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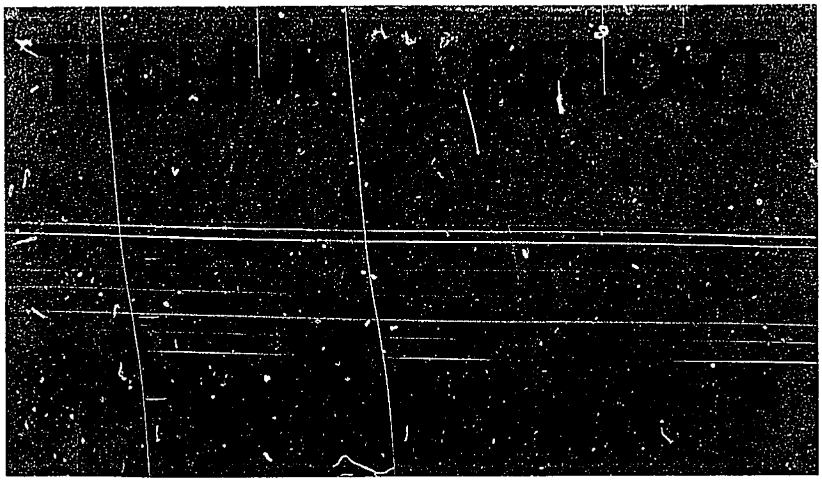
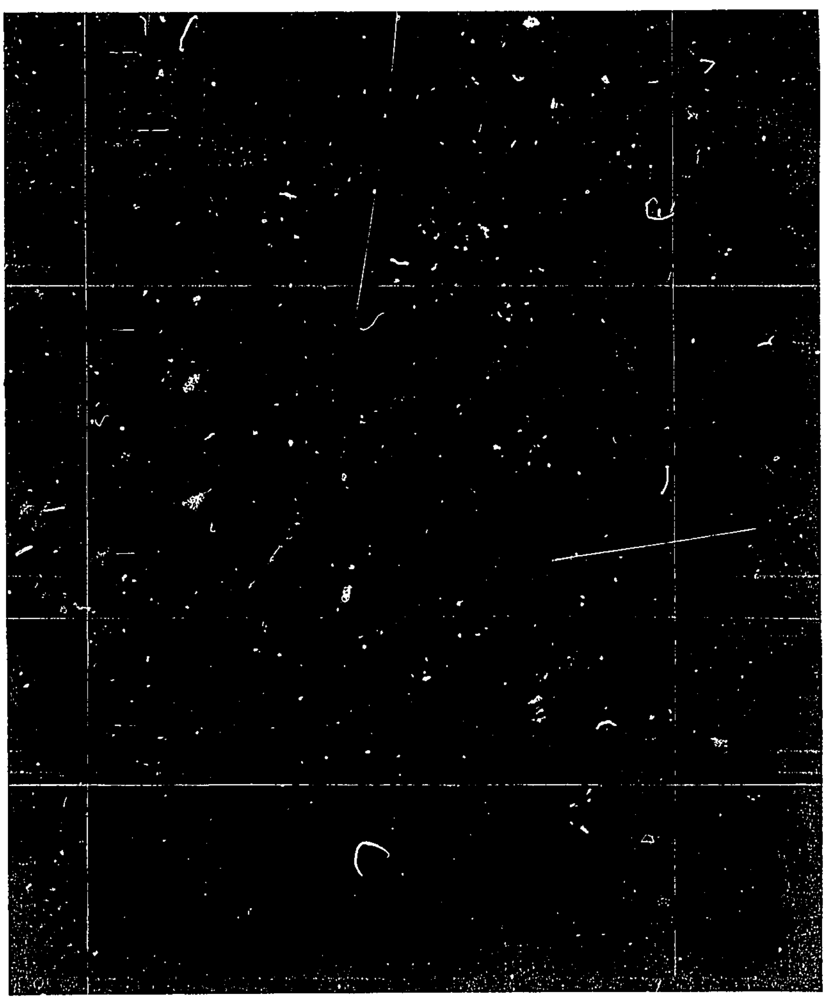
ABSTRACT

Children's pronunciations of vowel clusters in synthetic words were analyzed in relation to common English words containing the same vowel clusters. Subjects were 436 elementary students of both high and low reading levels from a suburban, an urban, and a rural community. Conclusions of the study, reported in Part 2, were (1) pronunciations more closely parallel common words as children progress through the grades; (2) sex differences are not significant; (3) better readers deviate less from correspondences in common words than do poorer readers; (4) suburban children tend to parallel more closely correspondences in common words than do urban and rural children; (5) principle pronunciations in word types relate more closely to children's pronunciations than do those in word tokens; (6) contextual environment and word position seem to influence pronunciation. Discussion of the statement and rationale of the problem, the procedures for selecting vowel clusters, and the procedures of the study are given in Part 1, RE 003 626. Appendixes are found in Part 3, RE 003 628. Tables are included. (VJ)





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FACTORS RELATED TO THE PRONOUNCIATION OF VOWEL CLUSTERS

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

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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 position seem to influence vowel cluster pronunciations by children.

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

*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
Wholly Within				
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
Between X Within				
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

Hypothesis Six. 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.

Results Related to Interactions Within Cells

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 0 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 ea, ie, and ou, 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.

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*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
Wholly Within				
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
Between X Within				
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 toke 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

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: $H_{10(TK)}$: $\mu_S = \mu_U = \mu_R$.

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—>/ʊ/ 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.

Table 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 presented 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/	3.0%	/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 —>/ɛ/ (type and token); oo—>/u/ and —>/ʊ/; 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—>/ɛ/. 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	/o/	/au/
mullow	50.8	35.0
sprow	43.2	45.5
stappow	36.6	45.7
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 ou, to a high of 7 of 10 synthetic words for the vowel cluster ay. 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.

The Study

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, sex by vowel cluster, grade 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"

*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.