THE UNIVERSITY OF ALBERTA

AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN LETTER CATEGORIZATION ABILITY AND READING ACHIEVEMENT OF GRADE ONE CHILDREN

by

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A THESIS

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ABSTRACT

The task of accurate letter categorization (the ability to identify differently printed letters as being functionally equivalent) appears to be a factor in the beginning stages of the reading process. The purpose of this study was to examine the relationship of a child's ability to categorize or classify various letter forms, which vary in type, style and size of print and examine its relationship to the beginning stages of reading achievement.

The sample consisted of eighty grade one children who were of at least average I.Q. with equal distribution over sex. Hypotheses concerning the total sample were tested. From this total sample were selected two groups of achieving (N=28) and non-achieving (N=15) readers and hypotheses concerning these two sub-samples were further examined.

Each child was administered the Keystone Visual Screening Test to ensure an adequate level of visual proficiency. Two sub-tests of the Gates-McKillop Reading Test were also administered to ensure adequate knowledge of letters by all the children. Scores containing the I.Q. for each member of the sample were obtained from the cumulative records of the school, while the Neale Analysis of Reading Ability was administered to assess reading ability.

The Letter Categorization test was specially constructed for this study. This was a test which purported to measure the child's ability to classify various allographs (different letter styles) as members of a particular grapheme. The Letter Categorization Test consisted of four sub-tests, each of which measured various abilities proposed as being important in the child's letter categorization ability. The total score obtained from the test was purported to be the measure of letter categorization ability. This test was modelled on Rystrom's (1969) Multiple-Form Letter Discrimination Test, but modified to suit local conditions.

Findings showed a significant correlation existed between a child's score on the Letter Categorization test, and his level of reading achievement. When the I.Q. factor was partialled out of the above relationship, it was found that a significant correlation remained illustrating a strong connection between these two variables.

A significant difference in scores was also found to exist between the scores obtained by achieving and non-achieving readers on the Letter Categorization Test. The non-achieving readers scored consistently below the achieving reading group on all variables.

Correlations between the Letter Categorization Test and the I.Q. score indicated a significant relationship between these two variables, suggesting that letter

categorization ability as measured by the present tests appears to be related to a general intelligence factor.

Educational implications and suggestions for further research were also discussed.

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CHAPTER I

INTRODUCTION AND PROBLEM

Despite the attention given to reading instruction by teachers and researchers, the nature of some basic skills involved in the reading process has not been sufficiently examined. Letter categorization -- the ability to identify various allographs (different letter styles) as being functionally equivalent is one of these.

Children learning to read must be able to identify letters and distinguish one from the other. While this is essentially a visual discrimination task, it can be affected by the type and style of print presented. The ability to categorize these differently printed letters and the relationship of this ability to reading achievement seems to be an area warranting investigation.

BACKGROUND

Letter Recognition and Reading

Gibson et al (1962) reported that certain types of letter confusions were harder for children to distinguish than others, resulting in differing improvement rates in reading. She subsequently evolved the theory of "distinctive features" as being of critical importance in discrimination. Vernon (1971) states that "the task of accurate letter

discrimination and identification appears to be a major factor in the beginning stages of reading." Wiener and Cromer (1967) also state that ". . . identification presupposes a discrimination of one graphic symbol from another . . . (p. 635)." Popp's (1964) results seem to substantiate the analysis of Gibson.

The above authors, although they regard discrimination ability as a necessary requirement for success in reading, do not elaborate to any extent on the possible effects of variations of the allograph on the child's ability to identify letters. Reading difficulties can be traced to a failure in acquiring the proper associations between the clearly perceived allograph and their verbal response (Zeman and House, 1963). Compounding this particular difficulty it appears that slight variations of the allograph which are representative of H (e.g. h H ℋ ℍ ℌ) could add further confusion to the poor reader, so that in some cases he may tend not to categorize the printed forms as members of the same graphemic class.

Letter-form content of children's reading materials

Burt (1959) summarizing research on letter forms concludes

> . . . for the very young, we are firmly convinced there would be a great advantage in selecting a single legible set of letter-shapes, keeping strictly to the lower case forms and allowing no picturesque divergences . . . (p. 10).

Various other researchers (Tinker, 1932) found that [illegible] presented special difficulties to children, because of the unusual shapes of certain allographs. The capital G caused many to mistake it for a C, and the reverse situation was true. The capital Q was also mistaken for O. Kerr (1926) points out that the peculiarities of the splayed capital C, W, and M are unsuited to the reading materials for the young. Burt (1959) comments that . . . "a moderately bold or heavy type seems definitely preferable in books intended for the very young . . . (p. 11)."

The above authors, while regarding stability of print form as important to the reader, do not relate these findings to the child's reading ability, nor give any evidence of the effect of variation of letter forms on the child's ability to identify and categorize these allographs as members of the same graphemic class.

Letter-form con[illegible]t of Alberta Reading Materials

While most of the current reading materials recommended by the Department of Education for use in Alberta Schools at the Grade One level have letter forms which are basically the same, there is some variation in the size, type and style of print used.

Variations in the way letters were printed depended largely on the series of Basal Re[illegible]ders used.

Each allograph was found to vary in some respect.

Thus it appears that while individual research has focused on the discrimination ability of children and the cues by which such ability is acquired, there has been little research which has attempted to study children's ability to categorize the various letter forms.

PURPOSE

The purpose of this study is to investigate children's ability to categorize or classify various letter forms, which vary in type, style and size of print and examine its relationship to the beginning stages of reading achievement.

RATIONALE

In linguistics there are two terms which are commonly accepted and are applicable to a clear understanding of letter recognition. One of these is the grapheme, which is the smallest unit of writing which can be used in composing a word (e.g. CAT is composed of three graphemes C-A-T). Second, is the allograph, which is any type of a particular letter in any language (e.g. A, a, a, a are all allographs of the same grapheme). Dale (1972) comments that

> just as there are many possible pronunciations of a given phoneme there are also many possible visual configurations for a

> given letter which are functionally equivalent. Learning the letters of the alphabet, then, is a matter of learning the relevant discrimination between categories of graphemes (p. 188).

While each allograph has very distinctive differences (e.g. S, *a*, *a*, S,) they are all classified as members of the same graphemic group. For the young child in grade 1 and 2, this would seem to be a very confusing situation. While encountering a stable letter environment in class, various reading materials differ in the type and style of print used, and so to some extent the letter presentation does vary somewhat according to the particular book or series of books used. While this variation may not be extreme, it could be a further hinderance to those children already having trouble with letter recognition. Children, then, must learn to ignore these different forms and respond to each allograph in the same way. While only one allographic form is taught to the child, he is likely to see different allographic forms in his reading materials and it is important that he responds to these in the same way. With English having 26 letters of the alphabet the possible variations which might occur make it imperative that the child is able to categorize these letters. It is this factor of letter categorization which while not major, needs to be taken into account in young children's letter recognition.

Two facts evolve from the preceeding discussion with particular relevance to letter recognition. First a young child must learn to classify various allographs (e.g. R, r, *R*, *r*,) as members of a particular graphemic category. However at the same time he must also learn to classify allographs which seem similar (e.g. n-m; b-d; b-p) as different members of different graphemic categories.

It appears then, from the preceding discussion, that for a child to know the letters of the alphabet thoroughly, he should be able to identify the grapheme category to which any allograph belongs. The following factors would seem important in a child's categorization ability of letters. Rystrom (1969) describes these as:

1. Naming a grapheme category to which any allograph fits.
2. Matching similar forms of the same allograph.
3. Selecting different allographic forms of the same grapheme.
4. Matching identified forms of a single allograph when they occur within words.
5. Identify different allographic forms as being the same grapheme when they occur in words.

DEFINITION OF TERMS

Grapheme

The grapheme refers to the smallest unit

of writing which can be used in composing a word (e.g. bat consists of three graphemes b-a-t).

Allograph (Allographic Variations)

The allograph is a feature of written language structure and in this study refers to any particular type style of letter in any language (e.g. G, g, G, g, g,) Allographic variations refer to the distinctive differences which occur among the allographs, as shown above.

Letter Categorization Ability

Letter categorization ability refers to the ability to identify the various allographic forms as being functionally equivalent.

Achieving Reader

These were students at the Grade One level who obtained a standard score that was one half standard deviation or more above the mean score on reading accuracy section of the Neale Analysis of Reading Ability.

Non-Achieving Readers

These were students at the Grade One level who obtained a standard score that was one half standard deviation or more below the mean score on the reading accuracy section of the Neale Analysis of Reading Ability.

Test of Letter Categorization*

This examiner-constructed test consists of four sub-tests, which cumulatively measure the extent to which a student can identify the grapheme category to which any particular allograph belongs. The test requires that the child be able to perform all of the following tasks:

(1) State the name of the grapheme category to which a particular allograph belongs. (Sub-test 1)

(2) Match identical forms of a single allograph (Sub-test 2)

(3) Identify different allographic forms as belonging to the same grapheme (Sub-tests 2 and 3)

(4) Match identical forms of a single allograph when they occur within words (Sub-test 4)

(5) Identify different allographic forms as being the same grapheme when they occur within words (Sub-test 4).

Sample Stimuli

Sample stimuli refers to the sample letter in each item of the Letter Categorization Test against which the testee must match a similar allograph. In each sub-test the sample stimulus is always situated on the left-hand side of the page.

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*See Appendix A for a complete copy of this test.

Choice Stimuli

Choice stimuli refers to the required letter in each item of the Letter Categorization Test, which the testee must choose in order to match it to the sample stimulus. The choice stimuli are always situated on the right-hand side of the page among the distractors.

Letter Categorization (Letter classification)

For the purpose of this research study the words "Letter categorization" and "Letter classification" will be used interchangeably as meaning the same thing.

Reading Achievement

For the purpose of this study reading achievement will refer to the score obtained by the child on the reading accuracy section of the Neale Analysis of Reading Ability.

HYPOTHESES

Research Hypothesis 1

Grade One children's ability to categorize letters is related to their level of reading achievement.

Null Hypothesis 1

There is no significant correlation between scores on the Neale Analysis of Reading Ability and Scores on the Letter Categorization Test.

Research Hypothesis 2

Grade One children who are more successful in reading will be better able to categorize alphabetic letters.

Null Hypothesis 2

There is no significant difference between the scores obtained by achieving and non-achieving readers on the Letter Categorization Test.

Research Hypothesis 3

Grade One children's performance on the letter categorization tests will be related to their performances on a test of general intelligence.

Null Hypothesis 3

There is no significant correlation between scores on the Letter Categorization Test and I.Q. scores.

Research Hypothesis 4

Girls in Grade One will be better able to categorize alphabetic letter forms than boys.

Null Hypothesis 4

There is no significant difference between the scores obtained by boys and girls on the Letter Categorization Test.

LIMITATIONS

The following factors are recognized as limiting the generalizability of the results of this study.

1. The sample for the current study was selected from three rural schools within the County of Strathcona, Alberta. Urban students may exhibit somewhat different categorizational abilities and may or may not have a clearer concept of letters.
2. The children were tested after seven months in grade one. Consequently, generalizations should be restricted to grade one students who have spent a comparable amount of time in grade one.
3. Particular letters of the alphabet have a greater number of variations than others and it was these particular letters which were used in the research. Consequently generalizations would be restricted to the specific letters used.
4. Not all variations which occur in reading materials recommended by the Alberta Department of Education were used in this study. This would also place limitations on the generalizability of the results.

SIGNIFICANCE OF THE STUDY

The role of letter recognition and letter-form content of reading materials has been discussed in the introduction of this chapter. Should the present study indicate that young children have difficulty in categorizing the various allographic forms and this difficulty is shown to relate to reading achievement, it may suggest that we need to be more consistent in presenting graphemic characters in all our reading materials.

Should the present study demonstrate a relationship between the Letter Categorization Test and Reading Achievement it would suggest that the factors discussed previously as being important to letter categorization are important in developing letter concepts in children.

Present approaches to letter discrimination tend to approach the letter as an isolated whole. The present study may help to determine if letter discrimination drills should be structured in such a way that children are required to identify allographs as members of a particular grapheme.

SUMMARY

This chapter has provided an introduction to the research conducted by the investigator. The problem was presented and discussed. A rationale for developing the

research around letter categorization was presented. Terms relevant to a good understanding of the study were defined. Five research hypotheses were formulated to investigate the problem. The limitations of the study were acknowledged and the possible significance of the study was presented.

OVERVIEW OF THE STUDY

In Chapter II the writer will review the available literature which is considered pertinent to the present study. In doing so, it is hoped to construct a stronger framework in which to consider the present research.

The experimental design of the study will be outlined in Chapter III. Information on the sample as well as the construction and administration of the testing instruments will be presented.

The results of the study will be analyzed and explained in Chapter IV.

The final chapter will present the summary, conclusions, implications and suggestions for further research.

CHAPTER II

REVIEW OF SELECTED LITERATURE

Letter discrimination and letter categorization (classification) have been proposed as skills related to the development of a child's reading ability. The purpose of this chapter is twofold, namely to consider the literature with particular reference to:

(a) visual discrimination of alphabetic letters and letter-like forms and its possible relationship to reading achievement.

(b) the relationship between classification ability and reading ability.

I. VISUAL DISCRIMINATION OF LETTERS AND LETTER-LIKE FORMS

Visual Discrimination of Letters & Grade One Reading Achievement

One of the earliest studies to consider visual discrimination of letters and its relation to reading achievement was conducted by Smith (1928). Letter matching ability measured by an individual test during the first week of grade one was correlated with the results from the Detroit Word Recognition Tests administered twelve weeks later. An analysis of the data on 200 children revealed a correlation coefficient of .87 which prompted Smith to conclude that letter discrimination could be used as a measure of reading readiness because it correlated so highly with reading achievement.

Such a high correlation as the above, may not have occurred had the children in this study been required to

read a continuous passage of prose, rather than recognize words. Smith also points out that the Detroit method of teaching reading required children to use picture dictionaries to locate words that they did not recognize in reading lessons.

Smith's study led Lee, Clark and Lee (1934) to consider the predictive possibilities of a group reading readiness test which employed letter discrimination tasks. They constructed a test with four sub-tests which required children to demonstrate the ability to:

(1) match capital letters;
(2) match lower case letters;
(3) locate and cross out the capital letter that did not belong in a series of four letters, and
(4) find and delete an extra letter in a word that made it different from a stimulus word.

After the components of the readiness test were completed the authors conducted predictive validity studies on two undescribed samples of children. Sample one, composed of 164 subjects, took the visual discrimination test at the beginning of first grade and the Lee Clark Primer Test toward the end of the school year. The same testing procedures were used with the second sample, which included 100 subjects, except the Gates Primary Reading Tests were substituted for the Lee-Clark Test. After the data were collected, scores on the visual discrimination tests were correlated with scores on the reading tests for each sample. The coefficients obtained were .49 and .54 for samples one and two respectively. Steinbach (1940) examined the visual

discrimination of words made to grade one reading achievement. She administered to her subjects the Lee-Clark Reading Readiness Tests, which measured the ability to see likenesses and differences in letters, and the Stone-Grover Reading Readiness Tests which tested the ability to discriminate between words. Reading achievement was measured in January and June with alternate forms of the Metropolitan Primary Reading Tests and the Progressive Reading Tests. Complete test data were obtained for 300 first-grade pupils composed of 147 boys and 153 girls.

Results revealed that the Lee Clark Test correlated with reading achievement .432 in January and .416 in June, while the Stone-Grover Test correlated with reading achievement .438 and .398 in January and June respectively. Thus it was suggested that the visual discrimination of letters was a slightly better predictor of reading achievement than was visual discrimination of words.

Two parallel studies published by Olson (1958) and Gavel (1958), investigated the relative merits of letter matching tasks as predictors of first-grade reading achievement when compared with visual discrimination and knowledge of letters test. Olson related the results from the September administered Boston University Letter Knowledge Tests to the scores from a self-constructed oral reading test given to 1,172 children in February. Using the same population from which Olson obtained his sample, Gavel (1958) extended his

work by correlating the September test results for 1,506 of the children with their June reading achievement, as measured by a word classification test and a paragraph meaning test of her own design.

Although tests of significance between correlation coefficients were not reported, the respective investigators concluded that readiness tests requiring visual discrimination of letters were a better predictor of first-grade reading achievement than tests requiring the ability to match letters directly or from memory.

In summary to this point the nature of the studies reviewed makes it extremely hazardous to develop any firm generalizations concerning the value of particular letter discrimination tasks as related to first-grad reading achievements for two main reasons:

(1) correlations in most studies were not high and tests of significance were not conducted on many of the correlations;

(2) much of the statistical analysis from these studies was not reported making it difficult to interpret the results. Nevertheless some observations may be made from the literature reviewed so far.

First it appears that the visual discrimination of letters is somewhat superior to direct letter matching or letter matching from memory and has a g[illegible]er relationship

to reading achievement. Second, a look at the two investigations which compared discrimination of letters and words as predictors permits two limited observations:

(1) there is not much difference between letter matching and word matching as predictors of reading achievement (Steinbach 1940) and

(2) visual discrimination and knowledge of letters is somewhat better than matching words as a predictor of first grade reading achievement.

Visual Discrimination of Letters and Letter-like Forms

More recently an experiment which, while not using alphabetic letters, used close approximations of letters, was conducted by Gibson et al (1962). These authors designed a study to examine development of the ability to visually discriminate a set of letter-like forms in children 4 through 8 years of age. Their aim as stated was

> . . . not merely quantitative comparison of different age levels, but primarily a qualitative developmental study of types of errors as related to certain critical features of letters . . . (p. 96).

The sample consisted of 167 children aged 4 through 8 from kindergarten through to grade 3. Each age group contained at least 24 children, drawn from what appears to be a cross section of socio-economic status groups.

The discrimination task required children to match a standard form with an identical form, in the following

manner. The standard form was put on the top row of a box and the child went through the various rows looking for any forms which were "exactly like" the standard. When he found one, he removed it and handed it to the experimenter and continued until he had scanned the entire board. Instructions were given very explicitly, so as to make absolutely clear that only an exact match was wanted. A demonstration was given first with very large sample forms and the child was asked if they were the same. To ensure that he knew exactly what the task was the child was given a practice row on the board again with real letters. As well as considering left-right and up-down rotations Gibson tested line-to-curve transformations as well as 'close' and 'break' transformations.

Results indicate that there was a decrease in errors for all transformations as age increased. The errors for rotations and reversals started high, but by 8 years had declined almost to zero. For left-right and up-down reversals the mean error was 6.56 and 6.47 respectively at age 4 and dropped to 0.59 and 1.08 respectively at age 8.

Gibson et al discussing these results mentioned that the most obvious and hardly unexpected outcome of the experiment was that the visual discrimination of letter-like forms, using a matching procedure which required a judgement of 'same' or 'different' improves from age four to age eight. She reasoned that:

> . . . it seems rather that children between four and eight learn something about letter-like forms, which makes possible better discrimination even between ones they have not seen before . . . (p. 904).

She continued

> . . . it is our hypothesis that it is the distinctive features of grapheme patterns which are responded to in discrimination of letter-like forms. The improvement in such discrimination from four to eight is the result of learning to detect these invariants and of becoming more sensitive to them . . . (p. 904).

Gibson did therefore show a developmental pattern in these letter-like forms but did emphasise that this would likely carry over to alphabetic letters which she did not use because of children's familiarity with that form. Therefore for the purpose of reading it would seem more appropriate to examine those symbols encountered in the actual reading process, for as Gibson points out, there is at present, little or no evidence that these experiences transfer to reading.

Cairns and Steward (1970) examined the effects of axes of symmetry and relative position of stimulus, by means of a letter orientation task. The sample consisted of 60 males from private schools serving middle and upper class families. There were three age groups 4-2 (4 years, 2 months) to 4-10 (4 years, 10 months); 5-2 to 5-10 and 6-2 to 6-10 with 20 in each group. The stimuli were 3 dimensional wooden letters on white cards. The letters used were A, B, D, E, H, T and U. Each child was tested indi-

vidually in an empty classroom at the school. Stimuli were presented to the children with each letter rotated 45 degrees counterclockwise. The child was then instructed to place the letter next to or below the example and make it "just like mine."

Results indicate that there was a significant correlation between age and axis of symmetry, such that younger children made more axis-related errors than older children. In discussing these results, the authors mention that

> . . . the present study indicates that errors made in orientation of simple geometric forms as a function of axis of symmetry and relative position of stimuli also occur with more complex geometric forms for example letters of the alphabet . . . (p. 999).

Popp (1964) using Gibson's hypothesis of distinctive features, provided further insight into discrimination of lower case alphabetic letters. Using a sample of 65 children aged five years and one month to six years one month, attending a public kindergarten, she divided them into five groups of thirteen subjects each. Discrimination testing apparatus consisted of a slide projector mounted behind a rear projection display panel. Two alternate choice stimuli were displayed in the middle two of four windows just below the sample. A correct choice closed a switch and caused the projector to advance the next slide. If the choice was incorrect nothing happened and the subject would respond again. Results of this study

substantiated the "distinctive features" analysis of Gibson (1962) as confusions did arise from reversal and rotations (p-q, b-d, b-q, d-p, b-p, n-u).

Asso and Wyke (1971) conducted a study of the ability of young children to discriminate spatially confusable letters using four different methods of discriminating (matching, copying, naming and writing). This study helped to show that the matching-to-sample method of testing, as used in the present study is probably the most effective method of measuring letter discrimination ability. The subjects were 31 English children whose ages ranged from 5-6 (5 years, 6 months) to 6-10 (6 years, 10 months). The test consisted of 10 spatially oriented confusable letters p,q,d,b,u, and n and to a lesser extent h,y,w and m. Results indicated that the accuracy of discrimination of these letters seemed to be dependent on the method of assessment employed. The matching task which is the method employed in the present study seemed to be less difficult than naming confusable letters or in writing them in dictation. This study then seemed to support the fact that a "matching" task in discrimination of letters is probably one of the most effective ways of testing discrimination.

Further support for the discrimination of letters difficulty is supplied by Blair and Ryckman (1969). Their purpose was to determine which pairs of lower-case alphabetic letters were most frequently confused by pre-reading

children. Following essentially the same method as Popp (1964) with the exception of using 3 sets of cards rather than a projector, they selected 50 children 5-5 to 6-4 years of age in a lower middle class community and 25 children 3-7 to 5-6 in an upper middle class area. Test results indicated that most errors were reversals or rotation transformations, which thus substantiated Popp's (1964) findings.

Although implications have been drawn to the reading process from many of these studies, no study seems to have directly related this letter discrimination ability to reading achievement.

However Twohig (1972) did examine the relationship of a child's ability to discriminate alphabetic letters which differed on a number of directional dimensions and reading achievement.

The sample consisted of 60 grade one children who were at least average I.Q. with an equal distribution over sex and reading level. Letter, word and sentence discrimination tests were specially constructed for the study and were proposed as special tests of objective spatial discrimination ability and tested a child's ability to discriminate the directional orientation of alphabetic letters transformed over various dimensions.

Results indicate a significant correlation between a child's score on the discrimination test, time taken to

complete the test and his level of reading achievement.

SUMMARY OF STUDIES ON DISCRIMINATION

In summary therefore the reviewed literature to this point suggests that the skill of letter discrimination is an important factor in the young child's ability to read. It also appears that it is the distinctive features -- the loops and curves which are responded to in the discrimination of letters.

However, as mentioned previously letter forms do vary somewhat depending on the series of books used. Having identified a single instance of the letter does not mean that the child will be able to discriminate all variations of that same grapheme, as the "distinctive feature" of these allographs may differ.

The discrimination of a single instance of the letter would seem to be the first stage. The discrimination and classification of all instances of the grapheme would seem to be a more advanced stage in the child's letter knowledge. If a child is to classify various allographs as members of a particular grapheme category, it means that his classification ability must be such that he can handle the task.

This general classification ability and its relationship to reading achievement will be discussed in the following section.

CLASSIFICATION ABILITY IN CHILDREN

Several studies of children's thinking, with particular reference to their classification ability have been reported by (Welch, 1940, Welch and Long, 1940, Sigel, 1953, and Wei, 1967), and are summarized by Rediger (1970). Their findings generally support Piaget's theory of sequence in logical development and of development being related to chronological age. Interaction between the individual and his environment appears to be an important factor in intellectual development and consequently classification ability. Opportunities for such interaction are often limited in deprived environments, and development of profi iency in classification ability may be adversely affected by lack of such opportunities.

It is this classification ability, with particular reference to alphabetic letter forms, and its relationship to reading achievement that is of most importance to the present study.

Since few studies are to be found which relate to the particular topic of the present study, most of the research studies cited in this section are used for the specific purpose of illustrating differences in general classification ability, between achieving and non-achieving readers, which may carry over into classification of letters,

particularly with reference to achieving and non-achieving readers.

Studies of Classification Ability and Reading Ability

The following studies explore differences in classification ability among good and poor readers. The majority of investigations use classification of non-verbal materials. However few involve alphabet letters. Observations of performance on this type of classification test give indications of how good and poor readers differ in their handling of a classification situation requiring the formation of class concepts.

Differences in the ability to classify was investigated by Kress (1955). Twenty-five pairs of boys between the ages of eight and twelve years were included in the study. All pupils were of average or above average intellectual ability. They were matched on the basis of chronological age, school experience, and intelligence with one member of each pair being a non-reader while his partner was an average reader. The tests used in this study were:

(1) Similarities subtest of the Wechsler Intelligence Scale for Children,

(2) Verbal Opposites subtest of the Detroit Tests of Learning Aptitude,

(3) Goldstein Scheerer Cube Test,

(4) Wisconsin Card Sorting Tests,

(5) Weigl-Goldstein-Scheerer Color-Form Sorting Test,

(6) Kasanin-Hanfmann Concept Formation Test, and

(7) the Gelb-Goldstein-Weigl-Sheerer Object Sorting Test.

The materials of the last five tests include blocks, geometric forms, colored materials, or representative objects. The last four tests require the pupil to sort the materials into classes and to verbalize the principle of each sorting. On some sub-tests the pupil is to give the principle of a sorting done by the examiner.

The findings of the study indicate a distinct difference in performance of good and poor readers on the concept formation tests which required classification ability. Poor readers exhibited the following characteristics: they lacked versatility and flexibility in handling classification tasks; they showed an elementary dependence upon the obvious physical characteristics of the materials; they lacked adequate labels for common, socially approved concepts; their classification ability appeared to be more concrete and less abstract than that of good readers; and they lacked adequate concepts for dealing with language, particularly reading. Letter classification being a somewhat similar task should, it is hypothesized also indicate differences in performance between good and poor readers.

Braun (1961) developed a concept formation test involving classification of series of words to study the relation of classification ability and reading achievement at the third, fifth and seventh grade levels. Boys in the Oak Park (Michigan) Public Schools participated in the study. Overachievers and underachievers in reading together with a comparison group of average readers were selected at each of the three grade levels. All pupils were given the appropriate level of the Gates Reading Tests. Selected sub-tests of the Wechsler Intelligence Scale for Children were administered to the under- and over-achievers being studied.

As the measure of the ability to classify, Braun developed a test consisting of twenty concepts. For each concept there were six series of four words. These series of words were typed on cards resulting in six card categories. On each card there was one word that had something in common with one word on each of the other cards in a set of cards. The pupil was required to give a generalization or classification which would include the six words which were examples of the category given on the cards for each concept.

Results of the investigation indicate that concept formation based on classification, as measured by the test developed by the investigator, was more closely related to reading achievement at the fifth and seventh grades than was intelligence. Further interpretations based on the data include:

1. The handicapped reader (of normal intelligence) represents a special population in classification ability and is relatively deficient in this probably independent cognitive process.

2. Certain children apparently reach an asymptote in classification ability at the end of the early elementary years that may account for an asymptote in their reading at the end of the primary stages.

3. Continuous growth in reading despite differences in factors found to be necessary for success at different grade levels may be attributable to the possibility that various stages in reading tap correspondingly advanced stages in the concept formation process.

4. Use of intelligence tests as the basis for expectancy seems questionable since the practice is followed with the very children in whom intelligence and reading are least closely related (pp. 71-72).

In discussing the situation of the under-achiever in reading, Braun suggests that what appears to be related to their achievement is their classification ability.

> We do not know, as yet, if these children are going to continue permanently low in this major cognitive process of classification or if they are simply uneven in their development (p. 681).

This classification ability, with particular reference to alphabetic letters would it is felt also be closely related to children's reading achievement.

Jan-Tausch (1962) studied the classification ability of 170 boys and girls in grades four through seven in the public schools of Springfield, New Jersey. At each grade level, half the pupils were boys. Of each sex at each grade

level, half were advanced readers and half were retarded readers as measured by California Reading Tests, Form CC of the Elementary series and Form AA of the Intermediate series. The intelligence quotients of the pupils ranged from 79 to 133, based on the California Short Form Test of Mental Maturity. To assess the ability to classify, the following tests were used:

(1) The Color Form Sorting Test, and

(2) the first six designs of the Cube Test of the Goldstein-Sheerer battery of abstract and concrete thinking tests.

Only the performance on the tests was evaluated but verbalization was not excluded though it was not essential.

An over-all comparison of performance of the pupils in the study revealed that good readers were characterized by abstract thinking in the classification tests. In addition, the significance of the relationship between classification ability and reading achievement tended to become greater in higher grades suggesting the possibility that reading comprehension at higher levels takes on more abstract qualities.

The girls tested tended to behave more abstractly than the boys perhaps indicating why boys have a higher incidence of disability in all phases of language than do girls. This conclusion was drawn by the author from the results of her study.

Since the reading process involves alphabetic letters, it would seem important to examine the extent to which good and poor readers classify various letters, in order to see if differences in this area exist as well, as this, it would appear has clear implications for reading.

Wickens (1963) investigated the relationship between reading ability and classification ability by analyzing the performance of twenty-five average readers and twenty-five poor readers on a series of classification tests. All pupils were in grade four with average and poor readers being compared on the following classification tests:

(1) the Raven Coloured Progressive Matrices,

(2) Word Grouping and Figure Grouping of the Primary Mental Abilities Tests,

(3) Shure-Wepman Concept Shift Test, and

(4) Rapaport's Object Sorting Test.

The activities the pupils did in relation to these tests included choosing a geometric design to complete a matrix, selecting a non-exemplar of a category consisting of either words or figures, and sorting representatives objects or variously shaped and colored geometric blocks together with giving a reason for each sorting. On some sub-tests, the pupil was to give the organizing principle basic to a sorting done by the examiner.

On both the manipulative tests and the verbal test, the average readers were significantly more proficient in

classification and recognition of classifications, than were the poor readers. The good readers also were more proficient than poor readers in verbalizing the organizing principles or bases of categories. Poor readers had particular difficulty in giving the organizing principle of a classification which was done for them by the examiner. While the study provides definite differences between good and poor reader, it is not clear if these differences would still exist with a letter classification task involving the categorization of certain letter variations.

Rystrom (1969) measured the extent to which children could recognize and classify letters. During the spring of 1969, the Rystrom Multiple Form Letter Discrimination Test was individually administered to 75 primary children in a rural Georgia Negro School. This test, consisting of three parts required the child to identify different letter forms. Except for grade 1, entire classes were tested. Grades used were Kindergarten, Grade 1, Grade 2 and Grade 3. All groups were chosen by random selection. Inherent in this study was a classification or categorization task of a kind, as the child was required to identify the letters as belonging to a grapheme class.

Results indicate the mean scores increased with grade level. As a result of maturation and more experience with graphemes the children in each higher grade consistently achieved higher scores on this test. The mean scores

differences between each grade level and the next higher grade were significant at and beyond the 0.05 level using the Welch Aspin t-test. Thus it would appear that children have less trouble with letter variations as they get older.

From these results the author made two principle observations, about the letter confusions made by children

> . . . children who make these types of errors have correctly identified the significant features of a letter but have avoided treating the non-significant variations as significant also. They incorrectly identify the particular letter because they do not distinguish between the letter, the one in position and the same shape in some other position, using one of the four edges of the letter as the axis. Secondly, some children have not yet fully identified significant and non-significant variations for a particular grapheme . . . (p. 46).

However, while suggesting that this letter categorization ability was related to reading achievement, Rystom did not relate it directly to the reading process by measuring the child's reading achievement.

Summary of Studies of Classification Ability

Findings of general investigations of classification ability of young children indicate that proficiency in forming classifications increases with age. Pre-school children tend to have considerable difficulty with classification. Ability to classify continues to develop throughout the early school years. In grades four through six, children show increasing use of hierarchical classification together with increasing recognition of relationships. At

this level, children tend to use generalizations as organizing principles for the formation of classifications.

The studies of classification ability of good and poor readers clearly indicate significant differences in ability to perform classification tasks. There also were significant differences between good and poor readers in the generality or abstractness of classifications that were used in forming classes of objects. The good readers were better able to express the organizing principles of classifications than were poor readers. However it is still not clear if this difference would occur in a classification task involving alphabetic letters as proposed, in this study.

Comparing the performance of good and poor readers on classification tasks appears to be a useful approach to acquiring information about aspects of classification ability and its possible relation to reading ability. The use of classification tests with non-verbal content has yielded valuable information about the ability to form class concepts.

However, since letter recognition can be affected by the type and style of print presented, further study is needed of classification involving alphabetic letters to obtain a more complete picture of the relationship between the classification or categorization of alphabetic letters and reading achievement. There appears to be little or no

research which has looked at the child's classification of allographs and its relationship to reading. In the following chapter, the design for such a study will be described using specifically, local letter forms as used in Alberta schools.

CHAPTER III

THE RESEARCH DESIGN

This chapter describes the research design, sample selection, test instruments including their reliability and validity, the pilot study, method of data collection and finally the statistical measures used in analyzing the data.

I. DESIGN OF THE STUDY

The main purpose of this study was to investigate the ability of grade one children to categorize or classify various letter forms and examine their relationship to the beginning stage of reading achievement. The children's ability to discriminate and categorize alphabetic letters was assessed. A sample of grade one children having at least average I.Q. was chosen with equal distribution over sex and over high and low reading ability. This involved forty boys and forty girls with the same number of high and low readers in each group. Hypotheses involving this total sample of eighty pupils were then tested. Following this, two groups of achieving (N=28) and non-achieving (N=15) readers were selected from this total sample and hypotheses concerning these two sub-samples were further examined.

II. SAMPLE SELECTION

The population for this study was chosen from the grade one classes of three schools in the County of Strathcona School System. The children comprising the sample, were distributed over four different classrooms. A grade one population was selected because this is the first year of formal reading instruction and it is at this level that some influence of letter discrimination and letter categorization ability on reading achievement can be expected.

Since it was thought that visual difficulties might influence the performance on the Letter Categorization Tests the total population of eighty-six children were administered a visual screening test. The Keystone Telebinocular was used to assess each child's visual efficiency. The children were tested on all the Keystone Visual Survey Tests to gain an overview of their general visual ability. However for the purpose of this research the children's visual evaluation was made on three of the Keystone Visual Survey Tests -- lateral posture, fusion and usable vision with both eyes. All these tests were given at near point. These three basic areas were considered to be essential for unhampered visual functioning while reading. Further, near-point was used because all the testing involving vision was performed at a distance of 16 inches. On the basis of this test five

children were eliminated from the sample and referred for further visual testing.

It was also felt that the children had to know the letters of the alphabet if children's scores were to be meaningful. Consequently the Gates McKillop letter-knowledge (upper and lower case) subtest was administered to the grade one population remaining in the sample. Any children who could not recognize all the letters in this test were eliminated from the sample. On the basis of this test one child was further eliminated from the sample.

The remaining eighty children constituted the final sample for this research study. This sample consisted of forty girls and forty boys, with a mean age of 82.14 months and a standard deviation of 5.28 months. From this sample, were selected two groups of achieving and non-achieving readers, on the basis of their reading accuracy performance on the Neale Analysis of Reading Ability (Form A 1966). The achieving reading group consisted of ten boys and eighteen girls, with a mean chronological age of 82.75 months and a standard deviation of 3.72 months. The non-achieving reading group consisted of ten boys and five girls, with a mean chronological age of 81.60 months and a standard deviation of 6.84 months. Table 1 summarises the chronological ages, I.Q. and reading accuracy scores for the sample and sub-samples of achieving and non-achieving readers.

III. TEST INSTRUMENTS

1. The Keystone Visual Survey Tests

This visual screening device is produced by the Keystone View Company of Meadville, Pennsylvania, U.S.A. It is an individually administered test which involves the use of the Keystone Telebinocular instrument. This instrument requires the child to look through two glass lenses and respond to the examiner's questions concerning the visually presented stimuli. The total test consists of fourteen card presentations or subtests nine of which are placed at the far point position which is the equivalent of an actual distance of twenty feet. The remaining card presentations are placed at the near-point position which is the equivalent of an actual distance of sixteen inches.

2. The Gates McKillop Diagnostic Reading Tests (Sub-test III-IV)

This instrument is intended for individual diagnosis of reading difficulties. There are various sections to this battery including the sub-test used to test children's letter knowledge of both upper and lower case letters. This particular section consists of a single sheet of paper on which are printed all the alphabetic letters in random order. On the top section of the page the letters are printed in upper-case lettering. On the bottom half of this page the letters are printed in lower-case lettering.

TABLE 1

MEAN CHRONOLOGICAL AGE, READING ACCURACY AND INTELLIGENCE QUOTIENT SCORES

Reading Achievement Groups		B O Y S			G I R L S			T O T A L		
		Chronological Age (mths)	Rdg. Accuracy	Intelligence Quotient	Chronological Age (mths)	Rdg Accuracy	Intelligence Quotient	Chronological Age (mths)	Rdg. Accuracy	Intelligence Quotient
Achieving Readers N = 28	$\bar{X}$	82.40	33.00	119.20	81.39	37.50	115.50	82.75	35.89	116.62
	SD	4.10	13.92	11.70	3.43	9.21	13.41	3.72	11.33	12.95
Non-Achieving Rdrs N = 15	$\bar{X}$	82.00	15.00	98.67	81.50	14.08	102.08	81.60	14.27	101.40
	SD	5.35	9.89	9.28	7.16	6.99	7.11	6.84	7.67	7.72
Total Sample N = 80	$\bar{X}$	82.92	24.75	111.12	81.35	31.57	115.22	82.14	28.16	113.17
	SD	4.96	8.60	9.61	3.73	12.04	8.85	5.28	10.82	13.19

This instrument requires the child to look at each letter and name the individual letters as he comes to each. Upon successful completion of the upper-case letters he commences the lower-case letters. This total sub-test consists of the 26 letters presented twice and normally takes a few minutes to administer.

To ensure accurate results, a child who is experiencing difficulties in his single letter knowledge would also be hampered in discriminating various different letter-form presentations and also this would affect his reading at near point. Therefore, considering the nature of the test instruments involved in the present study, the foregoing subtests were used to screen out children who could not recognize all the letters of the alphabet.

3. S.R.A. Primary Mental Abilities (revised 1963)

This instrument was designed to provide both multi-factored and general measures of intelligence. At the K-1 level, there are four sub-tests, each of which measures a primary ability while the total score provides an estimate of general intelligence. The four primary abilities assessed by the sub-tests are:

Sub-test 1 -- Verbal Meaning: The child is required to demonstrate an understanding of orally expressed ideas by marking one of four possible pictures. There are forty-nine test items as well as seven

practice items.

Sub-test 2 --Number Facility: This is comprised of simple quantitative problems requiring the child to count, add and subtract. The child is asked to respond by marking the appropriate number of pictures. There are twenty-seven test items and seven practice items.

Sub-test 3 -- Perceptual Speed: The child's ability to see likenesses and differences between objects and symbols (pictures and silhouettes) quickly and accurately is measured. This is a matching to sample task consisting of twenty-eight items and seven practice items. There is a time limit for this test.

Sub-test 4 --Spatial Relations: This sub-test measures a child's ability to visualize objects and figures rotated in space and the relations between them. The first task requires the child to mark the choice figure which completes the sample stimulus. The second task involves completing a geometric figure from a given model. Altogether there are twenty-four test items and ten practice items.

Reviews (Buros, 1972) have indicated test-retest reliability coefficients ranging between .83 and .95. Validity for this test was established by correlating test scores with the results of the S.R.A. Achievement Series:

Reading.

4. The Neale Analysis of Reading Ability (Form A, 1966)

This test was chosen as the measure of reading achievement mainly because it is both easily administered and well standardized. This oral reading test allows for a measurement of reading accuracy and comprehension ability. Allowance is also made for reading rate. However, these last two measures were not included as they were not considered pertinent to this study.

The test, which is administered individually, consists of six passages of graded difficulty and increasing length, with controlled variation of vocabulary and sentences. Reliability coefficients for reading accuracy scores on alternate forms exceed .96 (Neale, 1965). A validity coefficient of .95 was obtained using the pooling square method over the following tests; Ballard One-Minute Test, Holburn Scale, Peel English Test and the Schonell English Usage Test (Neale, 1965). Table 2 summarizes the mean and standard deviation of the reading achievement measure.

IV. TESTS CONSTRUCTED FOR THIS STUDY

A review of the related literature indicated that no test was available which measured an individual's ability to categorize letters. Also not available were tests which measured aspects of letter discrimination and letter

TABLE 2

MEANS AND STANDARD DEVIATIONS FOR PERFORMANCE ON READING ACHIEVEMENT TEST OVER SEX AND READING ABILITY

		Total Group (N=80)	Girls (N=40)	Boys (N=40)	Achieving (N=28)	Non-Achieving (N=15)	Achieving & Non-Achieving Readers combined (N=43)
Reading Achievement Measure	Reading Accuracy	$\bar{X}$ 28.16	$\bar{X}$ 31.57	$\bar{X}$ 24.75	$\bar{X}$ 31.20	$\bar{X}$ 18.81	$\bar{X}$ 22.53
		SD 10.82	SD 9.01	SD 7.15	SD 8.86	SD 3.01	SD 2.91

classification together. Therefore four sub-tests were constructed in order to assess these discrimination -- categorization abilities.

The purpose of the Letter Categorization Test* was to measure the subjects' ability to discriminate letters and then categorize these alphabetic letter forms. This test was constructed to measure certain factors which the researcher proposed as being important in a child's categorization ability of letters. These factors were:

1. Naming a grapheme category to which any allograph fits.
2. Matching similar forms of the same allograph.
3. Selecting different allographic forms of the same grapheme
4. Matching identical forms of a single allograph when they occur within words.
5. Identifying different allographic forms as being the same when they occur in words.

Four sub-tests, consisting of fifteen items each comprised the total Letter Categorization Test. To make the test more relevant to specific local conditions, alphabetic letter forms and their variations were chosen from reading materials recommended by the Department of Education, for use in Alberta Schools.

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*See Appendix A for a complete copy of the test.

The Letter Categorization Test

Sub-test 1**

This letter identification sub-test was designed to assess an individual's ability to identify and name the letter variations found in children's reading materials. It also satisfied the first requirement the researcher mentioned as being important in letter categorization. The test consisted of fifteen letter form presentations, randomly selected from all the letter variations the researcher could find in children's reading materials recommended by the Department of Education for use in Alberta Schools. These letters were placed vertically in three columns down the page, with equal spacing between each. The student, was required to name each letter-form as it appeared. No advance practice was given for this sub-test. It will be noted that cursive letters have been included in this and other sub-tests. They were included in order to measure the extent to which children in Grade One were able to correctly identify allographs in cursive form. These cursive forms were found to appear occasionally in children's reading materials reviewed by the researcher.

Sub-test 2**

This again, was an experimental test constructed by the researcher and designed to measure the extent to which

** See Appendix A for a complete copy of the subtest.

a subject had attained the ability to categorize alphabetic letters which differed in size, print form and style of presentation. Lower-case and Upper-case letters were both chosen and included in this test since they are both encountered in children's reading materials at the Grade One level. The actual letters were directly selected from the following basal readers:

Its Story Time ..... Ginn Basal Reader Series

Just For Me ..... Gage Basal Reader Series

The Toy Box ..... Gage Basal Reader Series

Sounds Around the Clock .... Ginn Basal Reader Series

On Cherry Street ..... Ginn Basal Reader Series

After the various letter forms had been selected they were isolated and extracted from the books by a photographic process. All the variations of the letter forms were assembled together and randomly selected for use in the Letter Categorization Test. The letters used in this sub-test, and for the total test were selected on two criteria. Firstly, the letters had to occur in commonly used reading materials for grade one children. Secondly the letters used had to have a number of possible variations so as to test this categorization ability.

Selected alphabetic letters were used to construct a test which elicited a matching-to-sample response. The choice stimuli consisted of a sample stimulus, three distractors, the sample itself or a variation of the sample

which nevertheless could still be classified as a member of that stimulus group. The sample stimulus was placed on the left side of the page and the choice stimuli plus the distractors were then randomly placed to the right on the same horizontal plane. This positioning of the letters on a horizontal plane is thus similar to the spatial positioning of letters in a normal reading situation.

The subject was given two practice attempts using two letters not used in the letter sample. When errors were made on these practice items the subject was redirected until the error was corrected. Each sample letter in the test was presented on a separate sheet. The subject was required to draw a circle around the choice stimulus which matched the sample stimulus. A single point was given for each correct choice. The following is a sample of one item of sub-test 2.

l e l f h

Sub-test 3**

A variation in format occurred in sub-test 3. While a sample stimulus was still presented on the left side of the page, five stimulus variations were placed on the right-hand side along with three distractors. These stimulus variations were placed in random order to the right, being mixed with the distractors and placed on the same horizontal

plane. Again the positioning of the letters on the horizontal plane is thus similar to the spatial positioning of letters in a normal reading situation.

The subject was given two demonstration attempts to ensure that he clearly understood the instructions. The demonstration items were not used in the test sample. When errors were made on these demonstration items the subjects were redirected until the error was corrected. Each demonstration was carried out on a separate sheet. The subject was required to draw a circle around the five allographic variations which represented the same grapheme as the sample stimulus. A single point was given for each correct choice. A total of five points could be gained for identifying all five allographic variations presented in each item. The following is a sample of one item of sub-test 3.

Sub-test 4

This sub-test consisted of letters included in whole words. It was constructed by the writer in order to assess the subjects' ability to: (i) match identical forms of a single allograph when they occur within words; and (ii) identify different allographic forms as being the same grapheme when they occur within words. While some sample letters

were the same as in previous subtests there were added to this test other letters which hitherto had not been used. The purpose for using words in this particular sub-test was in order to more closely approximate the reading situation encountered by the child, namely the discrimination and categorization of letters within words.

Fifteen items were included in this test. Eight three-letter words, six four-letter words and one five-letter word comprised the total of fifteen items. Using a stratified random procedure, five of the stimulus letters were placed in the initial position. Of the remaining, two were placed in the final position and one in the centre. For the four-letter words, two stimuli were placed in the initial position and two were placed in the medial position.

The format of this test was similar to that of the other Letter Categorization sub-tests. The stimulus word and choices were placed on a horizontal line and the subject was asked to choose the word which was the same as the first word. One point was given for each item correctly marked. The following is a sample of one item of sub-test 4.

lay lag lap · Lay

As sub-test 4 was new, an item analysis was conducted in order to determine how efficient this sub-test was. This item analysis provided information about each item of the test, such as; how well each item correlated with the total test; how well each item separated the good

(those students who were above the highest cut-off point of 40 on the letter categorization test) and poor (those students who were below the lowest cut-off point of 20 on the letter categorization test) students; the degree of difficulty of each item; and the number of students who either got that item correct or incorrect.

An analysis of this sub-test showed that the degree of difficulty of the various items differed from .57 to .77, thus illustrating a fair consistency among the items of the test. Biserial correlations were reported varying from .48 to .83 showing that all the items of the sub-test appeared to relate strongly to the total test.

When the total sample was analysed according to their performance on each item, it appeared that the top 20 per cent of students generally scored well on each item as expected, making a small number of errors. The bottom 20 per cent of students generally scored lower, again as expected, and appeared to make a greater number of errors. This pattern appeared to be consistent for each item in the test. The amount of spread between the good and poor students on each item was as expected, illustrating that each item of sub-test 4 was sufficient to separate the students.

When the test score means were analysed, the general trend appeared consistent. Those students who performed poorly on the particular item in every case had a lower

test score mean than those who did well on the item. The amount of variation differed according to the item, but the variation that did occur supported the point that all items in this sub-test were sufficient to discriminate between the good and poor students.

Validity

The purpose of the Letter Categorization Test has been explained previously. Items which required discrimination and some categorization to be made were based upon Rystrom's (1968) Multiple-Form Letter Discrimination Test. This test served as a model in developing certain sections of the test. Letters were chosen which had a large number of variations, but which children could be expected to be exposed to.

The Letter Categorization Test, after construction, was submitted to a panel of graduate students and professors who were asked to indicate their approval of certain items, based upon the purpose of the test and the criterion for test construction as previously described. Subsequently three items were eliminated and sub-test 3 was added as it was thought this could complement and balance the other tests. Improvements and modifications were also made to the "Instructions for Candidates" as it was thought some of the wording was confusing.

Thus, given the purpose of this test, as well as the nature of the task required by the test, it was felt therefore, that these instruments actually measure what they propose to measure. Subsequently it is considered that this device fulfils the requirements of content validity.

Reliability

A split-half method of achieving a measure of reliability was used for the present tests. Dividing the test tends to shorten it considerably and also tends to reduce its reliability. Thus a Spearman-Brown formula was applied in order to correct for its reductions in length. The reliability coefficient for the Letter Categorization Test was .84 using the Kuder-Richardson formula.

Therefore it may be concluded that for this test there exists a consistency of agreement between even and odd scores using a split-half-test of reliability.

V. PILOT STUDY

A pilot study, using ten grade one children, divided equally into high and low readers on the basis of their teachers' ratings, was conducted approximately one month prior to the final data collection. The purpose of the pilot study was to obtain further information with regard to the following areas: (a) to determine whether the Letter Categorization Test should be administered individually or in groups; (b) to test whether there was evidence of differing performances by the high and low readers; and (c) to check out the test instructions used, as well as the amount of time necessary to complete the tests.

On the basis of the results of the pilot study the following decisions were made: (a) the Letter Categorization Test should be administered individually to each child in the sample; (b) the format of sub-test 3 was changed, from a manual classification test where the child had to physically manipulate cards on which the letter forms were printed to a paper and pencil test for the child's convenience; (c) two similar items in sub-test 4 were altered. It was observed that (a) the children comprehended the instructions adequately;

(b) the sequence of test administration as first devised was adequate; and (c) the total time involved in administering the Letter Categorization Tests was fifteen minutes which did not appear to cause the children any undue strain or fatigue.

VI. COLLECTION OF DATA

All the visual screening tests were idividually administered by the experimenter to each subject in the original sample. This screening process lasted approximately 10 minutes per child. The Neale Analysis of Reading Ability was also individually administered. Approximately 10 to 15 minutes were involved in this test depending upon the number of passages read.

The Letter Categorization Test was administered individually to each child in the sample and took about fifteen minutes. No group tests were administered as part of the data collection.

All of the foregoing tests were administered during regular class time in each school. Private rooms were made available for each testing session. The S.R.A. -- Primary Mental Abilities Test scores were obtained from the cumulative record cards of each child in the sample. The administration of the I.Q. test was carried out one month previous to the research by the Guidance Officer for the County of Strathcona.

VII. ANALYSIS OF DATA

The data for this study were analyzed, using the following procedures:

(1) Pearson Product Moment Correlation (PEARSON T 02) Correlation matrices were computed for categorization, reading and I.Q. variables over reading groups, sex and total sample.

(2) Partial Correlation (APL STP 2) The effect of the I.Q. variable was partialled out from reading and categorization correlations to see if the relationship between reading and letter categorization still existed or was dependent on intelligence.

(3) One-Way Analysis of Variance (ANOV 15) This one-way analysis of variance was used to determine whether differences existed between the reading groups and between boys and girls on the categorization scores.

(4) Item Analysis (TEST 01) Using the item analysis, test reliability was obtained as well as an indication of how well each item was answered.

SUMMARY

In this chapter the design and sample selection was discussed. Eighty pupils constituted the final sample. Hypothesis were tested using this group. this eighty were selected two groups of achieving (N=28) and non-achieving (N=15) readers. Further hypotheses were tested using these two groups specifically.

Test instrument construction, along with validity and reliability of the instrument were reported. The Letter Categorization Test was shown to have reliability of .84 using the Kuder Richardson 20 Formula. A pilot study was conducted, which provided valuable information to the researcher in planning the format and presentation of the final testing program. Finally the data was statistically analysed with the help of various programs held by the Department of Education Research Service.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

The purpose of this chapter is to present and discuss the analysis of the data under the following headings, which coincide with the hypotheses presented in Chapter I.

1. Letter Categorizati ability and Reading Achievement with the total sample.
2. Letter Categorization ability and Reading Achievement with achieving and non-achieving readers.
3. Letter Categorization and Related Variables.

I. LETTER CATEGORIZATION ABILITY AND READI ACHIEVEMENT OF THE TOTAL SAMPLE

An overall view of the total sample of eighty grade one subjects was taken to determine whether there was a relationship between letter categorization and reading achievement.

Table 3 outlines the mean scores and standard deviations for this total sample as well as the achieving and non-achieving readers on the Letter Categorization Test. Table 4 outlines the mean scores and standard deviations for the total sample as well as boys and girls on the Letter Categorization Test. In each case results

TABLE 3

MEANS AND STANDARD DEVIATIONS OF LETTER CATEGORIZATION TESTS OVER ACHIEVING AND NON-ACHIEVING READERS

LETTER CATEGORIZATION TEST

	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
Achieving Readers N = 28	$\bar{X}$ 22.82	$\bar{X}$ 14.10	$\bar{X}$ 71.32	$\bar{X}$ 14.50	$\bar{X}$ 122.74
	S.D. 2.45	S.D. 0.82	S.D. 1.81	S.D. 1.00	S.D. 1.00
Non-Achieving Readers N = 15	$\bar{X}$ 22.00	$\bar{X}$ 13.00	$\bar{X}$ 61.04	$\bar{X}$ 13.40	$\bar{X}$ 109.33
	S.D. 3.66	S.D. 1.88	S.D. 14.50	S.D. 1.96	S.D.15.70
Achieving & Non Achieving Readers N = 43	$\bar{X}$ 22.53	$\bar{X}$ 14.09	$\bar{X}$ 67.86	$\bar{X}$ 14.11	$\bar{X}$ 118.44
	S.D. 2.91	S.D. 0.83	S.D. 9.74	S.D. 1.48	S.D.11.20
Total Sample N = 80	$\bar{X}$ =22.80	$\bar{X}$ 14.20	$\bar{X}$ 65.82	$\bar{X}$ 14.20	$\bar{X}$ 115.01
	S.D.= 2.70	S.D. 1.37	S.D. 13.50	S.D. 1.52	S.D.17.37

TABLE 4

MEANS AND STANDARD DEVIATIONS OF THE LETTER CATEGORIZATION TESTS FOR THE TOTAL SAMPLE OVER SEX

	LETTER CATEGORIZATION TEST				
	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
Total Sample N = 80	$\bar{X}$ 22.80 S.D. 2.70	$\bar{X}$ 14.20 S.D. 1.37	$\bar{X}$ 65.82 S.D. 13.50	$\bar{X}$ 14.20 S.D. 1.52	$\bar{X}$ 115.57 S.D. 17.37
Total Boys N = 40	$\bar{X}$ 22.82 S.D. 3.01	$\bar{X}$ 14.32 S.D. 2.91	$\bar{X}$ 66.52 S.D. 4.62	$\bar{X}$ 14.02 S.D. 1.21	$\bar{X}$ 114.01 S.D. 10.9
Total Girls N = 40	$\bar{X}$ 22.77 S.D. 2.10	$\bar{X}$ 14.07 S.D. 1.21	$\bar{X}$ 65.12 S.D. 7.63	$\bar{X}$ 14.40 S.D. 1.07	$\bar{X}$ 116.20 S.D. 13.01

tended to approach the maximum score possible particularly on sub-tests 1, 2 and 4..

Letter Categorization and Reading Achievement

Results for the total sample indicate a correlation of .42 between letter categorization and reading achievement which was significant at the .05 level. Results for the various sub-tests of the Letter Categorization Test also indicate significant relationships with reading achievement (Table 5.) Significant correlations were also found to exist between sub-tests 1, 3, and the total test with reading accuracy ($p < .05$). However a more significant correlation was found between subtest 4 with reading accuracy ($p < .01$).

TABLE 5

CORRELATIONS BETWEEN LETTER CATEGORIZATION TEST AND READING ACHIEVEMENT

Reading Achievement measure	LETTER CATEGORIZATION TESTS				
	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total Letter Categorization
Reading Accuracy	.25*	-.12	.20*	.38**	.42*

* Significant at the .05 level.

** Significant at the .01 level.

I.Q. Factor Partialled Out

When the I.Q. factor was subsequently partialled out from the foregoing correlations (Table 6) sub-test 4 maintained a significant level of correlation with reading accuracy ($p < .01$). Statistically significant levels were also maintained between the Total Letter Categorization scores and reading accuracy ($p < .05$).

TABLE 6

CORRELATIONS BETWEEN LETTER CATEGORIZATION TESTS AND READING ACHIEVEMENT WITH I.Q. PARTIALLED OUT

Reading Achievement measure	LETTER CATEGORIZATION TESTS				
	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total Letter Categorization
Reading Accuracy	.17	-.08	.12	.37**	.26*

** significant at the .01 level

* Significant at the .05 level

Correlations for Boys and Girls between Letter Categorization and Reading Achievement

When the total sample was broken down into boys and girls (Table 7) it was found that significant correlations existed for the boys between sub-tests 1, 3, 4 and the total test with reading accuracy ($p < .05$). Significant correlations for the girls were found to exist between sub-test 3 and the total test with reading accuracy

TABLE 7

CORRELATIONS BETWEEN LETTER CATEGORIZATION TEST AND READING ACHIEVEMENT OVER SEX FOR TOTAL SAMPLE

			LETTER CATEGORIZATION TESTS				
			Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total Letter Categorization
Reading Achievement Measure	Reading Accuracy	Girls	.36*	.12	.32*	.33*	.37*
		Boys	.38**	.13	.28*	.52**	.30*

* Significant at the .05 level.

** Significant at the .01 level.

($p < .05$) and between sub-tests 1 and 4 with reading accuracy ($p < .01$).

I.Q. Factor partialled out of Boy-Girl Correlations

When the I.Q. factor was subsequently partialled out from the foregoing correlations (Table 8) only sub-test 4 maintained a significant level with reading accuracy ($p < .05$).

Sub-test 4 appears to have maintained the highest and most consistent correlation with reading achievement. The apparent correlation between the Total Letter Categorization scores and reading accuracy may possibly be accounted for by the rather strong influence of sub-test 4 which consisted of letter variations within a word. It appears noteworthy that sub-test 4 was the only letter categorization sub-test score to maintain a significant positive correlation with reading accuracy after the intelligence factor had been partialled out.

Correlations for Sex, I.Q. and Reading Achievement

Correlation coefficients were also computed between sex, age, I.Q. and reading achievement, Table 9 in order to check the importance of I.Q. in children's reading. Results indicate significant relationships between sex (r.31) and I.Q. (r.50) with reading accuracy ($p < .01$). The decrease in correlations between the Letter Categorization Scores and Reading, when I.Q. was

TABLE 8

CORRELATIONS BETWEEN LETTER CATEGORIZATION TESTS AND READING ACHIEVEMENT OVER SEX WITH I.Q. PARTIALLED OUT FOR TOTAL SAMPLE

			LETTER CATEGORIZATION TESTS				
			Sub-Test 1	Sub-Test 2	Sub-Test 3	Sub-Test 4	Total
Reading Achievement Measure	Reading Accuracy	Boys	.27	-.04	.22	.27	.26
		Girls	.34	.04	.28	.46*	.22

* Significant at .05 level

partialled out was thus verified by the presence of the I.Q. factor in these correlations.

TABLE 9

CORRELATIONS BETWEEN SEX, AGE, I.Q. AND READING ACHIEVEMENT

		SEX	AGE	I.Q.
Reading Achievement Measure	Reading Accuracy	.31**	.06	.50**

** Significant at .01 level.

Analysis of Variance for Boys and Girls

In order to further analyse the relationship between letter categorization and reading achievement an analysis of variance was carried out to determine if differences on letter categorization scores existed between boys and girls. The data are shown in Table 10 and indicate no significant differences over the sub-tests and total test score. This apparent lack of difference between these two groups on the Letter Categorization Test was not unexpected considering that these two groups contained both achieving and non-achieving readers.

TABLE 10

SUMMARY OF ANALYSIS OF VARIANCE (T-TEST DIFFERENCES) BETWEEN MEANS OF THE LETTER CATEGORIZATION SCORES OVER BOYS AND GIRLS

Test (Letter Categorization)	Boys N = 40	Girls N = 40	df within score	F
Sub-Test 1	$\bar{X}$ 22.77 S.D. 2.81	$\bar{X}$ 22.82 S.D. 1.32	78	0 *
Sub-Test 2	$\bar{X}$ 14.07 S.D. 0.92	$\bar{X}$ 14.32 S.D. 1.73	78	-0.80 *
Sub-Test 3	$\bar{X}$ 65.13 S.D.14.92	$\bar{X}$ 66.52 S.D.12.28	78	-0.45 *
Sub-Test 4	$\bar{X}$ 14.40 S.D. 0.87	$\bar{X}$ 14.02 S.D. 1.54	78	1.33 *
Total	$\bar{X}$ 116.20 S.D.15.35	$\bar{X}$ 114.92 S.D.19.56	78	.31 *

* No significant difference.

II. LETTER CATEGORIZATION ABILITY AND READING ACHIEVEMENT WITH ACHIEVING AND NON-ACHIEVING READERS

Following an analysis of the total group of subjects, achieving and non-achieving readers were then analysed for the purpose of verifying hypothesis which centred around these particular sub-samples. These two sub-samples contained 28 achieving and 15 non-achieving readers.

Correlations between Letter Categorization and Reading Achievement for Achieving and Non-Achieving Readers

An analysis of the correlations between letter categorization and reading achievement for achieving and non-achieving readers (Table 11) indicate significant correlations for both achieving and non-achieving readers between sub-test 4 and reading accuracy ($p < .05$). Statistically significant correlations were also found to exist for non-achieving readers, between sub-test 1 and the reading accuracy score ($r = .73$, $p < .01$).

Correlations for Achieving and Non-Achieving Boys and Girls

These achieving and non-achieving groups were further broken down by sex and an analysis of the correlations between the Letter Categorization Test results and reading achievement scores was conducted (Table 12). These correlations proved to be rather low and non-

TABLE 11

CORRELATIONS BETWEEN LETTER CATEGORIZATION TESTS AND READING ACHIEVEMENT OVER ACHIEVING AND NON-ACHIEVING READING GROUPS

			LETTER CATEGORIZATION TEST				
			Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total Letter Categorization
Reading Achievement Levels	Reading Accuracy	Achieving N = 28	.007	-.10	.09	.34*	.13
		Non-Achieving N = 15	.73**	.10	.07	.39*	.26

** Significant at .01 level.

* Significant at .05 level.

TABLE 12

CORRELATIONS BETWEEN LETTER CATEGORIZATION TESTS AND READING ACCURACY OVER ACHIEVING AND NON-ACHIEVING BOYS AND GIRLS

			LETTER CATEGORIZATION TEST				
			Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
Reading Achievement Measure	READING ACCURACY	Achieving Girls N = 18	.25	.11	.34	.48**	.46
		Non-Achieving Girls N=5	.67**	.14	.09	.48**	.21
		Achieving Boys N = 10	-.04	-.03	-.11	.02	.17
		Non-Achieving Boys N = 10	.99**	.001	.02	.001	.43

** Significant at the .01 level

significant in a pattern somewhat similar to that already discussed for the achieving and non-achieving groups.

Sub-test 4 proved to be significantly correlated with reading accuracy ($p < .01$) for both achieving and non-achieving girls. However, while other correlations in some cases were high none proved to be significant except sub-test 1 which correlated significantly with reading accuracy for non-achieving girls ($r = .67$, $p < .01$). Apart from these, no other correlations were found to exist with reading accuracy.

Partialling out I.Q. from Achieving and Non-Achieving Boys and Girls

As a result of partialling out the I.Q. factor a pattern similar to that involving the total group tended to emerge (Table 13). The results of sub-test 4 tended to be most consistent in its correlation with reading accuracy for both boys and girls. Sub-test 1 also remained significantly correlated with reading accuracy for the non-achieving boys and girls. Again a pattern of non-significant correlations emerged for the remainder of the results.

When interpreting these results however, the reader is cautioned in forming definite conclusions on the basis of the above-mentioned data since the number of subjects in the foregoing analysis tended to be small. While all

TABLE 13

CORRELATIONS BETWEEN LETTER CATEGORIZATION SCORES AND READING ACCURACY OVER ACHIEVING AND NON-ACHIEVING BOYS AND GIRLS WITH I.Q. PARTIALLED OUT

		Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
READING ACCURACY	Achieving Girls N = 18	.17	.05	.26	.42**	.38
	Non-Achieving Girls N = 5	.47**	.12	.05	.34**	.19
	Achieving Boys N = 10	-	-	.06	-	.10
	Non-Achieving Boys N = 10	.82**	-	-	-	.28

** Significant at the .01 level

the correlational elements are correct, the small number of subjects in one group (e.g. Non-achieving girls = 5) are influenced by the number of variables in the above correlations thus reducing the meaningfulness of that group and correlations associated with it.

Analysis of Variance to Determine Differences between Achieving and Non-Achieving Groups

In order to further analyse the relationship between letter categorization and reading achievement an analysis of variance was carried out to determine if differences in letter categorization scores existed between the reading groups. Tables (14 and 15) indicate the means and standard deviations for these groups, while tables (16 and 17) summarize the analysis of variance. The data are shown in Table 16 and indicate significant differences over sub-test 3, 4 and the total letter categorization scores ($p < .01$), but not over sub-tests 1 and 2.

The differences between achieving and non-achieving readers proved to be significant for both the total Letter Categorization Test and Sub-tests 3 and 4 as mentioned previously. These major significant differences continued to appear after the Welch T-Prime Adjustment Test had been used to adjust for the unequal variances that existed in these two groups (Table 17).

It is interesting to note that the apparent greater differences between the groups existed in tests

TABLE 14

MEANS AND STANDARD DEVIATIONS FOR LETTER CATEGORIZATION TESTS FOR ACHIEVING BOYS AND GIRLS

	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
Achieving Readers Boys N = 10	$\bar{X}$ 22.90 S.D. .83	$\bar{X}$ 14.20 S.D. .87	$\bar{X}$ 71.40 S.D.1.80	$\bar{X}$ 14.20 S.D.1.4	$\bar{X}$ 122.60 S.D. 3.38
Achieving Readers Girls N = 18	$\bar{X}$ 22.78 S.D. 2.9	$\bar{X}$ 14.10 S.D. .76	$\bar{X}$ 71.28 S.D.1.78	$\bar{X}$ 14.67 S.D. .57	$\bar{X}$ =122.89 S.D. 3.28

TABLE 15

MEAN AND STANDARD DEVIATIONS FOR LETTER CATEGORIZATION TESTS FOR NON-ACHIEVING BOYS AND GIRLS

	LETTER CATEGORIZATION TEST				
	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
Non-Achieving Readers Boys N = 10	$\bar{X}$ 19.76 S.D. 2.10	$\bar{X}$ 13.91 S.D. 0.86	$\bar{X}$ 61.92 S.D. 14.60	$\bar{X}$ 13.25 S.D. 2.04	$\bar{X}$ 111.16 S.D. 15.12
Non-Achieving Readers Girls N = 5	$\bar{X}$ 19.66 S.D. 6.18	$\bar{X}$ 14.00 S.D. .81	$\bar{X}$ 59.33 S.D. 11.02	$\bar{X}$ 13.62 S.D. .81	$\bar{X}$ = 107.0 S.D. 14.89

TABLE 16

SUMMARY OF ANALYSIS OF VARIANCE (T-TEST) DIFFERENCE BETWEEN MEANS ON LETTER CATEGORIZATION SCORES OVER ACHIEVING AND NON-ACHIEVING READERS

VA	Mean and Standard Deviation for Both Groups			
Test (Letter Categorization)	Achieving Readers N = 28	Non-Achieving Readers N = 15	within scores	F
Sub-test 1	$\bar{X}$ 22.82 S.D. 2.45	$\bar{X}$ 22.00 S.D. 3.66	41	.88
Sub-test 2	$\bar{X}$ 14.18 S.D. 0.82	$\bar{X}$ 13.90 S.D. 0.88	41	.91
Sub-test 3	$\bar{X}$ 71.32 S.D. 1.81	$\bar{X}$ 61.40 S.D. 14.50	41	3.61**
Sub-test 4	$\bar{X}$ 14.50 S.D. 1.00	$\bar{X}$ 13.40 S.D. 1.96	41	2.45**
Total	$\bar{X}$ 122.79 S.D. 3.38	$\bar{X}$ 110.33 S.D. 15.70	41	4.06**

** Significant at the .01 level

TABLE 17

WELCH 'T' PRIME ADJUSTMENT OF T TESTS
FOR UNEQUAL VARIANCES

Test (Letter Categorization	Adjusted df (Within Scores)	F
Sub-test 1	20.89	0.78
Sub-test 2	26.89	0.89
Sub-test 3	14.23	2.64**
Sub-test 4	18.01	2.04*
Total	14.70	2.03**

* Significant at .05 level
** Significant at .01 level

TABLE 18

CORRELATIONS BETWEEN LETTER CATEGORIZATION ABILITY AND I.Q. FOR TOTAL SAMPLE

	LETTER CATEGORIZATION TEST				
	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
I.Q.	.22*	-.01	.17	.32**	.27*

*Significant at .05 level

**Significant at .01 level

consisting of single letters, rather than words. A possible explanation for this is that the tests consisting of letters were more clearly a classification task than the sub-test consisting of words from which the children could obtain other cues within the word.

III. LETTER CATEGORIZATION AND RELATED VARIABLES

Previous studies in the area of letter discrimination (Harris, 1957; Silver and Hagin, 1960; Coleman and Deutsch, 1964; Belmont & Birch, 1965) have raised the question of a relationship between discrimination ability and I.Q. In the area of categorization and classification studies by Braun (1963) and Jan-Tausch (1962) have raised a similar question. Few studies have looked at alphabetic letter categorization and its relation to I.Q. The present section therefore will consider the relationship of I.Q. and letter categorization ability. The intercorrelations between the various sub-tests of the Letter Categorization Test will also be examined, as well as relationships between sex, and letter categorization ability.

Letter Categorization and I.Q.

The S.R.A. Primary Abilities Test as described in Chapter III offers a total estimate of general intelligence. Table (18) presents the correlation coefficients

established in the present study between the general intelligence measure and the Letter Categorization Test for the total sample. These correlations appear to be moderate.

Statistically significant correlations were established between sub-test 1 and the total Letter Categorization Test ($p < .05$) and I.Q. Further, a greater significant correlation was established between sub-test 4 and I.Q. ($p < .01$).

Correlation coefficients between sub-tests 2 and 3 with I.Q. failed to reach an acceptable level of significance and tended to be extremely low ($r = -.01$; $r = .17$).

It appears therefore from these data that there exists a possible relationship between letter categorization ability (as measured by the Letter Categorization Test) and I.Q.

Intercorrelations of Sub-Tests of the Letter Categorization Tests

Correlations between the four sub-tests of the Letter Categorization Test were computed in order to obtain a measure of the internal consistency of these letter categorization sub-tests. The correlation coefficients and their levels of significance are shown in Table (19).

Some, but not all of the Letter Categorization sub-tests, which were constructed for this study reached

TABLE 19

INTER-CORRELATIONS OF SUB-TESTS WITH TOTAL SAMPLE

	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test4	Total
Sub-test 1	1.0				
Sub-test 2	.01	1.0			
Sub-test 3	.52**	.13*	1.0		
Sub-test 4	.17*	.08	.10*	1.0	
Total	.08	.15*	.75**	.14	1.0

** Significant at .01 level

* Significant at .05 level

the criterion level of significance ($p < .05$). Only sub-test 3 had a high correlation with the total Letter Categorization Test ($r = .75$, $p < .01$). None of the other inter-correlations were exceptionally high. The fact that the correlations, for the most part, were both positive and significant would suggest the existence of a common factor -- letter categorization ability. However, the lack of high correlation coefficients would also indicate that each test is measuring something different. The correlation coefficients between sub-test 3 and the total Letter Categorization scores are the only correlations which are high and which reached a statistically significant level at the same time.

When the I.Q. factor was partialled out of the foregoing correlations (Table 20), it was found except for sub-test 3 that all other correlations were low. Sub-test 3 remained at exactly the same significance level as previously mentioned, possibly indicating that it is the only sub-test which is measuring the same ability as the total test and which, at the same time is not influenced by the I.Q. factor.

Following the analysis of the intercorrelations of these sub-tests, using the total sample, achieving and non-achieving groups were used in further analysis. These two groups were combined and intercorrelations of sub-tests were

TABLE 20

CORRELATIONS BETWEEN SUB-TEST SCORES AND TOTAL LETTER CATEGORIZATION WITH I.Q. PARTIALLED OUT FOR TOTAL SAMPLE

	LETTER CATEGORIZATION SUB-TESTS				
	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
Sub-test 1	1.0				
Sub-test 2	.13	1.0			
Sub-test 3	-.02	.13	1.0		
Sub-test 4	.17	.07	.11	1.0	
Total	.08	.15	.75*	.13	1.0

*Significant at .01 level

obtained. The correlation coefficients are shown in Table (21).

Results indicate that correlations while still low exhibited the same pattern as previously observed. Sub-test 3 again correlated highly with the total Letter Categorization score (r = .94).

These data therefore would tend to suggest that sub-test 3 may possibly be the most meaningful instrument for the measurement of "letter categorization" ability, while the other sub-tests seem to be measuring different abilities.

TABLE 21

INTER-CORRELATIONS OF SUB-TESTS WITH TWO SAMPLES (ACHIEVING AND NON-ACHIEVING READERS) COMBINED

	Sub-test 1	Sub-test 2	Sub-test 3	Sub-test 4	Total
Sub-test 1	1.00				
Sub-test 2	0.14	1.0			
Sub-test 3	0.76	0.20	1.0		
Sub-test 4	0.18	0.31	0.24	1.0	
Total	0.45	0.33	0.94*	0.41	1.0

*Significant at the .01 level

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

1. SUMMARY

The main purpose of this study was to investigate the ability of grade one children to categorize alphabetic letter forms as members of a particular graphemic category and examine its relationship to the beginning stages of reading achievement. The children's ability to categorize alphabetic letter forms was assessed by means of an instrument devised by the researcher. The letter forms involved in the test were extracted directly from reading materials at the Grade One level recommended by the Alberta Department of Education for use in Alberta schools.

A sample of grade one readers of at least average I.Q. was chosen with equal distribution over sex and reading ability. The total sample involved groups of forty boys and forty girls.

Two groups of achieving and non-achieving readers were further obtained from the above sample, for the testing of other hypotheses. These groups contained twenty-eight achieving and fifteen non-achieving readers, with ten boys in each group and eighteen achieving and five non-achieving girls respectively.

II. FINDINGS AND CONCLUSIONS

Null Hypothesis 1

There is no significant correlation between scores on the Neale Analysis of Reading Ability and scores on the Letter Categorization Test.

This hypothesis was rejected for reading accuracy scores over the total sample. Further, when the I.Q. factor was partialled out, the correlation between Letter Categorization and reading accuracy remained at the same level of significance ($p < .05$).

In terms of the achieving and non-achieving reading groups this hypothesis was not rejected since none of the correlations reached the .05 level of significance.

This hypothesis was not rejected for the boy and girl groups. While the relationship was significant for boys and girls of the total sample with reading accuracy, it did not exist once the I.Q. factor was removed. When I.Q. was subsequently partialled out, none of the correlations reached the .05 level of significance, for either boys or girls.

Conclusion

The test results suggest that Letter Categorization tended to be highly related to reading accuracy. In view of the nature of the test it would seem that the child's ability to discriminate alphabetic letter forms and categorize or classify these letter forms into certain graphemic

categories is closely related to his ability to read accurately, thus confirming the original research hypothesis. The Letter Categorization Test appeared to have a strong relationship with reading accuracy, even when the I.Q. factor was partialled out. A possible explanation for this could be that the perceptual skills involved in the Letter Categorization Test (e.g. identifying graphemes, matching allographs, categorizing and classifying allographs) are similar to skills involved in the reading accuracy section of the Neale Analysis of Reading Ability, and thus even when the I.Q. factor is partialled out the skills because they are closely related, remain to give this strong relationship.

Null Hypothesis 2

> There is no significant difference between the scores obtained by achieving and non-achieving readers on the Letter Categorization Test.

This hypothesis was rejected since the analysis of variance indicated that the achieving and non-achieving reading groups differed significantly in their Letter Categorization scores. A comparison of means revealed that achieving and non-achieving groups differed significantly ($p < .01$) on their Letter Categorization scores. Further, using the Welch 'T' prime adjustment of T-Tests for unequal variances to account for the unequal numbers in each group, there continued to exist a significant difference ($p < .01$) between the means of each group.

This hypothesis was rejected for sub-tests 3 and 4 since the analysis of variance indicated that the achieving and non-achieving groups differed significantly over these sub-tests also.

Conclusion

The present data tend to indicate that the ability to categorize alphabetic letter forms appears to be a distinguishing factor in differentiating between achieving and non-achieving readers. These results further suggest that this apparent deficiency in letter categorization ability displayed by the low reading group might be a contributing factor to their lack of reading success.

The present finding lends support to Kress (1955), Braun (1961), Jan-Tausch (1962) and Wickens (1963) and other studies cited in chapter 2. While these studies were concerned mainly with object classification, it appears that this same ability, when transferred to alphabetic letter classification requires the same skill for its mastery.

Thus it would appear that those children who have attained a higher level of reading accuracy would also be more capable of categorizing various alphabetic letter forms as belonging to the same graphemic category. This finding confirms the original research hypothesis indicating that Grade One children who are more successful in reading will be better able to categorize alphabetic letters.

Null Hypothesis 3

There is no significant correlation between scores on the Letter Categorization test and I.Q. scores.

This hypothesis was rejected for I.Q. scores, over the total sample. Statistically significant correlations ($p < .05$) were found to exist between Letter Categorization and I.Q. scores for the total sample. With reference to sub-test 1 and sub-test 4, statistically significant correlations also existed with I.Q. thus adding further support to the original hypothesis.

Conclusion

The data pertaining to Letter Categorization scores and I.Q. seem to suggest that the factor measured by these Letter Categorization Tests generally tends to be more highly related to a general intelligence measure.

It would appear from the above results that theories which contend that categorization ability is related to I.Q. would be supported by the findings of this study.

Null Hypothesis 4

> There is no significant difference between the scores obtained by boys and girls on the Letter Categorization Test.

This hypothesis was not rejected for scores obtained by boys and girls. A one-way analysis of variance which compared the means for these two groups of readers on scores on the Letter Categorization Test indicated no significant difference between boys and girls. This hypothesis was not rejected with reference to the various sub-tests of the

Letter Categorization Test, since scores for boys and girls were not significantly different over any sub-tests.

Conclusion

The results show that there was no difference between the mean scores obtained by boys and girls on the Letter Categorization Test. Research Hypothesis 4 was refuted by this finding, thus indiciating that girls in grade one are no better able to categorize alphabetic letters than boys.

Theories which propose that sex is an important factor in classification have not been supported by this study. Sex as a variable, may have value in categorization situations other than those used in this study.

LIMITATIONS OF THE STUDY

In addition to those limitations already outlined in Chapter I, the following factors became apparent to the researcher during the period of this study. These factors may tend to limit the generalizability and applicability of the findings.

1. The average I.Q. for the total group ($\bar{x}$ = 113 was approximately thirteen points above the normative mean. Therefore, the sample involved in the present study may possibly be atypical in their level of general intelligence.

2. During the actual testing, the researcher noticed that some children tended to omit items. In some cases the researcher redirected the child, after having given the required practice items. This departure from the

standard method of test administration may have possibly introduced some bias in the test results.

3. The photographic process used to extract letters from books, sometimes produced unclear letter forms. When these test sheets were duplicated, not every test sheet was identical in clarity. This could also have biased the test results.

4. The use of cursive letters produced conflicting results. They were included in order to measure the extent to which children in grade one were able to identify allographs in cursive form. Depending upon the particular class from which the subject came their ability differed. During the testing session it became obvious that some children had more experience with these forms. Again, this would tend to bias the results.

5. Due to school commitments, the researcher was forced to test several children in the late afternoon, when the attention level of young pupils is known to drop, compared to the morning periods. Because of this time-testing factor children tested during this period, could possibly produce unreliable results. This time factor also could be responsible for a bias in the test results.

6. While item analysis of sub-test 4 was performed to demonstrate adequacy of the test with this particular sample, it is felt nevertheless that this particular sub-test has some serious limitations for future research. The number of distractors included in each item was insufficient to prevent a student from selecting a particular response because it was "different" from the other responses. While an item analysis has shown this test to be adequate it is felt by the researcher that this sub-test may have certain deficiencies when measuring the child's ability to select the choice stimulus in context. Some students may have used other cues in selecting the correct response.

Since sub-test 4 frequently appears in the preceeding chapter as a statistically significant correlational item, the reader is therefore cautioned in drawing any definite conclusions on the basis of these above mentioned facts.

IV. SUGGESTIONS FOR FURTHER RESEARCH

On the basis of the present study, the following areas of research are suggested:

1. A further study may be conducted using Grade 1, 2, and 3. This type of developmental study would possibly reveal if letter categorization ability is effected by age, as suggested in the present study. A study of this type may also show if there is an increase in the mean scores obtained by each successive higher grade in the Letter Categorization Test as suggested by Rystrom (1969).

2. Research might be conducted using both letter categorization and object classification tests. These two types of instruments could be correlated with reading in a manner similar to the present study in order to confirm studies of both type.

3. There is a definite need for the refinement of the letter categorization instrument used in this study. The photographic process seemed to produce unsatisfactory letter prints of the extracted material, and thus the test instrument did not give the appearance of being a neat test. A duplicate study with a refined format would be useful in verifying or disputing the present results.

4. The present study has explored one aspect of concept formation ability (classification of alphabetic letters) and has used one evaluation instrument to do so. A useful study could be conducted employing a battery of classification tests, which might be verbal or non-verbal in nature, to determine which tests or combination of tests provide a comprehensive picture of classification and which is most

effective in predicting reading performance.

5. A further study, more closely involved with reading, in which the reading passages from the Neale Analysis of Reading Ability are typed in different print styles, and used as a measure of reading ability could be helpful in assessing the effect of variations of the print form in an actual reading situation.

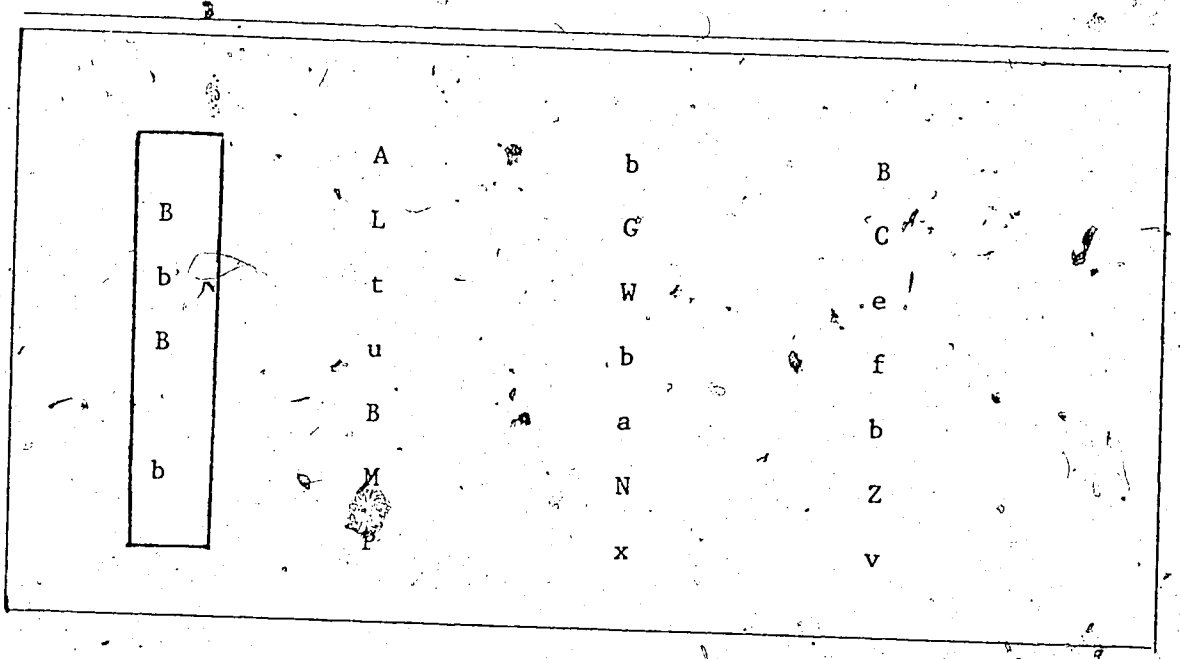
6. A further study may be conducted which looks at the comprehension aspect. The Letter Categorization Test could be correlated to the reading comprehension measure of children, in order to see if the skills involved in letter categorization are related to the comprehension ability of children.

IMPLICATIONS

1. The results of this study suggest that the non-achieving reader differs from the more successful reader in his/her ability to accurately categorize alphabetic letters. Thus, it would seem that those children experiencing difficulty in the categorization of alphabetic letter forms would benefit from training, in such a way that they are required to identify allographs as members of a particular grapheme. They should learn to avoid responding to non-significant features and to distinguish one grapheme from another.

The following illustrates a type of drill exercise

which might be used to accomplish this goal. After a child has been taught to name each of the B graphemes in the box at the side of the sample page, he should be able to identify each B on the page by circling it. Next, he might be taught to circle the B's on a similar page which does not contain the letter cues at the side.



2. Since the results of this study suggest that the non-achieving reader differs from the achieving reader in his/her ability to accurately categorize letters and since this ability was shown to have a significant relationship to reading ability, it suggests that stability of print form could be important for the young child learning to read. This study lends support to the position of Sir Cyril Burt (1959) who suggests that only one single type face

should be used in books printed for young children. It appears that non-achieving readers need much of this stability before they are exposed to other print variations.

3. The results of this study suggest that maybe special drills will need to be constructed for those children who distinguish between significant and non-significant features, but do not distinguish between letters in different spatial orientation.

4. In order to transfer this letter categorization ability to a reading situation, the child may be given a short passage with words containing letters he confuses. He may be instructed to underline these letters with different colors, for example, blue for all b's red for all d's and then read the passage. The purpose of the underlining would be to help focus his attention on those letters he tends to categorize differently.

5. Since the inability to categorize alphabetic letter forms appears to be consistently related to a low level of reading achievement, it could therefore be readily used as a diagnostic instrument by the teacher or reading clinician.

B I B L I O G R A P H Y

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A P P E N D I C E S

APPENDIX A

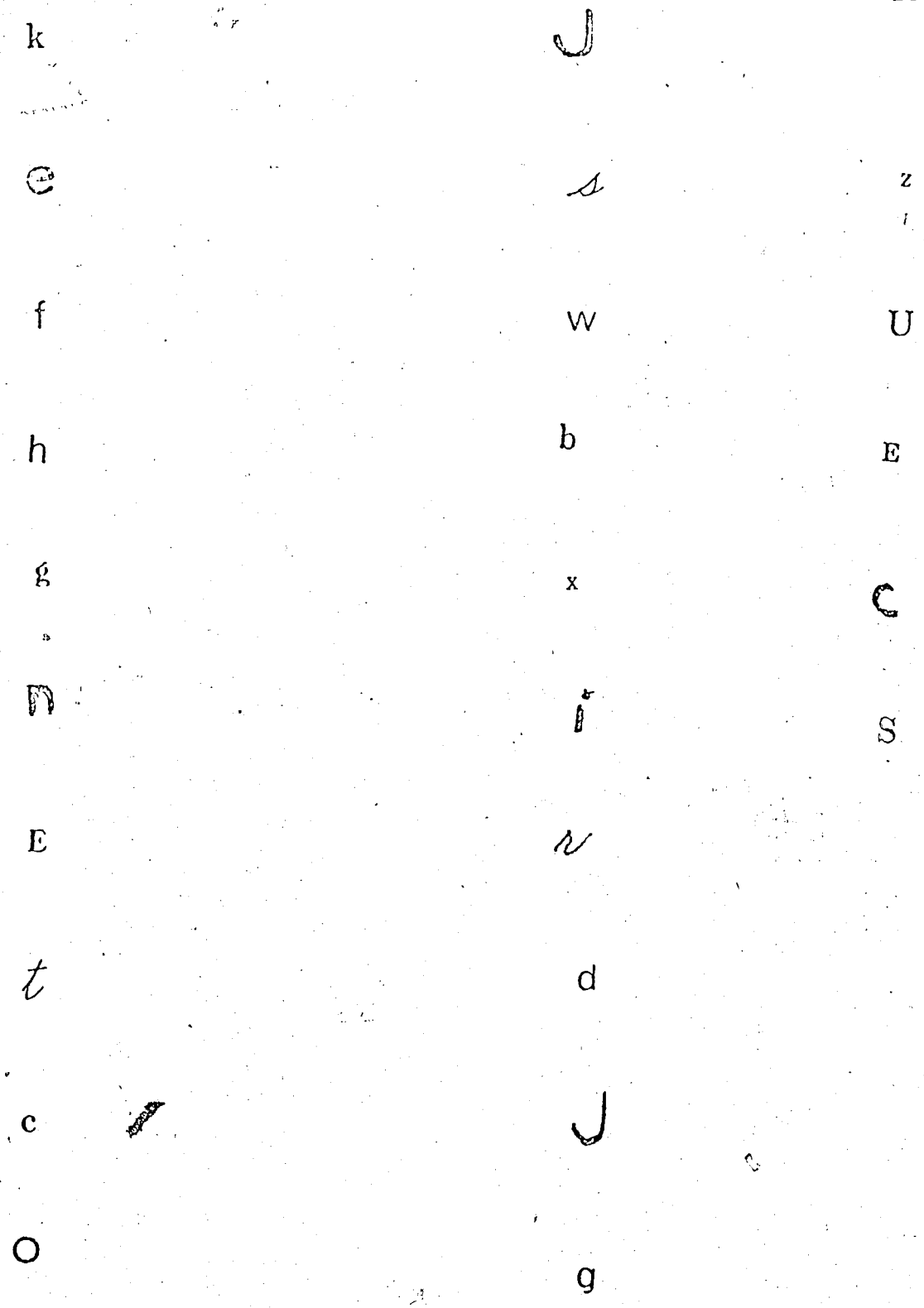
LETTER CATEGORIZATION TEST

DIRECTIONS GIVEN TO CHILDREN FOR THE

LETTER CATEGORIZATION TEST

SUB-TEST 1

I am going to point to each letter on this page and when I do, I want you to tell me the name of the letter.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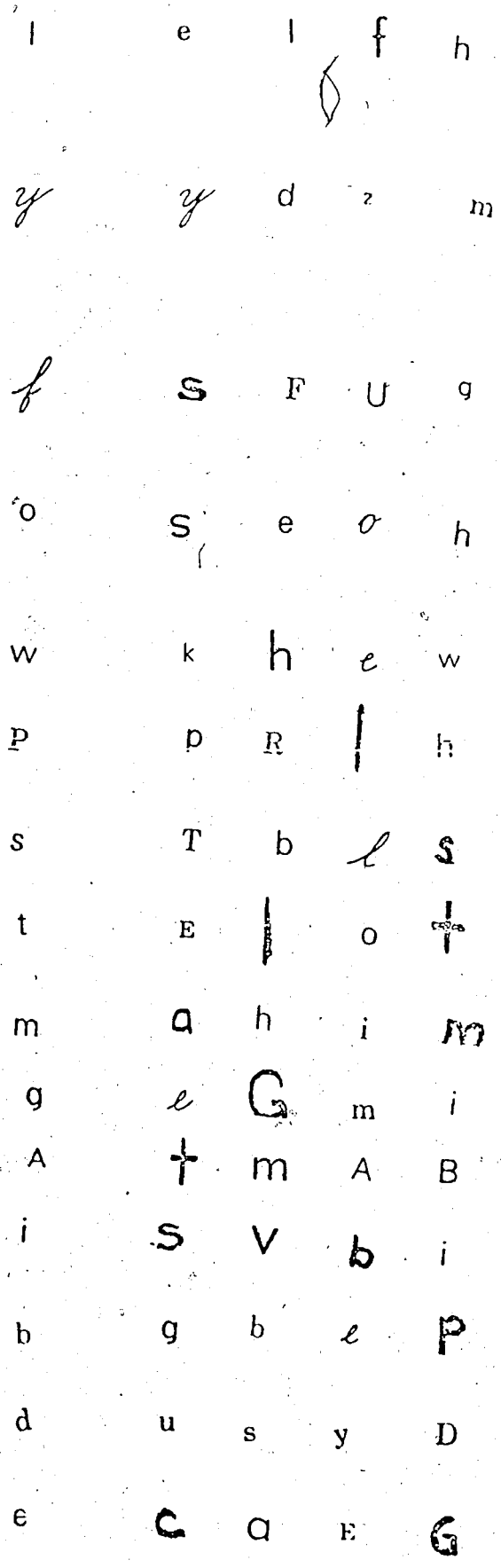
DIRECTIONS GIVEN TO CHILDREN FOR THE LETTER CATEGORIZATION TEST

SUB-TEST 2

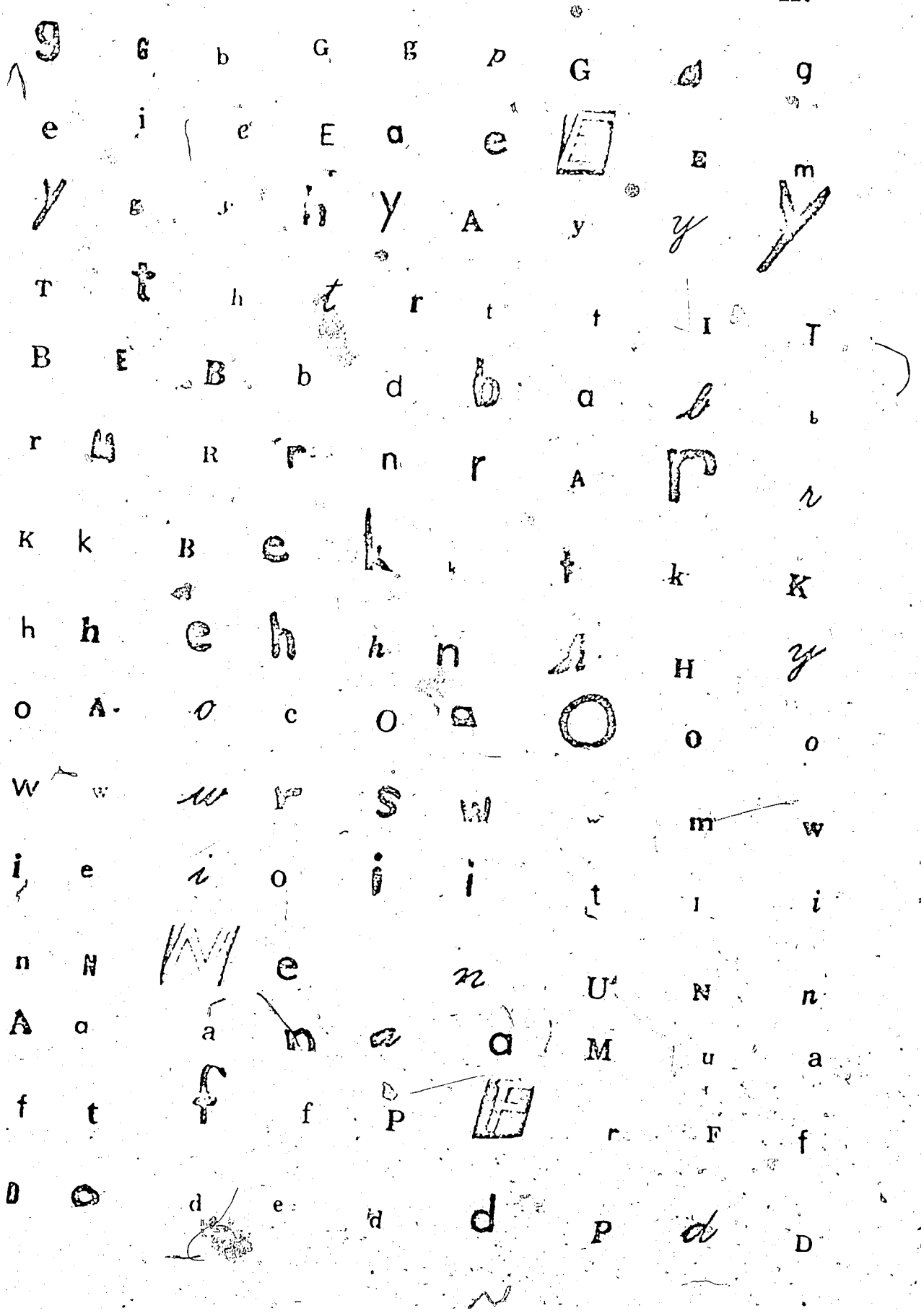
Put your finger on the first letter and find another letter along the line that is the same letter even though it may not look the same. When you find it put a circle around it.



DIRECTIONS GIVEN TO CHILDREN FOR THE LETTER CATEGORIZATION TEST

SUB-TEST 3

Put your finger on the first letter, then look along the line and find any other letters that are the same letter, even though they may not look all the same. When you find them, put a circle around each one.



DIRECTIONS GIVEN TO CHILDREN FOR THE LETTER GATEGORIZATION TEST

SUB-TEST 4

Look at the letters in the first word. Then look at the other letters in each of the words along the line. If another word has the same letters in it, draw a circle around it.

lay	lag	lap	Lay
set	sat	set	sit
bed	Bed	bid	bad
lot	lit	lot	lay
How	now	low	how
cat	cut	cat	cot
day	dog	dig	day
well	will	Well	wall
Fun	fan	fin	fun
with	will	with	wilt
some	some	same	sure
bill	bell	Bill	dill
long	like	late	long
road	rail	road	rate
begin	Begin	began	begun

DIRECTIONS GIVEN TO CHILDREN FOR THE GATES MCKILLOP READING TEST

When I point to each letter, tell me the name of it.

V-3 Naming capital letters

X	G	O	K	B	I	D	M	T
U	F	W	A	C	H	J	R	N
E	Z	S	Q	L	P	Y	V	

V-4 Naming lower-case letters

o	w	r	a	b	k	e	m	d
y	t	u	x	f	c	i	v	g
h	j	n	q	s	z	l	p	