test items. Such a study might show that the permissible structure chosen by the children was based on ease of pronounciation of these structures.

(7) A study might be designed to investigate the effectiveness of a reading program based upon the structure of English orthography. That is, this program might incorporate the ideas of invariant grapheme-phoneme correspondences as suggested by Gibson and her colleagues, and the spelling researchers. After a period of instruction, the results of an experimental and control group could be examined to provide further knowledge and insight into the teaching of reading.

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APPENDIX A

TEST OF ORTHOGRAPHIC STRUCTURE

TEST OF ORTHOGRAPHIC STRUCTURE

For this test, three sequences of letters in word-like structures were printed on three by five inch cards, as in the example below. The remaining fourteen items in this test are presented at the bottom of the page.

```
scup        spcu        sace
```

DIRECTIONS: I would like you to look at the words on each card that I show you. On each card there is one real word. Although you may not know the word or its meaning, choose the one that you think is a word. Point to the one that is more like a real English word.

2. drdy   dreb   dray
3. scitb   scibe   strop
4. yaws   yatw   yort
5. huzz   hzuf   heft
6. smruth   smutch   starsh
7. sruct   scurf   stace
8. rin   ret   rlt
9. surdq   squit   shard
10. senpw   spere   swain
11. stong   snogt   snath
12. brin   bnel   bleb
13. gcot   grog   geft
14. wbilr   wribs   whorl
15. snhun   snasp   shunt

SCORING SHEET FOR
TEST OF ORTHOGRAPHIC STRUCTURE

Name:_____

Grade_____ ACH NACH

CARD				COMMENTS MADE BY CHILD
1	scup l	spcu	sace h	
2	drdy	dreb l	dray h	
3	scitb	scibe l	strop h	
4	yaws l	yatw	yort h	
5	huzz l	hzuf	heft h	
6	smruth	smutch l	starsh h	
7	sruct	scurf l	stace h	
8	rin l	ret h	rlt	
9	surdq	squit l	shard h	
10	senpw	spere l	swain h	
11	stong h	snogt	snath l	
12	brin h	bnel	bleb l	
13	gcot	grog l	geft h	
14	wbilr	wribs l	whorl h	
15	snhun	snasp l	shunt h	

APPENDIX B

TEST OF LETTER FAMILIARITY

TEST OF LETTER FAMILIARITY

Directions: Look carefully at each word below. In each word one letter is missing. Following the word, three letters are given. Pick the letter which you think would best fit in the blank to make an English word, even though you may not know the word or its meaning. Write the best letter in the blank.

1. g_ig   (k l r)

2. pri_k   (s g n)

3. ki_h   (c t b)

4. yaw_   (l r k)

5. tin_   (g p k)

6. s_reed   (l c t)

7. we_t   (f c j)

8. _uern   (v r q)

9. knu_l   (t r l)

10. s_og   (l w g)

11. qui_ch   (t n s)

12. t_ill   (w m h)

13. _litch   (h f g)

14. _lebs   (p s j)

15. bran_   (h s t)

16. scri_   (q p n)

17. _hrips   (d t c)

18. lar_h   (k t c)

19. _hews   (t d w)

20. b_act   (l r n)

APPENDIX C

SAMPLE CATEGORIZED RESPONSES
TO QUESTIONS ON

TEST OF ORTHOGRAPHIC STRUCTURE

SAMPLE CATEGORIZED RESPONSES TO QUESTIONS
ON TEST OF ORTHOGRAPHIC STRUCTURE

After selecting a word-like structure on the <u>Test of</u>

<u>Orthographic Structure</u> , the children were asked to

indicate the basis for selection of that structure. The

responses were categorized into seven categories. The

following are some sample responses from each category:

CATEGORY 1: The word-like structure was selected because
it contained an embedded real word that was
familiar to the student.

  (a) "I picked "shard" because it has "hard" in it."

  (b) "There's "cot" and that's why the word is "gcot"."

CATEGORY 2: The word like structure was associated with
another real word that rhymed or had similar
structure.

  (a) "It could be "yaws" because it is like "paws"."

  (b) "Well, "geft" looks like "gift". Like you give a
gift."

CATEGORY 3: No response could be elicited from the
student to indicate a basis for a choice
of a word-like structure.

CATEGORY 4: The word-like structure was perceived and
identified as another real word that the
student knew.

  (a) "Because I know that word, it's "smooch"."

  (b) "It's "ribs", you know, something inside you."

CATEGORY 5: This category was considered 'insignificant'
because the student claimed familiarity with
the structure, but could not give either meaning
or reason for the familiarity.

  (a) "It's that one because I saw it once with my mother
downtown on a sign."

  (b) "I have a book about that - 'stace' ."

CATEGORY 6:   The word-like structure was selected because
              it was identified and read as part of a
              larger word.

(a)   "It's that (sruct) because it's like "instruct"."

(b)   "You know - to "descibe" (scibe) something."

CATEGORY 7:   The word like structure was chosen because
              it was said to be easier to read and pronounce.

(a)   "I picked it because it sounds like the easiest
      word and it looks English."

(b)   "It sounds like people use it."

(c)   "I told you, it looks like a real word."

SAMPLE CATEGORIZED RESPONSES TO QUESTIONS
ON TEST OF ORTHOGRAPHIC STRUCTURE

After selecting the non-permissible orthographic structure,

the student was asked to indicate the basis for choosing

that structure. The responses were categorized into six

categories. The following are some sample responses from

each category:

CATEGORY 1:   The non-permissible structure was reported as
              being difficult to pronounce.

  (a)   "It's got 's-n-o-g-t' and I can't pronounce it."

  (b)   "I picked that one because I can't read it too well."

CATEGORY 2:   The non-permissible structure was reported as
              being misspelled or having a peculiar spelling,
              but the children were unable to specify the error
              or the peculiarity.

  (a)   "It's got funny letters."

  (b)   "It doesn't look like a real word with 'd-r-d-y'."

CATEGORY 3:   No reason could be elicited from the student
              for having selected this response.

CATEGORY 4:   The reason given bore little significance to
              the orthographic structure of the word.

  (a)   "It doesn't look like a good word. You don't use
        it often."

  (b)   "I've never seen it before."

CATEGORY 5:   The non-permissible sequence was correctly
              identified and given as the reason to why
              this structure was selected.

  (a)   "It's got a 'dq' and I can't say that."

  (b)   "Because 'gc' don't go together."

CATEGORY 6:   The non-permissible sequence was not named, but
              the student would remove one letter.

  (a)   "It could be surf."

  (b)   "It should be "snog"."