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ABSTRACT

This research report examines the pronunciation that children give to synthetic words containing vowel-cluster spellings and analyzes the observed pronunciations in relation to common English words containing the same vowel clusters. The pronunciations associated with vowel-cluster spellings are among the most unpredictable letter-sound correspondences in English. More than 425 elementary school pupils in Wisconsin schools were administered a 100-item, multiple-choice test of 90 synthetic words containing vowel clusters ("ai," "au," "ay," "ea," "ie," "oa," and "ow") and 10 additional check items. Results and conclusions discuss the relationship of vowel cluster pronunciation, grade level, sex, reading level, community type (suburban, urban, and rural), and response type. Inclusion of extensive statistical data supports the research findings. Appendixes contain: (1) the International Phonetic Alphabet symbols for American English; (2) vowel-cluster, multiple-choice tests; (3) subject data; (4) summary of tests administered; and (5) F values of main effects and interactions for analyses 1 and 2. A bibliography is provided. (RL)

Technical Report No. 149

FACTORS RELATED TO THE PRONOUNCIATION OF VOWEL CLUSTERS

Report from the Project on Basic Pre-Reading Skills: Identification and Improvement

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Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
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STATEMENT OF FOCUS

The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Technical Report is from the Basic Pre-Reading Skills: Identification and Improvement Project in Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities. Contributing to these Program objectives, this project's basic goal is to determine the processes by which children aged four to seven learn to read and to identify the specific reasons why many children fail to acquire this ability. Later studies will be conducted to find experimental techniques and tests for optimizing the acquisition of skills needed for learning to read.

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ABSTRACT

Statement of the Problem

The purpose of this study was to determine the pronunciations children give to synthetic words containing vowel cluster spellings, and to analyze the observed pronunciations in relation to common English words containing the same vowel clusters. The pronunciations associated with vowel cluster spellings are among the most unpredictable letter-sound correspondences in English. If learning to read includes learning to translate from spelling to sound, then vowel clusters should pose a particularly difficult problem for children. Determining the manner in which children solve this problem--i.e., the factors related to children's pronunciations of vowel clusters in unfamiliar words--could shed more general light on this complex decoding act.

The study dealt with the following independent variables: grade level (second, fourth, and sixth), sex, reading level (high and low), community type (suburban, urban, and rural), vowel cluster (a subset of nine--ai, au, ay, ea, ie, oa, oo, ou, and ow), and response type (principal and secondary). The dependent variables were difference scores between the subjects' principal and secondary pronunciations of vowel clusters and the principal and secondary pronunciation proportions of vowel clusters on two corpora--a 1963 modification of the 20,000 most common words on the Thorndike Frequency count (Type Corpus) and the most frequent 1,000 words on the 1967 Kucera and Francis computational analysis of present-day American English (Token Corpus).

Procedures

Two pilot studies were conducted to refine and modify the testing instrument, a 100 item multiple choice test. The instrument included 90 synthetic words containing vowel clusters, (ten synthetic words for each of the nine selected vowel clusters) and ten check items. Four real word distractors contained the major pronunciations for the vowel cluster on the type and token corpora.

The sample consisted of 436 elementary pupils from a suburban an urban, and a rural community, all in Wisconsin. Second, fourth and sixth grade boys and girls of both high and low reading levels were included. Each subject responded to two 50 item halves of the instrument on two consecutive days.

To test twelve hypotheses and answer three questions two analyses were performed. In each analysis the design was a 3 x 2 x 2 x 3 x 8 (or 7) x 2 analysis of variance, in which the main effects were grade, sex, reading level, community type, vowel cluster (eight on the type analysis and seven on the token analysis) and response type.

Results

1. Grade level was significantly related to vowel cluster pronunciation. There was an upward progression from second to sixth grade in the proportion of principal vowel cluster pronunciations given in both analyses.

2. There were no significant sex differences in either analysis.

3. Subjects of high reading level consistently gave more principal pronunciations to vowel clusters in both analyses than the poorer readers.

4. Suburban subjects tended to give the principal pronunciations of vowel clusters more consistently than urban and rural subjects.

5. Subjects' pronunciations were more closely related to word types than to word tokens, particularly to the principal pronunciations in the type corpus.

6. Word configuration seemed related to vowel cluster pronunciations.

Conclusions

1. As children progress through the grades, their vowel cluster pronunciations more closely parallel the correspondences occurring in common English words.

2. Being a preference inventory, not a test of "correctness", sex differences were not significant.

3. Better readers are less deviant from correspondences in common words in their pronunciation of vowel clusters than are poorer readers.

4. Suburban children tend to more closely approximate the vowel cluster correspondence frequencies in common words than urban and rural pupils.

5. Principal pronunciations of vowel clusters in word types relate more closely to children's pronunciations than do the correspondences in word tokens.

6. Contextual environment and word postion seem to influence vowel cluster pronunciations by children.

INTRODUCTION

It has been said that the act of learning to read is perhaps the greatest intellectual feat of anyone's lifetime, and teaching people to read has been the concern of educators since the development of the first alphabet. In spite of this long history of teaching reading, there is yet no universally accepted definition of "reading."

The history of reading instruction in this country, perhaps moie than any other educational endeavor, has been characterized by a variety of methodologies and by missionary zeal. More research has been done on reading than any other school subject. Reading materials appear, flourish, and fade with amazing rapidity. Phrases come and go. Ten years ago "decoding" was uttered only by the unenlightened--today its popularity is immense.

In the past decade the field of reading has felt the influence of linguistic science, and the impact has been profound. Linguists study language, and their discoveries and theories have offered insights to those who would help children learn to read. Linguists have isolated the features of language, and have described their functions and relationships. Studies have been done of phonology, morphology, and syntax, of pitch, juncture and stress, and of competence and performance and of countless other related areas. Some studies have dealt with the relationship between orthography and phonology.

Language is a system of oral codes through which humans communicate, and writing is a graphic representation of these oral and audible symbols. Children learn to listen, speak, read and write--usually in that order, and most develop considerable aural/oral facility before any formal reading instruction begins. They have learned to discriminate and articulate most of the phonemes of their native language, and to comprehend and generate meaningful sentences before they enter school.

Of all the skills of language and thought, perhaps the only one unique to beginning reading is the ability to translate what is written to oral language already possessed. Symbols represent sounds; unfortunately, some symbols represent many sounds, and some sounds are represented by many symbols in English. Recent studies (Venezky, 1966; Hanna *et al.*, 1966) aided by computer technology have tabulated correspondences between spelling and sound and sound and spelling in common English words. However, little research has been done to determine whether or not these relationships are actually used by competent readers--and if they are, how children acquire them.

If initial reading includes the translation from spelling to sound, and if these symbol-sound correspondences are not one to one, research is needed regarding children's pronunciation behavior. When a child encounters an unfamiliar written word, what factors influence his choice of pronunciation? The present study is concerned with this question.

Chapter I

STATEMENT, BACKGROUND AND RATIONALE OF THE PROBLEM

Statement of the Problem

This study was designed to investigate elementary pupils' pronunciations of selected vowel clusters for which predictable letter-sound correspondences rarely exist, and to compare the observed pronunciations to pronunciation frequencies of vowel clusters in common English words.

In more specific terms, the investigation dealt with the following questions:

1. How well do children's pronunciations of vowel clusters in synthetic words approximate the actual pronunciation frequencies of the same vowel clusters?

2. What differences are there in the vowel cluster pronunciation frequencies of good and poor readers?

3. Do boys and girls differ in their pronunciations of vowel clusters?

4. What differences are there in the vowel cluster pronunciations of second, fourth, and sixth grade subjects?

5. Do children of different community types differ in their pronunciations of vowel clusters?

6. Will children's pronunciations of vowel clusters be more closely related to the letter-sound correspondences on a type corpus or a token corpus?

7. Will word position or consonant environment affect the pronunciation of vowel clusters in synthetic words?

Background

Educators who are concerned with the improvement of reading instruction are rarely satisfied with the status quo. For years the field of reading has been characterized by the ubiquitous debate over beginning reading methodology. Proponents of such methods as language experience, whole-word, individualized instruction, synthetic phonics, linguistic, and modified alphabets have been prolific in their research, writing and speaking.

The publication of Chall's survey (1967) generated increased polemics, for her conclusions tended to dispel "conventional wisdom". Admitting that no single approach to beginning reading was all good or all bad, she nevertheless concluded that ". . . the first step in learning to read one's native language is essentially learning a printed code for the speech we possess" (p. 83). A growing number of reading specialists (Clymer, 1968; Goodman, 1964; Burns, 1965; Betts, 1964; Lamb, 1968; and others) and linguists (Fries, 1963; Bloomfield, 1961; Hall, 1961; Venezky, 1966; Weber, 1968; Weir, 1964; and others) are generally in accord with this view.

This study was not designed to compare methodologies in either the "meaning emphasis" or "decoding emphasis" philosophies, but was intended to examine in detail one aspect of the "code." American English uses more than 40 phonemes, depending on regional dialect, represented in a variety of ways by the 26 letters of the Roman alphabet. The net result is several hundred letter-sound correspondences (Bronstein, 1960). Whatever method of reading instruction is used with the beginning reader, the child must somehow develop the ability to translate the written form of English into its oral counterpart. He must sooner or later be taught--or discover for himself--the code.

Only a knowledge of the code--the relationship between some two dozen letters and 40 or more sounds--will permit readers to increase their reading fluency and vocabulary. Without this understanding and its inherent transfer, each word would have to be memorized. In fact, studies show that good "whole-word" readers have discovered and use letter-sound correspondences (Bishop, 1964).

Language has been dissected in various ways by linguists and educators. Bloomfieldian linguists refer to four levels of language: the phonemic, morphemic, syntactic, and semantic (Hockett, 1958). The transformational-generative linguists of the Chomsky school speak of competence and performance--the deep structure and surface structure, and the syntactic, lexical, semantic, and phonetic components (Chomsky, 1957), while the importance of the suprasegmental phonemes of stress, intonation, and juncture, is advanced by Trager and Smith (1957). Regardless of one's notions of the structure and component parts of the language, the graphic representation of language, the orthography, is the barrier which must be crossed in learning to read. The orthography--and its relation to sound--is the most important feature of language for anyone learning to read.

Mathews attributes the extraordinary greatness of the Greeks to the acceptance of this linguistic fact:

> Although various peoples had been writing for thousands of years before the Greeks, the latter outstripped all those who had preceded them in this field. The secret of their phenomenal advance was in the vividness of their conception of the nature of a word. They reasoned that words were sounds, or combinations of ascertainable sounds, and they held inexorably to the basic proposition that writing, properly executed, was a guide to sound. Their firm adherence to this view caused them to be dissatisfied with the failure of the Egyptians and the Semites to take full account of all the speech sounds, the vocalic ones in writing being slighted.
>
> Other peoples, such as the Babylonians and the Egyptians, had caught glimpses of the desirability of having signs represent sounds, not things, but they were never able to break with convention to the extent of setting aside picture writing in favor of letter writing. The fundamental defect of picture writing was that it was not based upon sounds at all. The Greeks saw this basic weakness and by avoiding it achieved everlasting distinction (Mathews, 1967, p. 7).

If one accepts the fact that language is oral and writing is a representation of speech, and further that the ability to read involves, either consciously or subconsciously, the translation from written symbols to sound, it must follow that accurate information about the symbol-sound relationships of English is needed. Until this decade little information of this nature had been accumulated scientifically. Spelling reformers had, perhaps, contributed the greatest quantity of literature on English orthography, but their arguments were based on the assumption that alphabets should be perfectly phonetic or phonemic, i.e., for each sound there should be a letter. Nevertheless, many interesting observations of the nature of speech came from reformers such as Hart.

Since the 16th Century, studies of symbol-sound relationship in English have been published. Abercrombie (1948) and Dobson (1959) survey most (if not all) of the earlier works. Perhaps the most complete analysis of spelling-to-sound correspondences during those early times was that of Douglas in 1740 (Holmberg, 1956). In fact, some of the more recent descriptions of letter-sound relationships are inferior to the work of Douglas.

Robert Hall published a monograph barely a decade ago, concerned with the relationship between letters and sounds (1961). His primary intent was to present solid linguistic information which might contribute to the demise of the then prevalent "look-say" method of reading instruction. His work includes lists of English phonemes and their various graphemic representations. Hall's contention that many of the "irregularities" in English were intentionally devised some 500 years ago to keep reading and writing in the hands of the upper classes, runs contrary to language history. However, he feels the only way to teach reading effectively is to establish in the learner's mind a correlation between letters and sound (p. 60).

In 1961 Venezky (1963) developed a computer program to derive and tabulate spelling-to-sound correspondences in a corpus of 20,000 common English words. The computer analysis provided:

> A complete tabulation of the spelling-to-sound correspondences in a corpus, based upon the position of consonant and vowel clusters within the printed words. For any continuous string of vowels or consonants found in a printed word, the tabulations include all of the pronunciations found for that string, along with the totals and percentages for each pronunciation in each word-position (initial, medial and final), and complete word lists for each correspondence found . . ." (Venezky, 1967).

Weir (1964) advanced the hypothesis that if the writing system of English is viewed as a morphophonemic system, there is a much greater degree of regularity evident than if a letter-to-sound relationship were assumed. That study and later work by Weir and Venezky (1965) lent considerable support to this hypothesis. One of the results of their analyses was the description of language-dependent units on the graphemic level, called functional units, which are significant for the prediction of sound from spelling. Functional units are divided into two classes--relational units and markers. Relational units refer to a string of one or more graphemes which relate directly to a morphophonemic correspondent; for example, t —>/t/ and ph —>/f/ not /p/ + /h/. Markers are one or more graphemes whose primary function is to indicate the correspondences of relational units, or to preserve a pattern, For example, the e in rate marks a —>/e/. The major relational units include simple and compound consonants, single vowels, and vowel clusters.

Venezky's and Weir's work showed that many letter-to-sound correspondences are very predictable, while others are not. F is /f/ in all English words except of, for example, and c is /k/ before a, o and u and /s/ before e, i, and y (with certain exceptions, cello, social), but oo may be either /u/, /ʊ/ or /ə/ before d as in food, good and blood.*

Other examinations of letter-sound correspondences have been conducted by Oaks, Fry, Clymer, and Burmeister (Burmeister, 1968). The principal purposes of these studies were to test the usefulness of commonly taught phonics generalizations. These writers generally concluded that many of the phonics "rules" being taught were of little

*All phonemic symbols are from the International Phonetic Alphabet, devised by the International Phonetic Association. A listing of most phonemic symbols of American English is given in Appendix A.

value because of the numerous exceptions. These studies, though interpreted by the authors to show the irregularities of English, point out in a limited way what the computers have divulged more thoroughly--English orthography is not the highly irregular system many have thought it to be.

Hanna approached the problem of symbol-sound relationships from the other direction, that is, from sound to symbol (Hanna, et al., 1966). Since Hanna et al., were concerned with spelling rather than reading improvement, they tabulated the different spellings for a given sound, rather than the different sounds for a given spelling. They developed a 17,000 word corpus extracted from the Thorndike-Lorge, Teacher's Word Book of 30,000 words and Merriam-Webster, New Collegiate Dictionary. Their computer analysis of the corpus provided a complete analysis of sound to spelling correspondences in these English words.

To test the utility of certain phonic generalizations, Burmeister attempted to identify the most common sounds of each vowel pair through an analysis of the aformentioned Hanna study (Burmeister, 1968). However, her tables list only 26 of the many vowel clusters listed by Hanna; among the omitted clusters is io, which is the most common in English. Furthermore, some of her conclusions lack observable support. For example, her tables show ea —>/i/ 50.5% and ow —>/o/ 50%, yet she includes them in the category of vowel clusters which can be profitably taught with the "two vowels go a 'walking'" rule. Some of her terminology is confusing. "Ordinarily when two vowels appear together they should be viewed as a grapheme . . ." (p. 445), probably refers to the fact that contiguous vowels usually represent one phoneme.

In general, her investigation seemed less than rigorous.

While both linguists and educators have examined the relationship between symbol and sound in the English language, very little research has been conducted on the child's acquisition of the symbol-sound code. Descriptions of two such studies follow.

Biemiller and Levin conducted a study of the latency of oral response to words containing digraph spellings (sh, ai, ng) and "common clusters" (sl, cl). Their study was designed to examine the importance of auditory versus visual processing of stimulus words. They sampled 48 children drawn from the second, third and fourth grades, and presented them with words either preserving the intactness of the digraph (sh ed) or breaking the two letters (s hed).

> Results indicated that second and third graders took nearly one second longer to read words whose initial and final digraph were broken than they did to read words whose digraphs were presented intact. The effect did not occur for fourth grade children. There were no latency effects attributable to breaking medial, vowel digraph (Levin, et al., 1968, p. 178).

Of relevance to the current study is the conclusion that pronunciation of vowel clusters is not affected by division of the cluster. This suggests that children expect one phoneme rather than two when encountering vowel clusters.

Another investigation of children's acquisition of symbol-sound correspondences was undertaken by Calfee, Venezky and Chapman (1968) whose major concern,

> was to find the extent to which the reader used (regular) correspondences in pronouncing synthetic words, and how they pronounced synthetic words for which no such regular correspondence existed (p. IX).

They used 40 synthetic words, each typed in sans-sarif capital letters and mounted on a 35mm slide, which the subjects were to pronounce. A total of 245 students from the third, sixth, eleventh and twelfth grades, and college, participated in the study. Their general conclusion was that good readers consistently gave more appropriate responses to predictable letter-sound correspondence patterns than poor readers, though no group--even the oldest and the best readers--gave appropriate responses all the time.

Some of the synthetic words contained vowel clusters which have, as noted earlier, unpredictable letter-sound correspondences. Calfee, et al., found,

> With the exception of ea and ee, overall agreement on a preferred pronunciation for a vowel digraph was not high; neither was there high agreement on specific items. Shifts in pronunciation of a given digraph as a result of context were observed, however, suggesting that choice of pronunciation may be contextually bound. Whatever the moderating mechanism, the spread of observed pronunciations for most digraph spellings suggests that it tends to be idiosyncratic (p. 167).

No other research regarding children's pronunciations of vowel clusters has been undertaken, to the knowledge of this investigator.

While developing reading ability, children's generalizations result more often from example than from rule. Therefore, more information is needed about how children generalize from language input data, and the first step is to know what the input is. Since reading involves the ability to translate written symbols to sound, and since the letter-sound correspondences of vowel clusters are generally not predictable, awareness of the frequencies of the several pronunciations of each vowel cluster spelling in common English words is required.

Nearly one-third of the most common 20,000 words, and one-fifth of the 1,000 most frequent words in English contain vowel cluster spellings. Unless each of these is to be learned as a sight word, which is not practicable, a listing of all vowel clusters in English, and the phonemes and phonemic strings they represent, is needed. This information is an essential basis for an investigation of children's generalization behavior with vowel cluster spellings.

What do young readers do when they encounter familiar vowel clusters in unfamiliar words? When they come upon an unfamiliar word with an ea cluster, do they attempt /i/ as in teach, or /ɛ/ as in dead, or /e/ as in great? Accurate and all-encompassing generalizations about compound vowel pronunciations cannot be taught, as they can with many other letter-sound correspondences--(t usually is /t/, c is usually /k/ before a, o, and u, etc.). Information is needed about how young readers pronounce unfamiliar words containing vowel clusters. Flexibility has long been a goal of reading instruction. Are children flexible readers? For example, when asked to pronounce unfamiliar words containing ow, will a child always give the /o/ pronunciation as in grow, or the /au/ sound as in now, or will he vary his pronunciations? Research is needed which will relate the pronunciation preferences of children to actual characteristics of the language.

Rationale for the Investigation

Vowel clusters are perhaps the most complex and unpredictable components of the letter-sound correspondence code. Vowel cluster spellings differ from single vowel spellings in several ways. They rarely appear before geminate consonant clusters; some, such as ai and au occur infrequently in word-final position. Others, oa, ie, etc., rarely begin a word in English.

Some vowel clusters have a major phonemic correspondent, and possibly several minor correspondents. The major correspondent of ai is /e/ as in bait, and it represents this sound in 85% of its occurrences. It represents /ə/, villain; /ai/, aisle, /ɛ/, again; /æ/, plaid; and others much less frequently. Other vowel clusters have two or more major correspondents, as well as minor correspondents. For example, ow is /o/ as in own 51% of the time and /au/ as in owl 48%. Its only minor correspondent is /a/ as in knowledge. On the other hand, all single vowel spellings have two major correspondents, (e.g., a —>/e/ or /æ/) plus several minor correspondences.

While single-vowel spellings can be traced to the earliest English writing, most vowel cluster spellings are much more recent, having been introduced during the late Middle English period. Consequently, vowel cluster correspondences underwent considerably fewer sound changes than did single-vowel spelling, though they did undergo some change (Mosse, 1952). For example, the Middle English diphthong /au/, spelled au or aw, developed in a complex manner (including French borrowings). With the Great Vowel Shift, Middle English /au/ became /ɔ/, though the au-aw spelling was retained. The vowel cluster oo first appeared in the 14th Century to represent /o:/, but did not become established until the 16th Century. /o:/ changed to /u:/ through the Great Vowel Shift, and to /u/ in Modern English. In some oo spelled words, /u:/ shortened to /ʊ/ as in book, and was later unrounded to /ə/ as in flood (Venezky, 1963).

The goals of the present study are to examine vowel cluster-sound relationships. Given that certain factors of pronunciation exist, (that is, in common English words many vowel clusters have six or more pronunciations), what factors influence a child's pronunciations of vowel-cluster words? Are good readers' pronunciations more often in the range of theoretical possibility than poor readers? What differences arise as children progress through the elementary grades? Is pronunciation related to community environment or sex? Does consonant environment affect pronunciation choice?

The present study seeks to answer questions about the relationships between the pronunciations of vowel clusters by a representative sample of elementary school children, and vowel cluster--phoneme correspondences in a large corpus of common English words. Such information should provide a source for the modification of beginning reading materials and methods. For example, au is /ɔ/ as in cause in 90% of common English words but is /æ/ as in laugh in only two words and their derivations. Since laugh and aunt are frequently taught as "sight" words in early reading, it might be expected that children develop a false generalization about au which they apply to unfamiliar words they encounter--even though letters and sounds are not stressed with "sight" words. The present study will reveal the extent to which this happens with the different types of children studied.

Definition of Terms

Several terms are important to an understanding of this study. They are defined as follows:

Vowel Cluster: a group of letters composed of two or more contiguous vowel graphemes. It is used synonomously with compound vowel, vowel pair, or vowel digraph. There are 61 different vowel clusters in the corpus of 20,000 common English words used by Venezky, 1963; some occur in only one word and one occurs in more than 1,000 words. (aie occurs in one word--gaiety, while io occurs in 1,293 words--action, ratio, lion, etc.)

Letter-Sound Correspondence: a grapheme-phoneme relationship. Many letters, like d, f, l and z have invariant or nearly invariant pronunciations (d—>/d/, f—>/f/ except in of where f—>/v/) and are, therefore, predictable. Some letters, like b, c, and m have variant letter-sound correspondences which can be predicted on the basis of grapheme environment (c—>/s/ before e, i, or y--cell, city, cyst, otherwise c—>/k/). Each single letter vowel, (a-e-i-o-u-y), has two major correspondences (long and short as in cape and cap), which are usually predictable, and other less predictable pronunciations. Vowel clusters generally have several letter-sound correspondences (ou—>/au/, /ʊ/, and /u/ as in found, would and you) which, in most instances, are not predictable.

20,000 Word Corpus: a 1963 modification of the Thorndike list of 20,000 most frequent English words (Venezky, 1963). The original Thorndike list was revised by Venezky primarily through deletion of archaic words and addition of new words. The revised list was programmed for a computer analysis of the letter-sound correspondence therein. The output included a complete tabulation of spelling-to-sound correspondences, along with word lists for each correspondence. In addition, a sound-to-spelling correspondence listing, a reversed spelling listing, and a reversed pronunciation listing was obtained. An analysis of the corpus by this investigator revealed 61 different vowel clusters, representing 92 different phonemes and phoneme strings for a total of more than 300 letter-sound correspondences in over 6,000 words.

1,000 Word Corpus: the 1,003 most frequent English words derived from a corpus of 1,000,000 running words by Kučera and Francis (1967). This corpus is the most recent and certainly the most exhaustive computer tabulation of word frequencies to date. The 1,000 word corpus used in this study contains the 1,003 most frequently written American English words, ranging from the most frequent, the, which occurs 69,971 times per million running words, to the 1,003rd most frequent (11 words, each occurring 106 times per 1,000,000 running words--applied, reach, etc.).

Type: a "distinct word," viewed as one word regardless of how frequently the word appears. (the and applied are considered distinct words regardless of their frequencies.)

Token: an "individual word" considered for this study in terms of frequency of its appearance. In this study pronunciation frequencies of words in the 1,000 word corpus are based on tokens, while pronunciations in the 20,000 word corpus are based on types. The following example is offered for clarification. In the 1,000 word corpus there are five words which contain the au spelling. Of these five, four have the /ɔ/ pronunciation (because, etc.), while one has the /æ/ pronunciation (laugh). With a token description--based on number of occurrences of each word in 1,000,000 running words, /ɔ/ is equal to 91.34% and /æ/ 8.57%. By comparison, if the pronunciation frequencies were based on types, /ɔ/ would equal 80% and /æ/ 20%.

Reading Ability: performance on a standardized reading test. All subjects in this study received a grade-level equivalent reading score, on such standardized reading tests as the Metropolitan Achievement or the Iowa Test of Basic Skills (see Appendices D, E, and F).

Intelligence: performance on a standardized group intelligence test (see Appendices D, E, and F).

Distractor: a multiple choice response item.

Chapter II

SELECTION OF VOWEL CLUSTERS

This study was designed to achieve two broad objectives: (1) to investigate elementary pupils' pronunciations of vowel clusters in unfamiliar words, and (2) to analyze the observed pronunciations in relation to existing letter-sound correspondences of vowel clusters in common English words. This chapter contains a description of the analysis of the vowel clusters in 20,000 common English words, and the procedures followed in the selection of representative vowel clusters used in this investigation. The symbol-sound correspondences of the selected vowel clusters as they occur in the 1,000 most frequent English words are presented also.

Analysis of Vowel Cluster Letter-Sound Correspondences

As part of an inter-disciplinary study of the reading process begun at Cornell University in 1961, Venezky developed a computer program to derive and tabulate letter-sound correspondences in a corpus of 20,000 common English words (Venezky, 1963). The 20,000 word corpus was a modification of the most common 20,000 words according to the Thorndike frequency count (Thorndike, 1941). Venezky omitted many archaic and low frequency words, particularly proper nouns, and added a number of words in their place. Along with other information, the computer analysis provided an inclusive tabulation of letter-sound correspondences found in the corpus as well as totals and percentages for each pronunciation in each word position, and a complete word list for each correspondence. A Pronouncing Dictionary of American English (Kenyon & Knott, 1953) was used to determine the pronunciation of most words in the corpus.

The principal purpose of this analysis and later research by Venezky and Weir was, ". . . to construct a theoretical framework for deriving sound from spelling and to search for the most plausible linkages for fitting these relationships into the total language structure" (Venezky, 1967, p. 80). Later work by Venezky and others was concerned with whether or not readers use these theoretical patterns of symbol-sound relationships when reading.

Venezky's unpublished computer print-out of spelling-to-sound correspondences in 20,000 English words was made available to this investigator during the academic year 1968-1969. An analysis of the vowel cluster letter-sound correspondences in this print-out disclosed the following:

1. There were 61 vowel clusters, including those containing the semi-vowels w and y in the corpus.

2. The 61 vowel clusters represented 92 different single vowel phonemes and phoneme strings, producing more than 300 symbol-sound correspondences.

3. The 61 vowel clusters appeared 6,272 times in the 20,000 word corpus.

4. There was great variance in the frequency of occurrence of the 61 vowel clusters in the 20,000 word corpus. As shown in Table 2:01, one occurred in more than 1,000 words while 25 occurred in three words or less.

Table 2:01

Frequency of Vowel Clusters in 20,000 Word Corpus

Number of Clusters	Number of Words
1	over 1000
2	500 - 999
14	100 - 499
9	50 - 99
4	10 - 49
6	4 - 9
25	1 - 3

5. Vowel clusters varied greatly in the number of individual phonemes or phoneme strings they represented. Table 2:02 indicates that some represented only one sound while one represented 17 sounds.

Table 2:02

Frequency of Occurrences of Vowel Clusters and the

Numbers of Sounds they Represent

Vowel Cluster	Number of Words in Which it Occurs	Number of Sounds it Represents
io	1293	10
ea	599	17
ia	581	15
ou	475	11
ee	319	6

Table 2:02 (cont.)

Vowel Cluster	Number of Words in Which it Occurs	Number of Sounds it Represents
oo	312	7
ai	303	9
ie	274	15
ow	256	3
au	191	6
ay	159	8
iou	139	5
oi	130	7
oa	125	7
ue	108	16
ua	104	13
ui	102	8
ei	94	8
ey	92	5
aw	88	3
ew	82	3
eo	75	13
iu	56	4
oy	56	2
oe	52	10
eu	51	8
eou	33	2
uou	27	3

Table 2:02 (cont.)

Vowel Cluster	Number of Words in Which it Occurs	Number of Sounds it Represents
ae	21	7
eau	14	3
ao	6	3
ieu	5	2
iew	5	1
oui	5	3
aeo	4	4
uo	4	3
uy	3	1
uoy	3	1
aa	2	1
oia	2	1
uay	2	1
eea	1	1
aea	1	1
eia	1	1
iaow	1	1
ii	1	1
oau	1	1
eow	1	1
ioa	1	1
uia	1	1
eoi	1	1

Table 2:02 (cont.)

Vowel Cluster	Number of Words in Which it Occurs	Number of Sounds it Represents
eei	1	1
oeu	1	1
oie	1	1
oua	1	1
eue	1	1
aiia	1	1
aii	1	1
aie	1	1
oue	1	1
uu	1	1

6. Most vowel cluster pronunciations are unpredictable; their sounds cannot be predicted from their spellings.*

7. Of the 61 vowel clusters, 30 occurred in 10 or more words in Venezky's modification of Thorndike's list of 20,000 common words. Of the 30, 23 occurred in words in which the vowel cluster is sometimes disyllabic. Only six of these vowel clusters were disyllabic more often than monosyllabic. Thus, the 30 vowel clusters, occurring in more than 6,000 words, represented single vowel phonemes about 80% of the time and two or more phonemes about 20%. This is shown in Table 2:03.

*A symbol-sound correspondence is considered predictable if it can usually be determined within a consonant environment. For example, g is usually /g/ before a, o, and u, as in game, go, and gum. On the other hand, ea may be either /i/, /ɛ/, or /e/ before /t/, as in heat, threat, and great. Therefore, ea is considered unpredictable.

Table 2:03

Monosyllabic and Disyllabic Status of the

30 Most Common Vowel Clusters

	One Syllable		Disyllabic	
Vowel Cluster	Number of Words	Per Cent	Number of Words	Per Cent
ae	18	85.7%	3	14.3%
ai	298	98.3%	5	1.7%
au	191	100.0%	0	0.0%
aw	86	87.7%	2	2.3%
ay	158	99.4%	1	0.6%
ea	486	81.1%	113	18.9%
ee	310	97.2%	9	2.8%
ei	68	72.3%	26	27.7%
eo	19	25.3%	56	74.6%
eou	8	24.2%	25	75.8%
eu	37	72.5%	14	27.5%
ow	82	100.0%	0	0.0%
ey	92	100.0%	0	0.0%
ia	150	25.8%	431	74.2%
ie	184	67.1%	90	32.9%
io	1,141	88.2%	152	11.8%
iou	79	56.8%	60	43.2%
iu	4	7.1%	52	92.9%
oa	104	83.2%	21	16.8%

Table 2:03 (cont.)

Vowel Cluster	One Syllable Number of Words	One Syllable Per Cent	Disyllabic Number of Words	Disyllabic Per Cent
oe	30	57.7%	22	42.3%
oi	108	83.1%	22	16.9%
oo	305	97.8%	7	2.2%
ou	475	100.0%	0	0.0%
ow	256	100.0%	0	0.0%
oy	56	100.0%	0	0.0%
ua	1	1.0%	103	99.0%
ue	76	70.3%	32	29.7%
ui	68	62.7%	34	37.3%
uou	0	0.0%	27	100.0%
TOTAL	4,904		1,307	

Perhaps the best way to exemplify the variety of possible pronunciations of the vowel clusters is to list the most common clusters and their most common pronunciations. The following tables, 2:04 through 2:20, list each of the 17 vowel clusters which occurred in more than 100 words in the corpus. For each cluster the four most common pronunciations are included.

Table 2:04

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster <u>ai</u>

Phoneme	Number of Words	Percentage	Example
/e/	260	85.8%	bait
/ə/	20	6.6%	villain
/ɪ/	6	2.0%	captain
/ai/	5	1.7%	aisle
5 others	12	3.9%	plaid

Total Occurrences - 303 words

Table 2:05

Frequency of Occurrence of the 4 Most Common

Pronuncuations of the Vowel Cluster <u>au</u>

Phoneme	Number of Words	Percentage	Example
/ɔ/	175	91.6%	cause
/o/	6	3.1%	chauffeur
/æ/	5	2.6%	laugh
/au/	3	1.6%	kraut
2 others	2	1.1%	gauge

Total Occurrences - 191 words

Table 2:06

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster ay

Phoneme	Number of Words	Percentage	Example
/e/	142	89.3%	day
/ɪ/	10	6.3%	always
/ai/	2	1.3%	aye
/ɛ/	1	0.7%	says
4 others	4	2.5%	picayune
Total Occurrence - 159 words			

Table 2:07

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster ea

Phoneme	Number of Words	Percentage	Example
/i/	318	53.1%	each
/ɛ/	135	22.6%	breakfast
/iə/	45	7.5%	cereal
/ɪə/	24	4.0%	area
13 others	77	12.8%	ocean, great
Total Occurrence - 599 words			

Table 2:08

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster ee

Phoneme	Number of Words	Percentage	Example
/i/	293	91.8%	bleed
/ɪ/	12	3.8%	been
/iɛ/	8	2.5%	preempt
/e/	3	1.0%	matinee
2 Others	3	0.9%	reelection
Total Occurrence - 319 words			

Table 2:09

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster ia

Phoneme	Number of Words	Percentage	Example
/ɪə/	238	41.0%	alias
/ə/	124	21.3%	special
/ɪe/	77	13.2%	humiliate
/aiə/	56	9.7%	giant
11 Others	86	14.8%	piano
Total Occurrence - 581 words			

Table 2:10

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster ie

Phoneme	Number of Words	Percentage	Example
/i/	73	26.7%	movie
/ɪ/	42	15.3%	sieve
/ɪə/	33	12.0%	audience
/aiə/	27	9.9%	diet
11 Others	99	35.1%	friend, lie

Total Occurrence - 274 words

Table 2:11

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster io

Phoneme	Number of Words	Percentage	Example
/ə/	1,138	88.0%	action
/ɪə/	33	2.5%	idiot
/jə/	30	2.3%	onion
/aiə/	29	2.2%	lion
8 Others	63	5.5%	trio

Total Occurrence - 1,293 words

Table 2:12

Frequency of Occurrence of the 5 Most Common

Pronunciations of the Vowel Cluster <u>iou</u>

Phoneme	Number of Words	Percentage	Example
/ə/	75	54.0%	delicious
/ɪə/	59	42.4%	furious
/jə/	3	2.2%	rebellious
/u/	1	0.7%	Sioux
/aijə/	1	0.7%	pious
Total Occurrence - 139 words			

Table 2:13

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster <u>oa</u>

Phoneme	Number of Words	Percentage	Example
/o/	94	75.2%	oat
/oə/	13	10.4%	coalition
/ɔ/	9	7.2%	broad
/oæ/	6	4.8%	coagulate
3 Others	3	2.4%	oasis
Total Occurrence - 125 words			

Table 2:14

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster <u>oi</u>

Phoneme	Number of Words	Percentage	Example
/ɔi/	104	80.0%	coin
/oɪ/	18	13.8%	coincide
/ə/	3	2.3%	porpoise
/uɪ/	2	1.5%	doing
3 Others	3	2.4%	chamois

Total Occurrence - 130 words

Table 2:15

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster <u>oo</u>

Phoneme	Number of Words	Percentage	Example
/u/	194	62.2%	boot
/ʊ/	84	26.9%	foot
/ə/	23	7.4%	flood
/oa/	6	1.9%	zoology
3 Others	5	1.6%	brooch

Total Occurrence - 312 words

Table 2:

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster ou

Phoneme	Number of Words	Percentage	Example
/au/	238	50.1%	ounce
/ə/	181	38.2%	touch
/u/	30	6.3%	soup
/o/	13	2.7%	soul
6 Others	13	2.7%	should
Total Occurrence - 475 words			

Table 2:17

Frequency of Occurrence of the 3 Most Common

Pronunciations of the Vowel Cluster ow

Phoneme	Number of Words	Percentage	Example
/o/	131	51.2%	own
/au/	122	47.7%	cow
/a/	3	1.1%	knowledge
Total Occurrence - 256 words			

Table 2:18

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster <u>ua</u>

Phoneme	Number of Words	Percentage	Example
/uə/	44	42.3%	actual
/ue/	14	13.5%	fluctuate
/jue/	13	12.5%	evacuate
/juə/	11	10.6%	annual
9 Others	22	21.1%	language
Total Occurrence - 104 words			

Table 2:19

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster <u>ue</u>

Phoneme	Number of Words	Percentage	Example
/u/	25	23.1%	blue
/ju/	24	22.2%	value
/#/	23	21.3%	tongue
/uə/	14	13.0%	cruel
12 Others	22	20.4%	guess
Total Occurrence - 108 words			

Table 2:20

Frequency of Occurrence of the 4 Most Common

Pronunciations of the Vowel Cluster <u>ui</u>

Phoneme	Number of Words	Percentage	Example
/ju/	21	20.6%	ambiguity
/u/	19	18.6%	fruit
/ɪ/	13	17.6%	build
/wɪ/	18	17.6%	penguin
4 Others	26	25.6%	ruin
Total Occurrence - 102 words			

<u>Selection of Vowel Clusters for Study</u>

Rather than study all 61 vowel clusters, it was decided that a representative subset of the total array of vowel clusters would permit sufficient analysis of children's vowel cluster pronunciation behavior. The two principal criteria used for selection of the appropriate vowel clusters to include were frequency of occurrence and phonemic representation.

To begin, all vowel clusters occurring in fewer than 100 words were eliminated; these totaled 44. The remaining 17 were analyzed to determine the range of their sound correspondences. To test children's pronunciations of the spectrum of vowel clusters it was deemed necessary to include: (1) some clusters which have one principal pronunciation, such as ai—>/e/ (gain), oa—>/o/ (boat), and au—>/ɔ/ (pause); (2) clusters which have two principal pronunciations such as oo—>/u/ (food) or /ʊ/ (good), and ow—>/o/ (grow) and /au/ (plow), and ou->/au/ (proud) and /ə/ (famous); and (3) clusters with more than two main pronunciations such as ie->/i/ (movie), /I/ (sieve) and /ai/ (die). The cluster ay was included because of its alternation with ai in word position, and ea was included because of its frequency. Though io was the most frequent vowel cluster, it was omitted because nearly 90% of the time it occurs in /ʃən/ syllables as in nation and passion.

Based upon the preceding criteria, these nine vowel clusters, ai, au, ay, ea, ie, oa, oo, ou, and ow, appeared to comprise a representative cross-section of all vowel clusters. Further, they accounted for nearly half of all the occurrences of all 61 vowel clusters in the modified Thorndike 20,000 word corpus. By testing each of them in a variety of environments, a manageable instrument could be constructed.

Letter-Sound Correspondences of the Nine Selected Vowel Clusters in the 1000 Most Frequent English Words

The pronunciation frequencies of the modified Thorndike 20,000 word corpus discussed and tabled previously, were based on word types. That is, each word received the same weight and was counted only once regardless of its frequency in the sample of written words from which the corpus was selected. Common vowel cluster words such as would, could, and should affected the pronunciation proportions no more than such rarely used words such as brooch and ooze.

To provide another basis for the analysis of children's pronunciations of vowel clusters in relation to actual pronunciation frequencies, an analysis of token word frequencies was required. In 1967 Kučera and Francis published an exhaustive computational tabulation of English words. The corpus consisted of 1,014,232 words of natural-language text in 15 different genre, and included 50,406 distinct words (types). Their analysis ranked these fifty thousand words on the basis of their frequencies in the total sample. For example, the was the most frequent word, occurring 69,971 times while accordian was one of the most infrequent, occurring only once.

One possible influence on children's pronunciations could be a large number of words with the same vowel cluster letter-sound correspondence, and another influence could be highly frequent words with a different correspondence. Assuming a child knows five words with ai spellings, maid, lain, paid, pain, and said, would his pronunciation of ai in an unfamiliar word be more greatly influenced by the first four relatively infrequent words, or by the highly frequent word said? For example, ou is /au/ (ounce) in 50% of the words in which it occurs and is /ʊ/ (could) in only 1%. Yet the /ʊ/ pronunciation occurs in three highly frequent words, would, could, and should. Would children's pronunciations of vowel clusters in unfamiliar words be more closely related to the vowel cluster pronunciation proportions on the type corpus or the token corpus?*

*In subsequent analyses of the data, the pronunciation proportions of both the type corpus and the token corpus were used in relation to the pronunciation proportions of the subjects. All hypotheses tested in this investigation are based on either type or token vowel cluster pronunciation proportions.

This investigation analyzed the 1000 most frequent words in the Kučera-Francis Corpus to determine the frequency of pronunciation of the nine vowel clusters based on tokens. Pronunciations were derived from Kenyon and Knott's A Pronouncing Dictionary of American English. Words in this subset of 1000 words occurred from 106 to 69,971 times per million running words. It was found that approximately 20% of the words in this (token) corpus contained vowel clusters, compared with a third of the words in the 20,000 word (type) corpus.

Table 2:21 compares the pronunciation proportions of the type and token corpora for the vowel clusters selected for this study. Further, it shows that for some vowel clusters (e.g., ow, au) there was little difference between type and token pronunciation frequencies, while for others (e.g., ou, ie) the differences were considerable. These differences were an important aspect of this study. For each vowel cluster, the principal and secondary pronunciation proportions on each corpus was determined. For example, on the type corpus the principal pronunciation of ai was /e/ at .86 and the secondary was /ɛ/ at .07. On the token corpus the principal pronunciation of ai was /ɛ/ at .38 and the secondary was /e/ at .27. In the analyses reported in Chapters 3 and 4, subjects' pronunciation proportions were related to the proportions on each corpus.

Table 2:22 presents the words' position percentages for each of the selected vowel clusters. These percentages became the basis of word positions of the vowel clusters in the synthetic words used in the study. Construction of these synthetic words is discussed in Chapter 3.

Table 2:21

A Comparison of Vowel Cluster Pronunciation Proportions

in the 20,000 Word and 1,000 Word Corpora

Vowel Cluster	Phoneme	Type Corpus (20,000)		Token Corpus (1,000)		Example
		Words	Per Cent	Words	Per Cent	
ai	/e/	260	85.8%	10	27.4%	bait
	/ə/	20	6.6%	2	9.1%	villain
	/ɪ/	6	2.0%	2	26.1%	captain
	/ɛ/	3	1.0%	1	38.3%	said
	others	10	4.6%	0	0.0%	
ay	/e/	142	89.3%	14	89.5%	days
	/ɪ/	10	6.3%	1	7.3%	always
	/ai/	2	1.3%	0	0.0%	aye
	/ɛ/	1	0.7%	1	3.2%	says
	others	4	2.5%	0	0.0%	

Table 2:21, cont.

Vowel Cluster	Phoneme	Type Corpus (20,000)		Token Corpus (1,000)		Example
		Words	Per Cent	Words	Per Cent	
au	/ɔ/	175	91.6%	4	91.4%	cause
	/o/	6	3.1%	0	0.0%	chauffer
	/æ/	5	2.6%	1	8.6%	laugh
	/au/	3	1.6%	0	0.0%	sauerkraut
	others	2	1.1%	0	0.0%	
ea	/i/	318	53.1%	22	57.4%	each
	/ɛ/	135	22.6%	9	22.8%	bread
	/iə/	45	7.5%	3	8.1%	cereal
	/e/	12	2.0%	2	10.2%	great
	others	89	14.8%	1	1.5%	
ie	/i/	73	26.7%	8	46.6%	movie
	/ai/	25	9.1%	2	10.7%	lie
	/ɛ/	5	1.8%	2	11.4%	friend

Table 2:21, cont.

Vowel Cluster	Phoneme	Type Corpus (20,000)		Token Corpus (1,000)		Example
		Words	Per Cent	Words	Per Cent	
(cont.)						
ie	/aiə/	4	1.5%	2	14.3%	diet
	others	166	60.9%	3	16.7%	
oa	/o/	94	75.2%	2	100.0%	boat
	/oə/	13	10.4%	0	0.0%	coalition
	/ɔ/	9	7.2%	0	0.0%	broad
	/oae/	6	4.8%	0	0.0%	coagulate
	others	3	2.4%	0	0.0%	
oo	/u/	194	62.2%	8	47.8%	boot
	/U/	84	26.9%	7	50.0%	foot
	/ə/	23	7.4%	1	2.2%	flood
	/oa/	6	1.9%	0	0.0%	zoology
	others	5	1.6%	0	0.0%	

Table 2:21, cont.

Vowel Cluster	Phoneme	Type Corpus (20,000)		Token Corpus (1,000)		Example
		Words	Per Cent	Words	Per Cent	
ou	/au/	238	50.1%	15	36.4%	ounce
	/ə/	181	38.2%	7	7.9%	touch
	/u/	30	6.3%	4	22.5%	soup
	/U/	6	1.3%	5	25.9%	should
	others	20	4.1%	4	7.2%	
ow	/o/	131	51.2%	15	46.7%	own
	/au/	122	47.7%	6	51.4%	cow
	/a/	3	1.1%	1	1.9%	knowledge
	others	0	0.0%	1	0.0%	

Table 2:22

Word Positions of the 9 Selected Vowel Clusters in the 20,000 Word Corpus

Vowel Cluster	Number of Words	Initial Position		Medial Position		Final Position	
		Words	Per Cent	Words	Per Cent	Words	Per Cent
ai	303	7	2.3%	294	97.0%	2	0.7%
ay	159	1	0.6%	48	30.2%	110	69.2%
au	191	53	27.7%	136	71.2%	2	1.0%
ea	599	16	2.7%	559	93.3%	24	4.0%
ie	274	0	0.0%	247	88.0%	33	12.0%
oa	125	7	6.0%	112	90.0%	6	4.0%
oo	312	2	0.6%	294	94.2%	16	5.1%
ou	475	37	7.8%	433	91.2%	5	1.0%
ow	256	4	1.6%	161	62.9%	91	35.6%

Chapter III

DEVELOPMENT OF THE INSTRUMENT AND PROCEDURES OF THE STUDY

The two broad purposes of this study were: (1) to investigate the pronunciation of vowel clusters in synthetic words by elementary school children, and (2) to analyze the observed pronunciations in relation to existing letter-sound correspondences of vowel clusters in common English words.

This chapter deals with the development of experimental oral and multiple-choice instruments, the two pilot studies (A, which was concerned with testing procedures, and B, which was used to refine the instrument), the final instrument, the procedures of the study, and the design and statistical analyses of the study.

Development of the Experimental Oral and Multiple-Choice Instruments

Test Items

To adequately measure children's pronunciations of vowel clusters, it was essential that real words not be used. Had real words been used it was likely that most subjects would have been familiar with some of them, and consequently the results would have been clouded. The dependent variable, based on pronunciation of familiar vowel clusters in unfamiliar contexts, could be assessed accurately only by constructing synthetic words containing the nine vowel clusters. It was determined that each vowel cluster should be tested in ten different synthetic words to enable any pronunciation patterns to emerge.

The principal guideline followed in the construction of the synthetic words was linguistic plausibility. To assure content validity it was essential that the synthetic words resemble real words in both appearance and sound. For example, many consonant clusters appear only in initial word positions in modern English spelling, dr, fl, fr, gl, gr, sm, etc., while others occur only in final positions; ck, nt, ll, etc. To be plausible, synthetic words had to be constructed upon the patterns of English spelling.

The word positions of the vowel clusters included were controlled to reflect their position frequencies in the 20,000 word corpus. These positions were ascertained from the analysis presented in Table 2:22, found on page 42.

In the construction of the synthetic words, the choice of preceding and following consonants was based on further examination of the 20,000 word corpus. For example, since ee is never followed by g nor is ie preceded by c in English, such sequences were avoided.

The first draft of the synthetic word list, containing 10 synthetic words for each of the 9 vowel clusters was submitted to a linguist, a psycholinguist, a reading specialist and a psychologist as a further check on content validity. As a result of their evaluation, several items were deleted because of their high similarity to real words in either appearance or sound, and additional synthetic words were added.

In addition to the 90 items made up of synthetic words containing vowel clusters (10 each of the 9 vowel clusters: ai, ay, au, ea, ie, oa, oo, ou and ow) 10 check items were included to determine reliability. Five of these items were real words and five were synthetic words with predictable letter-sound correspondences (e.g., pid p—>/p/). By including 10 check items, the accuracy of subjects' performance on the instrument could be established. If a subject's responses were unreliable, that is, if he simply guessed or checked responses randomly, he could be expected to miss many of the check items. The reason for demonstrating the reliability of the instrument in this fashion was drawn from the work of Kerlinger (1957, pp. 429-430).

Kerlinger defines reliability as the accuracy or precision of a measuring instrument, and he advances several synonyms for reliability: accuracy, consistency, dependability and predictability. Of his approaches to reliability, one seemed most suitable for this instrument: "Are the measures obtained from a measuring instrument the "true" measure of the property measured?". Implicit in this question is the notion of accuracy. Each of the vowel clusters included in this study has several phonemic correspondents in common English words. For example, the vowel cluster ea is /i/ in bead, /ɛ/ in bread, /e/ in break, /ə/ in ocean. Likewise, it is /i/ in read, and lead, and /ɛ/ in read and lead. Because there were no right or wrong answers to the 90 vowel cluster items, other means of determining reliability were deemed less appropriate than assessing accuracy of response through the 10 check items.

Other suggestions by Kerlinger for the improvement of reliability of the instrument were incorporated (442-443). The items were unambiguous; each item was simply a synthetic word. Care was taken to assure that the written instructions were clear (see Appendix B). In addition, the instructions were given orally by the investigator.

Nature of the Instruments

Using the items described, two experimental tests were developed, an oral pronunciation test, and a written multiple-choice test containing the 100 test items and real word response items similar in sound to the pronunciation of the vowel cluster being tested. Both tests contained the same 100 items. The 100 items were divided into two halves (labeled A and B), each half was composed of five synthetic words for each of the nine vowel clusters, and five check items. Using a table of random numbers, each 50 items subtest was arranged in two orderings. The four orderings were designated A1, A2, B1, and B2. On the four oral subtests, each item was printed on a flash card; on the four multiple-choice subtests, the test items and response choices were duplicated on two pages (see Appendix B).

Three real words were offered as multiple-choice distractors for each synthetic word used as a stimulus. The three (distractors) contained at least two of the most frequent pronunciations of the vowel cluster in the modified Throndike 20,000 word corpus. Furthermore, the distractors were selected from Clarence R. Stone's Revision of the Dale List of 769 Easy Words (Spache, 1960), words which, purportedly, most children can read by the end of the second grade. In no case were the vowel sounds in the real words spelled the same as the vowel cluster in the synthetic word being tested. To control for order effects, the distractors for each vowel cluster were randomly assigned to each subtest ordering. As an example, Table 3:01 presents two synthetic words used to test the vowel cluster ea, and shows their test form, item number and response sequence.

Table 3:01

An Example of Test Form, Item Number and Response Sequence of Two Synthetic Words

Test Form	Item Number	Synthetic Word	Response Sequence		
A1	3	polead	be	bed	baby
A2	50	polead	be	baby	bed
B1	28	deach	bed	be	baby
B2	15	deach	baby	bed	be

In summary, there were 100 test items of which 90 were synthetic words containing 10 each of the 9 vowel clusters, 5 test items were real words, and 5 were synthetic words with predictable letter-sound correspondences. The five real words and the five predictable synthetic words were included as reliability control items.

Pilot Studies

Two pilot studies were conducted and were designated Pilot Study A and Pilot Study B. Both pilot studies were done at Waterloo Elementary School, Waterloo, Wisconsin. The essential purpose of Pilot Study A was to refine the testing procedures. Pilot Study B was designed to secure information which would contribute to the final testing instruments used in the study.

Testing Procedures for Pilot Studies A and B

During Pilot Study A and Pilot Study B, both oral and multiple-choice forms of the test were used. On the multiple-choice test, each synthetic stimulus word was followed by three discractors. All three distractors for each synthetic word contained phonemes represented by that vowel cluster in the 20,000 word corpus (see Appendix B). The multiple-choice test was designed to be administered either individually or to groups. The pupils' task was to circle a real word from a choice of three whose underlined letters were, he felt, closest in sound to the underlined letters in the synthetic stimulus word.

In addition, each synthetic word was typed on a 5" x 7" flash card using primary type, lower case letters. The flash cards were arranged in sequences identical to tests A1, A2, B1, and B2, and were designed for oral pronunciation use in Pilot Study A and Pilot Study B. The oral pronunciation test was an individual test. Each subject viewed each synthetic word on a flash card and pronounced into a tape recorder. Later, phonemic transcriptions of the tape recording were made.

Pilot Study A

Pilot Study A was conducted to refine the testing procedures. The pilot sample consisted of three second, three fourth, and two sixth grade pupils at Waterloo Elementary School, Waterloo, Wisconsin. Four of the subjects were girls, one second grader, two fourth graders, and one sixth grader; four were boys, two second graders, one fourth grader and one sixth grader. On the basis of the Gates McGinty Primary

A reading test, two second grade readers of low reading ability and one of high ability were randomly selected. Scores on the Nelson Reading Test, Form A, were used to randomly select two fourth graders and one sixth grader of low reading ability and one fourth and one sixth grade pupil of high reading ability. All subjects were randomly selected from the two halves of each class based on achievement test median splits. Pupils were given one oral and one multiple-choice form of the test next. Thus, they responded to each of the 100 items twice, once in oral form and once in multiple-choice form. Pilot Study A indicated that the subjects could comprehend the instructions and perform the tasks satisfactorily. Thus, no significant changes in the testing instrument or procedures were made.

Pilot Study B

Pilot Study B was designed to examine the relationship between subjects' oral pronunciations of synthetic words containing vowel clusters, and their multiple-choice response to the same synthetic words. The reason for determining this relationship was to gain information that would contribute to the construction of the final multiple-choice instrument to be used in the study. For example, if there were no differences in the subjects' oral and multiple-choice test performance, it could be assumed that the multiple-choice test was adequate in its present form. If there were differences, on the other hand, the final multiple-choice test would reflect such findings.

Subjects

Forty-eight subjects were selected from Waterloo Elementary School, Waterloo, Wisconsin. Waterloo is a city of 2,000 residents and it is somewhat of a composite of community types. It is near enough to Madison, Wisconsin, the State Capitol, to be considered a suburb, yet it is in a rural area, and it has some light industry. Thus, some of the school children are from farm families, others have fathers who commute to Madison, and other parents are employed in local industry.

The 48 subjects included 16 second, 16 fourth, and 16 sixth graders, Each group of 16 included 8 boys and 8 girls. Each subgroup of 8 boys or 8 girls contained 4 who were designated high in reading ability, and 4 designated low in reading ability. The reading level split was based on class median scores on the Gates McGinity Reading Test Form A in grade two, and on the Nelson Reading Test, Form A, in grades four and six. Four boys and four girls from each side of the Median Score were randomly assigned to the sub-groups to be tested. Table 3:02 shows the mean reading score for each cell in the design by grade level, by sex and by reading ability. (For a description of all subjects, see Appendix D. A listing of all reading achievement tests is found in Appendix F.)

Table 3:02

Pilot Study B

Mean Reading Score for Each Cell by Grade Level,

Sex and Reading Ability

There were 4 subjects in each cell

		Grade 2	Grade 4	G ade 6
Boys	High	3.2	6.1	8.5
	Low	2.2	3.7	6.3

Table 3:02 (cont.)

		Grade 2	Grade 4	Grade 6
Girls	High	3.3	5.4	9.2
	Low	2.4	3.9	6.0

Testing Procedures

Both oral and multiple-choice forms of the four test orderings were used. Combinations of four tests, two multiple-choice and two oral, were administered to each of the subjects.

To control for order and test-type effects, four two-day testing sequences were devised and one subject from each cell was tested with each of the four sequences. Each subject was tested with one oral and one multiple-choice test on one day, and another oral and multiple-choice test on the following day. Table 3:03 presents the four testing sequences used during Pilot Study B.

Table 3:03

Testing Sequences - Pilot Study B

First Day	Second Day
A1 Written - B1 Oral	A2 Oral - B2 Written
B1 Written - A1 Oral	B2 Oral - A2 Written
A2 Oral - B2 Written	A1 Written - B1 Oral
B2 Oral - A2 Written	B1 Written - A1 Oral

Each of the four testing sequences was administered to one subject from each cell (see Table 3:02). The oral tests were administered individually, and the multiple-choice tests were administered to each of the four groups of 12 subjects. All testing was done during an eight day period in March, 1969.

In summary, each of the 48 subjects in Pilot Study B responded to all 100 test items in two ways: orally, and through a multiple-choice test. Phonemic transcriptions of the tape recorded oral pronunciations were made by the investigator. All data were key punched for computer analysis. A computer program was written to tabulate the pronunciation proportions, and to test the statistical significance of the results using analysis of variance.

Results of Pilot Study B

The analysis examined the specific agreement of the oral and multiple-choice responses of each subject to each synthetic word. For computer purposes a 1 was assigned to each response pair (oral/multiple-choice) which was the same, and a 0 to each that was different. There were 320 responses to each vowel cluster at each of three grade levels; second, fourth and sixth.

The hypothesis tested was: There are no differences in subjects' oral (O) and multiple-choice (M-C) responses to synthetic words containing vowel clusters, that is, H_0: $\mu_O = \mu_{MC}$ $\alpha = 0.01$.

The dependent variable for this analysis was the specific agreement of each subject's oral and multiple-choice responses to each of the 10 synthetic words used to test each of the 9 vowel clusters. Using the ANOVA H computer program, a 10 x 2 x 2 x 3 analysis of variance, in which the main effects were 9 vowel clusters (and check items) sex, two reading levels and three grade levels, was performed on the oral/written agreement scores. The main effects and interactions in this analysis, together with their F values, are given in Table 3:04.

As Table 3:04 shows Vowel Cluster, Reading Level and Grade Level were significant main effects ($p < .01$) and there was a significant interaction between Vowel Cluster and Grade Level ($p < .01$). Thus, there was deemed to be a significant difference in the subjects' oral and multiple-choice responses and the hypothesis could not be accepted.

Table 3:04

F Values of Main Effects and Interactions for Pilot Study B

Source of Variation	Degrees of Freedom	Mean Square	F Value	p <
Vowel Cluster	9,324	135.568518	44.05	.01
Sex	1,36	7.50	1.37	NS
Reading Level	1,36	407.008333	19.94	.01
Grade Level	2,36	117.352083	5.75	.01
Cluster X Sex	9,324	2.712963	0.88	NS
Cluster X Rdg. Level	9,324	3.239815	1.05	NS
Sex X Rdg. Level	1,36	1.008333	0.05	NS
Cluster X Grade	18,324	7.099769	2.31	.01
Sex X Grade	2,36	38.268750	1.87	NS
Rdg. Level X Grade	2,36	12.152083	0.60	NS

Table 3:04 (cont.)

Source of Variation	Degrees of Freedom	Mean Square	F Value	p <
Cluster X Sex X Rdg. Level	9,324	4.517593	1.47	NS
Cluster X Sex X Grade	18,324	6.252546	2.03	NS
Cluster X Rdg. Level X Grade	18,324	3.918287	1.27	NS
Sex X Rdg. Level X Grade	2,36	10.502083	0.51	NS
Cluster X Sex X Rdg. Level X Grade	18,324	3.032176	0.99	NS

To illustrate the main effects found significant in this analysis three tables are included. Table 3:05 shows that there was considerable variation in oral-multiple-choice agreement scores by vowel cluster. There was total agreement on from five to seven synthetic words for five vowel clusters: ai, ou, oa, ea, and ow, while for one, ou, there was agreement on only three synthetic words.

Agreement in oral and multiple-choice responses to synthetic words containing vowel clusters was also a factor of reading level and grade level as shown in Tables 3:06 and 3:07. Subjects of high reading level agreed on nearly seven of ten words, as compared to five of ten for subjects of low reading level. There was an upward progression in oral-multiple-choice agreement on nearly five synthetic words by second grade subjects, on nearly six words by fourth grade subjects, on more than six words by sixth grade subjects.

Further, the analysis showed that the instrument was reliable (Table 3:05). The mean oral and multiple-choice agreement score for the ten check items was 8.667. This mean is very high considering five of the check items were also synthetic words, though with predictable letter-sound correspondence. Subjects reliably responded to the instrument.

Table 3:05

Oral-Multiple-Choice Agreement

Means by Vowel Cluster Where Ten Items Were Used for Each Cluster

ou	au	ie	oo	ai	ow	oa	ea	ay
3.021	3.854	4.625	4.729	5.667	5.833	6.512	6.729	7.167
		Grand Mean			Check Items Mean			
		5.683			8.667			

Table 3:06

Oral-Multiple-Choice Agreement

Means by Reading Level Where Ten Items Were Used for Each Vowel Cluster

Grand Mean	High Reading Level	Low Reading Level
5.683	6.604	4.762

Table 3:07

Oral-Multiple-Choice Agreement

Means by Grade Level Where Ten Items Were Used for Each Vowel Cluster

Grand Mean	Second Grade	Fourth Grade	Sixth Grade
5.683	4.737	5.906	6.406

Development of the Final Instrument

The final multiple-choice test was constructed on the basis of the results of Pilot Study B. The results indicated that subjects used a wider variety of responses on the oral test than on the multiple-choice test. These oral preferences were considered in the development of the final instrument by the selection of an additional alternate choice for each item for each of the nine vowel clusters. Thus, the same 100 multiple-choice test items were retained, but four alternative choices rather than three were made available for each item in the final instrument.

Tables 3:08 and 3:09 are presented to show this modification. Table 3:08 presents the three most frequent oral pronunciations for each vowel cluster made by the Pilot Study B subjects. Each of the three pronunciations of each vowel cluster except ai—>/æ/ (because of its low frequency on both corpora) was included in the final multiple-choice instrument. In addition, examination of the raw data revealed four other oral pronunciations from the "other" categories which were given frequently enough to be included in the final instrument.

They were: au—>/o/, ie—>/ɛ/, oo—>/ə/, and ou—>/ə/.

Table 3:09 shows the four phonemic response choices included in the final instrument used in the study. These response choices not only reflected the common oral pronunciations o vowel clusters given in Pilot Study B, but included the principal and secondary pronunciations of each vowel cluster on both the type and token corpus, when those pronunciations were monosyllabic. (See also Table 3:10 for principal and secondary pronunciation proportions on the type and token corpus, and Table 2:21 for a more complete listing of type and token vowel cluster pronunciation proportions.) Since the nine vowel clusters were nearly always monosyllabic (see Table 2:04 to 2:21) only monosyllabic response words were included. All forms of the final multiple-choice instrument are presented in Appendix C.

Table 3:08

The Three Most Frequent Oral Pronunciations of Each Vowel Cluster made by Pilot Study B Subjects

Vowel Cluster	Phoneme	Percentage	Vowel Cluster	Phoneme	Percentage
ai	/e/	71.3%	oa	/o/	75.6%
	/ɪ/	5.3%		/ɔ/	8.6%
	/æ/	5.0%		/au/	6.3%
	others	18.4%		others	9.5%

Table 3:08 (cont.)

Vowel Cluster	Phoneme	Percentage	Vowel Cluster	Phoneme	Percentage
au	/ɔ/	52.6%	oo	/u/	58.3%
	/æ/	12.0%		/ʊ/	19.6%
	/au/	11.0%		/o/	11.0%
	others	24.4%		others	11.1%
ay	/e/	82.3%	ou	/au/	43.4%
	/ɪ/	6.1%		/ʊ/	10.5%
	/ai/	3.2%		/u/	10.0%
	others	8.4%		others	36.4%
ea	/i/	75.3%	ow	/au/	48.3%
	/ɛ/	11.3%		/o/	43.6%
	/e/	7.0%		/ɔ/	4.0%
	others	6.4%		others	4.1%
ie	/ai/	42.4%			
	/i/	32.5%			
	/ɪ/	8.5%			
	others	16.8%			

Table 3:09

The Four Phonemic Response Choices for Each Vowel Cluster on the Modified Multiple-Choice Instrument

Vowel Cluster	Phonemic Response Choice in the Study			
ai	/e/	/ɛ/	/ai/	/ɪ/
au	/ɔ/	/æ/	/au/	/o/
ay	/e/	/ɛ/	/ai/	/ɪ/
ea	/i/	/ɛ/	/e/	/ə/
ie	/ai/	/i/	/ɪ/	/ɛ/
oa	/o/	/ɔ/	/au/	/a/
oo	/u/	/ʊ/	/ə/	/o/
ou	/au/	/ʊ/	/ə/	/u/
ow	/au/	/o/	/ɔ/	/a/

Table 3:10

Principal and Secondary Pronunciation Proportions of the Nine Vowel Clusters on the Type and Token Corpora

		Type Corpus		Token Corpus	
ai	principal	/e/	.86	/ɛ/	.39
	secondary	/ai/	.07	/e/	.27
au	principal	/ɔ/	.92	/ɔ/	.91
	secondary	/o/	.03	/æ/	.09

Table 3:10 (cont.)

		Type Corpus		Token Corpus	
ay	principal	/e/	.89	/e/	.90
	secondary	/ɪ/	.06	/ɪ/	.07
ea	principal	/i/	.53	/i/	.57
	secondary	/ɛ/	.23	/ɛ/	.23
ie	principal	/i/	.27	/i/	.47
	secondary	/ɪ/	.15	/ə/	.14
oa	principal	/o/	.75	/o/	1.00
	secondary	/oa/	.10		
oo	principal	/u/	.62	/ʊ/	.50
	secondary	/ʊ/	.27	/u/	.48
ou	principal	/au/	.50	/au/	.36
	secondary	/ə/	.38	/ʊ/	.26
ow	principal	/o/	.51	/au/	.51
	secondary	/au/	.48	/o/	.47

The Study

The study was planned to examine several questions about factors related to the pronunciation of vowel clusters:

1. How well do children's pronunciations of vowel clusters in synthetic words approximate the actual pronunciation frequencies of the same vowel clusters in both a type and a token corpus?

2. What differences are there in the vowel cluster pronunciation frequencies of good and poor readers?

3. Do boys and girls differ in their pronunciations of vowel clusters?

4. What differences are there in the vowel cluster pronunciations of second, fourth, and sixth grade subjects?

5. Do children of different community types differ in their pronunciations of vowel clusters?

In addition to testing hypotheses examining these relationships, the study was designed to provide information about three further questions.

1. Will subjects' pronunciations of vowel clusters be more closely related to the letter-sound correspondences on the type corpus or on the token corpus?

2. Will consonant environment affect the pronunciation of vowel clusters in synthetic words?

3. Will word position affect the pronunciation of vowel clusters in synthetic words?

These three questions were not tested statistically, but the raw data was examined. A discussion of these questions is contained in Chapter 4.

Selection of Subjects

The school authorities of three distinct community types (rural, suburban, urban) agreed to participate in the study; Seneca, Cedarburg, and Racine, Wisconsin. Seneca is a rural village in Western Wisconsin with a population of 137 (rural). Ninety-seven per cent of the district's 547 pupils are bussed to school from surrounding farms. Cedarburg, a community of 10,000, is a northern suburb of Milwaukee (suburban). Many of its residents commute to Milwaukee for their employment, and Cedarburg is in one of the fastest growing counties in the United States. Racine is an urban city of 100,000 and is considered the most industrial community in Wisconsin. Many of its residents are factory employees.

Two classrooms at each of the three grade levels, second, fourth, and sixth, in each of three school systems were selected for the study. This resulted in an initial sample of 453 elementary school pupils.

Seventeen of these subjects were omitted because they were not present during one of the two days of testing. It was determined that the loss of such a small number of subjects would not affect the outcome of the study. On the other hand, had the subjects been retained and tested at a later date, the effects of these delayed responses would have been uncertain. Thus, 436 subjects, all of whom were tested on two consecutive days, were included in the study. The distribution of these subjects is summarized in Table 3:11.

Table 3:11

Distribution of Subjects by Community, Grade and Sex

		Rural	Suburban	Urban	Totals
Grade 2	Male	21	23	27	133
	Female	16	25	21	
Grade 4	Male	20	30	32	142
	Female	16	24	20	
Grade 6	Male	16	32	39	161
	Female	20	28	26	
	TOTAL	109	162	165	436

There were 109 rural, 162 suburban, and 165 urban pupils included in the sample. Of these, 133 were in second, 142 in fourth and 161 in sixth grade. The sample consisted of 240 boys and 196 girls. Reading level was determined by a median split for each sex in each classroom. (The reading achievement tests used are listed in Appendix E.) This resulted in 202 subjects of low reading level and 234 subjects of high reading level.

The participating classes at each grade level in each community were selected randomly from a list of all classes at these grade levels in each district. In the case of Seneca, rural, however, there were only two classes at each grade level, so the sample there consisted of all second, fourth and sixth grade pupils who were not absent during the testing. At Cedarburg, suburban, the classes were selected randomly from a minimum of eight classes at each grade level. The Racine school system, urban, is a unified district encompassing urban, suburban and rural schools. Because suburban and rural pupils were being tested in Seneca and Cedarburg, Racine school authorities randomly assigned classes from schools designated "inner city" or "urban." Table 3:12 summarizes the class identifications, grades, schools, school districts, and median reading scores for the study. For a description of all subjects, see Appendix E.

Table 3:12

The 436 Subjects in the Study by Class, Grade, School, District, and Median Reading Scores by Sex

Class	Grade	School	District	Male Median Reading Score	Female Median Reading Score
A	2	South	Seneca	2.7	2.8
B	4	South	Seneca	4.3	6.2
C	6	South	Seneca	7.7	8.7
D	6	Lynxville	Seneca	6.5	7.2
D	4	Seneca	Seneca	4.7	4.8
F	2	Seneca	Seneca	2.8	2.8
G	2	Westlawn	Cedarburg	3.1	3.3
H	2	Hacker	Cedarburg	1.8	2.2
I	4	Westlawn	Cedarburg	4.4	4.9
J	4	Lincoln	Cedarburg	4.8	5.0
K	6	Washington	Cedarburg	6.6	7.2
L	6	Washington	Cedarburg	6.0	7.0
M	4	Janes	Racine	2.3	4.0
N	6	Janes	Racine	5.2	4.9
O	2	Janes	Racine	1.5	1.6
P	2	McKinley	Racine	1.8	1.7
Q	6	McKinley	Racine	6.7	6.6
R	4	McKinley	Racine	3.8	3.6

Measurement Procedures Used in the Study

In this investigation pupils responded to the final multiple-choice test. Since the multiple-choice test was constructed to reflect the oral preferences of Pilot Study B the oral test was omitted. Each pupil responded to all 100 test items over a two-day period, one randomization of 50 items the first day, and a randomization of the other 50 items the next day. As with Pilot Study B, each of the two subtests of 50 items was arranged in two orderings: A1, A2, B1, and B2. Eight two-day testing sequences were possible; the sequences were labeled A through H, as shown in Table 3:13.

Each of the 436 subjects was assigned a code number, then the eight testing sequences were assigned sequentially to the subjects. That is, subject #1 followed sequence A; #2, B; #3, C, etc. The tests were administered to class groups on two consecutive days in each community during late April and early May, 1969.

In summary, all 436 subjects responded to the same 100 synthetic words, 50 items a day on two consecutive days. Both boys and girls at each grade level and in each community followed each of the eight testing sequences.

Table 3:13

Testing Sequence During the Study

Sequence Label	First Day	Second Day
A	A1	B1
B	A1	B2
C	B1	A1

Table 3:13 (cont.)

Sequence Label	First Day	Second Day
D	B1	A2
E	A2	B1
F	A2	B2
G	B2	A1
H	B2	A2

Hypotheses and Statistical Analyses for the Study

The study was designed to examine the relationships between vowel cluster pronunciations by subjects of high and low reading level, male and female subjects, second, fourth, and sixth grade subjects, and urban, suburban and rural subjects, and to analyze the observed pronunciations in relation to existing letter-sound correspondences of vowel clusters in common English words.

For this investigation, two sources of letter-sound correspondences of vowel clusters were used: the type corpus and the token corpus. As defined on page 16, the type corpus is a body of 20,000 common words; a 1963 revision of the Thorndike frequency count. In this corpus, each of the 20,000 words was considered a type. That is, each word (type) received the weight of one regardless of its frequency of occurrence in the written materials analyzed to determine the corpus.

The token corpus contained the 1000 most frequent English words according to the 1967 Kučera-Francis study. This study provided a ranked listing of more than 50,000 words and listed the total occurrence of each word in a sample of 1,014,232 words of natural language text. A token was considered an "individual" word and was counted each time it occurred. The present investigator analyzed the 1000 most frequent words, in the token corpus, to determine the frequency of pronunciation of the nine vowel clusters based on word tokens. That is, each word was multiplied by its number of occurrences in the sample of words analyzed by Kučera and Francis.

Thus, the type corpus contained 20,000 words and the letter-sound correspondences of the vowel clusters reflected a single occurrence of each word containing a vowel cluster spelling. The token corpus contained only the 1000 most frequent words, and the letter-sound correspondences were based on the total occurrences of each word containing a given vowel cluster spelling. For example, one correspondence of the vowel cluster ou was /ʊ/. On the type corpus this correspondence was true in 1.3% of its occurrences, while on the token corpus this correspondence occurred 25.9% of the time. This difference was due to three very common words, would, could, and should. On the type corpus each of these words was counted once, while on the token corpus each of these words was multiplied by its number of occurrences.

An underlying question of this investigation was whether subjects' vowel cluster pronunciation would be related to vowel cluster pronunciation proportions on either the type corpus or token corpus.

The study was constructed to test 12 null hypotheses about vowel cluster pronunciation scores To test these hypotheses, two analyses were performed. For each subject, two frequency difference scores were calculated for each vowel cluster in each analysis. These frequency scores were obtained in the following manner. Of the four response choices to each item on the test, two pronunciations of each vowel cluster were used in each analysis. They were the principal and secondary pronunciation proportions on the type corpus in analysis one, and the principal and secondary pronunciation proportions on the token corpus in analysis two (see Table 3:10). Each subject's responses to the ten items for each vowel cluster were analyzed to determine the number of responses which were principal and secondary pronunciations on the type corpus, and the number of responses which were principal and secondary pronunciations on the token corpus. Then, the frequency differences were calculated as follows:

Analysis One: The principal pronunciation proportion for each vowel cluster on the type corpus minus the principal pronunciation proportion actually occurring, and the secondary pronunciation proportion for each vowel cluster minus the secondary pronunciation actually occurring. For example, the principal pronunciation of ai on the type corpus was /e/. Its proportion was .86. The secondary pronunciation was /ai/ at .07. Assuming a subject pronounced ai—>/e/ on eight test items, the difference score would be .06 (.86 - .80 = .06). If he had selected the secondary pronunciation, /ai/ on two items the difference score would be -.13 (.07 - .20 = .13).

Analysis Two: The prinicpal pronunciation proportions for each vowel cluster on the token corpus minus the principal pronunciation actually occurring, and the secondary pronunciation proportions for each vowel cluster minus the secondary pronunciation proportions actually occurring.

The scores used to test the hypotheses (the dependent variables for each analysis) were defined in each analysis as the sum of the differences between the subject's principal and secondary pronunciation proportions and the principal and secondary pronunciation proportions on the corpus. For example, continuing with the hypothetical subject discussed above, his difference score for ai would be .07 (.06 and -.13 = .07). These sums were used to test the following hypotheses:

Hypothesis One: There is no difference in the type corpus (TP) difference scores of second (G2), fourth (G4), and sixth (G6) grade subjects, that is: $H_{1(TP)}$: $\mu_{G2} = \mu_{G4} = \mu_{G6}$.

Hypothesis Two: There is no difference in the type corpus (TP) difference score of male (M) and female (F) subjects, that is: $H_{2(TP)}$: $\mu_M = \mu_F$.

Hypothesis Three: There is no difference in the type corpus (TP) difference scores of subjects of high (H) and low (L) reading levels, that is: $H_{3(TP)}$: $\mu_H = \mu_L$.

Hypothesis Four: There is no difference in the type corpus (TP) difference scores of subjects of suburban (S), urban (U), and rural (R) communities, that is: $H_{4(TP)}$: $\mu_S = \mu_U = \mu_R$.

Hypothesis Five: There is no difference in the type corpus (TP) difference scores of the eight vowel clusters, that is: $H_{5(TP)}$: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8$.

Hypothesis Six: There is no difference in the type corpus (TP) difference score of principal (P) and secondary (S) response types, that is: $H_{6(TP)}$: $\mu_P = \mu_S$.

Hypothesis Seven: There is no difference in the token corpus (TK) difference scores of second (G2), fourth (G4), and sixth (G6) grade subjects, that is: $H_{7(TK)}$: $\mu_{G2} = \mu_{G4} = \mu_{G6}$.

Hypothesis Eight: There is no difference in the token corpus (TK) difference score of male (M) and female (F) subjects, that is: $H_{8(TK)}$: $\mu_M = \mu_F$.

Hypothesis Nine: There is no difference in the token corpus (TK) difference scores of subjects of high (H) and low (L) reading levels, that is: $H_{9(TK)}$: $\mu_H = \mu_L$.

Hypothesis Ten: There is no difference in the token corpus (TK) difference scores of subjects of suburban (S), urban (U), and rural (R) communities, that is: $H_{10(TK)}$: $\mu_S = \mu_U = \mu_R$.

Hypothesis Eleven: There is no difference in the token corpus (TK) difference scores of the seven vowel clusters, that is: $H_{11(TK)}$: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$.

Hypothesis Twelve: There is no difference in the token corpus (TK) difference score of principal (P) and secondary (S) responses, that is: $H_{12(TK)}$: $\mu_P = \mu_S$.

In addition to testing these hypotheses, the raw data were examined to provide answers to the following questions:

1. Will subjects' pronunciations of vowel clusters be more closely related to the letter-sound correspondences on the type corpus or on the token corpus?

2. Will consonant environment affect the pronunciation of vowel clusters in synthetic words?

3. Will word position affect the pronunciation of vowel clusters in synthetic words?

These questions are discussed in Chapter 4.

The ANOVA-FINN computer program, which treats unequal n's, was used for the two analyses of the data. A 3 x 2 x 2 x 3 x 8 x 2 analysis of variance (with repeated measures on the last two factors) in which the main effects were three grade levels, sex, two reading levels, three community types, eight vowel clusters* and two response types (principal and secondary) was performed on the type corpus frequency difference scores. A 3 x 2 x 2 x 3 x 7 x 2 analysis of variance (with repeated measures on the last two factors) in which the main effects were three grade levels, sex, two reading levels, three community types, seven vowel clusters* and two response types, (principal and secondary) was performed on the token corpus frequency difference scores. Geisser-

*In analysis one (type) the vowel cluster oa was omitted because its secondary pronunciation /oə/, being disyllabic, was not offered as a response choice on the instrument. In analysis two (token) the vowel cluster ie was omitted for the same reason, and oa was omitted because it has no secondary pronunciation on the token corpus (see Table 3:10). Both vowel clusters were included in the study, however, because of their frequency of occurrence and their extreme dissimilatory in principal and secondary pronunciation frequencies. These vowel clusters will be discussed in Chapter 4.

Greenhouse corrections on degrees of freedom for repeated measures were used. Duncan's New Multiple Range Test was used to make post hoc comparisons among the means of main effects found significant.

Before the analyses were run on the data, complete tabulations of all 436 subjects' responses were made and pronunciation percentages calculated. These tabulations are presented in Chapter 4.

Summary of the Study

The purpose of this study was to investigate elementary pupils' pronunciations of vowel clusters and to analyze factors which may relate to pronunciation preferences. The study was done in three stages: Pilot Study A, Pilot Study B and the Study.

An instrument was constructed to measure pupils' pronunciations of vowel clusters in synthetic words. During Pilot Study B, 48 subjects gave oral pronunciations to 90 synthetic words and ten check items, and completed a 100-item vowel cluster multiple-choice test containing the same items. After the pilot study, the final multiple-choice instrument was developed to reflect major oral pronunciations given.

During the Study 436 subjects, male and female second, fourth, and sixth graders of high and low reading level from suburban, urban, and rural communities, responded to the modified 100-item multiple-choice test.

The statistical technique of analysis of variance was used to analyze the data in an evaluation of 12 hypotheses.

Chapter IV

RESULTS AND DISCUSSIONS

Two analyses of the data were used to test the 12 hypotheses of the study. In this chapter each hypothesis will be restated in relation to the analysis used to test it. Results will be presented in tabular form and discussed in the text.

The organization of this chapter is as follows:

1. Analysis One: Results Related to the Modified Thorndike Type Corpus, which treats Hypotheses One through Six;
2. Analysis Two: Results Related to the Kučera-Francis Token Corpus, which treats Hypotheses Seven through Twelve;
3. Discussion of Relationships between Subjects' Vowel Cluster Pronunciations, and the Pronunciation Frequencies on the Type and Token Corpora;
4. Discussion of Contextual Relationships to Vowel Cluster Pronunciation;
5. Discussion of Word Position Relationships to Vowel Cluster Pronunciation, and
6. Summary of the Results of the Study.

Analysis One: Relationships Between Children's Pronunciations of Selected Vowel Clusters and the Letter-Sound Correspondences of Vowel Clusters in the Modified Thorndike 20,000 Word List (Type Corpus)

To determine the relationships between children's pronunciations of selected vowel clusters and the pronunciations of such vowel clusters found in the type corpus, a 3 x 2 x 2 x 3 x 8 x 2 analysis of variance was performed to test hypotheses one through six. The dependent variable, in this instance, was the sum of the difference scores between the principal and secondary pronunciation proportions for each vowel cluster found in the type corpus and the proportion of principal and secondary pronunciations designated by the subjects on the multiple-choice test. The dependent variables can be considered continuous since any of the difference means could be viewed as representing an interval from .5 below it to .49 above it.

Results Related to the Main Effects Between Cells

Four hypotheses which dealt with the main effects of grade level, sex, reading level, and community type were tested. In each of these cases the main effects of vowel clusters and pronunciation types were collapsed. In other words, the eight vowel clusters* and two pronunciation types, principal and secondary, were treated as one and the total difference scores were summed.

> Hypothesis One. There is no difference in the type (TP) corpus difference scores of second (G2), fourth (G4), and sixth (G6) grade subjects, that is: $H_{1(TP)}$: $\mu_{G2} = \mu_{G4} = \mu_{G6}$.

The overall F ratio was significant ($p < .01$) and thus indicated that differences existed between the vowel cluster pronunciations of second, fourth and sixth grade subjects; therefore, hypothesis one was not accepted (see Table 4:01). Since the test of significance did not permit the acceptance of Hypothesis One, the Duncan New Multiple Range

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*For this analysis the vowel cluster oa was omitted because the secondary response type on the type corpus (/oə/) was not offered as a response choice on the multiple-choice test since it was disyllabic. However, subjects' pronunciations of oa are discussed later in the chapter.

Test, which is used to make post hoc pairwise comparisons among means, was performed on the grade level means shown in Table 4:02.

Table 4:01

Analysis of Variance F Values of Main Effects and First Order Interactions* for Analysis One: Type Corpus Relationship

Source of Variation	Degrees of Freedom**	Mean Squares	F Values	p <
Between				
Grade Level (G)	2,400	1042873	93.2776	.01
Sex (S)	1,400	29010.7	2.5948	NS
Reading Level (R)	1,400	466808	41.7527	.01
Community Type (C)	2,400	72453	6.4804	.01
G X S	2,400	3091	.2765	NS
G X R	2,400	3369	.3013	NS
G X C	4,400	40786	3.6480	.01
S X R	1,400	391	.0350	NS
S X C	2,400	26078	2,3325	NS
R X C	2,400	17646	1.5783	NS
G X S X R	2,400	10130	.9061	NS
G X S X C	4,400	6130	.5483	NS

* Only first order interactions will be dealt with in Chapter 4 since this level of interaction seemed most significant in relation to the hypotheses tested. The entire table, showing all interactions, can be found in Appendix G.

** Geisser-Greenhouse corrections on degrees of freedom for repeated measures were used. This correction accommodates any possible violation of the assumption of homogeneity of variance. It is discussed in Appendix I.

Table 4:01 (cont.)

Source of Variation	Degrees of Freedom **	Mean Squares	F Values	p <
G X R X C	4,400	7887	.7054	NS
S X R X C	2,400	30788	2.7538	NS
G X S X R X C	4,400	13962	1.2488	NS
<u>Wholly Within</u>				
Vowel Clusters (VC)	1,400	96795	340.8036	.01
Response Type (T)	1,400	13090	2.3539	NS
VC X T	1,400	40904	199.4929	.01
<u>Between X Within</u>				
G X VC	2,400	2372.6	8.3535	.01
S X VC	1,400	530.6	1.8686	.01
R X VC	1,400	1899.8	6.6888	.01
C X VC	2,400	855.7	3.0128	NS
G X T	2,400	439053.9	78.9498	.01
S X T	1,400	27065.7	4.8669	NS
R X T	1,400	230587.6	41.4638	.01
C X T	2,400	26937.2	6.6421	.01

Table 4:02

Type Corpus Difference Means by Grade Level

Second Grade	Fourth Grade	Sixth Grade
187	68	20

Using the Duncan New Multiple Range Test, all grade level means were found to be significantly different from one another ($p < .01$). Table 4:03 shows this using adjusted differences based on unequal N's. The table shows that these differences were due to the decrease in deviance from the type corpus pronunciation proportions from second to fourth to sixth grade. Thus the subjects at the sixth grade level responded more closely to the type corpus proportions than did the younger subjects.

Table 4:03

Duncan's New Multiple Range Test Applied to Type Corpus Means by Grade Level

	Sixth Grade (G6)	Fourth Grade (G4)	Second Grade (G2)	Shortest Significant Ranges	
Means	20	68	187		
G6 20		175.92*	2006.15*	R^1_2	125.05
G4 68			1458.31*	R^1_3	130.55
G2 187					

*Significant $p < .01$

Hypothesis Two. There is no difference in the type corpus (TP) difference scores of male (M) and female (F) subjects, that is: $H_{2(TP)}: \mu_M = \mu_F$.

Hypothesis Two was not rejected (see Table 4:01). Sex was not a significant main effect in terms of the relationship between children's pronunciation of vowel clusters, and the pronunciation proportions on the type corpus. Much research done on reading achievement has shown girls to be superior to boys in readiness and certain aspects of achievement (Dykstra, 1968, p. 63). These measures typically involved some aspect of correctness. This was not the case in the present study which was designed to assess preferences in vowel cluster pronunciations. Incorrect responses were not possible because all of the response items which the subjects had to choose from were actual vowel cluster letter-sound correspondences, and girls' preferences did not differ significantly from those of the male subjects.

Hypothesis Three. There is no difference in the type corpus (TP) difference scores of subjects of high (H) and low (L) reading levels, that is: $H_{3(TP)}: \mu_H = \mu_L$.

As shown in Table 4:01, there were significant differences ($p < .01$) between the mean type corpus difference scores for subjects of high and low reading level. Hypothesis Three, therefore, was not accepted.

Table 4:04 contains the means for subjects of both low and high reading levels. These means are difference scores between subjects' responses and type corpus proportions. The smaller the mean, the closer it was to the type corpus pronunciation proportions. Table 4:04 shows that the significant F value for the main effect reading level is due to subjects of high reading level being less deviant from the type corpus pronunciation proportions than subjects of low reading level.

Table 4:04

Type Corpus Difference Means by Reading Level

Low Reading Level	High Reading Level
123	55

Hypothesis Four. There is no difference in the type corpus (TP) difference scores of subjects of suburban (S), urban (U) and rural (R) communities, that is: $H_{4(TP)}: \mu_S = \mu_U = \mu_R$.

The overall F ratio was significant ($p < .01$) and thus indicated that differences existed between the vowel cluster pronunciations of suburban, urban, and rural subjects; therefore, Hypothesis Four was not accepted (see Table 4:01).

The Duncan New Multiple Range Test was performed on the community type means presented in Table 4:05.

Table 4:05

Type Corpus Difference Means by Community Type

Urban	Rural	Suburban
105	92	64

The results of the Duncan New Multiple Range Test showed that all treatment means were significantly different from one another ($p < .01$). Suburban subjects' responses were more closely related to the type corpus pronunciations than were the response of urban and rural subjects. Suburban children generally have greater access to reading materials in the home and high parental expectations for reading achievement, which may have caused this suburban relationship. Table 4:06 presents the adjusted differences based on unequal N's.

Table 4:06

Duncan's New Multiple Range Test Applied to Type Corpus Means by Community Type

	Suburban (S)	Rural (R)	Urban (U)	Shortest Significant Ranges
Means	64	92	105	
S 64		321.14*	519.98*	$R^1 2$ 125.05
R 92			141.22*	$R^1 3$ 130.55
U 105				

*Significant $p < .01$

Results Related to Interactions Between Cells

There was one significant interaction between cells (see Table 4:01), that of Grade by Community Type. Table 4:07 presents the means for second, fourth and sixth grade subjects from suburban, urban and rural communities.

Table 4:07

Type Corpus Difference Means by Grade

Level and Community Type

	Suburban	Urban	Rural
Grade 2	132	241	187
Grade 4	58	70	79
Grade 6	15	32	8

These means are difference scores between subjects' responses and type corpus proportions. Thus the lower the mean, the closer it was to the type corpus pronunciation proportions. Table 4:07 shows, among other things, that the second grade urban subjects' pronunciations deviated most from the type corpus predictions, whereas the rural sixth grade subjects were the closest to the type corpus predictions. It is also evident that of all second grade subjects, the suburban pupils were less deviant from the type corpus proportions. These subjects seem off to a "faster start" in vowel cluster letter-sound acquisition than their urban and rural colleagues.

Results Related to the Main Effects Within Cells: H_5 and H_6

Two hypotheses which dealt with the main effects of vowel cluster and response type were tested. In each of these cases, the main effects of grade level, sex, reading level and community type were collapsed. Thus, the difference score means for all subjects were summed for each vowel cluster and for the two response types, principal and secondary.

Hypothesis Five. There is no difference in the type corpus (TP) difference scores of the eight vowel clusters, that is: $H_{5(TP)}: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8$.

As shown in Table 4:01, there were significant differences ($p < .01$) among the type corpus mean difference scores for the selected vowel clusters; therefore, Hypothesis Five was not accepted. Table 4:08 contains the type corpus difference means for each vowel cluster. Since these are difference means, positive scores indicate subjects gave the principal and secondary responses less often than the type corpus "predicted". Negative scores mean that subjects gave principal and secondary responses more often than predicted by the type corpus pronunciation proportions. A score of 0 would mean that subjects gave principal and secondary pronunciations in equal proportions to those of the type corpus.

The table shows that with two vowel clusters, ea and ie, subjects tended to maximize the principal and secondary pronunciations; that is, they gave them more frequently than would be expected from the type corpus proportions. However, with the remaining six vowel clusters, subjects gave the pronunciations less often, proportionately, than occurred in the type corpus. The greatest deviation was with the vowel clusters au and ou.

Table 4:08

Type Corpus Difference Means by Vowel Cluster

au	ou	oo	ai	ow	ay	ea	ie
69	44	34	29	27	23	-18	-36

<u>Hypothesis Six</u>. There is no difference in the type corpus (TP) differences of principal (P) and secondary (S) response types, that is: $H_{6(TP)}$: $\mu_P = \mu_S$.

Hypothesis Six was not rejected (see Table 4:01). Response type was not a significant main effect in the analysis, although it did interact with other variables. This means there was no significant difference in the difference scores based on principal responses and the difference scores based on secondary responses. This result would seem to suggest that subjects' secondary pronunciations did not deviate to any significantly greater degree from the type corpus predictions than did the principal pronunciations. Had they employed a maximizing strategy (in which the most common pronunciation is always given) the secondary difference scores would have been much larger than the principal. Instead, this result indicates that subjects' pronunciations related to more than one pronunciation of each vowel cluster.

<u>Results Related to Interactions Within Cells</u>

There was one significant interaction within cells; vowel cluster by response type. Table 4:09 presents the means for both the principal and secondary pronunciations of all eight vowel clusters.

Positive means indicate that subjects gave responses less often than the pronunciation proportions on the type corpus, while negative means show that subjects gave the responses more frequently than predicted by the corpus. A score of <u>0</u> would mean that subjects' pronunciation proportions matched those of the corpus.

Table 4:09 shows that subjects gave the principal pronunciations of three vowel clusters <u>ea</u>, <u>ie</u>, and <u>ou</u>, a greater percentage of the time than occurred in the corpus, but for the other vowel clusters, ai, au, ay, oo, and ow, subjects gave the pronunciation less often. The secondary pronunciations of au, ie and ow, were selected more often than "predicted" by the corpus. It is also evident that subjects were most deviant from the principal pronunciation of au /ɔ/ and the secondary pronunciation of ou /ə/. Generally there was greater deviance from the principal pronunciation proportions than from the secondary.

Table 4:09

Type Corpus Difference Means by Vowel Cluster and Response Type

	Principal	Secondary
ai	24	04
au	71	-02
ay	16	07
ea	-32	14
ie	-22	-14
oo	10	26
ou	-07	51
ow	37	-10

Results Related to Between and Within Cells First Order Interactions

As shown in Table 4:01, there were six significant first order interactions ($p < .01$): Grade by Vowel Cluster, Sex by Vowel Cluster, Reading Level by Vowel Cluster, Grade by Response Type, Reading Level by Response Type and Community by Response Type.

To show the significant Grade by Vowel Cluster interaction, Table 4:10 presents the means for second, fourth, and sixth grade subjects for each vowel cluster.

This table demonstrates the different pronunciation proportions of the three grade levels. With the vowel clusters ea and ie second grade subjects gave fewer principal and secondary responses than occurred on the type corpus, while fourth and sixth grade subjects gave these pronunciations more frequently. With the remaining vowel clusters there was a steady progression from greater to less deviance from second to sixth grade, though all subjects gave pronunciations less frequently than occurred in the type corpus. With all vowel clusters there was a greater change from second to fourth grade than from fourth to sixth, suggesting that there may be greater growth in letter-sound correspondence acquisition prior to fourth grade than after it.

Table 4:10

Type Corpus Difference Means by Grade

Level and Vowel Cluster

	Grade 2	Grade 4	Grade 6
ai	33	11	2
au	50	32	20
ay	25	09	3
ea	6	-11	-18
ie	9	-17	-20
oo	30	15	8

Table 4:10 (cont.)

	Grade 2	Grade 4	Grade 6
ou	33	18	16
ow	27	10	06

Table 4:11 presents the significant sex by vowel cluster interaction. Means for each vowel cluster by sex are given.

This table shows no clear-cut preferences of vowel cluster pronunciation by sex. However, with five vowel clusters, ai, au, ay, oo, and ow, male subjects were slightly more deviant from the type corpus proportions than were the female subjects.

Table 4:11

Type Corpus Difference Means by Sex and Vowel Cluster

	Male	Female
ai	16	13
au	35	33
ay	13	10
ea	-06	-12
ie	-19	-18
oo	18	16
ou	21	23
ow	15	12

The type corpus difference means by reading level and vowel cluster are presented in Table 4:12.

This table reveals a pattern not dissimilar from that of the grade level by vowel cluster interaction. With two vowel clusters ea and ie, subjects of both high and low reading ability preferred the principal and secondary pronunciations more frequently than the proportions on the type corpus with the good readers surpassing the poor readers, and with all other vowel clusters the principal and secondary pronunciations were given less frequently than predicted. With the vowel clusters ai, au, ay, oo, ou, and ow, the better readers deviated less than the poor readers from the type corpus pronunciation proportions.

Table 4:12

Type Corpus Difference Means by Reading Level and Vowel Cluster

	Low Reading Level	High Reading Level
ai	21	9
au	42	28
ay	17	07
ea	-04	-12
ie	-18	-19
oo	25	11
ou	24	20
ow	17	11

Table 4:13 presents the type corpus difference means by grade level and response type. It is evident that second grade principal pronunciations were far more deviant than those of fourth and sixth graders. All cells gave both principal and secondary responses less frequently than occurred within the type corpus. This greater deviance by second grade subjects suggests that older pupils become more certain in their preference for the principal pronunciations of vowel clusters on the type corpus.

Table 4:13

Type Corpus Difference Means by Grade Level and Response Type

	Grade 2	Grade 4	Grade 6
Principal	163	29	28
Secondary	27	41	30

The significant interaction between reading level and response type is presented in Table 4:14. As shown in the table, the subjects of high reading level gave the principal pronunciations of vowel clusters on the type corpus more frequently than subjects of low reading ability. With the secondary pronunciation subjects of low reading ability were less deviant.

Table 4:14

Type Corpus Difference Means by Reading

Level and Response Type

	High Reading Level	Low Reading Level
Principal	11	93
Secondary	44	30

Table 4:15 shows the type corpus difference means by community type and response type. The table demonstrates that suburban subjects selected principal vowel cluster pronunciations most frequently and urban subjects least frequently. This is consistent with the suburban differences discussed previously. Both principal and secondary pronunciations were given less frequently by all cells than the occurrences on the type corpus.

Table 4:15

Type Corpus Difference Means by Community

Type and Response Type

	Suburban	Urban	Rural
Principal	25	73	48
Secondary	39	32	45

Analysis Two: Relationships Between Children's Pronunciation of Selected Vowel Clusters and the Principal and Secondary Pronunciation of Such Vowel Clusters in the Kučera-Francis 1,000 Word List (Token Corpus)

To determine the relationship between children's pronunciations of selected vowel clusters and the pronunciations of such vowel clusters found in the type corpus, a 3 x 2 x 2 x 3 x 7* x 2 analysis of variance was performed to test Hypotheses Seven through Twelve. The dependent variable in this analysis was the sum of the difference scores between the principal and secondary pronunciations for each of seven vowel clusters found in the token corpus, and the proportion of principal and secondary pronunciations designated by the subjects on the multiple-choice instrument.

Results Related to the Main Effects Between Cells

Hypotheses Seven through Ten which dealt with the main effects of grade level, sex, reading level, and community type were tested. To accomplish this the main effects of vowel clusters and pronunciation types were collapsed. The seven vowel clusters and two pronunciation types were treated as one and the total difference scores were summed.

*The vowel clusters oa and ie were omitted for this analysis. The vowel cluster oa was omitted because it had no secondary pronunciation in the token corpus; all oa occurrences corresponded to /o/. The vowel cluster ie was omitted because the secondary pronunciations on the token corpus was /i/ which, being disyllabic, was not offered as a response choice on the instrument. Both were included on the instrument, however, because of variation in principal phonemic correspondence. They are discussed later in this chapter.

Hypothesis Seven. There is no difference in the token corpus (TK) difference scores of second (G2), fourth (G4) and sixth (G6) grade subjects, that is: $H_{7(TK)}$: $\mu_{G2} = \mu_{G4} = \mu_{G6}$.

As shown in Table 4:16, there were significant differences ($p < .01$) among the mean token corpus difference scores for second, fourth and sixth grade subjects. Hypothesis Seven, therefore, was not accepted. Since the test of significance led to the rejection of the null hypothesis, further exploration of the data was warranted.

Table 4:16

Analysis of Variance F Values of Between Cells Main Effects and First Order Interactions* for Analysis Two = Token Corpus Relationships

Source of Variation	Degrees of Freedom **	Mean Squares	F Values	p <
Between				
Grade (G)	2,400	703865.82	72.439	.01
Sex (S)	1,400	31711.21	3.264	NS
Reading Level (R)	1,400	373501.70	38.439	.01
Community Type (C)	2,400	76242.73	7.847	.01
G X S	2,400	9833.52	1.012	NS
G X R	2,400	13340.55	1.373	NS

*Only first order interactions will be dealt with in Chapter 4 since this level of interaction seemed most significant in relation to the hypotheses tested. The entire table, showing all interactions, can be found in Appendix H.

**Geisser-Greenhouse corrections on degrees of freedom for repeated measures were used.

Table 4:16 (cont.)

Source of Variation	Degrees of Freedom **	Mean Squares	F Values	p <
G X C	4,400	33367.60	3.434	.01
S X R	1,400	43.62	.004	NS
S X C	2,400	21429.27	2.205	NS
R X C	2,400	15426.98	1.588	NS
G X S X R	2,400	7063.19	.727	NS
G X S X C	4,400	7094.43	.730	NS
G X R X C	4,400	5440.67	.560	NS
S X R X C	2,400	20370.52	2.096	NS
G X S X R X C	4,400	8873.20	.913	NS
<u>Wholly Within</u>				
Vowel Cluster (VC)	1,400	215119.39	317.2068	.01
Response Type (T)	1,400	5404639.56	528.9131	.01
VC X T	1,400	4866364.50	1803.7156	.01
<u>Between X Within</u>				
G X VC	2,400	13237.63	19.5196	.01
S X VC	1,400	966.46	1.4250	NS
R X VC	1,400	1547.97	2.2825	NS
C X VC	2,400	882.77	1.3016	NS
G X T	2,400	675732.22	66.1290	.01
S X T	1,400	2145.23	.2099	NS
R X T	1,400	164410.35	16.0897	.01
C X T	2,400	127006.53	12.4292	.01

Duncan's New Multiple Range Test, used to make post hoc, pairwise comparisons among means was performed on the grade level means shown in Table 4:17.

Table 4:17

Token Corpus Difference Means by Grade Level

Grade 2	Grade 4	Grade 6
1649	445	04

The results of the Duncan New Multiple Range Test, using adjusted differences based on unequal N's, are presented in Table 4:18. As shown, each grade level mean was significantly different from each other grade level mean. It is evident that the significant F value for the main effect grade level was due to the decrease in deviance from the token corpus pronunciation proportions from second to fourth to sixth grades. Further, while second and fourth grade subjects' responses were very deviant, sixth grade subjects' responses deviated very little from the token corpus proportions. This result is consistent with the type corpus analysis.

Table 4:18

Duncan's New Multiple Range Test Applied to Token Corpus Means by Grade Level

	Grade 6 (G6)	Grade 4 (G4)	Grade 2 (G2)	Shortest Significant Ranges
Means	04	445	1649	
G6 04		1632.30*	19856.75*	$R^1 2$ 358.81
G4 445			14795.67*	$R^1 3$ 374.58
G2 1649				

*Significant $p < .01$.

Hypothesis Eight. There is no difference in token corpus (TK) difference scores of male (M) and female (F) subjects, that is: $H_{8(TK)}: \mu_M = \mu_F$.

Hypothesis Eight was not rejected (see Table 4:16). Sex was not a significant main effect. Both male and female subjects performed equally well on a test of vowel cluster pronunciation, in relation to token corpus pronunciation proportions. This result was true of analysis one as well. Vowel cluster pronunciation preference did not seem to be related to sex.

Hypothesis Nine. There is no difference in the token corpus (TK) difference scores of subjects of high (H) and low (L) reading levels, that is: $H_{9(TK)}: \mu_H = \mu_L$.

The overall F ratio was significant ($p < .01$) indicating that differences existed between the vowel cluster pronunciations of subjects of high and low reading level; therefore, Hypothesis Nine was not accepted (see Table 4:11). Table 4:19 shows the means for subjects of high and low reading levels. These means are difference scores between subjects' responses and token corpus proportions. In other words, the smaller the mean the closer it was to the token corpus pronunciation proportions. This table indicates that the cause of the significant F value for the main effect reading level was due to the greater deviance from the token corpus pronunciation proportions by subjects of low reading level than by subjects of high reading level. This result was consistent with the grade level finding of analysis one.

Table 4:19

Token Corpus Difference Scores by Reading Level

Low Reading Level	High Reading Level
1560	538

<u>Hypothesis Ten</u>. There is no difference in the token corpus (TK) difference scores of subjects of suburban (S), urban (U), and rural (R) communities, that is: $H_{10(TK)}: \mu_S = \mu_U = \mu_R$.

As shown in Table 4:16, there were significant differences ($p < .01$) among the mean token corpus difference scores for subjects of suburban, urban, and rural communities. Hypothesis Ten, therefore, was not accepted. Duncan's New Multiple Range Test was performed on the community type means shown in Table 4:20. The results of this test, which are presented in Table 4:21, showed that all treatment means were significantly different from one another, $p < .01$. Adjusted differences for unequal N's, upon which the test was based, are shown in Table 4:21.

Table 4:20

Token Corpus Difference Means by Community Type

Urban	Rural	Suburban
977	631	491*

Table 4:21

Duncan's New Multiple Range Test Applied to Token Corpus Means by Community Type

	Suburban (S)	Rural (R)	Urban (U)	Shortest Significant Ranges
Means	491	631	977	
S 491		1578.06*	6204.43*	$R^1 2$ 358.81
R 631			3965.02*	$R^1 3$ 374.58
U 977				

*Significant $p < .01$.

As can be seen in Table 4:21, the suburban subjects' responses were closest to the token corpus pronunciation proportions, while urban subjects' responses were farthest removed. This is consistent with the results related to communities in the first analysis.

Results Related to Interactions Between Cells

The only significant between cells interaction was that of grade level by community type. Table 4:22 gives the token corpus difference means for second, fourth, and sixth grade subjects from suburban, urban, and rural communities.

Table 4:22

Token Corpus Difference Means by Grade Level and Community Type

	Suburban	Urban	Rural
Grade 2	370	769	511
Grade 4	128	166	152
Grade 6	-06	42	32

Being token corpus difference means, positive numbers indicate subjects gave principal and secondary pronunciations in lesser proportions than were found on the token corpus. Negative scores indicate subjects gave these pronunciations more frequently than occurred in the corpus. The smaller the mean, the closer it was to the proportions on the token corpus. Table 4:22 shows that urban second grade subjects were most deviant from the token corpus predictions and suburban sixth grade subjects were least deviant. At all grade levels, suburban subjects were less deviant than urban or rural subjects.

Results Related to the Main Effects Within Cells

Two additional hypotheses were tested. Hypothesis Eleven dealt with the main effect vowel cluster and Hypothesis Twelve dealt with the main effect response type. In each of these cases, the main effects of grade level, sex, reading level, and community type were collapsed. Thus, the difference score means for all subjects were summed for each of the seven vowel clusters, and for the two response types, principal and secondary.

Hypothesis Eleven. There is no difference in the token corpus (TK) difference scores of the seven vowel clusters, that is: $H_{11(TK)}$: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$.

As presented in Table 4:16, there were significant differences ($p < .01$) among the token corpus difference scores for the seven selected vowel clusters; therefore, Hypothesis Five was not accepted. Presented in Table 4:23 are the token corpus difference means for the seven vowel clusters. These scores are summations of all subjects' difference scores for both principal and secondary pronunciation proportions. Positive scores, therefore, indicate that subjects gave less principal and secondary pronunciations than predicted by the token corpus. Negative scores mean that subjects gave principal and secondary responses more frequently than predicted by the corpus. This table shows that with three vowel clusters, ea, ou, and ai, subjects tended to maximize the principal and secondary pronunciations; that is, they gave them more frequently than would be expected from the token corpus proportions.

Table 4:23

Token Corpus Difference Means by Vowel Cluster

oo	au	ay	ow	ea	ou	ai
963	747	510	463	-128	-150	-406

By comparing Tables 4:23 and 4:08, it is obvious that the difference scores, both positive and negative, are much larger with the token corpus than with the type corpus. This seems to suggest that subjects' pronunciations were more closely related to the vowel cluster pronunciation proportions on the type corpus than on the token corpus.

> Hypothesis Twelve. There is no difference in the token corpus (TK) differences of principal (P) and secondary (S) response types, that is: $H_{1(TK)}$: $\mu_P = \mu_S$.

As shown in Table 4:16, there were significant differences among the token corpus difference scores of principal and secondary response types; therefore, Hypothesis Twelve was not accepted. Table 4:24 presents the difference sums for principal and secondary pronunciations, collapsed across vowel clusters. As shown, the subjects gave the secondary pronunciations of vowel clusters far more often than might have been expected on the basis of the pronunciation proportions on the token corpus. Conversely, they gave the principal pronunciations less often than what was predicted by the token corpus. These differences will be discussed in the next section of this chapter.

Table 4:24

Token Corpus Difference Scores by Response Type

Principal Pronunciation	Secondary Pronunciation
3148	-1162

Results Related to the Significant Within Cells Interaction

In addition to the significant main effects vowel cluster and response type, the two significantly interacted, $p < .01$, (see Table 4:16). Table 4:25 presents the means for all subjects by vowel cluster and response types.

Table 4:25

Token Corpus Difference Means by Vowel Clusters and Response Types

	Principal	Secondary
ai	69	-92
au	70	-23
ay	19	08
ea	-23	13
oo	73	-19
ou	-35	25
ow	04	29

Table 4:25 shows that with two vowel clusters, ea and ou, subjects gave the principal pronunciations more frequently than occurred on the token corpus. With three others, ai—>/ɛ/, au—>/ɔ/ and oo—>/U/ subjects selected the principal pronunciations considerably less often than might be expected. The secondary pronunciations of ai—>/e/ was chosen much more often than occurred in the token corpus. This seems to indicate that subjects' pronunciations were more closely related to the highly frequent ai—>/e/ correspondence, although it was the secondary correspondence on the token corpus.

Results Related to Significant Between and Within Cells First Order Interactions

As indicated in Table 4:16, there were four significant between and within cells first order interactions ($p < .01$): Grade by Vowel Cluster, Grade by Response Type, Reading Level by Response Type and Community Type by Response Type.

To present the significant Grade by Vowel Cluster Interactions, Table 4:26 gives the token corpus difference means for second, fourth and sixth grade subjects for each vowel cluster. As the table indicates, with all vowel clusters second grade subjects chose principal and secondary pronunciations less frequently than they occurred in the token corpus. Fourth and sixth grade subjects selected predicted pronunciations for three vowel clusters ai, ea and ou, more frequently than occurred and sixth grade subjects did for au as well. No other grade level by vowel cluster patterns are evident.

Ta ,le 4:26

Token Corpus Difference Means by Grade

Level and Vowel Cluster

	Grade 2	Grade 4	Grade 6
ai	15	-15	-24
au	29	12	-02
ay	28	11	05
ea	13	-08	-14
oo	37	24	17
ou	03	-09	-08
ow	26	08	05

There was a significant interaction between grade level and response type (see Table 4:16). The token corpus difference means by grade level and response type are presente in Table 4:27. As with analysis one, type corpus relationships, (see Table 4:13) there was an evident progression from second to sixth grade in approximation of principal vowel cluster pronunciations on the token corpus. At each grade level, subjects selected secondary responses more frequently than occurred on the token corpus. This was probably due to the highly frequent secondary correspondences of the vowel clusters ai—>/e/ and oo—>/u/.

Table 4:27

Token Corpus Difference Means by Grade Level and Response Type

	Grade 2	Grade 4	Grade 6
Principal	172	65	30
Secondary	-29	-28	-33

Table 4:28 presents the token corpus difference means by reading level and response type. This table shows the subjects of high reading level were less deviant from the token corpus principal pronunciation proportions than were subjects of low reading level. While both cells gave secondary pronunciations more frequently than occurred in the token corpus, the better readers did so to a greater degree.

Table 4:28

Token Corpus Difference Means by Reading Level and Response Type

	High Reading	Low Reading
Principal	60	109
Secondary	-35	-24

Finally, there was also a significant interaction between community type and response type. Table 4:29 presents the token corpus difference means by community type and response type. This table demonstrates that with principal vowel clusters pronunciations on the token corpus, suburban subjects were more consistent than urban and rural subjects. While all subjects selected secondary pronunciations more frequently than occurred on the token corpus, rural subjects did so to the greatest degree.

Table 4:29

Token Corpus Difference Means by Community Type and Response Type

	Suburban	Urban	Rural
Principal	58	93	104
Secondary	-24	-16	-50

Summary of Analyses One and Two

On both analyses (analysis one related subjects' responses to the type corpus frequencies and analysis two related subjects' responses to the token corpus frequencies) grade level, reading ability and community type were significant main effects. There was a decrease in deviance from second to sixth grade between subjects' responses and the frequencies on both corpora; better readers' responses were less deviant than those of the poorer readers; and suburban subjects' responses more closely approximated the frequencies on the type and token corpus than did the urban or rural subjects.

Sex was not a significant main effect in either analysis.

On analysis one (type corpus) there were significant first order interactions between vowel cluster by response type, grade by vowel cluster, sex by vowel cluster, reading ability by vowel cluster, grade by response type, reading ability by response type and community type by response type.

On analysis two (token corpus) there were significant first order interactions between vowel cluster by response type, grade by vowel cluster, grade by response type, reading ability by response type and community type by response type.

Relationships Between Subjects' Pronunciations of Vowel Clusters and the Vowel Cluster Pronunciation Frequencies on the Type and Token Corpora

Two methods of predicting the distribution of vowel cluster pronunciations by reading level, sex, grade level, and community type were studied. The words containing a given vowel cluster spelling in the Modified Thorndike 20,000 word corpus were tabulated, and the per cent of each vowel cluster pronunciation was calculated for the token corpus of the 1000 most frequent words. The inherent question regarding each corpus was whether or not subjects would employ either a matching or maximizing strategy with respect to the two probability distributions of possible pronunciations. That is, would subjects produce responses in the same proportions as either the type or token corpus proportions, or would they always or nearly always give the most frequent response of either distribution? The results of Analyses One and Two showed that subjects' responses were much more closely related to the type corpus proportions than to the token corpus proportions.

Examination of the Raw Data

Table 4:30 is a tabulation of vowel cluster pronunciations by all 436 subjects. This table shows the great range of pronunciations both within and between vowel clusters. Errors refer to items which were either omitted, or for which more than one response was circled.

Table 4:30

Per Cent of Vowel Cluster Pronunciations

by all 436 Subjects

ai		au		ay		ea	
/e/	79.7%	/ɔ/	56.7%	/e/	80.6%	/i/	68.9%
/ɪ/	14.7%	/æ/	20.5%	/ai/	12.0%	/ɛ/	15.8%
/ai/	5.0%	/au/	16.6%	/ɪ/	2.6%	/e/	10.4%
/ɛ/	4.6%	/o/	4.3%	/ɛ/	2.4%	/ə/	2.6%
error*	1.9%	error	1.9%	error	2.4%	error	2.2%
ie		**oa**		**oo**		**ou**	
/i/	37.9%	/o/	67.2%	/u/	58.0%	/au/	53.7%
/ai/	28.8%	/au/	11.5%	/o/	21.4%	/u/	17.9%
/ɪ/	22.2%	/ɔ/	10.2%	/ʊ/	14.1%	/ʊ/	13.3%
/ɛ/	9.0%	/a/	9.3%	/ə/	4.6%	/ə/	12.5%
error	2.1%	error	1.8%	error	2.0%	error	2.6%
ow		**Check Items**					
/au/	53.1%	correct	79.8%				
/o/	32.5%	incorrect	18.0%				
/a/	6.6%	error	2.2%				
/ɔ/	5.8%						
error	2.0%						

*Error refers to an item which was either omitted or for which more than one response was circled.

Of the seven vowel clusters included in both analyses of the data, ai, au, ay, ea, oo, ou, and ow, the principal pronunciations of four were the same on both the type and token corpora: au—>/ɔ/, ay—>/e/, ea—>/i/, and au—>/au/. With three of these four, the pronunciation proportions were very similar: au, type .92, token .91; ay, type .89, token .90; and ea, type .53, token .57. For ou the proportions were .50 and .36.

With the remaining three vowel clusters included in both analyses, the principal pronunciations were different on the two corpora: ai—>/e/ and —>/ε/ (type and token); oo—>/u/ and —>/U/; and ow—>/o/ and —>/au/. Though the principal and secondary pronunciations of ow were reversed on the two corpora, the proportions were very similar: ow—>/o/, type .51, token .47, and /au/, type .48, token .51 (see Table 3:10).

The secondary pronunciations were the same on both corpora for only two vowel clusters: ay—>/ɪ/, and ea—>/ε/. With these two the proportions were also very similar: ay, type .06, token .07, and ea, type .23, token .23. For the remaining five vowel clusters, the secondary pronunciations were different on the two corpora (see Table 3:10).

Thus, of the 14 pronunciation positions (principal and secondary) for the seven vowel clusters used in both analyses, there was an overlap of four principal and two secondary vowel cluster pronunciations. Two additional vowel clusters were included in the instrument, ie and oa, but were not included in both analyses. The vowel cluster oa was omitted from both analyses because the secondary pronunciation was disyllabic on the type corpus and could not be accounted for on the multiple-choice instrument, and there was no secondary response on the token corpus. Similarly, ie was omitted from the token analysis because its secondary response was disyllabic. Subjects' responses to all nine vowel clusters were tabulated, however, because of the disparity in frequency of principal pronunciation.

The following table, 4:31, presents the most frequent pronunciation given to each vowel cluster by all subjects, and indicates its position on both the type and token corpus. From this table it can be seen that of the two corpora, the type corpus was perhaps the better predictor of children's vowel cluster pronunciations. Of the most frequent pronunciation to each of the nine vowel clusters given by the subjects, eight were the principal pronunciations on the type corpus, while only one, ow, was secondary (and its proportion was very close to that occurring in the study). Further, the pronunciation proportions on the type corpus were closer than the token corpus proportions to the pronunciation proportions occurring in the study for five of the nine vowel clusters, ai, ay, oa, oo, and ou. For three of these, ai, oa, and ou, the type corpus proportions were considerably closer. For the four remaining vowel clusters whose proportions on the token corpus were closer than the type corpus proportions to those actually occurring, there was very little difference: au, .92 and .91 (type and token); ea, .53 and .57; ie, .27 and .47; and ow, .48 and .51.

Table 4:31

The Most Frequent Pronunciation of Each Vowel Cluster by all Subjects and Their Positions on the Type and Token Corpora

M Vowel Cluster	Subjects' Most Frequent Pronunciation		Response Position on Type Corpus		Response Position on Token Corpus	
ai	/e/	.74%	principal	.86%	secondary	.27%
au	/ɔ/	.57%	principal	.92%	principal	.91%
ay	/e/	.81%	principal	.89%	principal	.90%
ea	/i/	.69%	principal	.53%	principal	.57%
ie	/i/	.38%	principal	.27%	principal	.47%
oa	/o/	.67%	principal	.75%	principal	1.00%
oo	/u/	.58%	principal	.62%	secondary	.48%
ou	/au/	.54%	principal	.50%	principal	.36%
ow	/au/	.53%	secondary	.48%	principal	.51%

In addition, Table 4:31 shows that for no vowel cluster was an exact matching strategy employed by subjects with respect to pronunciation proportions on either the type or token corpora. However, it is apparent that subjects did not employ a maximizing strategy in relation to the type corpus though the principal pronunciation of each vowel cluster on the type corpus was the most frequent pronunciation given by the subjects for eight of the nine vowel clusters. Thus, the type corpus principal pronunciations seem to be the best "predictors" of actual vowel cluster pronunciations by children. In other words, children's pronunciations seemed to be less closely related to highly frequent words (token corpus), than to a larger variety of words with the same vowel cluster letter-sound correspondence. For example, the principal pronunciation of oo on the token corpus was /ʊ/ because of such highly frequent words as look, book and good. Likewise, the word said caused the principal pronunciation of ai to be /ɛ/ on the token corpus. Even though children obviously encounter these words frequently in their reading, they encounter a greater number of oo and ai words with the type corpus principal pronunciations: moon, soon, too; rain, wait, laid.

Table 4:31 also reveals another phenomenon: the more frequently a vowel cluster pronunciation occurred within English words, the greater its relation seemed to be to readers' pronunciations. For example, the principal pronunciations of ai and ay occurred very frequently on the type corpus, and subjects gave these pronunciations very often. The principal pronunciation frequencies for ie and ow were much lower on the type corpus and similarly with the subjects. Two vowel clusters, au and ea, seemingly contradicted this. With au the principal pronunciation on both the type and token corpora, .92 and .91, was much higher than the subjects' response, .57. The reverse was true with ea where the subjects' response proportion, .69, was higher than that of the type or token corpora whose proportions were .53 and .57. This was likely due to the fact that there are many more common English words with ea spellings than with au spellings, on both the type and token corpora (see Table 2:21).

Comparison of Analyses One and Two

Additional comparisons show the greater relationship between the type corpus pronunciation frequencies and those of the subjects, rather than the token corpus pronunciations.

Tables 4:04 and 4:19 show a much greater deviance by reading level from the token corpus pronunciation frequencies than from the type corpus. This difference can also be seen by comparing Tables 4:03 and 4:18 and Tables 4:05 and 4:20.

In summary, then, it seems apparent that children's pronunciations of vowel clusters were related more to a large number of words with the same letter-sound correspondence (word types) than to a few highly frequent words with a different correspondence (word tokens).

Effects of Consonant Environment on Vowel Cluster Pronunciations

In addition to examining the foregoing hypotheses and question, the study was designed to provide information about the effects of consonant environment on vowel cluster pronunciation. Previous research had indicated that contextual features may influence pronunciation preferences (Calfee, et al., 1968). Some letter-sound correspondences are invariant or nearly invariant; therefore, the sound can be derived from the symbol regardless of contextual restraints. Other sound correspondences are variant but are considered predictable because the correspondence can be determined by some feature within the word, such as a consonant environment. For example, c is usually /k/ before a, o, and u, as in cat, cot and cup. On the other hand, ea may be either /i/, /ɛ/ or /e/ before /t/ as in heat, threat and great, and both /i/ and

/ɛ/ after /h/ as in heat and head. Therefore, since features within a word do not signal the pronunciation of ea, it is considered unpredictable.

Tabulations of subjects' vowel cluster pronunciations by synthetic words within vowel clusters, indicated that some vowel clusters, though considered unpredictable, were indeed affected by contextual features. Several examples are presented in Table 4:32.

This table shows considerable pronunciation differences within differing contextual environments. For example, when ie preceded s, it received the /ai/ pronunciation more frequently than the /i/. The reverse was true in the k environment and in final position.

Table 4:32

Pronunciation Percentages of Sample Synthetic Words by all Subjects

Vowel Cluster	Synthetic Word	Phoneme and Percentage	Phoneme and Percentage
ie		/ai/	/i/
	Wies	50.6	23.6
	Abiek	18.3	45.5
	porie	17.6	60.2
	gies	48.0	26.9
oo		/u/	/ʊ/
	sloot	72.0	6.9
	yook	31.6	34.1

Table 4:32 (cont.)

Vowel Cluster	Synthetic Word	Phoneme and Percentage	Phoneme and Percentage
ou		/au/	/u/
	Coudry	69.3	9.6
	toul	52.0	30.3
ow		/au/	/o/
	mullow	35.0	50.8
	frowl	63.8	20.6
au		/ɔ/	/æ/
	paud	65.1	14.3
	naugh	54.2	29.7

Table 4:33 shows the lowest and highest principal pronunciation percentage by synthetic word for each vowel cluster. Ten synthetic words were used to test each of the nine vowel clusters. The table shows that for some vowel clusters the range in principal pronunciations by synthetic words was much greater than for others.

This table shows that the smallest range in principal pronunciation percentages by synthetic word was with the vowel cluster ai (9.8%), and the largest with oo (40.4%). In addition to oo, the range was great with ie (36.6%), ow (28.8%) and ou (27.2%). The range was small with ay (10.5%), oa (14.3%), au (15.0%), and ea (17.1%). This spread is revealing. Those vowel clusters which have the highest frequency principal pronunciations, ai, au, ay, and oa, had the smallest range of principal pronunciation by synthetic word. Conversely, the vowel clusters with the lowest frequency of principal pronunciation by synthetic word, oo, ie, ow and ou, had the greatest range of principal pronunciation by synthetic word (see also Table 2:32).

Table 4:33

Pronunciation Percentages for Synthetic Words Receiving the Fewest Principal Pronunciations and the Most Principal Pronunciations

Vowel Cluster	Principal Pronunciation Type Corpus	Lowest Percentage		Highest Percentage	
ai	/e/	ogaim	69.4	chaig	79.2
au	/ɔ/	aucol	50.1	paud	65.1
ay	/e/	pokay	76.9	chays	87.4
ea	/i/	fead	60.7	dease	77.8
ie	/i/	wies	23.6	porie	60.2
oa	/o/	toang	59.8	coad	74.1
oo	/u/	yook	31.6	sloot	72.0
ou	/au/	manous	42.1	coudry	69.3
ow	/au/	mullow	35.0	frowl	63.8

It must be noted that ea is seemingly an exception to this pattern. Nearly all subjects preferred the principal pronunciation of ea—>/i/. Though the percentage of ea—>/i/ on the type corpus is only 53%, most subjects preferred the /i/ pronunciation from 60 to 80% of the time with the ten synthetic words containing ea spellings. This may possibly be explained by the erroneous phonics generalization which is still popular in elementary school reading programs: "When two vowels go walking, the first one does the talking."* Words with ea spellings are often used to support this generalization.

With synthetic words containing oo spellings, subjects clearly favored the /u/ pronunciation in all words except those ending in k. The synthetic word yook received the /ʊ/ pronunciation 34.1 % of the time and /u/ 31.6%. The word mook was pronounced /ʊ/ 33.3% of the time. By comparison, the word sloot was pronounced /ʊ/ only 6.9% of the time. It is likely that such frequent words as book, look, and took have an influence on pronunciation preferences for oo in the k environment.

Effects of Word Position on Vowel Cluster Pronunciation

Pronunciation preference for words containing the ow vowel cluster seemed somewhat related to word position. Subjects favored the /au/ pronunciation in all ow words except one, mullow, in which /o/ was preferred. However, the /o/ pronunciation was greater in all words in which ow was in final position than when ow was in medial position. This is shown in Table 4:34.

Though the differences were not great, ow received the /o/ pronunciation slightly more often when in final position than when in medial position.

*Tables 2:04 through 2:20 on pages 26 through 34 show that of the 17 vowel clusters which occur in 100 words or more on the type corpus, the generalization is accurate 75% of the time or more for only four vowel clusters, ai, ay, ee, and oa. For two more, ea and ow, the generalization is true in slightly more than 50% of their occurrences. For the remainder it is rarely or never true.

Table 4:34

The Influence of Word Position on

the ow /o/ Correspondence

Synthetic Word	/c/	/au/
mullow	50.8	35.0
sprow	43.2	45.5
stappow	36.6	48.7
aclow	36.4	49.0
frowl	20.6	63.8
gowl	23.1	60.6
zown	30.7	55.8
fowt	22.5	60.9
spows	24.6	60.0
trown	36.1	52.0

There were no discernible contextual patterns to the pronunciation variances of the ie and ou vowel clusters in synthetic words.

Summary of Contextual Features

In summary, the pronunciation percentages of vowel clusters varied among synthetic words for each vowel cluster. With the oo cluster in the k environment, and with ow in final position these variations seemed to be contextually related. The strongest relationship, however, was the converse relationship between frequency of principal pronunciation and range of principal pronunciation percentage by synthetic word.

Summary of Results of the Study

Analysis One and Analysis Two show that there were no obvious patterns of vowel cluster pronunciation on the basis of sex. This seems to run contrary to considerable research in this country which shows girls superior to boys in reading and related tasks, particularly in the early grades. In the present study sex was not a significant main effect and was not significantly interacted with grade level.

Reading ability was clearly related to vowel cluster pronunciation. The better readers consistently gave more principal pronunciations (type corpus) than did the subjects of low reading level. This was probably due to the greater and wider reading typical of better readers, enabling them to encounter more words with vowel cluster spellings upon which to develop pronunciation generalizations.

Grade level was significantly related to vowel cluster pronunciation. There was a progression from second to fourth to sixth grade in the percentage of both type and token corpus pronunciations. This progression was only slightly affected by community type and was not at all related to sex or reading level. Good readers and poor, boys and girls, increasingly favored the principal pronunciations as they advanced through the elementary grades. This, also, was undoubtedly affected by an increased reading vocabulary.

Community type was also related significantly to vowel cluster pronunciation. Suburban subjects tended to favor the principal pronunciations of vowel clusters on the type corpus slightly more than the urban and rural subjects. This difference could have been caused by any number of factors not isolated in this study. Generally, suburban communities are more affluent and suburban children own more books than their urban or rural counterparts. However, many factors cloud the issue and make it difficult to explain the suburban "edge" with any degree of confidence.

To this investigator, the latter results are not surprising, but the absence of a pattern of sex differences is. Perhaps the most significant finding of the study is the observation that word types seem to be more closely related than word tokens to the pronunciation of unfamiliar words containing vowel clusters by elementary children.

In addition, subjects' pronunciation frequencies of synthetic words varied within each vowel cluster. No two words received identical pronunciation proportions. The greater the frequency of principal pronunciations, the narrower the range of pronunciation percentages by synthetic word. The only discernible patterns of contextual or positional effects on pronunciation choice were with oo in the k environment, and ow in final position.

Chapter V

SUMMARY AND CONCLUSIONS

The final chapter of this dissertation contains a brief summary of the problem, the procedures, and the results of the study. Also included is a statement of the conclusions, a discussion of the implications and suggestions for further research.

Summary

The Problem

This investigation was designed to examine elementary school children's pronunciations of vowel clusters and to analyze factors that may be related to their pronunciation preferences. The major concern of the study was to determine the pronunciations children give to synthetic words containing vowel cluster spellings, and to analyze the observed pronunciations in relation to common English words containing the same vowel clusters.

Seven specific research questions were posed:

1. How well do children's pronunciations of vowel clusters in synthetic words approximate the actual pronunciation frequencies of the same vowel clusters?
2. What differences are there in the pronunciations of good readers and poor readers?
3. Do boys and girls differ in their pronunciations?

4. What differences are there in the pronunciations of second, fourth, and sixth grade pupils?

5. Do children of different communities differ in their pronunciations?

6. Will subjects' pronunciations of vowel clusters be more closely related to pronunciation frequency on a type corpus or a token corpus?

7. Will word position or consonant environment effect the pronunciation of vowel clusters in synthetic words?

Construction of the Instrument for Testing Vowel Cluster Pronunciation

In 1961 Venezky developed a computer program to derive and tabulate letter-sound correspondences in a corpus of 20,000 common English words (1963). This corpus was a modification of the most common 20,000 words in English according to the Thorndike Frequency Count (1941). The modification included the deletion of many low-frequency and archaic words, particularly proper nouns, and the addition of a number of words in their place. The computer analysis provided an inclusive tabulation of all letter-sound correspondences found in the corpus.

Venezky's unpublished computer print-out of spelling-to-sound correspondence in 20,000 words was analyzed by this investigator to determine letter-sound correspondences for vowel cluster spellings. Among other things, this analysis disclosed the following:

1. There were 61 vowel clusters (including those containing the semi-vowels w and y) in the corpus.

2. There was great variance in the frequency of the 61 vowel clusters. One occurred in more than 1000 words, while 17 occurred in more than 100 words, and 26 occurred in three words or less.

It was decided that testing a representative subset of the most common vowel clusters would permit sufficient analysis of children's vowel cluster pronunciation behavior. Nine vowel clusters were selected on the basis of frequency of occurrence, and frequency variations in phonemic correspondence. The vowel clusters ai, au, ay, ea, ie, oa, oo, ou, and ow appeared to comprise a representative cross-section of all vowel clusters. These nine accounted for nearly half of all occurrences of all 61 vowel clusters in the 20,000 word corpus.

For this study, two models of existing letter-sound correspondence of vowel clusters were used, the Modified Thorndike 20,000 word type corpus and a 1000 word token corpus. The token corpus contained the 1000 most frequent words of the 1967 Kučera-Francis study which provided a rank order listing of more than 50,000 words on the basis of a computer analysis of 1,014,232 words of natural language test.

The type corpus analysis provided all letter-sound correspondence proportions of vowel clusters on the basis of word types, whereby each word in the corpus was counted once regardless of frequency. The token corpus analysis provided letter-sound correspondence proportions of the nine selected vowel clusters on the basis of word tokens, that is, each word containing one of the selected vowel clusters was multiplied by its number of occurrences.

To measure pronunciation of vowel clusters in unfamiliar words, it was essential that synthetic words be used rather than real words. The principal guideline followed in the construction of these words was linguistic plausibility. Ten synthetic words for each of the nine vowel clusters were constructed. In addition to the 90 synthetic words containing vowel clusters, ten check items were included to determine reliability. Five of these were real words and five were synthetic words with predictable letter-sound correspondences (e.g., pid, p = /p/).

The 100 items were divided into two halves (labeled A and B), each half composed of five synthetic words containing each vowel cluster and five check items. Using a table of random numbers, each 50 item subtest was arranged in two orderings. The four orderings were designated A1, A2, B1 and B2. Three real words were offered as multiple-choice response items for each synthetic word, and these response words contained at least two of the most frequent pronunciations of each vowel cluster on both corpora. This experimental instrument was used during Pilot Study A and Pilot Study B. The test was not designed to see whether children pronounced vowel clusters in synthetic words correctly or incorrectly, but to determine which of the correct pronunciations they preferred. In addition to the experimental multiple-choice test, an oral pronunciation test was given using the same items in the same sequences. The purpose of this test was to enable the investigator to account for oral preferences in the final multiple-choice instrument.

The Sample and Testing Procedures

Pilot Study A

Pilot Study A was conducted to refine the testing procedures. The pilot sample consisted of three second, three fourth, and two sixth grade pupils at Waterloo Elementary School, Waterloo, Wisconsin. Each test item was typed on a 5 x 7 flash card, and the flash cards were arranged in sequences identical to tests A1, A2, B1 and B2. During an oral test each subject viewed each synthetic word and pronounced it into a tape recorder. With the multiple-choice test the subject's task was to circle a real word from among the response items, whose underlined letters represented the same sound as that represented by the underlined letters in the synthetic word. Pilot Study A indicated that no significant changes in the testing instrument or procedures were needed.

Pilot Study B

Pilot Study B was designed to determine the relationship between oral pronunciations of synthetic words containing vowel clusters, and multiple-choice responses to the same synthetic words so that oral preferences could be incorporated into the final multiple-choice instrument. The sample consisted of 48 pupils at Waterloo Elementary School, Waterloo, Wisconsin. The 48 subjects included 16 subjects at each of three grade levels--second, fourth, and sixth. Each subgroup contained an equal number of boys and girls of high and low reading ability. Each subject was tested with one oral and one multiple-choice test on each of two days, thus responding to all 100 test items twice.

The Study

The Study was designed to examine the relationships between grade level, reading ability, sex, community type and the pronunciation of vowel clusters. The sample consisted of 436 elementary pupils from Racine (urban), Cedarburg (suburban), and Seneca (rural), Wisconsin. Two classrooms at each of the three grade levels (second, fourth and sixth) were randomly selected. The sample consisted of 240 boys and

196 girls. Within each class, reading level was determined by a standardized reading test median split for each sex. Since the final multiple-choice test reflected the oral preferences of Pilot Study B, the subjects in the Study only responded to the multiple-choice test. Each subject responded to one subtest of 50 items on one day and another subtest of 50 items the following day.

Analysis of the Data

Pilot Study B

The analysis examined the agreement of oral and multiple-choice responses by each subject to each synthetic word. The hypothesis being tested was:

> There are no differences in subjects' oral (O) and multiple-choice (MC) pronunciations of synthetic words containing vowel clusters, that is, $H_1 = \mu_O = \mu_{MC} = 0.01$.

Using the ANOVA H computer program, a 10 x 2 x 2 x 3 analysis of variance, in which the main effects were nine vowel clusters (plus check items), sex, two reading levels and three grade levels was performed on the oral/multiple-choice agreement scores. At the .01 level of significance there were three significant main effects: vowel cluster, reading level, and grade level, and one significant interaction, vowel cluster by grade level.

Oral/multiple-choice agreement ranged from a low of 3 of 10 synthetic words for the vowel cluster <u>ou</u>, to a high of 7 of 10 synthetic words for the vowel cluster <u>ay</u>. This analysis showed the necessity of revising the multiple-choice instrument to be used in the Study.

As a result of Pilot Study B, the final multiple-choice instrument for use with the study was developed. The same 100 test items were retained, but four distractors were offered instead of three. Thus, the multiple-choice distractors for the study reflected not only the major pronunciations for the vowel clusters on the type and token corpora, but included the major oral responses from Pilot Study B as well.

<u>The Study</u>

A computer program was written which tabulated the subjects' pronunciations and which listed the pronunciation proportions for each word and for each vowel cluster. Previously the principal and secondary pronunciation frequencies of the vowel clusters on both the type corpus and the token corpus had been determined (see Table 3:10). Two concurrent analyses of the data were performed. Each subjects' principal and secondary responses were summed up for each vowel cluster; then two frequency differences were calculated for each subject. These were:

1. The principal and secondary pronunciation proportions of each vowel cluster on the type corpus minus the principal and secondary pronunciation proportions actually occurring.

2. The principal and secondary pronunciation proportions of each vowel cluster on the token corpus minus the principal and secondary pronunciation proportions actually occurring.

The study was designed to test 12 hypotheses and to answer several questions. The hypotheses were concerned with the relationships between vowel cluster pronunciation frequencies of the type and token corpora with vowel cluster pronunciation of subjects by grade level, reading level, sex, and community type. The questions were concerned with the effect of word position and consonant environment on vowel cluster pronunciations and with the relationship between subjects' vowel cluster pronunciations and the pronunciation frequencies on the type and token corpora.

To test the hypotheses, two analyses were performed. In each analysis the design was a 3 x 2 x 2 x 3 x 8 (or 7) x 2 analysis of variance, in which the main effects were three grades, sex, two reading levels, three community types, seven or eight vowel clusters (seven on the token analysis and eight on the type analysis), and two response types (principal and secondary). The ANOVA FINN computer program, which treats unequal n's was used.

Results

1. Grade level was significantly related to vowel cluster pronunciations. There was an upward progression from second to fourth to sixth grade in the percentage of principal vowel cluster pronunciations given in both analyses.
2. There were no significant differences in the vowel cluster pronunciations of male and female subjects in either analysis.
3. Reading ability was significantly related to vowel cluster pronunciation. Subjects of high reading level consistently gave more principal pronunciations to the vowel clusters in both analyses than did the subjects of low reading level.
4. Community type was significantly related to vowel cluster pronunciations, though a pattern was minimally visible. Suburban subjects tended to give the principal pronunciations of vowel clusters slightly more consistently than rural and urban subjects.

5. Grade level and community type were significantly interacted in both analyses. Suburban subjects were less deviant from the type and token corpus predictions, and in all community types there was a progression in consistency from grades two to six.
6. In analysis one (type corpus) there were significant first order interactions between vowel cluster by response type, grade by vowel cluster, sex by vowel cluster, grade by response type, reading level by response type and community type by response type.
7. In analysis two (token corpus) there were significant first order interactions between vowel cluster by response type, grade by vowel cluster, grade by response types, reading level by response type and community type by response type.

Exploration of Questions

1. Subjects' proportions of principal and secondary pronunciations varied for all vowel clusters in both analyses. The principal pronunciations of vowel clusters on the type corpus were more closely related to the vowel cluster pronunciation preferences of children, than were the type corpus secondary pronunciations, or the token corpus principal or secondary pronunciations.
2. Generally, the more frequently a given vowel cluster pronunciation occurred, the greater its influence was on subjects' pronunciations. For vowel clusters with a highly frequent principal pronunciation, ay—>/e/, subjects' pronunciations were accordingly higher than for vowel clusters with a less frequent principal pronunciation, ie—>/i/.

3. Two other observations are worth noting:

   a. No two synthetic words testing any of the vowel clusters received identical pronunciation percentages. Pronunciations of oo varied when followed by k in other environments. Final word position seemed to influence pronunciation preferences of ow. No other contextual patterns were visible.

   b. There was a converse relationship between frequency of principal pronunciation on the type corpus, and the range of principal pronunciation percentages for the synthetic words testing each vowel cluster. The greater the frequency of principal pronunciation, the narrower the range of principal pronunciation percentages by synthetic word.

Limitations

The results of this study must be interpreted in the light of its limitations.

The vowel cluster multiple choice test was not tested for reliability using test-retest or split half measures. A prerequisite to its future use should be a determination of its reliability using a test-retest method.

The findings are, of course, limited to the population from which the sample was drawn.

Conclusions and Implications

This research study was designed to answer questions relative to children's pronunciations of vowel clusters. Unlike most single consonants and many single vowels and consonant clusters, vowel cluster pronunciations are not predictable and are, perhaps, the most complex set of letter-sound correspondences.

Beginning reading books continue to stress one primary generalization governing vowel cluster pronunciations. This is the highly erroneous "rule"--"When two vowels are together, the first is long and the second is silent."* As stated previously, only four vowel clusters, ai, ay, ee, and oa, follow this generalization in 75% or more of their occurrences.

Despite the lack of generalizability about vowel cluster pronunciations and contrary to the aforementioned erroneous "rule", readers apparently do develop logical vowel cluster pronunciation preferences.

This study revealed an upward progression from second to sixth grade, particularly in preference for the principal vowel cluster pronunciations on the type corpus, though this progression was evident in relation to the token corpus as well. Apparently as children progress through the elementary grades and their reading vocabularies grow, they form generalizations about symbol-sound relationships which they apply to unfamiliar words containing vowel cluster spellings.

Similarly, the responses of good readers more closely approximated the vowel cluster pronunciation frequencies, than did the responses of poor readers. Poor readers' responses were more erratic. This is perhaps due to the fact that good readers, in general, read more than poor readers and thus encounter more words with vowel cluster spellings.

The fact that suburban subjects were somewhat more consistent than urban and rural subjects in relation to the corpora "predictions"

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*In one recent reading methods textbook, Teach Them to Read by Dolores Durkin, 1970, future teachers of reading are still urged to teach this faulty generalization.

may be due to the usually higher economic levels of suburban communities. More children's books and magazines are generally found in affluent homes, and the accessibility of reading materials may tend to enlarge the reading vocabularies of suburban children. However, the performances of subjects by community type is undoubtedly related to a variety of confounded factors (socioeconomic level, amount of reading training at home, etc.) for which no measures were available, thus precluding any conclusions about the influence of community type on vowel cluster pronunciations.

Another finding of the investigation was the absence of significant pronunciation differences by subjects of the two sexes on both analyses. Considerable research concerned with pre-school reading readiness and primary grade reading achievement has shown girls to be superior to boys in reading-associated tasks in this country.* Although girls generally do better than boys in overall reading achievement, particularly in the early elementary grades, preference in pronunciations of vowel clusters was not related to sex.

Perhaps the most interesting finding of this study was the greater relationship between type corpus principal pronunciations and the pronunciations given by children, than the token corpus pronunciations relationship. The vowel cluster pronunciations of the subjects of this study seemed to be more closely related to a variety of words containing

*In Germany, however, the opposite is true (Preston, 1962), suggesting that sex differences in reading are culturally affected.

a particular vowel cluster-sound correspondence, than to a few highly frequent words containing a different vowel cluster-sound correspondence. For example, subjects' pronunciations of ou were related less to three highly frequent words, would, could, and should, in which ou—>/ʊ/ than to the large number of words in which ou—>/au/, as in ounce.

It can be further concluded that the less variation in pronunciation of a vowel cluster, the more consistent the subjects' pronunciations of that vowel cluster. Subjects were much more consistent in their preference for a highly frequent principal pronunciation, such as ay—>/e/, than for an infrequent principal pronunciation such as ie—>/i/. If the "two vowel" phonics rule were influential, these differences would not have occurred. (That subjects' pronunciations were more greatly related to a variety of words with a particular pronunciation than to the faulty "two vowel" rule, was clearly demonstrated in Table 4:30.)

The differing pronunciations of synthetic words containing the same vowel cluster suggested that word configuration may be related to pronunciation. It seems likely that some synthetic words reminded subjects of real words in appearance or sound, and consequently influenced their pronunciation of those words.

Educational Implications

1. Since the commonly taught vowel cluster generalization, "When two vowels are together the first is long and the second is

silent," has been demonstrated to be inaccurate, and further, since it seems to have had little impact on vowel cluster pronunciation strategies of children anyway, this generalization should no longer be taught.

2. Only those vowel clusters with sufficient frequency of occurrence should be taught. This should perhaps include the 17 which occur in 100 words or more, io, ea, ia, ou, ee, oo, ai, ie, ow, au, ay, iou, oi, oa, ue, ua, and ui, and a few others, such as ew, oy and oe, which occur in highly frequent words: new, boy and does.

3. When teaching each of the vowel clusters, the principal pronunciation on the type corpus should be the first correspondence introduced (ea—>/i/, oo—>/u/, au—>/ɔ/, etc.). Following this, other highly frequent pronunciations on the type corpus and the most frequent pronunciations on the token corpus, when different should be taught (ea—>/ɛ/, oo—>/ʊ/, etc.). This would enable children to apply the one or more most likely correspondences when decoding on unfamiliar word containing a vowel cluster spelling.

4. Authors of beginning reading materials should select vocabulary items which will help develop the most frequent letter-sound generalizations for the most common vowel cluster spellings. In particular, words with very infrequent vowel cluster-sound correspondences should be introduced only after the most frequent generalizations have been established. For example,

au—>/æ/ occurs in only a few English words; therefore, words such as laugh and aunt should not be introduced until the highly frequent au—>/ɔ/ correspondence has been developed through such words as Santa Claus and because. Likewise, the ou—>/au/ correspondence as in ounce and south should be developed before introducing such words as soup in which ou—>/u/.

Recommendations for Future Research

Several considerations for further research were suggested by the conclusions of this study:

1. A similar investigation should be conducted using other common vowel clusters which were not included in the present study (oi, ia, ue, etc.). This study could further investigate the influence of type corpus principal pronunciations on children's vowel cluster pronunciation preferences.
2. Similar investigations should be conducted among subjects of different dialects and cultural backgrounds to determine the effect of these variables on vowel cluster pronunciation.
3. Experiments should be constructed to test the efficacy of teaching the principal pronunciations of vowel clusters in comparison to the conventional vowel cluster generalization. It is known what exists within the language, and that pronunciations of better readers and older children relate to type corpus principal pronunciations. Research could show the practicality of teaching these insights in the early grades.

4. Further research should be done to explore sex differences in all aspects of reading acquisition.

Information gained from these suggested studies would help to provide further insight about teaching the most complex aspect of the letter-sound correspondence code, the vowel cluster.

APPENDICES

International Phonetic Alphabet Symbols for Phonemes of American English

Vowels

Phonemic Symbol	Representative Word	Qualification
/i/	bee	
/ɪ/	bit	
/e/	date	
/ɛ/	yet	
/æ/	hat	
/a/	bath	Used in Eastern U.S. between /æ/ and /ɑ/
/ɑ/	hot	
/ɔ/	jaw	
/o/	go	
/U/	full	
/u/	mood	
/ə/	above	Unaccented syllable only
/ʌ/	above	Accented syllable only

Diphthongs

/ai/	while	
/au/	how	
/ɔi/	boy	
/ju/	fuse	

International Phonetic Alphabet Symbols

for Phonemes of American English, cont.

Consonants

Phonemic Symbol	Representative Word
/p/	pin
/b/	big
/t/	team
/d/	dish
/k/	cat
/g/	go
/f/	fall
/v/	vision
/θ/	breath
/ð/	breathe
/s/	sang
/z/	using
/ʃ/	dish
/ʒ/	vision
/h/	happy
/ts/	watch
/dʒ/	gym
/m/	meat
/n/	new
/ŋ/	angry

International Phonetic Alphabet Symbols

for Phonemes of American English, cont.

Phonemic Symbol	Representative Word
/l/	full
/w/	watch
/hw/	while
/j/	yet
/r/	rate

Appendix B

Four Forms of Vowel Cluster Multiple-Choice Test

Used With Pilot Studies A and B

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST A-1

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are three words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go
B.	gan	let	call	dad
C.	pode	baby	no	cow

As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

These are the words you know that will be on the test. Listen to the sound of the underlined letters as you read these words with me.

go	let	put	saw	gave	took	house
no	but	dad	new	baby		
be	ran	try	cow	come		
my	call					
we	bed					
to	him					
	pin					

1.	thaim	let	but	gave
2.	chause	ran	call	go
3.	polead	be	bed	baby
4.	tay	him	gave	bed
5.	coad	saw	cow	no
6.	pid	him	pin	but
7.	abiek	my	bed	we
8.	monood	new	put	but
9.	coudry	cow	took	hew
10.	frowl	call	house	go
11.	man	saw	baby	dad
12.	pokay	pin	gave	be
13.	kaidon	let	him	gave
14.	saut	cow	ran	call
15.	dease	be	let	baby
16.	mullow	took	go	house
17.	manous	but	cow	put
18.	yook	to	put	come
19.	yiet	try	we	bed
20.	smoal	cow	no	saw
21.	droon	but	new	put
22.	slaum	go	saw	ran
23.	oan	house	to	no
24.	dat	bed	took	pin
25.	bease	we	gave	let

26.	ploub	put	to	now
27.	comiel	be	baby	let
28.	gowl	no	house	saw
29.	chaig	bed	we	baby
30.	betay	my	gave	we
31.	feel	him	bed	be
32.	baish	gave	be	try
33.	trould	no	put	new
34.	vayt	pin	let	gave
35.	wies	try	pin	be
36.	theat	baby	be	let
37.	aclow	house	call	no
38.	broam	saw	go	new
39.	naugh	ran	saw	cow
40.	frool	to	put	call
41.	goag	cow	no	saw
42.	cote	house	to	go
43.	porie	my	we	him
44.	dusaig	bed	gave	be
45.	bloose	go	put	new
46.	ays	try	gave	let
47.	ealod	bed	we	gave
48.	fough	no	cow	new
49.	haup	call	go	cow
50.	zown	go	call	house

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST A-2

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are three words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go
B.	gan	let	call	dad
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As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

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go	let	put	saw	gave	took	house
no	but	dad	new	baby		
be	ran	try	cow	come		
my	call					
we	bed					
to	him					
	pin					

1.	saut	cow	call	ran
2.	porie	we	my	him
3.	ays	try	gave	let
4.	coad	cow	saw	no
5.	frowl	house	call	go
6.	oan	no	to	house
7.	dease	let	be	baby
8.	smoal	cow	saw	no
9.	pid	but	him	pin
10.	ealod	gave	bed	we
11.	manous	put	cow	but
12.	yook	come	to	put
13.	thaim	but	let	gave
14.	fough	cow	no	new
15.	bloose	put	new	go
16.	vayt	pin	gave	let
17.	zown	call	house	go
18.	dat	bed	pin	took
19.	baish	gave	try	be
20.	frool	put	call	to
21.	theat	let	be	baby
22.	aclow	no	house	call
23.	haup	call	cow	go
24.	wies	pin	be	try
25.	gowl	house	saw	no

26.	kaidon	let	gave	him
27.	ploub	now	put	to
28.	droon	new	but	put
29.	abiek	bed	my	we
30.	cote	house	go	to
31.	coudry	took	cow	new
32.	naugh	cow	saw	ran
33.	pokay	gave	pin	be
34.	broam	go	saw	new
35.	slaum	saw	go	ran
36.	mullow	house	took	go
37.	feel	be	bed	him
38.	betay	we	my	gave
39.	bease	gave	we	let
40.	goag	cow	saw	no
41.	chaig	we	bed	baby
42.	trould	put	no	new
43.	dusaig	bed	be	gave
44.	chause	call	ran	go
45.	comiel	be	let	baby
46.	monood	put	but	new
47.	man	baby	dad	saw
48.	yiet	bed	try	we
49.	tay	him	bed	gave
50.	polead	be	baby	bed

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST B-1

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are three words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go
B.	gan	let	call	dad
C.	pode	baby	no	cow

As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

These are the words you know that will be on the test. Listen to the sound of the underlined letters as you read these words with me.

go	let	put	saw	gave	took	house
no	but	dad	new	baby		
be	ran	try	cow	come		
my	call					
we	bed					
to	him					
	pin					

1.	boys	baby	him	took
2.	loat	cow	saw	no
3.	chays	try	gave	let
4.	sprow	house	call	go
5.	houn	put	cow	but
6.	areak	let	be	baby
7.	mauf	cow	call	ran
8.	thood	come	put	to
9.	mief	we	my	him
10.	ogaim	my	let	gave
11.	stappow	call	house	go
12.	trak	took	gave	to
13.	gies	pin	be	try
14.	poad	go	saw	new
15.	poom	put	but	to
16.	konay	pin	gave	let
17.	koump	cow	no	new
18.	laip	my	let	gave
19.	fead	let	be	baby
20.	paud	call	cow	go
21.	blay	him	bed	gave
22.	yoap	cow	saw	no
23.	blue	new	no	saw
24.	poup	but	cow	put
25.	mook	go	to	put

26.	prient	bed	my	we
27.	trown	house	saw	no
28.	deach	bed	be	baby
29.	aucol	cow	saw	ran
30.	taise	gave	him	try
31.	frean	let	we	gave
32.	wouth	now	put	to
33.	sunt	dad	him	saw
34.	spows	go	took	house
35.	hauge	saw	go	ran
36.	sloot	new	but	put
37.	blaing	let	gave	him
38.	toang	go	saw	new
39.	ziegle	bed	my	we
40.	onchay	we	my	gave
41.	fowt	go	house	but
42.	biesh	bed	try	we
43.	toul	took	cow	new
44.	saw	call	no	dad
45.	boase	go	cow	saw
46.	ducay	him	bed	gave
47.	raitel	gave	ran	try
48.	voop	put	but	new
49.	aup	call	house	dad
50.	cheam	be	baby	bed

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST B-2

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are three words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go
B.	gan	let	call	dad
C.	pode	baby	no	cow

As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

These are the words you know that will be on the test. Listen to the sound of the underlined letters as you read these words with me.

go	let	put	saw	gave	took	house
no	but	dad	new	baby		
be	ran	try	cow	come		
my	call					
we	bed					
to	him					
	pin					

1.	onchay	gave	we	my
2.	aucol	no	cow	saw
3.	spows	took	house	go
4.	ogaim	my	gave	let
5.	prient	my	bed	we
6.	frean	we	gave	let
7.	biesh	try	we	bed
8.	trak	gave	took	to
9.	stappow	go	call	house
10.	paud	cow	go	call
11.	raitel	try	gave	ran
12.	mauf	call	ran	cow
13.	trown	saw	no	house
14.	thood	to	come	put
15.	deach	baby	bed	be
16.	ducay	gave	him	bed
17.	blue	no	saw	new
18.	voop	but	new	put
19.	aup	dad	call	house
20.	toul	new	took	cow
21.	blaing	him	let	gave
22.	fead	be	baby	let
23.	chays	gave	let	try
24.	loat	saw	no	cow
25.	sloot	put	new	but

26.	konay	gave	let	pin
27.	sunt	him	saw	dad
28.	taise	try	gave	him
29.	poad	saw	new	go
30.	wouth	put	to	now
31.	chean	bed	be	baby
32.	mook	to	put	go
33.	hauge	go	ran	saw
34.	toang	go	saw	new
35.	mief	him	we	my
36.	boys	took	baby	him
37.	fowt	but	go	house
38.	areak	be	baby	let
39.	saw	dad	call	no
40.	poup	cow	put	but
41.	boase	go	cow	saw
42.	blay	him	bed	gave
43.	poom	but	to	put
44.	koump	no	new	cow
45.	gies	try	pin	be
46.	houn	cow	put	but
47.	yoap	saw	no	cow
48.	laip	gave	my	let
49.	ziegle	my	we	bed
50.	sprow	call	house	go

Appendix C

Four Forms of Vowel Cluster Multiple-Choice Test Used With the Study

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST A-1

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are four words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go	say
B.	gan	let	call	dad	so
C.	pode	baby	no	cow	me

As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

These are the words you know that will be on the test. Listen to the sound of the underlined letters as you read these words with me.

put	gave	no	but	be
ran	cow	my	ball	top
out	bed	to	him	

1.	thaim	my	bed	him	gave
2.	chause	ran	ball	no	cow
3.	polead	but	be	bed	gave
4.	tay	my	him	gave	bed
5.	coad	ball	cow	top	no
6.	pid	him	my	put	but
7.	abiek	my	bed	be	him
8.	monood	no	to	put	but
9.	coudry	cow	but	to	put
10.	frowl	ball	top	out	no
11.	man	him	ball	gave	ran
12.	pokay	my	bed	gave	him
13.	kaidon	gave	my	him	bed
14.	saut	cow	ran	ball	no
15.	dease	be	but	bed	gave
16.	mullow	ball	out	top	no
17.	manous	to	but	cow	put
18.	yook	to	no	put	but
19.	yiet	my	we	him	bed
20.	smoal	top	cow	no	ball
21.	droon	no	but	to	put
22.	slaum	no	cow	ball	ran
23.	oan	ball	cow	top	no
24.	dat	put	bed	no	ran
25.	bease	be	but	gave	bed

26.	ploub	put	to	cow	but
27.	comiel	my	be	him	bed
28.	gowl	no	top	out	ball
29.	chaig	bed	my	gave	him
30.	betay	gave	my	him	bed
31.	feel	him	be	bed	my
32.	baish	him	gave	my	bed
33.	trould	to	but	put	cow
34.	vayt	bed	gave	my	him
35.	wies	my	him	bed	be
36.	theat	gave	be	but	bed
37.	aclow	top	out	ball	no
38.	broam	cow	ball	no	top
39.	naugh	ran	no	ball	cow
40.	frool	no	to	but	put
41.	goag	top	cow	ball	no
42.	cote	no	top	to	out
43.	porie	my	be	bed	him
44.	dusaig	him	bed	my	gave
45.	bloose	to	put	no	but
46.	ays	bed	my	gave	him
47.	ealod	bed	be	gave	but
48.	fough	to	but	cow	put
49.	haup	no	ball	ran	cow
50.	zown	out	no	ball	top

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST A-2

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are four words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go	say
B.	gan	let	call	dad	so
C.	pode	baby	no	cow	me

As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

These are the words you know that will be on the test. Listen to the sound of the underlined letters as you read these words with me.

put	gave	no	but	be
ran	cow	my	ball	top
out	bed	to	him	

1.	saut	no	cow	ball	ran
2.	porie	be	bed	my	him
3.	ays	my	gave	him	bed
4.	coad	cow	ball	no	top
5.	frowl	top	out	ball	no
6.	oan	no	ball	top	cow
7.	dease	bed	be	but	gave
8.	smoal	cow	ball	top	no
9.	pid	but	him	put	my
10.	ealod	but	gave	bed	be
11.	manous	put	to	cow	but
12.	yook	but	to	no	put
13.	thaim	him	bed	gave	my
14.	fough	put	cow	but	to
15.	bloose	put	but	to	no
16.	vayt	him	gave	bed	my
17.	zown	top	ball	out	no
18.	dat	bed	no	put	cow
19.	baish	gave	my	bed	him
20.	frool	no	put	but	to
21.	theat	but	bed	be	gave
22.	aclow	no	top	out	ball
23.	haup	ball	cow	ran	no
24.	wies	him	be	my	bed
25.	gowl	top	out	ball	no

26.	kaidon	bed	my	gave	him
27.	ploub	cow	put	but	to
28.	droon	to	but	put	no
29.	abiek	him	bed	my	be
30.	cote	cow	ran	no	to
31.	coudry	put	cow	but	to
32.	naugh	cow	ball	ran	no
33.	pokay	my	gave	him	bed
34.	broam	no	top	ball	cow
35.	slaum	ball	no	cow	ran
36.	mullow	out	top	no	ball
37.	feel	to	be	bed	him
38.	betay	him	bed	my	gave
39.	bease	gave	we	but	bed
40.	goag	cow	ball	no	top
41.	chaig	my	him	bed	gave
42.	trould	put	but	cow	to
43.	dusaig	bed	him	gave	my
44.	chause	cow	ball	ran	no
45.	comiel	be	my	bed	him
46.	monood	put	but	no	to
47.	man	gave	ran	ball	him
48.	yiet	him	bed	my	be
49.	tay	him	my	bed	gave
50.	polead	be	gave	but	bed

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST B-1

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are four words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go	say
B.	gan	let	call	dad	so
C.	pode	baby	no	cow	me

As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

These are the words you know that will be on the test. Listen to the sound of the underlined letters as you read these words with me.

put	gave	no	but	be
ran	cow	my	ball	top
out	bed	to	him	

1.	boys	gave	bed	him	to
2.	loat	cow	ball	no	top
3.	chays	him	my	gave	bed
4.	sprow	out	top	ball	no
5.	houn	put	cow	to	but
6.	areak	bed	be	gave	but
7.	mauf	no	cow	ball	ran
8.	thood	but	no	put	to
9.	mief	be	my	bed	him
10.	ogaim	my	bed	gave	him
11.	stappow	top	ball	out	no
12.	trak	put	cow	gave	no
13.	gies	him	bed	be	my
14.	poad	no	ball	top	cow
15.	poom	put	but	to	no
16.	konay	my	him	gave	bed
17.	koump	cow	put	but	to
18.	laip	my	bed	gave	him
19.	fead	but	bed	be	gave
20.	paud	ball	ran	cow	no
21.	blay	him	bed	my	gave
22.	yoap	cow	ball	no	top
23.	blue	put	to	no	ball
24.	poup	but	to	cow	put
25.	mook	no	to	but	put

26. prient	bed	my	be	him
27. trown	top	out	ball	no
28. deach	bed	but	be	gave
29. aucol	cow	ball	no	ran
30. taise	gave	him	my	bed
31. frean	but	bed	be	gave
32. wouth	cow	but	put	to
33. sunt	ran	be	him	put
34. spows	no	ball	top	out
35. hauge	ball	no	ran	cow
36. sloot	no	to	but	put
37. blaing	bed	my	gave	him
38. toang	no	ball	top	cow
39. ziegle	bed	my	be	him
40. onchay	him	bed	my	gave
41. fowt	no	ball	out	top
42. biesh	him	bed	my	be
43. toul	put	but	cow	to
44. saw	ball	no	to	ran
45. boase	no	cow	ball	top
46. ducay	my	him	bed	gave
47. raitel	gave	bed	him	my
48. voop	put	but	no	to
49. aup	no	ball	cow	ran
50. cheam	but	be	gave	bed

COMPOUND VOWELS - MULTIPLE-CHOICE TEST - LIST B-2

This is a test of how you pronounce unfamiliar English words. At the far left of each page, in every row of the test, there is a short English-like word that you probably have never seen before. On the right, in each row, there are four words that you already know how to say. First decide how you would say the new word on the left, and notice what sound you make for the underlined letter. Then circle the word on the right that has that same sound for its underlined letters.

Here are three examples:

A.	mip	him	bed	go	say
B.	gan	let	call	dad	so
C.	pode	baby	no	cow	me

As you work through the test be careful to check which letters are underlined in each word. It could be any one of them or two together.

These are the words you know that will be on the test. Listen to the sound of the underlined letters as you read these words with me.

put	gave	no	but	be
ran	cow	my	ball	bed
to	him	out	bed	

1.	onchay	gave	him	my	bed
2.	aucol	no	ran	cow	ball
3.	spows	out	ball	top	no
4.	ogaim	him	my	bed	gave
5.	prient	my	bed	him	be
6.	frean	be	but	gave	bed
7.	biesh	my	be	bed	him
8.	trak	gave	no	put	cow
9.	stappow	no	top	ball	out
10.	paud	cow	no	ball	ran
11.	raitel	him	my	gave	bed
12.	mauf	ball	ran	cow	no
13.	trown	ball	no	out	top
14.	thood	put	to	no	but
15.	deach	gave	but	bed	be
16.	ducay	gave	my	him	bed
17.	blue	no	ball	to	put
18.	voop	but	no	to	put
19.	aup	ran	ball	no	cow
20.	toul	to	put	cow	but
21.	blaing	my	him	bed	gave
22.	fead	be	gave	bed	but
23.	chays	bed	gave	him	my
24.	loat	ball	top	no	cow
25.	sloot	put	to	no	but

26.	konay	gave	my	bed	him
27.	sunt	him	put	be	ran
28.	taise	my	gave	bed	him
29.	poad	ball	cow	top	no
30.	wouth	put	to	cow	but
31.	cheam	bed	gave	be	but
32.	mook	to	put	no	but
33.	hauge	cow	no	ran	ball
34.	toang	ball	no	cow	top
35.	mief	him	be	bed	my
36.	boys	to	gave	him	bed
37.	fowt	ball	top	no	out
38.	areak	be	gave	bed	but
39.	saw	ran	no	ball	to
40.	poup	cow	put	but	to
41.	boase	top	no	cow	ball
42.	blay	my	him	bed	gave
43.	poom	no	but	to	put
44.	koump	but	to	put	cow
45.	gies	my	him	be	bed
46.	houn	cow	to	put	but
47.	yoap	ball	top	no	cow
48.	laip	bed	gave	my	him
49.	ziegle	him	my	be	bed
50.	sprow	no	ball	top	out

Appendix D

Pilot Study B

Waterloo Subject's Code Number, Sex, Grade Level,

Reading Grade Level and IQ Score

Code	Sex	Grade	Reading Score*	IQ Score*
1	M	2	3.1	107
2	M	2	3.4	124
3	M	2	3.0	116
4	M	2	3.2	109
5	F	2	3.4	103
6	F	2	3.2	109
7	F	2	3.4	110
8	F	2	3.0	No score
9	M	2	2.5	83
10	M	2	2.4	116
11	M	2	2.0	106
12	M	2	1.9	88
13	F	2	2.6	109
14	F	2	2.6	115
15	F	2	2.3	93
16	F	2	2.2	97
17	M	4	7.9	129
18	M	4	5.4	100
19	M	4	6.2	127

* See Appendix F

Waterloo Subject's Code Number, Sex, Grade Level,

Reading Grade Level and IQ Score, cont.

Code	Sex	Grade	Reading Score*	IQ Score*
20	M	4	4.7	117
21	F	4	6.2	131
22	F	4	5.8	118
23	F	4	5.0	106
24	F	4	4.8	109
25	M	4	4.5	110
26	M	4	3.8	87
27	M	4	3.8	105
28	M	4	2.7	70
29	F	4	4.6	97
30	F	4	4.0	91
31	F	4	3.7	111
32	F	4	3.5	No score
33	M	6	9.3	118
34	M	6	9.0	116
35	M	6	8.7	102
36	M	6	6.9	94
37	F	6	10.4	112
38	F	6	10.3	106

* See Appendix F

Waterloo Subject's Code Number, Sex, Grade Level,

Reading Grade Level and IQ Score, cont.

Code	Sex	Grade	Reading Score*	IQ Score*
39	F	6	8.6	112
40	F	6	7.6	106
41	M	6	6.5	120
42	M	6	6.4	104
43	M	6	6.2	96
44	M	6	5.7	94
45	F	6	6.4	114
46	F	6	6.2	113
47	F	6	6.0	99
48	F	6	4.3	88

* See Appendix F

Appendix E

The Study

Subject's Code Number, Sex, Grade Level, School,

Reading Score and IQ Score

Investigation Two: Subject's Code Number, Sex,

Grade Level, Reading Score and IQ Score

Code	Sex	Grade	School	Reading Score*	IQ Score*
1	M	2	Seneca	3.8	119
2	M	2	Seneca	2.9	101
3	M	2	Seneca	2.7	98
4	M	2	Seneca	2.5	95
5	F	2	Seneca	3.9	116
6	F	2	Seneca	4.0	145
7	M	2	Seneca	2.6	131
8	M	2	Seneca	2.4	103
9	F	2	Seneca	2.1	100
10	F	2	Seneca	2.8	107
11	M	2	Seneca	2.2	97
12	F	2	Seneca	2.1	101
13	M	2	Seneca	2.1	124
14	M	4	Seneca	2.1	97
15	M	4	Seneca	4.3	110
16	M	4	Seneca	3.0	95
17	M	4	Seneca	4.0	101
18	M	4	Seneca	5.1	104
19	M	4	Seneca	5.1	113

*See Appendix F

Code	Sex	Grade	School	Reading Score	IQ Score
20	M	4	Seneca	6.2	117
21	F	4	Seneca	6.2	106
22	F	4	Seneca	3.4	105
23	M	4	Seneca	4.2	113
24	F	4	Seneca	4.5	110
25	F	4	Seneca	6.5	150
26	F	6	Seneca	8.7	127
27	F	6	Seneca	6.5	115
28	M	6	Seneca	8.6	No score
29	M	6	Seneca	8.4	122
30	M	6	Seneca	6.7	96
31	F	6	Seneca	6.4	113
32	M	6	Seneca	7.7	116
33	F	6	Seneca	9.1	134
34	F	6	Seneca	6.0	122
35	M	6	Seneca	3.6	109
36	M	6	Seneca	5.7	96
37	M	6	Seneca	8.0	123
38	M	6	Seneca	7.0	110
39	F	6	Seneca	7.0	121
40	F	6	Seneca	5.4	107
41	M	6	Seneca	3.8	92
42	F	6	Seneca	7.5	115
43	M	6	Seneca	7.8	112
44	F	6	Seneca	7.8	120

Code	Sex	Grade	School	Reading Score	IQ Score
45	F	6	Seneca	7.2	117
46	M	6	Seneca	6.2	105
47	F	6	Seneca	6.3	96
48	F	6	Seneca	6.2	114
49	F	6	Seneca	8.2	120
50	F	6	Seneca	8.0	116
51	M	6	Seneca	6.5	106
52	F	6	Seneca	8.7	115
53	M	6	Seneca	5.4	98
54	M	6	Seneca	6.8	112
55	F	6	Seneca	6.7	115
56	F	6	Seneca	7.4	116
57	F	6	Seneca	8.3	130
58	F	6	Seneca	5.5	102
59	F	4	Seneca	5.6	120
60	M	4	Seneca	5.0	115
61	M	4	Seneca	4.3	117
62	M	4	Seneca	5.9	120
63	F	4	Seneca	6.2	114
64	F	4	Seneca	3.5	109
65	M	4	Seneca	4.7	108
66	M	4	Seneca	5.7	111
67	F	4	Seneca	4.8	95
68	M	4	Seneca	4.2	98

Code	Sex	Grade	School	Reading Score	IQ Score
69	M	4	Seneca	4.5	107
70	F	4	Seneca	4.4	103
71	F	4	Seneca	5.2	126
72	F	4	Seneca	4.8	108
73	F	4	Seneca	5.4	113
74	F	4	Seneca	4.3	109
75	M	4	Seneca	5.5	116
76	M	4	Seneca	4.8	128
77	F	4	Seneca	4.5	104
78	F	4	Seneca	4.2	112
79	M	4	Seneca	3.3	87
80	F	4	Seneca	3.9	96
81	M	4	Seneca	4.6	98
82	M	4	Seneca	3.6	86
83	F	2	Seneca	4.1	131
84	M	2	Seneca	4.1	141
85	F	2	Seneca	3.9	139
86	M	2	Seneca	3.7	116
87	M	2	Seneca	3.5	114
88	F	2	Seneca	3.5	122
89	M	2	Seneca	3.2	120
90	F	2	Seneca	3.1	112
91	M	2	Seneca	2.9	139
92	M	2	Seneca	2.8	131

Code	Sex	Grade	School	Reading Score	IQ Score
93	M	2	Seneca	2.8	90
94	M	2	Seneca	2.8	137
95	F	2	Seneca	2.7	114
96	F	2	Seneca	2.7	105
97	F	2	Seneca	2.6	108
98	F	2	Seneca	2.6	119
99	F	2	Seneca	2.6	103
100	M	2	Seneca	2.5	131
101	M	2	Seneca	2.5	104
102	M	2	Seneca	2.4	108
103	M	2	Seneca	2.4	119
104	M	2	Seneca	1.9	96
105	F	2	Seneca	1.7	91
106	M	2	Seneca	1.5	107
107	F	6	Seneca	5.1	106
108	F	6	Seneca	6.6	108
109	M	6	Seneca	6.0	110
110	F	2	Cedarburg	2.6	112
111	M	2	Cedarburg	2.1	100
112	M	2	Cedarburg	2.6	97
113	F	2	Cedarburg	3.9	93
114	F	2	Cedarburg	2.0	93
115	M	2	Cedarburg	3.1	109
116	F	2	Cedarburg	3.9	110

Code	Sex	Grade	School	Reading Score	IQ Score
117	M	2	Cedarburg	2.0	105
118	M	2	Cedarburg	3.8	112
119	M	2	Cedarburg	2.3	114
120	M	2	Cedarburg	4.3	104
121	F	2	Cedarburg	2.6	118
122	M	2	Cedarburg	3.6	109
123	M	2	Cedarburg	3.7	114
124	F	2	Cedarburg	2.6	101
125	F	2	Cedarburg	4.1	119
126	M	2	Cedarburg	1.5	92
127	F	2	Cedarburg	3.4	109
128	F	2	Cedarburg	1.9	93
129	M	2	Cedarburg	2.5	103
130	F	2	Cedarburg	1.8	99
131	M	2	Cedarburg	3.1	104
132	F	2	Cedarburg	3.3	116
133	F	2	Cedarburg	2.6	104
134	F	2	Cedarburg	1.6	104
135	M	2	Cedarburg	3.4	119
136	M	2	Cedarburg	1.9	104
137	F	2	Cedarburg	3.8	123
138	F	2	Cedarburg	2.2	123
139	M	2	Cedarburg	1.5	111
140	F	2	Cedarburg	3.3	116

Code	Sex	Grade	School	Reading Score	IQ Score
141	M	2	Cedarburg	1.5	No score
142	F	2	Cedarburg	1.7	116
143	M	2	Cedarburg	2.2	130
144	F	2	Cedarburg	1.7	No score
145	F	2	Cedarburg	2.5	115
146	M	2	Cedarburg	1.8	95
147	M	2	Cedarburg	1.6	87
148	F	2	Cedarburg	3.4	115
149	F	2	Cedarburg	2.9	118
150	F	2	Cedarburg	3.8	116
151	F	2	Cedarburg	1.7	110
152	F	2	Cedarburg	1.5	106
153	F	2	Cedarburg	1.9	98
154	F	2	Cedarburg	2.2	112
155	M	2	Cedarburg	1.9	113
156	F	2	Cedarburg	No score	No score
157	M	2	Cedarburg	1.5	109
158	F	2	Cedarburg	2.1	122
159	M	2	Cedarburg	3.4	128
160	F	2	Cedarburg	1.5	103
161	M	2	Cedarburg	1.8	114
162	F	2	Cedarburg	2.0	124
163	M	2	Cedarburg	1.7	107
164	F	2	Cedarburg	4.3	127

Code	Sex	Grade	School	Reading Score	IQ Score
165	M	2	Cedarburg	1.9	117
166	F	2	Cedarburg	1.9	132
167	M	4	Cedarburg	5.0	104
168	F	4	Cedarburg	4.6	106
169	F	4	Cedarburg	No score	No score
170	F	4	Cedarburg	3.2	97
171	F	4	Cedarburg	3.4	87
172	F	[illegible]	Cedarburg	5.1	102
173	M	4	Cedarburg	2.9	96
174	M	4	Cedarburg	5.4	115
175	F	4	Cedarburg	4.9	116
176	M	4	Cedarburg	4.4	99
177	F	4	Cedarburg	3.6	94
178	M	4	Cedarburg	6.0	107
179	M	4	Cedarburg	4.2	108
180	M	4	Cedarburg	3.1	86
181	F	4	Cedarburg	6.3	117
182	M	4	Cedarburg	3.3	97
183	F	4	Cedarburg	5.9	104
184	F	4	Cedarburg	5.0	114
185	F	4	Cedarburg	4.9	87
186	F	4	Cedarburg	5.3	107
187	M	4	Cedarburg	4.2	84
188	F	4	Cedarburg	2.1	83

Code	Sex	Grade	School	Reading Score	IQ Score
189	M	4	Cedarburg	3.4	94
190	F	4	Cedarburg	4.8	106
191	F	4	Cedarburg	4.7	115
192	F	4	Cedarburg	5.1	96
193	M	4	Cedarburg	6.1	119
194	M	4	Cedarburg	4.4	97
195	M	4	Cedarburg	No score	No score
196	M	4	Cedarburg	6.1	122
197	M	4	Cedarburg	3.4	81
198	M	4	Cedarburg	5.9	114
199	F	4	Cedarburg	6.7	129
200	M	4	Cedarburg	5.4	112
201	M	4	Cedarburg	4.4	115
202	M	4	Cedarburg	5.2	109
203	M	4	Cedarburg	4.7	100
204	F	4	Cedarburg	4.1	100
205	M	4	Cedarburg	1.7	64
206	M	4	Cedarburg	6.1	119
207	F	4	Cedarburg	5.1	101
208	M	4	Cedarburg	3.8	91
209	F	4	Cedarburg	5.0	102
210	M	4	Cedarburg	5.4	118
211	F	4	Cedarburg	6.5	124
212	F	4	Cedarburg	3.3	104

Code	Sex	Grade	School	Reading Score	IQ Score
213	M	4	Cedarburg	3.2	100
214	M	4	Cedarburg	2.4	70
215	M	4	Cedarburg	4.7	99
216	F	4	Cedarburg	5.3	116
217	F	4	Cedarburg	5.9	118
218	F	4	Cedarburg	4.8	107
219	M	4	Cedarburg	3.8	103
220	F	4	Cedarburg	5.8	121
221	M	4	Cedarburg	6.7	125
222	M	4	Cedarburg	4.8	109
223	M	4	Cedarburg	3.4	101
224	F	4	Cedarburg	2.0	100
225	M	4	Cedarburg	4.8	89
226	F	4	Cedarburg	3.4	103
227	F	6	Cedarburg	6.3	88
228	M	6	Cedarburg	6.4	93
229	F	6	Cedarburg	7.2	111
230	F	6	Cedarburg	6.9	118
231	F	6	Cedarburg	6.5	104
232	M	6	Cedarburg	7.9	129
233	F	6	Cedarburg	7.2	103
234	F	6	Cedarburg	7.1	122
235	M	6	Cedarburg	3.4	89
236	M	6	Cedarburg	7.8	96

Code	Sex	Grade	School	Reading Score	IQ Score
237	F	6	Cedarburg	7.8	121
238	F	6	Cedarburg	5.7	99
239	F	6	Cedarburg	6.2	104
240	M	6	Cedarburg	6.6	103
241	F	6	Cedarburg	7.4	118
242	M	6	Cedarburg	6.0	No score
243	F	6	Cedarburg	8.0	112
244	M	6	Cedarburg	6.5	103
245	M	6	Cedarburg	7.9	139
246	F	6	Cedarburg	10.0	127
247	F	6	Cedarburg	8.1	119
248	M	6	Cedarburg	8.2	112
249	M	6	Cedarburg	5.7	86
250	M	6	Cedarburg	6.8	121
251	M	6	Cedarburg	7.5	104
252	M	6	Cedarburg	8.2	114
253	M	6	Cedarburg	4.9	89
254	M	6	Cedarburg	No score	No score
255	M	6	Cedarburg	7.3	No score
256	F	6	Cedarburg	8.3	120
257	M	6	Cedarburg	5.6	100
258	M	6	Cedarburg	6.2	114
259	M	6	Cedarburg	8.7	115
260	M	6	Cedarburg	5.5	114

Code	Sex	Grade	School	Reading Score	IQ Score
261	M	6	Cedarburg	5.8	98
262	M	6	Cedarburg	4.2	96
263	F	6	Cedarburg	7.1	125
264	F	6	Cedarburg	9.4	133
265	F	6	Cedarburg	8.5	117
266	F	6	Cedarburg	8.2	110
267	M	6	Cedarburg	6.0	104
268	F	6	Cedarburg	6.9	93
269	M	6	Cedarburg	8.2	105
270	M	6	Cedarburg	4.4	111
271	M	6	Cedarburg	7.8	115
272	M	6	Cedarburg	6.4	95
273	M	6	Cedarburg	8.8	134
274	F	6	Cedarburg	7.0	114
275	F	6	Cedarburg	9.0	120
276	M	6	Cedarburg	6.0	91
277	F	6	Cedarburg	5.5	100
278	M	6	Cedarburg	4.9	100
279	F	6	Cedarburg	9.2	120
280	F	6	Cedarburg	4.9	100
281	F	6	Cedarburg	5.5	100
282	F	6	Cedarburg	8.4	117
283	M	6	Cedarburg	5.6	106
284	F	6	Cedarburg	No score	130

Code	Sex	Grade	School	Reading Score	IQ Score
285	M	6	Cedarburg	No score	135
286	F	6	Cedarburg	5.6	115
287	M	4	Racine	2.5	90
288	M	4	Racine	No score	No score
289	M	4	Racine	No score	125
290	M	4	Racine	2.0	101
291	M	4	Racine	3.3	91
292	M	4	Racine	No score	103
293	M	4	Racine	2.1	105
294	M	4	Racine	2.1	110
295	M	4	Racine	3.0	92
296	M	4	Racine	2.3	99
297	M	4	Racine	2.9	101
298	M	4	Racine	No score	77
299	M	4	Racine	2.5	98
300	M	4	Racine	1.7	105
301	F	4	Racine	No score	113
302	F	4	Racine	No score	104
303	F	4	Racine	2.4	77
304	F	4	Racine	4.0	106
305	F	4	Racine	2.8	101
306	F	4	Racine	5.1	126
307	F	4	Racine	5.7	136
308	F	4	Racine	5.1	115

Code	Sex	Grade	School	Reading Score	IQ Score
309	F	4	Racine	4.0	114
310	F	4	Racine	2.8	109
311	F	4	Racine	No score	104
312	M	6	Racine	5.2	103
313	M	6	Racine	No score	89
314	M	6	Racine	5.4	105
315	M	6	Racine	No score	99
316	M	6	Racine	5.1	102
317	M	6	Racine	5.6	95
318	M	6	Racine	6.2	No score
319	M	6	Racine	6.4	106
320	M	6	Racine	5.1	80
321	M	6	Racine	9.6	117
322	M	6	Racine	4.6	89
323	M	6	Racine	9.0	92
324	M	6	Racine	4.2	90
325	M	6	Racine	5.2	85
326	M	6	Racine	No score	No score
327	F	6	Racine	4.1	98
328	F	6	Racine	5.1	78
329	F	6	Racine	8.0	108
330	F	6	Racine	7.8	110
331	F	6	Racine	4.9	85
332	F	6	Racine	4.6	93

Code	Sex	Grade	School	Reading Score	IQ Score
333	F	6	Racine	4.8	95
334	F	6	Racine	5.1	105
335	F	6	Racine	No score	No score
336	M	2	Racine	1.8	116
337	M	2	Racine	1.5	93
338	M	2	Racine	No score	No score
339	M	2	Racine	No score	100
340	M	2	Racine	1.3	85
341	M	2	Racine	1.3	86
342	M	2	Racine	1.9	120
343	M	2	Racine	1.6	100
344	M	2	Racine	1.5	97
345	M	2	Racine	0.5	76
346	M	2	Racine	1.5	109
347	M	2	Racine	1.6	93
348	M	2	Racine	No score	101
349	M	2	Racine	1.7	95
350	M	2	Racine	1.3	96
351	M	2	Racine	1.6	103
352	F	2	Racine	1.9	103
353	F	2	Racine	1.7	101
354	F	2	Racine	1.8	111
355	F	2	Racine	1.4	104
356	F	2	Racine	1.6	123

Code	Sex	Grade	School	Reading Score	IQ Score
357	F	2	Racine	1.6	124
358	F	2	Racine	1.0	101
359	F	2	Racine	1.5	94
360	F	2	Racine	1.5	99
361	F	2	Racine	2.0	127
362	M	2	Racine	1.8	130
363	F	2	Racine	1.5	110
364	F	2	Racine	1.5	119
365	M	2	Racine	1.8	121
366	F	2	Racine	2.0	127
367	M	2	Racine	1.7	108
368	M	2	Racine	1.3	117
369	F	2	Racine	1.5	95
370	F	2	Racine	1.7	119
371	F	2	Racine	1.8	114
372	F	2	Racine	1.7	105
373	F	2	Racine	1.7	95
374	M	2	Racine	2.6	137
375	F	2	Racine	1.9	115
376	M	2	Racine	1.6	96
377	F	2	Racine	1.5	112
378	M	2	Racine	1.7	126
379	F	2	Racine	2.2	114
380	M	2	Racine	1.6	115

Code	Sex	Grade	School	Reading Score	IQ Score
381	M	2	Racine	1.4	124
382	F	2	Racine	2.6	124
383	M	2	Racine	2.7	120
384	F	2	Racine	No score	102
385	F	6	Racine	7.1	123
386	M	6	Racine	7.5	No score
387	F	6	Racine	6.4	135
388	M	6	Racine	5.6	97
389	M	6	Racine	8.0	97
390	M	6	Racine	6.7	96
391	M	6	Racine	5.9	108
392	M	6	Racine	5.1	106
393	F	6	Racine	7.3	110
394	F	6	Racine	5.9	106
395	F	6	Racine	5.1	106
396	M	6	Racine	6.9	108
397	M	6	Racine	6.6	112
398	F	6	Racine	6.0	107
399	M	6	Racine	6.9	98
400	F	6	Racine	8.5	117
401	M	6	Racine	6.6	99
402	M	6	Racine	7.1	122
403	M	6	Racine	6.6	111
404	M	6	Racine	6.7	117