THE EFFECTIVENESS OF THE USE OF COLOR CUES TO TEACH LOW-ACHIEVING SECOND GRADERS VISUAL DISCRIMINATION IN PAIRED-ASSOCIATE LEARNING OF PREVIOUSLY ENCOUNTERED SIGHT-VOCABULARY WORDS

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This is to certify that the

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ABSTRACT

THE EFFECTIVENESS OF THE USE OF COLOR CUES TO TEACH LOW-ACHIEVING SECOND GRADERS VISUAL DISCRIMINATION IN PAIRED-ASSOCIATE LEARNING OF PREVIOUSLY ENCOUNTERED SIGHT-VOCABULARY WORDS

By

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Problem

This study was designed to determine the effect of color as a facilitator of visual discrimination on paired-associate learning. Specifically, the purpose of the study was to determine which of three treatments, maximum color, vanishing color, or no color, was more effective in visual discrimination training when a single color was used as a cue on a variety of stimuli. It was felt that the use of a single color might eliminate the problems previously associated with the use of multiple color cues while still focusing the subject's attention on the distinctive features of the stimuli.

Procedure

The population for the study included students from 15 schools in one school district, who were identified by classroom teachers and reading specialists as having difficulty in word recognition. A random sample

was taken to generate three groups of 40 second graders for each treatment.

An instructional episode which consisted of 12 pairs of words on which some children often make "static" and "kinetic" reversals was developed employing three sets of 120 cue cards for each treatment. Verbal directions for each group remained the same throughout the treatments. The only source of variation was the method of color highlighting applied to the stimulus word.

Each subject was taken through an instructional episode individually. Three posttests--Naming, Pairs, and Match to Form from Memory--were administered upon completion of the instruction.

Results

The data collected were analyzed using a two-way multivariate analysis of variance. A treatment main effect of .05 level of significance was revealed.

The univariate F-test was employed to specify on which dependent variable the treatment main effect was found to be significant. It was established that all three dependent variables were influenced by the treatment main effect. The univariate F-tests were found to be significant at the .01 level.

Four post-hoc contrasts were constructed to find where the significant differences existed among the three

groups. As a result of using the t-test to test the contrasts on the three dependent variables at the .01 level, vanishing color was found to be significant on the three variables.

Significantly better ($p < .05$) achievement was found on the three tasks favoring the vanished color treatment over the maximum color and no color treatments.

Conclusions

Within the limitations of the study, the investigator concluded that children who receive instruction that utilizes vanishing color cues learn the tasks of visual discrimination, visual memory, and association of a verbal response at a significantly higher level of achievement than children who receive instruction with maximum color cues and no color cues.

Finally, it can be concluded that the use of vanishing color cues serves to focus attention on the distinctive features of the words to be learned without producing interference at transfer.

Implications

Teachers of reading should consider the use of vanishing hue color cues to assist children with the following tasks: (1) learning to visually discriminate between words that are confusing, (2) learning to visually discriminate between words that have all or

many common letters, and (3) learning words that contain letters that are rotations of each other.

Research should be undertaken in a school setting using materials that employ the vanishing hue color technique for one group and materials with no color for one group for a specified period of time. Comparison of the achievement of the two groups would provide information concerning the relative potency of the vanished color cues.

Finally, publishers may wish to consider using the technique with beginning reading materials.

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Alberta W. Sims

A DISSERTATION

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Dedicated to my son,

Mathew Abrams, Jr., M.D.,

who made me aware of the need

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CHAPTER I

INTRODUCTION

Reading is a concept that seems to defy universal definition. This phenomenon is brought about because of the number of aspects involved in the reading process and the lack of agreement among educators and researchers as to what those aspects are. There is also much theory explaining how this process actually takes place. However, most tend to agree that reading involves a process of interaction with visual stimuli in terms of what is known from the reader's experience and what the writer is conveying on the printed page. In other words, the reader must have experiences that can be utilized in his reaction to what the author is saying. Therefore, reading is a process of encoding, decoding, and recoding of information.

During this information processing the child is taught to pair the correct spoken word with its printed counterpart. When he has done this he has learned an association. The accumulation of these associations creates a sight vocabulary. An adequate sight vocabulary is necessary if he is to become a good reader.

A primary problem in teaching sight words to some beginning readers is grasping the significance of the spelling code. This code is complex and built on the assumption that no two words in English will be spelled alike. Every word, whatever its length, will have significant discriminations--letter differences--either within word portions or inclusions. To help a child discover this insight is a major portion of a teacher's responsibility in beginning reading. Teaching techniques seem minimal for this important training.

Background of the Problem

The terms "kinetic" and "static" were coined by Orton (1937) to describe the reversal errors experienced by children in their early reading behavior.

Many theories have been advanced by researchers as explanations for these reversal problems. However, two seem most prevalent: (1) immaturity of the learner or (2) a lack of training in visual discrimination. It appears that children who are making reversals because of maturation and developmental factors experience minimal difficulty in making progress in school because of the nature of reversal tendencies for this group. The tendency to make reversals seems to fluctuate in that they are not always present.

However, for that group of children who are making reversals because of a lack of visual discrimination training or code insight, profound difficulties can develop. The deficiencies caused by word reversals will often result in low reading achievement and an avoidance of reading or participation in any activity which is related to it.

Importance of the Study

Because of the difficulty experienced by a large segment of children learning to read with word reversals or confusing similar words, many learners are not able to perform the reading act with proficiency and teachers are not certain about how to provide the necessary remediation. Therefore, many of these learners lose efficiency and motivation because of this deficiency even though they have the necessary cognitive ability for performing the reading task. This research hopefully will provide information as to whether two types of reading problems, kinetic or static reversals (Orton, 1937), will respond to instruction and whether the same type of instruction or a differential treatment is necessary for each of these discrimination problems.

Purpose of the Study

It can be postulated that the use of color cues will be of benefit to those students identified as

low-achieving readers if a major problem is the lack of mature discrimination skills. Thus the purpose of this study is to analyze the effect of a single-hue color cue in assisting children experiencing difficulty with these tasks. Specifically, the purpose of this study is to identify whether maximum color treatment, vanishing color treatment, or no color treatment is more effective in visual discrimination training and to determine the effects of selective cueing of significant letter discrimination as an aid to accurate recognition of confused words.

Statement of the Problem

The research described here was an investigation of the following questions: Will there be a significant difference in the performance of children using color cues or no color treatment on the discrimination of words previously encountered as sight words when presented visually? Will there be a significant difference in the performance of boys and the performance of girls in the use of color cues or no color treatment on the discrimination of words previously encountered as sight vocabulary? Will there be a significant interaction in the performance of boys and the performance of girls on sight words previously encountered whether presented with color cues or no color treatment? To answer these

questions, hypotheses were formulated, a population for research identified, and a methodology was selected, using an instrument developed by the investigator.

Definition of Terms

The following definitions are to be used when reference is made to any of the terms below:

Matching to Form From Memory: The subject selects a word from a group of four words from a test sheet that has been presented to him in a ½-second flash.

Naming: The student makes the appropriate verbal response to a word presented to him on a card.

Pairs: The student makes the appropriate verbal response to pairs of words which are easily confused.

Discrimination: The student is able to tell the difference between two easily confused words or letters.

Vanishing: A method of removing a visual prompt; specifically, removing the color highlighting by gradually reducing the area of color until no color remains.

Association: When the child can pair the correct sound (spoken word) with the correct signal (printed word), he has learned an association.

Stimulus: In this study stimulus refers to the words; the prompting stimuli are the color highlights added to letters in the words.

Strephosymbolia: A delay or difficulty in learning to read which is out of harmony with a child's general intellectual ability. At the outset it is characterized by confusion between similarly formed but oppositely oriented letters, and a tendency to a changing order of direction in reading.

Kinetic Reversals: Sequential reversal of letter order, confusion or misreading a series of letters or words in which a progressional element enters, as when a whole word is used backwards, or a transposition of letters in a word is made (ex. was, saw).

Static Reversals: Orientational reversal of letter form. Confusion or mistakes in recognition of single letters which are alike except for their orientation. It is characterized by an interchange or reversal of form (ex. "iorn" for "iron," "boy" for "dog").

Highlighting: Method of adding color to the stimulus word.

Population and Sample

The population under investigation comprised those elementary school children in second grade who were identified by their teachers as readers who were confusing words. All second grade children in the Lansing school district who were making reversals, transpositions of letters, rotation of letters, and confusing

words in context or isolation were eligible for the study. The racial and socioeconomic composition of the group was nonspecific. Fifteen elementary schools were randomly selected from a list of 20 schools to participate in the study.

The sample consisted of 174 students from the Lansing, Michigan, school district. From this sample 120 children were randomly selected to participate in the study. The 120 children were randomly assigned to one of three treatment groups. Each group contained 20 boys and 20 girls. An instructional episode was developed in which only the visual stimulus varied in three treatments. Treatment 1 consisted of maximum color highlights added to and continued until transfer; treatment 2 consisted of maximum color highlights which were added and then vanished prior to transfer; treatment 3 had no color highlights added. Upon completion of the instructional episode each child was post-tested for three tasks: naming task consisted of the ability to name correctly the 24 words taught by the investigator, match to form from memory consisted of the child's being able to match the word presented in a ½-second flash presentation to the word like it from a list of four similar words, and naming word pairs consisted of identifying correctly each set of paired words.

The results for all treatment groups were analyzed to determine whether color, color with fading, or no color at all were effective as techniques in teaching sight words to children who were making reversals, rotations, transpositions, and confusing words.

Hypotheses

The results for the effect of all treatment groups--(1) maximum color, (2) vanishing color, and (3) no color--will be analyzed to determine whether the following null hypotheses are to be rejected. The control limit for the probability is set at $p < .05$.

Ho_1: There will be no significant difference among three methods of teaching word discrimination on a 12-item Match to Form From Memory posttest.

Ho_2: There will be no significant difference between boys and girls in learning word discrimination as measured by a 12-item Match to Form From Memory posttest.

Ho_3: There will be no significant interaction between sex and treatment on the learning of word discrimination as measured by a 12-item Match to Form From Memory posttest.

Ho_4: There will be no significant difference among three methods of teaching word discrimination on a 24-item Naming posttest.

Ho_5: There will be no significant difference between boys and girls in learning word discrimination as measured by a 24-item Naming posttest.

Ho_6: There will be no significant interaction between sex and treatment on the learning of word discrimination as measured by a 24-item Naming posttest.

Ho_7: There will be no significant difference among three methods of teaching word discrimination as measured by a 12-item paired word Naming posttest.

Ho_8: There will be no significant difference between boys and girls in learning word discrimination as measured by a 12-item paired word Naming posttest.

Ho_9: There will be no significant interaction between sex and treatment on the learning of word discrimination by a 12-item paired word Naming posttest.

Limitations of the Study

The following limitations are noted in regard to the study: The study is limited to the tasks under investigation or similar tasks; the study is further limited to situations in which similar materials and environments are employed, and finally, the study is limited to populations that are similar in requirements for inclusion in this study.

Organization of the Remainder of the Dissertation

Chapter II will present a review of pertinent literature. Particular emphasis will be on the role of color in learning and specifically in discrimination and paired-associate learning.

Chapter III will contain a description of all materials and procedures employed in this study. The design of the study will be presented in detail.

Chapter IV will include presentation of the data collected, treated, and analyzed for the study.

Chapter V will provide a summary of the study and appropriate conclusions. Implications of this study and suggestions for future research are also included.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The review of literature is organized under three major headings. These are (1) word recognition, (2) word reversals and confusions, and (3) color as an aid to visual discrimination training. Research findings in these areas provide the basis for the research questions and hypotheses of this study.

Word Recognition

The Place of Word Recognition in Reading

Reading is a process that involves reacting to printed symbols. Words and their immediate context are symbols in that they stand for or represent concepts. Prevalent reading theories suggest that specific skills are required in order to be able to read. A primary skill in learning to read is the acquisition of an adequate sight vocabulary.

According to Samuels (1970), "whatever one's ultimate definition or criterion of reading may be, word recognition must be included as one of the primary and major component skills."

Carroll (1968) described the reading process as one of recognition of words by a procession of rapid fixations which merge together with material recognized in such a way as to build up an impression of a meaningful message. The components for learning to read include recognition of printed words from whatever cues can be used--total configuration, the letters composing them, the sounds represented by those letters, and/or the meanings suggested by the context.

Travers (1975) conducted research on a new theory of word recognition which holds that word recognition is accomplished by filtering visual feature information from the printed word through a hierarchy of letter, letter-cluster, and word detectors. Of the studies conducted, two studies demonstrated that skilled readers draw visual information from all the letters in a word at once, rather than from one letter at a time; and that statistical co-occurrence of letter sequences affects the perceptibility of those sequences, independent of their pronouncability. This information appears to support in part the observations made by Carroll.

Goodman, Burke (1973) defined reading as a process in which written language conveys meaning between writer and reader. The reader uses graphic, syntactic, and semantic cues to get to the message. In this

definition and letter combinations graphic refers to the letters of which words are composed, it would appear then that theories as diverse as those coming from reading researchers to psychologists include the recognition of visual graphmic components as an integral part of the reading act.

Characteristics of the Word Recognition Process

Marzano and Distefano (1975) indicated that the whole-word characteristics are strong predictors of recognition difficulty at all levels; sound symbol characteristics are significant predictors up to the fourth grade. This was interpreted as evidence that beginning readers use sound symbol and whole-word cues but gradually become less reliant on sound symbol information. In an effort to increase the predictable variance in word recognition difficulty, another predictor (previous exposure to a word) was experimentally entered into the regression equation. It was found that exposure to a word was the strongest predictor of word recognition.

This conclusion is in contrast with research reported by Bond and Dykstra (1967), who stated that the child's ability to name letters is one of the best predictors of beginning reading performance. A study by DeHirsch, Jansky, and Langford (1966) yielded similar results.

However, that letter-naming is a valid predictor is not without controversy. Samuels (1969) differed with the import assigned to letter-naming and argued instead that knowledge of letter sounds is the more relevant variable. Research by Ohnmacht (Samuels, 1969) demonstrated that letter-trained subjects performed no better on transfer tasks than control subjects and that the letter- and sound-trained group performed significantly better than either group. Johnson (1970) and Samuels (1970) both reported the relativeness of letter-naming knowledge on transfer tasks. Knowledge of both letter names and letter sounds appears to be indispensable for further acquisition and development of hierarchical word recognition skills.

According to Gibson (1962), identifying graphemes and letters accurately involves a process of focusing on critical features or dimensions of differences. In a study using letter-like forms, Gibson showed that normal children between four and eight years old learn something which may make possible better discrimination of letters. She analyzed the visual characteristics of actual letters (printed capitals, upper case) in terms of the number of strokes, straight versus curved lines, angles,

open versus closed forms, etc. This analysis provided a set of characteristics or rules on the basis of which one could generate artificial graphemes that follow these rules. Twelve such artificial graphemes were constructed according to the same constraints which appear in printed capitals. From these standards, four types of transformations--line to curve or curve to line, rotation reversals, perspective transformations, and topological or close and break transformations--were constructed for each standard form. Subjects' errors were classified according to the kind of transformation mistakenly matched with the standard.

Gibson found that errors decreased with age but that more errors were made on some transformations than others. Errors were greatest among four-year-olds; even though there was a slight decrease with age, they remained high across all grade levels. The other three transformations showed significant decreases in errors with age, so that eight-year-olds made few errors.

Thus, certain kinds of transformations in letters seem to become more distinctive as children grow older, allowing them to discriminate among letter forms with increasing accuracy. Perspective transformations, on the other hand, are not distinctive, and must be tolerated in order to discriminate letters which appear at different angles of sight. Gibson concluded,

> . . . It is the distinctive features of grapheme patterns which are responded to in the discrimination of letter-like forms. The improvement in such discrimination from four to eight (in normal children) is the result of learning to detect these invariants and becoming sensitive to them.

Reading specialists and psychologists have been interested in whether words are processed letter by letter or in larger units. Research by Williams (1970) in which strategies children use when they recognize words was explored. To measure the effectiveness of two different methods of training children to attend to the critical features of letters, first grade urban children were presented two pairs of letters (similar and dissimilar) simultaneously or successively. It was found that with highly similar stimuli the successive problem was less difficult than the simultaneous problem; while with dissimilar stimuli the successive presentation was more difficult. On the basis of this finding, a more complex experiment was designed which combined highly similar letters into trigrams. Similar results were obtained as in the first experiment. From two additional studies it was found that children with some reading training used the initial and then the final letter of a word as the most important cues in word recognition. A study of the cues used by young children in identifying a word aurally revealed that the final and the initial consonant syllables were chosen more

frequently than any of the given five cues. This study indicates that visual word recognition experimental techniques are feasible in studying aural modality. Kuenne and Williams (1972) further supported the above findings in a study conducted to investigate a series of hypothesized cues using aural stimuli (nonsense syllable trigrams) by adapting to the oral mode an experimental technique used successfully in visual word recognition studies. It was found that: (1) children in visually discriminating between two similar-looking words of one syllable tend to use the initial grapheme, (2) in aurally discriminating between two similar-sounding one-syllable words, children tend to use the final segment or rhyme, (3) the first unit of recognition used visually is the single-letter segment, and (4) the unit of recognition used aurally is a two-phoneme segment made up of a vowel and consonant combination.

Instructional Techniques Used in Word Recognition Discrimination Training

It has not been determined whether the kinds of discrimination skills described by Gibson are important for more complex reading requirements like word recognition. Vernon (1957) has indicated that children who have reading problems show perceptual difficulty in their inability to recognize significant details, distinguish

one letter from another, and have confusion about the direction of letters and words. Frostig (1964) postulated that:

> (a) children who could not recognize words often had disturbances in figure-ground perception, (b) children who had difficulty in recognizing a letter when written in different sizes or colors had poor form constancy, and (c) children who had rotations or reversals indicated difficulty in perceiving position in space.

But Gibson has shown that as children grow older errors of this type seem to disappear. In order to find out if this finding was agreeable with those of reading experts, Ash and Buckland (1974) conducted a study to investigate the visual discrimination abilities of children who varied in their ability to recognize letters and words. Word recognition skill was selected as the variable to be related to visual discrimination performance because it is a fundamental reading behavior that is not confounded with other, more cognitive reading skills.

Three important questions were posed by this study. First, what is the overall relation between grapheme discrimination skills and word recognition ability? Second, do qualitative differences in grapheme discrimination exist between children of varying word recognition skills; do they make the same kinds of errors? Third, do the relations between grapheme

discrimination skills and word recognition ability vary with age?

First, second, and third graders were the subjects used in the study. Measures of word recognition and intelligence were obtained on 87 children. All subjects then performed a visual discrimination task that uses artificial graphemes as stimuli. The task required subjects to match the standard grapheme with an identical form. Errors on this task were classified into six categories. A two-way multivariate analysis of covariance was performed. In the analysis intelligence test scores were covaried. The main effect for grade was significant, while neither word recognition skill nor grade x word recognition skill interaction approached significance. The procedure used by Gibson was replicated.

> Conclusions of the researchers are: visual discrimination skills of the type needed to discriminate between artificial graphemes do not seem essential for the word recognition aspect of reading. Apparently the time and expense currently devoted to visual training in the school should be re-evaluated especially if the purpose of such training is to enhance letter and word recognition abilities.

In a recent review of the literature relating visual perceptual abilities to school learning, Larsen and Hammill (1974) discovered that in the vast majority of such studies IQ was inadequately controlled. Analysis of the present data without using IQ as a covariate

obtained large significant relations between word recognition ability and visual discrimination skills. However, when the results of IQ variation were controlled, no relation was obtained. This result carries with it some important implications for public school personnel who are engaged in the diagnosis of learning difficulties. The efficacy of placing children in special learning environments designed to improve alleged visual perceptual deficits is called to question. Considering the outcomes of the Larsen and Hammill review and the present study, one can conclude that visual skills are not independently related to achievement, but rather are confounded with other more global measures like IQ.

Jansen (1972) reported research on the effects of visual and auditory perceptual aptitudes and letter discrimination pretraining on word recognition in which alternate methods were used with 70 kindergarten children. The children were trained to recognize eight printed words in a vocabulary list by a mixed-list, paired-associate method. Four of the stimulus words had visual response choices (pictures) and four had auditory response choices (spoken). Both methods involved a memory component; the stimulus and two response choices were presented sequentially. Method of instruction was also varied by two types of letter discrimination pretraining in which response choices were

presented auditorily. The predictive measure of visual perception was the Frostig Developmental Test of Visual Perception, and the measure of auditory perception was a composite of the Memory subtest of the Test of Auditory Perception and the Sentences subtest of the Weschler preschool scale of intelligence. The results indicated that three of the four predicted interactions between measures of perceptual ability and method of letter discrimination pretraining were not significant. One significant interaction was between visual perceptual ability and method of pretraining.

In contrast, Venezky (1971) questioned the assumption that the learning of letter names in their proper sequence is a prerequisite for literacy. There is disagreement over the value of early letter-name training. It is variously said to aid in letter or word discrimination, to aid in attaching sounds to letters, and to interfere with both of these tasks. An analysis of the letter names and of experimental and pedagogical evidence lends little support to the claims of letter-naming benefits. Only 16 English letter names begin with a sound they represent, and of these, seven (the five vowel letters, plus c and q) do not begin with the sound introduced first in most reading programs. In several countries including the

United States, the Soviet Union, and Israel, letter-name knowledge has been found to interfere with learning to attach sounds to letters. But letter-name knowledge has also been shown to be one of the best single predicators of reading success, and no matter what can or cannot be shown experimentally about the utility of letter names, they are efficient labels for the letters and an inseparable element in the popular concept of reading instruction. Assuming that letter names are an aid to word recognition, success in early reading, it becomes necessary to study how children are taught or how they learn letter names.

Gibson (1970) reported research in which children given a stylus that leaves a trace spent significantly more time in voluntary scribbling than children with a nontracing tool. This was interpreted as evidence of visual stimulation as a reinforcer, or source of motivation. Gibson Schapiro, and Yonas (1968) reported that letters are distinguished from one another by virtue of their distinctive patterns. This research yielded data showing the significance for discriminability of dimensions such as verticality, horizontality, diagonality, curvature, openness, or closeness. Gibson concluded that children can discriminate the presence or absence of two specific letters that are pointed out to them (song, ring, team, read, chop, chin) but that this is not the ability that

leads to detecting common spelling patterns among items. Instead, she proposed that a child learns to search for invariant patterns and a discovery of them is necessary for transfer to new problems.

The evidence comes from a series of studies, one of which included a searching set condition in which pairs of words were presented to children, along with instructions that induced a general hint, specific hint, or no hint. The result suggests that it is better to get only a general hint to search for invariant features in a stimulus array than it is to get "specific" help. Lott, Smith, and Cronnell (1968) conducted research that appears to support the notion of search for invariant patterns or regularities.

Visual-Perceptual Problems

To the more recent advocates (Bender, 1957; Frostig, 1967; Anapolle, 1967; Cruickshank, 1972), visual perceptual problems have been trumpeted as a primary source of difficulties in learning to read. The perceptual deficit hypothesis operates under the assumption that reading disability is a resulting effect of inaccurate perception of letters and words.

In contrast, research by Vellutino, Stegar and Kandel (1972) and Vellutino, Smith, Stegar and Kaman

(1974) was conducted in two experiments that indicate disabled readers accurately perceive letters, symbols, and words, but incorrectly label them because of difficulty in making verbal associations. Subjects ranged from second to eighth grades. Poor readers achieved better performance in visual recall of words presented tachistoscopically than they did in pronouncing those same words. Their performance was similar when they were required to graphically reproduce the stimuli. This was possible even though they had a large number of spatial and sequential errors in oral reading of the stimuli (ex. was/saw, bin/din, cob/cod, lion/loin, snug/sung).

Allington et al. (1975) conducted a study to further examine the hypothesis that a perceptual deficit is not the major difficulty for poor readers. Poor and normal third graders were presented with high-frequency, low-discriminability words in four varying perceptual tasks. It was predicted that poor and normal readers would differ significantly in their ability to read tachistoscopically presented words in isolation but that their achievement would not differ significantly on the remaining tasks. An analysis of the results suggests that (1) poor readers have developed the ability to identify and match the necessary distinctive features, whatever they may be, for successful completion of this

task; (2) reading disability cannot be attributed to a deficiency in visual memory; and (3) a perceptual deficit cannot adequately explain reading disability.

Lahey et al. (1975) questioned the effectiveness and appropriateness of perceptual training programs. They proposed the following questions: (1) Can visual perception be trained at all? and (2) What success have we had in such projects? Perceptual motor training programs emanate from the overtly expressed or covertly implied assumption that perception à la Frostig, Getman, Garsch, etc. can be developed or remediated. But this belief is by no means conclusively demonstrated by empirical research.

This study considers the problem of training perceptual skills in young children. However, it approaches this problem from a behavioral point of view rather than from the point of view of traditional perceptual-training programs. The study attempted to isolate a single academically relevant behavior and directly modify it rather than attempting to deal with the problem indirectly through the underlying process of perception.

In Experiment I 40 Ss from Head Start preschools, private preschools, and children enrolled in a county-wide summer remedial reading program who had completed the first, second, and third grades were studied. At the

elementary levels these children were selected by their teachers as being the poorest readers in each school in a predominantly rural Florida county.

The test consisted of 50 match-to-sample items made up of a sample letter and six choice letters:

c	I
iocmly	SDRBTI

The items were printed 10 to a page in standard type. Subjects were given repeated simple directions and additional help if the experimenter observed that a subject was not following instructions (no additional help was given to subjects who were simply making incorrect choices; i.e., help was given only to those who were circling every letter, the sample letter, etc.). Therefore, the study dealt with a fundamental aspect of visual discrimination: the discrimination of single letters presented as printing on paper under untimed conditions. In all groups as in previous studies by Gibson, Smythe, Stennett, Hardy, and Wilson, most of the errors involved two letters which differed only in orientation (d and b) or a single feature (l and i).

There is considerable evidence suggesting that good readers differ significantly from poor readers throughout the elementary years on visual discrimination tasks where the stimuli are presented tachistoscopically

for very brief periods of time. The evidence thus suggests that these children may need training in speed of discrimination. These data put into questions theories that assume deficiencies of this type of visual discrimination persist into the elementary grades as a major source of reading difficulties.

Two operant procedures were used in Experiment II, one with and one without a fading technique.

Thirty low-income preschool children were selected for the study. They participated individually in 30-minute sessions for 8 consecutive school days. The Ss were presented with a series of match-to-sample items.

The results of these experiments suggest two things. First, there are large individual differences in the accuracy of letter discriminations among children entering the first grade. Second, these problems in letter discriminations which have proved refractory to traditional interventions can be quickly and effectively modified through operant techniques. Teachers need not and should not wait for changes in an inferred autonomous developmental process (Piaget, 1969). Nor should they wait for the possible neurological or pharmacological interventions. There are two possible explanations for the significant changes in letter discrimination. First these procedures focused directly on changing the

behavior in question instead of attempting to train an inferred "process" of perception. Second, the studies employed the systematic application of operant reinforcement.

Summary

The review of related research in this section has been concerned with word recognition and how it comes about. There is an enormous amount of research on word recognition but there tends to be little agreement as to how this ability is developed. However, all agree that in order to read one must first learn to recognize and distinguish between letters of the alphabet because that is the basis upon which words are formed.

Word Reversal Difficulties

Because of the difficulty experienced by a large segment of the school population with word reversals or confusing similar words, many learners seem never able to perform the reading act effectively. This causes them to lose efficiency and motivation even though they have the ability to perform the reading task. These learners are not able to apply a specific technique of word recognition to their learning style. An individual will never become a good reader who can get meaning from the

printed page until he develops some efficient method for achieving this task.

Interest in reversals of letter order and orientation in reading and writing stems primarily from the work of Orton (1937), who viewed childhood dyslexia as one element of a developmental syndrome that has as its basis an anomaly of cerebral dominance. Orton wished to establish a causal link between two observations in forming this neurological conception of reading disability: first, that children with reading disability tend to have poorly established or unstable lateral preferences, and second that they tend to reverse letters and words in reading and writing. Such difficulties were seen as related to manifestations of a failure of one cerebral hemisphere to become dominant. This conception has been challenged by some workers in the field (Schonell, 1948; Burt, 1950; Vernon, 1960) and supported by others (Zangwill, 1960; Critchley, 1964).

Types of Reading Reversals

The term "reversals" is used to describe a variety of different kinds of errors in orientation. They are among the most troublesome errors made by disabled readers. The problems of full reversals, part reversals, axial rotations of letters, and other orientational confusions in word recognition interfere with

successful reading development. Any child who makes an extreme number of such errors has a limiting condition that must be corrected before continued growth in reading can be expected.

Strephosymbolia, meaning "twisted symbols," is a term used by Orton (1937) to designate the striking tendency to distort order in the recall of letters. He called individuals exhibiting this type of behavior in reading "strephosymbolics."

Confusions of single letters similar in configuration are called static reversal errors. Examples of this type of error include saying pig for dig, bad for pad, but for put, and big for pig. Confusions on b, p, d, and q are most common; n and u are also often confused, the individual saying mouth for month. Static reversals represent reversed or inverted orientation of letters.

Confusions characterized by a reversal of the sequence of letters in a word are called kinetic reversals. Word recognition errors of this type include saying <u>on</u> for <u>no</u>, <u>saw</u> for <u>was</u>, <u>tub</u> for <u>but</u>, <u>dab</u> for <u>bad</u>, and <u>god</u> for <u>dog</u>. In other words, a right to left sequence is used for the reversible words. Kinetic reversals, static reversals, and transposition of words in a sentence are sometimes associated with facility in mirror reading. Reversals are not the commonest types

of errors in word recognition, as they are found among the errors of only about one out of ten reading disability cases. However, they are very significant and deserve careful analysis and treatment when they persist.

Perhaps reversals are very prevalent in young children beginning to read because they have learned to recognize people, animals, landscapes, and objects both from first-hand visual experience and from viewing pictures and diagrams. From these experiences they tend to think that the difference in position of letters such as b and d, or the order of letters in words like was and saw is not important. They generalize that they can recognize letters and words about as well when upside down or sideways as when they are right side up.

Characteristics of Reading Reversals

In a study of reversal tendencies in reading, Gates and Bennett (1933) concluded that known visual defects existed with twice the frequency in the reversals as in the nonreversals group. Further study of the degree and type of visual defects of such pupils is indicated as a promising means of revealing causes of reversal tendency. Indeed, considering merely these base data, it would appear that visual defects of some sort are the most conspicuous characteristic of the

reversal group thus far. These findings were corroborated in a study by Hildreth (1933), which indicated that defective vision may be a contributing factor in reading disability, both on account of distortion or vagueness of visually perceived word and letter forms, as well as tension, fatigue, strain, or nervousness resulting from compensatory effort.

Barger (1953) recently reported some spectacular results in remedial reading with children showing strong reversal tendencies, by having them read materials by looking into a mirror that reverses the material both vertically and horizontally. He believed that this corrects a functional neurological peculiarity that causes these children to see the print normally. Leavell (1955) developed a method of overcoming directional confusions in cases of crossed dominance by training the nondominant eye to coordinate with the dominant hand.

Blau (1945) attempted to show that left-sidedness in general is a form of neurotic negativism or defiance. While as a general explanation of left-sidedness his theory seems farfetched, it may very well apply to a few cases. Parks (1953) reported two cases in which a strong directional confusion in reading seemed to be a disguised form of negativism. This information lends credence at least in part to Blau's theory.

Rubenstein (1975) conducted a study to investigate the effects on oral reversals of various contextual conditions ranging from no context to highly predictable contexts among white, middle-class male first graders. It was hypothesized that increasing the predictability of a reversible word by manipulating contextual conditions would result in a decrease in reversals.

The rationale for the study was provided by Shannon's (1948) theory of communication, which enunciated the mathematical concept of redundancy. Smith (1971) and Weaver (1963) have attempted to apply redundancy to the reading process. The present study was designed to demonstrate the relationship between language redundancy and reversals in a beginning reading population to suggest an alternate to the organismic view posited by Orton (1937).

A list of 11 reversible words was derived from a pilot study that was devised to determine the ambiguity of potentially reversible words. The resultant Contextual Reversals Test consisted of four "conditions" ranging from low redundancy to high redundancy. The conditions were: (1) Reversible Word in Isolation, (2) Reversible Word in a Semantically Ambiguous Sentence, (3) Reversible Word in a Semantically Ambiguous Embedded Paragraph, and (4) Reversible Word in a Semantically Unambiguous Sentence.

Reversible words were held constant across all conditions. Condition I consisted of reversible words in isolation; Condition II of the same reversible words in ambiguous sentences; Condition III of the same sentences from Condition II embedded in paragraphs designed to increase redundancy; and Condition IV of the reversible words embedded in unambiguous sentences.

The results demonstrated that as redundancy increased, reversal frequencies declined in the average reading population used in the study. It was concluded that the manipulation of contexts with varying amounts of redundancy would have an effect on reversal tendencies among beginning readers, within the limitations of the study as a remedial as well as a preventative procedure.

The study also demonstrated a practical reading application of Shannon's (1948) theory of communication by showing the extent to which the processing of redundant information enabled subjects to choose the correct form of a reversible word. In addition, Smith's (1971) assertion that as redundant context increases, readers use less visual information, was supported; and his theory was extended downward to include the immature readers as well. Finally, this study suggested that beginning readers do use bilaterial context while reading, an implication contrary to Weaver's conclusions.

Liberman (1971) conducted a study of letter confusions and reversals of sequence in the beginning reader. The subjects for the study consisted of 18 children selected from the second grade of an elementary school system. The purpose of the study was to provide a more systematic approach to the questions of relationship of sequence and orientation reversals to each other and to different aspects of reading mastery as well as the nature of the general error pattern in the disabled reader. The subjects were given a list of 60 real-word monosyllables including a group of primer-level sight words, a group of nonsight words, and word-forming reversals of both types of words, where such were possible.

Responses were recorded on tape as well as being transcribed during administration, to check on the accuracy of transcription. Each child's responses were analyzed for reversals of sequence and of orientation, for consonant and vowel errors, and for total errors.

The word list was administered twice to each subject--once at the end of the school year and again in the first week of the following school year. Data from the two presentations were combined in scoring the responses of each subject, but were available separately for assessment of test-retest reliability. The following testing procedures were used:

Gray-Oral Reading Test, Form A. Administered by standardized procedure. Raw paragraph scores based on Gray's system of weighting time and number of errors were used to evaluate the subject's performance, rather than grade-level equivalents.

Single-Letter Presentation (Tach) List of 100 items in which a given letter was to be matched to one of a group of five including four reversible letters in manuscript form (b,d,p,q) and one nonreversible letter (e) that was added as a reliability check. There were 20 such items for each letter. The order of the 100 items was randomized as was the order of the multiple choice sequence for each item on the answer sheet. A brief training session was provided for each child.

The results revealed that for most of the children reversals accounted for only a rather small proportion of the total of misread letters; thus only some poor readers reverse. Certainly it is important to explore the other differences among children who do and do not make reversals of sequence and orientation. It may be that reversals loom larger in importance in certain children with particularly severe and persisting reading difficulty.

Examination of the interrelations among various reading errors showed that the two types of reversals

are wholly uncorrelated. This is a finding of considerable interest since both were considered by Orton and subsequent investigators to be manifestations of an underlying tendency to reverse the direction of the scan. That view cannot easily be reconciled with two additional findings: First, among reversible letters, vertical reversals occurred with as great frequency as horizontal reversals. Second, confusions among reversible letters rarely occurred when these letters were presented singly, even when briefly exposed.

The relationship between both types of reversals and other errors in reading syllables showed individual error rates on vowels and consonants correlated highly with each other.

An analysis of the nature of substitutions among reversible letters (b,d,p,q) showed that the possibility of generating another letter by a simple 180-degree transformation is a relevant factor in producing a relatively high rate of confusion among letters, a finding that is in agreement with conclusions reached by Davidson (1935) and by Gibson and her associates (1962).

Other observations indicated the importance of linguistic determinants: differences in pattern of confusions among b,d,p, and q in real words and nonsense words showed that misperceptions even of reversible letters

are content dependent and not merely an automatic consequence of optical reversibility. Moreover, the substitutions tended to differ from the presented consonant in one phonetic feature. Finally, relatively few confusions of these letters occurred when they were presented in isolation rather than in word context. All of these observations point to the conclusion that the characteristic of reversibility is not by itself a sufficient condition for confusion.

Summary

Research has been done on reading reversals in an attempt to clarify the causes and to develop a method or technique by which they could be eliminated. Attempts have been made to establish whether both types of reversals, kinetic or static, were correlated.

Color as a Cue

Researchers have been interested in the role of color in the general area of learning for a number of years. Therefore a considerable amount of literature exists on the application of color in education. Color has been most commonly used as a contextual cue in a paired-associative learning task in the majority of these studies.

There is a need for a more accurate means of word recognition for some learners, especially those

individuals who are experiencing problems of sequencing and orientation of words and letters associated with reversals. Because of the requirement for clearly discriminated stimulus as a key to accurate word recognition more effective techniques in relation to this need seem to offer an avenue to this need. Vanished hue color cues appear to be a valuable technique for helping the learner focus on the discriminator of words to be learned.

The Use of Color in Paired-Associate Learning

As early as 1926, Pan (1926) had subjects associate names and faces presented on picture postcards and found that they made more recall errors when the postcard backgrounds were different than when they remained the same. However, Dulsky (1935) conducted the most carefully conceived research. By varying the color of the cards on which paired-associates were placed, he found that recall is reduced when the color background present in the learning situation is changed for the retention test. His subjects were presented with pairs of nonsense words on two types of backgrounds. They were classified as (1) homogeneous, that which featured a different color for a pair or the same color for all pairs of words; (2) heterogeneous, that which featured the stimulus half of each word card colored and the response half

gray and vice versa. Three conditions were observed for learning: replication of the learning conditions, interchange of colored backgrounds, and change to all gray backgrounds. Recall was most accurate when the gray stimulus backgrounds and colored response backgrounds remained the same as in the learning trials. The learning colors were changed then when stimulus or total backgrounds were changed.

Weiss and Margolius (1954) conducted research to determine the effectiveness of the retentive support provided by context when the primary stimuli were changed and to determine whether or not the presence of a distinct nondistracting context stimulus would affect the learning of a response. This consideration differs from the above in that it is concerned with the relationship between environmental stimulation in the learning and retention situations. The question now being raised is: Regardless of the condition under which retention will occur, might there be any advantage for learning if certain context stimuli are presented throughout the learning session? Since the learning of complex responses requires a series of trials, it is conceivable, in accord with behavior theory, that the presence of an extraneous stimulus to which a desired response could provoke the arousal of that response in the early trials, before it is strongly associated with the appropriate primary

stimulus. Weiss and Margolius stated the following concerning their findings.

> The research confirms the theoretical prediction that the representation of context stimuli, which had been present consistently while learning was occurring, would aid retention of the learned responses. The retentive support provided associated context stimuli occurs not only when the original primary stimuli are present, but also when generalized primary ones are introduced. Thus the findings of Dulsky are confirmed and extended. . . . Presence of distinct context stimuli facilitates acquisition of the stimulus-response association.

The Weiss and Margolius procedure has served as a model for subsequent research designed to determine the functional component in paired-associate learning.

Underwood et al. (1962) reported that subjects could not recall a list of low-meaning trigrams that had originally been learned on different-colored cards; but, when meaningful words were learned instead of low-meaning trigrams familiar colors became the functional stimuli. But because the adult subjects were more accustomed to responding to words than to colors the familiar words were the functional stimuli.

Hill et al. (1962) felt that the form and color components of a stimulus might summate to evoke a response, whereas either presented singly would not. After speculation they had subjects learn nonsense word/color-common word pairs in a nonanticipation

sequence in which pairs were presented together in learning trials and stimuli were presented alone in the alternate testing trials.

The best results were attained by the subjects who learned the components separately and then responded to a combination in final testing. Because many subjects responded correctly to only one component before a combination was formed, the researchers rejected the summation theory. They concluded that two cues were more helpful than one because each subject was free to choose his functional stimulus.

Experimental research has shown that paired-associate learning could be facilitated by surrounding each verbal stimulus with a different color. Saltz (1963) conducted research designed to determine if such facilitation occurs when the colors cannot readily be used as cues. Critical manipulations involved alternating learning trials and test trials. Availability of color as cues was reduced by presenting them during learning trials but not test trials, or during test trials but not learning trials. The results indicated that color differentiation can significantly facilitate learning even when color cannot readily be used as a cue. Concerning the findings, Saltz commented:

> . . . [The] principal contribution of the present study is that it operationally distinguishes between the effects of cognitive and sensory differentiation and indicates that both may facilitate verbal learning. . . . The greatest amount of facilitation occurred in the color-color condition. . . . Only condition in which color could readily act as a cue. . . . Stimulus selection as well as differentiation acted to facilitate learning. . . . Only one in both cognitive and sensory differentiation operate simultaneously. The possibility remains, therefore, that the superiority of the color-color condition may be accounted for by assuming a simple additive relationship between cognitive and sensory differentiation.

This study indicates that color can facilitate learning even when the color cue is not readily accessible as a cue, depending upon the manipulation of treatments. Whereas, Birnbaum (1966), alternating study and test trials in paired-associate learning, provided secondary color cues on the study trials only. Subjects were presented with 10 consonant-vowel-consonant trigrams (CVC) paired with nonsense syllables, each trigram outlined with distinctive color during the study trials. After intervening tasks, she presented half of her subjects with the same task and the others with the same stimulus-response pairs but different secondary color cues. The latter group did less well on the post-test in spite of the fact that the stimulus-response pairs were unchanged. This is an indication of the potency of the color as well as the need for careful planning if it is to be used to facilitate learning.

The Use of Color Cues by Good and Poor Readers

Otto et al. (1968) conducted a series of four studies dealing with good and poor readers' utilization of selected cues in paired-associated learning. Specific cues considered were color, order of presentation, and verbal mediators. Answers to two basic questions were sought: Do the selected cues have a facilitative effect upon children's paired-associate learning? Is the learning of good and poor readers affected differently by the additional cues? Color was shown to have a positive effect upon learning when intralist similarity was high, but there was no reliable differential effect for good and poor readers. Serial as opposed to scrambled order of presentation was shown to enhance both initial learning and recall. Instructions to use verbal mediators also enhanced learning; but again there was no differential effect for good and poor readers.

In the four studies reported, it was shown that certain cues affect the rate of learning a paired-associate list, but each subject's selection from available cues is also an important determiner of learning speed. The first three experiments indicated that color cues may facilitate learning and/or retention if other, more powerful cues are absent or ignored

by the subjects. In Experiment II, color enhanced learning, while in Experiment III, color did not affect the learning rate, but the removal of color had an adverse effect on subsequent performance; thus, color cues were better than no cues at all. It was demonstrated in Experiment IV that verbal mediators are extremely powerful cues regardless of type of materials, grade, and reading ability. The questions that still remain pertain to the relationship among all possible cues. Otto asked:

> . . . Can they be placed on a continuum of facilitation? If so how do they stand in relation to each other? If a certain type of cue aids initial learning, does it also aid retention or relearning?

Differences in rate of learning by good and poor readers were apparent in Experiments I and II. In Experiment IV, it was suggested that good readers may be more apt to provide their own verbal mediators than poor readers, had more learning experiences and verbal experiences on which to base future learning strategies, and have more successful verbal learning experiences than poor readers. The material in the first two studies, where good and poor did differ, the stimulus materials and tasks were much more reading-like than the fourth study, which may have enabled the good readers to capitalize on their more successful and broader verbal experiences.

The trends noted in Experiment I indicate that the good readers and the sixth graders benefited more from color cues, but the opposite was noted in Experiment II. The increased intralist similarity in Experiment II may have affected the direction of these trends; as shown in Experiment III, the second graders learned faster with low-intralist similarity.

Color as an Aid to Visual Perception in Early Reading

Jones (1965) examined color as an aid to visual discrimination of words and letters among nursery school children. He reasoned that nursery school children are old enough to take visual matching tests but too young to have acquired reading habits that would influence their responses. The task comprised a pair of matching tests, one black and one with color, of six English reversal letters (p,q,u,n,d,b) followed by a second pair of matching tests in black with and without color of six English words transposed into an unfamiliar script to control for learned reading responses. On the basis of the data, Jones concluded that without color the task was "at least three times" as difficult as with color, even when possible color matching was considered. Furthermore, he noted that the subjects strongly

preferred the colored test materials. The implication seems to be that color may have value both as an aid to discrimination and as a motivational device in early reading.

The Use of Color to Isolate a Single Stimulus

Hedwig von Restorff (1933) demonstrated with her research that more rapid learning of an item in a list which was different from other items in the list was possible. Her findings have been confirmed by other research. The facilitation in learning a particular item in a list produced by isolating that item or making it distinctive from other items has come to be called "the von Restorff effect." Many variables can be cited which should influence the von Restorff effect in a somewhat similar manner as does meaningfulness in formal stimulus similarity. Formal similarity refers to the degree of visual distinctiveness among items. Samuels (1968) used first graders in Experiment I to determine the effect stimulus similarity and stimulus isolation have on the von Restorff effect when only a single stimulus within the list is isolated by color. It was predicted that when stimulus similarity is high, rate of PA learning will be faster for the S-R pair in which the stimulus term is isolated. When similarity is moderate or low, there will be no difference in rate of PA learning

between S-R pairs having an isolated stimulus term and S-R pairs having nonisolated stimulus terms. During learning trials an isolated stimulus term was presented in red, while the nonisolated stimulus terms were presented in black. After each five learning trials, a transfer test was given to determine if Ss were able to give the correct response when a formerly isolated (red) stimulus term was presented in black. During learning trials in the high-similarity list more correct responses were given to the stimulus in red. At transfer there was a reversal of significance, and fewer correct responses were given to the stimulus formerly in red. On medium- and low-similarity lists the difference in correct responses to red and black stimuli was not significant at learning or at transfer. Samuels stated:

> . . . While significant differences during learning in number of correct responses were found in one of the three lists favoring the isolated over the nonisolated words, the critical issue was one of transfer or ability to give the correct response when the word formerly in red was presented in black. . . . Ss responded to isolated words on the basis of color. On transfer the color cue was absent, and Ss did poorly with the formerly isolated words. . . . Lists where discrimination on the basis of letter form was easier, color was a less potent cue. For these lists it appears that Ss tended to use letter form as a cue for responding even for isolated words.

Samuels conducted Experiment II using adult subjects because of the possibility that Ss in Experiment I did not have sufficient experience with the

transfer task to realize that color was an irrelevant cue and letter shape the primary cue. The purpose of Experiment II was to determine whether it would be possible to facilitate PA learning by (1) isolating with color one of the stimulus terms, (2) providing enough transfer tests for S to realize that in order to respond correctly at transfer he would have to focus on letter shape during learning, and (3) using Ss with sophisticated learning strategies. Thirty college Ss learned a high-stimulus similarly paired-associate list. During learning trails one stimulus was in red. The other stimuli were in black. On transfer trials all stimuli were in black. Learning and transfer trials were alternated. The results were similar to those found in Experiment I for the high-similarity list. It appears that the magnitude of the von Restorff effect is influenced by stimulus similarity. Samuels concluded:

> . . . During learning trials, when color cues were present, significantly more correct responses were given to the isolated than to the nonisolated S terms. During transfer, when color cues were removed, significantly more correct responses were given to the nonisolated S terms. Correct responses to isolated S terms on learning trials and failure to do so at transfer indicated that Ss were attending to stimulus color and not stimulus shape. The fact that subjects focused primarily on the irrelevant dimension of color rather than the relevant dimension of shape for the isolated S-R pair is surprising first, because the number of alternations between learning and transfer trials was sufficient to indicate that color cues were being removed at transfer and second, because Ss were told that some nonsense syllables would appear at learning and at transfer.

It appears that the learning strategy of college Ss was similar to that of the children in Experiment I, because they also found it difficult to focus on a less salient but critical cue in the presence of a more salient cue, color.

In contrast, Allington (1973) conducted research using kindergarten children to determine whether subjects who received one of three treatments of color cues in an instructional program differed significantly on three learning tasks. Four letter-like transformations and their up-and-down, left-to-right transformations were selected for use in the study. These eight figures were presented in one of three treatments: (1) no color added to letter-like figures, (2) maximum color added to the letter-like figures, and (3) maximum color added and then vanished from the letter-like figures.

A program sequence was developed employing an audio-flash card reader. The verbal directions of the program sequence remained identical for all subjects, while the treatment of color cues varied.

Subjects were pretested and posttested on their ability to match to form and match from memory, and to associate a low-meaningfulness C-V-C trigram with each figure.

Significant achievement on all three tasks was found for the vanished color treatment over no-color treatment. From these results it was concluded that vanished color treatment enhances the learning of visual discrimination, visual memory, and paired-associate tasks when compared to the no-color treatment. This effect seems to stem from improved attention to the distinctive feature of a stimulus.

Summary

The studies reviewed on color as a cue often demonstrated that color facilitated rate of initial learning but produced undesirable complications on a transfer task. This phenomenon was one of the major characteristics of the study conducted by Samuels. His research provided insight into the potency value of color and provided some necessary cautions for the use of color cues. The utility of color under varying conditions was investigated by Otto. His research demonstrated that color enhanced learning but that other cues, such as order of presentation, could have a more facilitative effect.

Other research studies focusing on color as an attentional factor attempted to clarify the roles of attention, distinctive features, and color cues in discrimination and paired-associate learning. Many studies

demonstrated that poor readers and children who had difficulty with the task of visual discrimination were inferior in their ability to attend to and identify distinctive features of letters and words. Research by Jones showed that color aided his subjects in helping them to pick out distinctive features of letters and words.

CHAPTER III

DESIGN OF THE STUDY

In this chapter, the description of the sample, the methodology, the development of the instrument, the testable hypotheses, and the pilot study are discussed.

Sample

The Lansing school district was selected for the study. Fifteen elementary schools were randomly selected from a list of 20 schools.

The population under investigation comprised those elementary school children in second grade who were identified by their teachers as low-achieving readers who were confusing words. The total sample population for this study consisted of 174 second graders from the 15 Lansing elementary schools selected.

A simple random sample was used to select 60 boys and 60 girls to participate in the study. The subjects from each of the two groups (boys, girls) were randomly assigned to one of three treatment groups. (See Figure 1.) The total number of children in the sample was 120.

T_1	T_2	T_3
n = 40	n = 40	n = 40

Number of subjects per cell for the treatment effect

Boys	n = 60
Girls	n = 60

Number of subjects per cell for the sex effect

	T_1	T_2	T_3
Boys	n = 20	n = 20	n = 20
Girls	n = 20	n = 20	n = 20

Number of subjects per cell for the treatment x sex interaction effect

Figure 1.--Distribution of the sample.

Methodology

An instructional episode was used as the data-gathering method for the study. An instrument was developed which consisted of 120 words that were paired, and bound into booklets, for each of three treatment groups. The instrument measured the effectiveness of vanishing hue color cues on the paired-associate learning of previously encountered sight vocabulary words by low-achieving second graders.

The investigator administered all treatments in November and December, 1976. It took approximately 15 to 20 minutes for each subject in the study. One day was designated for each school. The treatments were administered randomly in each building. The investigator returned to schools where some subjects had been absent.

The experiment took place in small rooms in all schools. The investigator sat at a low table, which contained a tape recorder, the instructional episode booklets, 12 flash cards, and the posttest sheets. The subject sat on the right of the investigator. The instructional booklets were placed in front of the learner as needed. The cards were turned by the investigator.

The Instrument

In developing the research instrument the general idea was to use sight words that children reverse, transpose, rotate, and confuse. A review of literature revealed some of these words. The results of the Slossen and Dolch lists, which had already been administered to children, were analyzed for look-alike words that children were miscueing. These word lists had been administered to children by graduate students enrolled in a diagnostic class, Reading 830E, at Michigan State University. The list was compiled and a tally was made of the words most often missed by the children who were tested. The list contained word pairs, that is the word missed and the word it was mistaken for. The list was validated by reading experts at Michigan State University as those that are often confused. From this list was generated a second list of words--those words most commonly missed that contained letter differentiations that are critical for some learners.

Twelve words were paired with a word of high similarity or one that had been identified in the literature as being one children confuse or miscue. The paired word contained no highlighting for any group. (See Figure 2.)

1.	want	13.	went
2.	no	14.	on
3.	every	15.	very
4.	boy	16.	dog
5.	always	17.	away
6.	where	18.	were
7.	saw	19.	was
8.	those	20.	these
9.	sit	21.	its
10.	been	22.	be
11.	they	23.	that
12.	many	24.	may

Figure 2.--Words used for the instrument.

For each treatment a matched set of 12 booklets was used. The only variation was the color highlighting. Each word was presented to the learner five times. The booklet contained 10 words. The first two presentations of the words were used as the instructional episode. The pairs of words were randomly arranged throughout the booklet. The words were presented 10 times throughout the episode. (See Figure 3.)

Three sets of 120 3 x 5 cards were prepared for each treatment in the instructional episode. The first set consisted of the cards printed in black with the stimulus letter or letters printed with maximum

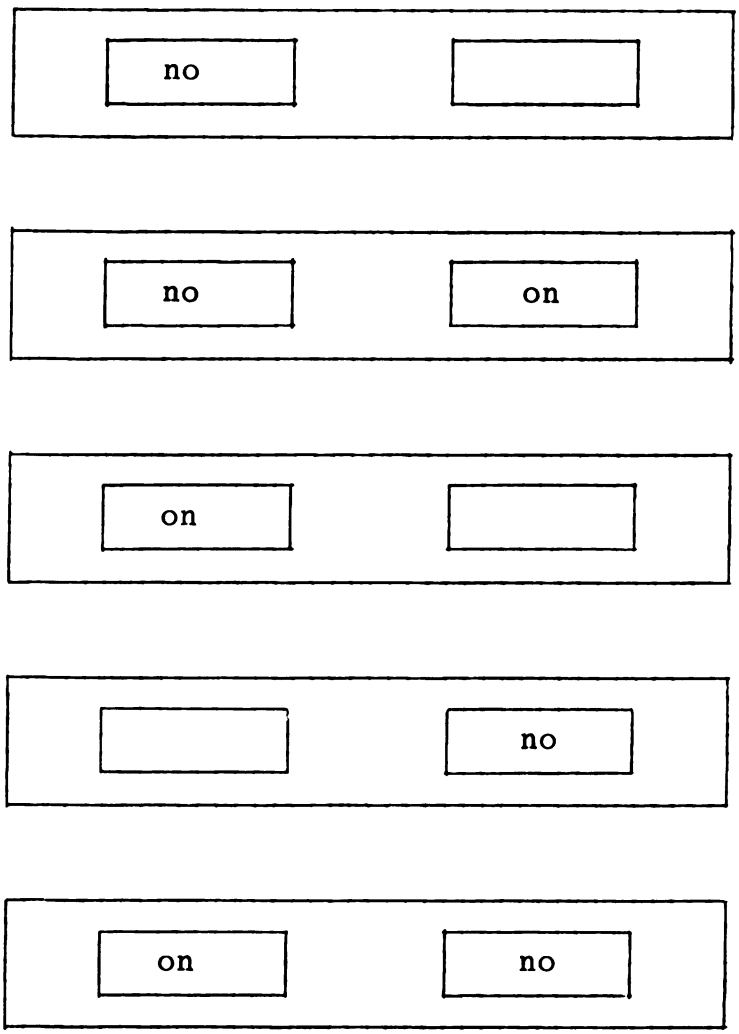


Figure 3.--Sample booklet showing word and its paired-associate. Words were placed randomly in the booklets.

highlighting on trials one through eight, while trials nine and ten presented both words in plain black letters. The second set of cards consisted of the word printed in black on white with maximum color on the stimulus letter or letters in trial one and subsequently vanished in trials two through eight, with the criterion word in plain black in trials nine and ten. The third set of cards consisted of all the letters of the word printed in black throughout the treatment. (See Figure 4a-d.) In addition to the 360 cards printed for the instructional episode, 120 plain cards were prepared and placed randomly in the booklets so that only one word was revealed at a time.

Figure 2 showed the pairs of words used in the study. The words were in spiral-bound booklets. There were 12 booklets for each treatment. Each booklet contained two paired words placed in random order. The booklets were 4" x 11" in size. The cards were bound in the booklets as a means of keeping them in the same order for each treatment. The booklets were color coded for easy identification by the investigator. They were numbered from 1 to 12, for consistency in administration.

Each learner was given directions prior to the beginning of the instructional episode. The words were randomly placed in the booklets to prevent serial learning. The instructional episode was presented to the

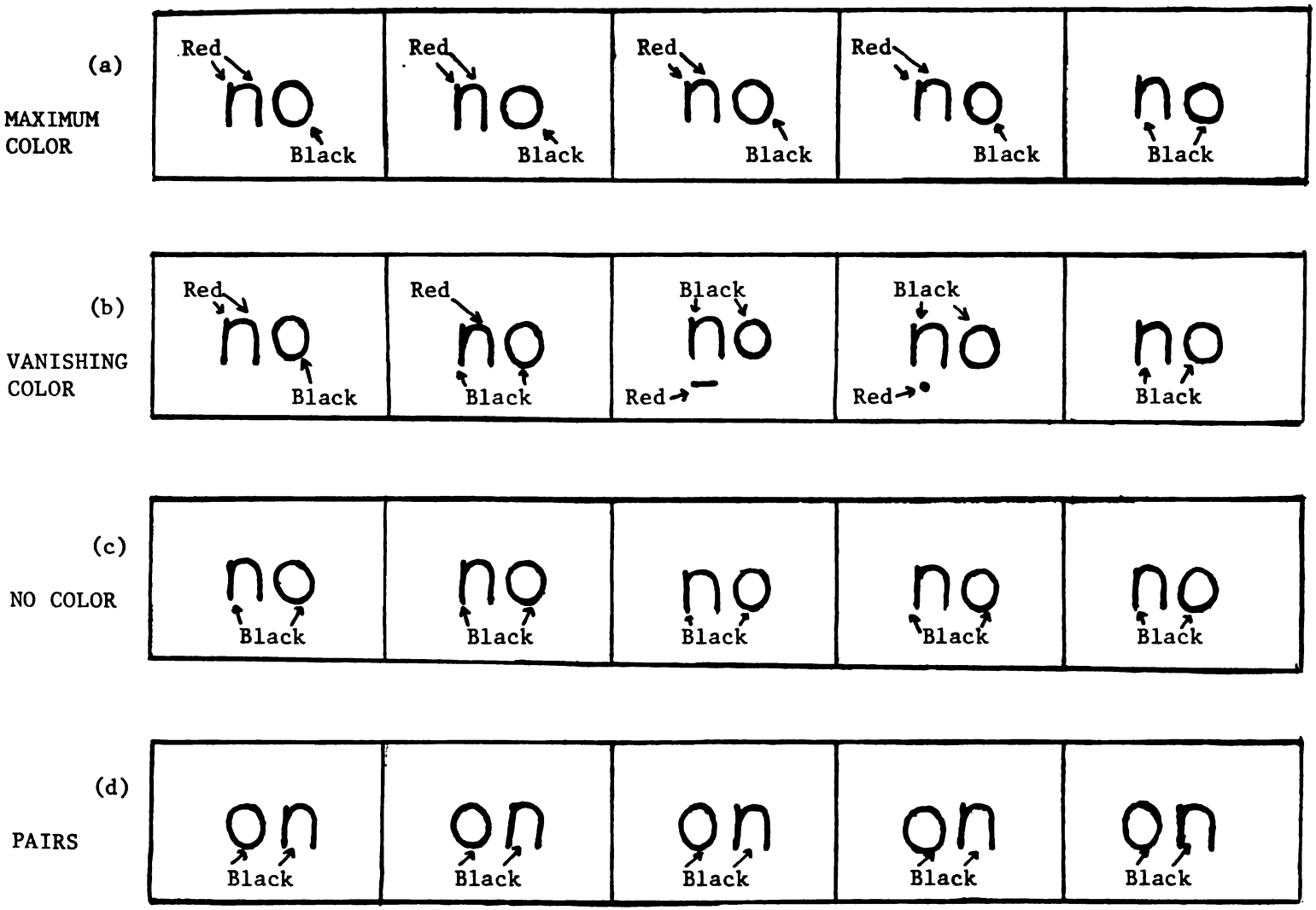


Figure 4.--Methods of highlighting for the three treatments.

learner from booklets 1 through 12 without interruption. (See Figure 5.)

Immediately after the last booklet was read the learner was given the directions for responding to the Match to Form from Memory posttest. Each word for this test was presented with a ½-second flash; the learner then drew a circle around the word he saw from a selection of four words that were quite similar in form to the flashed word, with one word identical to the word that was flashed. The information for each Naming task (word, pairs) was recorded on the tape recorder. This information was recorded by the investigator each afternoon.

The instructional episode and the posttest took approximately 15 to 20 minutes for each learner. Each correct response was given a score of one. On the Match to Form from Memory test, there was a possible score of 12. The Naming test contained 24 items; therefore it was possible to earn a maximum score of 24. On the Pairs test a score of 12 was possible.

Pilot Study

A pilot study was conducted to standardize procedures for administering the test. An opportunity to familiarize the researcher with the actual presentation procedure of the instrument was provided.

1	2	3	4	5	6	7	8	9	10
Instruction	Instruction	Studying	Studying	Studying	Studying	Studying	Studying	Studying	Criterion Test

Figure 5.--Instructional episode: Order of teaching and testing.

The pilot study was conducted at one location; however, subjects from three second grade classrooms were included in the study. Nine children were randomly selected and assigned to the three treatments.

The pilot study served to confirm the timing aspects of the instrument. It served to establish the fact that second graders could sit through the instructional episode without becoming bored. From the performance of the pupils in the pilot study it was decided that there was no need to eliminate any of the 12 booklets.

Experimental Design

A two-way multivariate analysis of variance was used for the statistical analysis of the research data. Figure 6 illustrates the design of the study.

Research Hypotheses

Ho_1: There will be no significant difference among three methods of teaching word discrimination on a 12-item Match to Form From Memory posttest.

Ho_2: There will be no significant difference between boys and girls in learning word discrimination as measured by a 12-item Match to Form From Memory posttest.

Ho_3: There will be no significant interaction between sex and treatment on the learning of word discrimination as measured by a 12-item Match to Form From Memory posttest.

Ho_4: There will be no significant difference among three methods of teaching word discrimination on a 24-item Naming posttest.

Ho_5: There will be no significant difference between boys and girls in learning word discrimination as measured by a 24-item Naming posttest.

Ho_6: There will be no significant interaction between sex and treatment on the learning of word discrimination as measured by a 24-item Naming posttest.

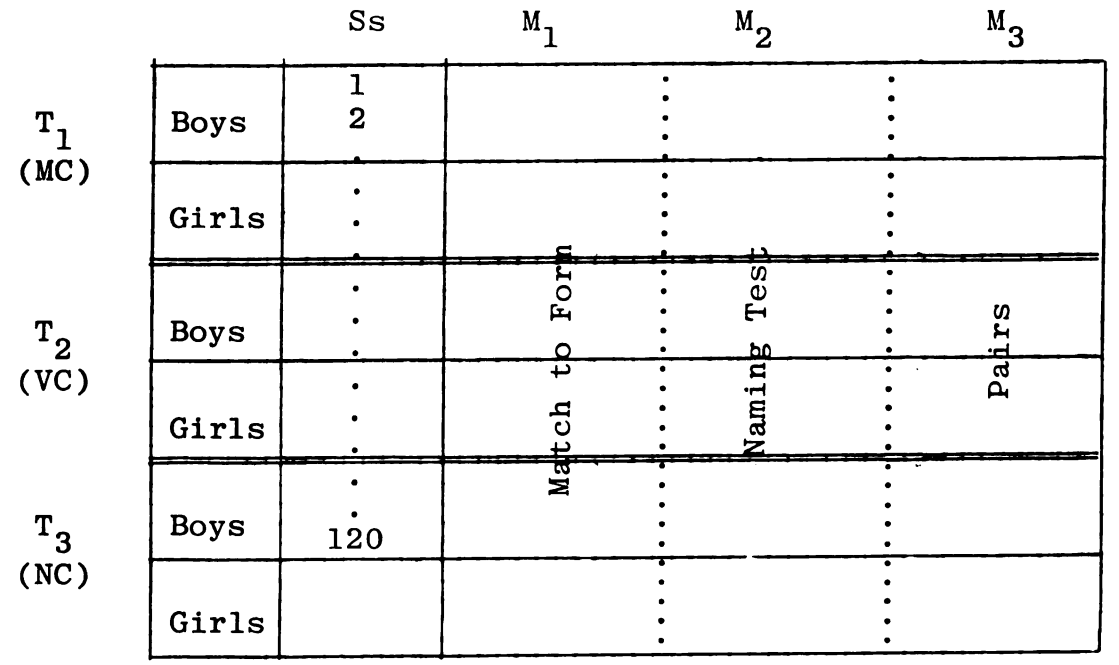
Ho_7: There will be no significant difference among three methods of teaching word discrimination as measured by a 12-item paired word Naming posttest.

Ho_8: There will be no significant difference between boys and girls in learning word discrimination as measured by a 12-item paired word Naming posttest.

Ho_9: There will be no significant interaction between sex and treatment on the learning of word discrimination by a 12-item paired word Naming posttest.

Statistical Procedures

A two-way multivariate analysis, the univariate analysis, and the t-test were employed to test the research hypotheses. The multivariate analysis of variance was used for each main effect (treatment and sex) and for the interaction effect (treatment x sex). The multivariate analysis of variance provided an overall test based on all three dependent variables (MC, VC, NC). If a source of variation was found to be significant in the multivariate analysis of variance, the



Key: MC = Maximum color; maximum color on the stimulus letter or letters of the word.

VC = Vanishing color; maximum color on the stimulus letter or letters of the word gradually vanishing with all black letters in criterion test.

NC = No color; no color on the stimulus letter or letters in the word.

Figure 6.--Experimental design.

univariate analyses of variance were then applied to the data to identify on which dependent variables the significant effect occurred. If the treatments main effect was significant, four post-hoc contrasts (VC-MC, VC-NC, MC-VC, VC-$\frac{MC+NC}{2}$) were investigated employing the t-test.

Summary

This study was conducted to determine the effectiveness of color cues in discrimination and paired-associate learning of words that are easily confused. The subjects for the study consisted of 120 second graders from 15 elementary schools in Michigan.

Subjects were randomly selected and randomly assigned to one of three treatment groups: maximum color added, vanishing color added, and no color added. Each subject completed an instructional episode designed to teach him to visually discriminate and name 12 pairs of words that are easily confused. Upon completion of the instructional episode, each subject was tested on the ability to perform three tasks: match each word to form from memory, name the words, and name the pairs of words.

Multivariate and univariate analyses of variance were used to determine whether significant differences existed between treatment groups. The results of these analyses are reported in Chapter IV.

CHAPTER IV

ANALYSIS OF RESULTS

Introduction

This study was designed to determine the effectiveness of the use of color cues to teach low-achieving second graders visual discrimination in paired-associate learning of previously encountered sight-vocabulary words. To accomplish this objective, a 24-item list of words was paired in terms of words that children (1) reverse, (2) confuse, (4) rotate and transpose. These words were presented in three treatments: (1) maximum color added to a distinguishing characteristic of the word, (2) vanishing color added to a distinguishing characteristic of the word, and (3) no color added to a distinguishing characteristic of the word.

The subjects for this study were 120 randomly selected and randomly assigned low-achieving second graders from the populations of 15 randomly selected elementary schools from Lansing, Michigan. Each subject was recommended for the program by his classroom teacher and the reading specialist of the school.

The dependent variables observed consisted of (1) Match to Form From Memory, (2) Naming, and (3) Pairs.

The independent variables were (1) treatment with three levels: Treatment 1, maximum color (MC); Treatment 2, vanishing color (VC); and Treatment 3, no color (NC); and (2) sex with two levels, boys and girls. For all measures a score of one was given for each correct choice. The Match to Form From Memory task consisted of 12 items; therefore, each subject could earn a score of 12 on this measure. The Naming task consisted of 24 items; each subject could earn a maximum of 24 on this measure. The Pairs task consisted of 12 pairs of words; a score of one was given for each pair of words that was answered correctly. Thus each subject could earn a maximum of 12 on this measure.

Research Hypotheses

Specifically, the following null hypotheses were tested:

Ho_1: There will be no significant difference among three methods of teaching word discrimination on a 12-item Match to Form From Memory posttest.

Ho_2: There will be no significant difference between boys and girls in learning word discrimination as measured by a 12-item Match to Form From Memory posttest.

Ho_3: There will be no significant interaction between sex and treatment on the learning of word discrimination as measured by a 12-item Match to Form From Memory posttest.

Ho_4: There will be no significant difference among three methods of teaching word discrimination on a 24-item Naming posttest.

Ho_5: There will be no significant difference between boys and girls in learning word discrimination as measured by a 24-item Naming posttest.

Ho_6: There will be no significant interaction between sex and treatment on the learning of word discrimination as measured by a 24-item Naming posttest.

Ho_7: There will be no significant difference among three methods of teaching word discrimination as measured by a 12-item paired word Naming posttest.

Ho_8: There will be no significant difference between boys and girls in learning word discrimination as measured by a 12-item paired word Naming posttest.

Ho_9: There will be no significant interaction between sex and treatment on the learning of word discrimination by a 12-item paired word Naming posttest.

Are There Significant Differences?

The multivariate and univariate analyses of variance are statistical techniques for testing whether or not two or more population means for an effect differ at a specified significance level. Thus, the first step in this analysis was to conduct a two-way multivariate analysis of variance in order to test the above hypotheses at .05. The results of the multivariate analysis of variance identified a significant treatment main effect. However, while this analysis indicated the significant treatment main effect, it does not identify

on which dependent variables the significant treatment main effect existed. A series of univariate analyses of variance were employed to identify which of the three dependent variables (Match to Form From Memory, Naming, Pairs) produced the effect.

The univariate analysis of variance identified on which of the three dependent variables significant treatment effects occurred at .01. A significant treatment effect for each univariate analysis of variance was found. Therefore, it was necessary to identify between which treatment groups the significant differences occurred. Here four post-hoc contrasts were investigated to find where the specific difference existed. The t-test was employed, which revealed a .01 level of significance. The following sections report the results of the multivariate analysis of variance and the post-hoc analyses.

Results of the Multivariate Analysis of Variance

A two-way multivariate analysis of variance was the first statistical analysis applied to the data. The two independent variables were sex and treatment. The sex variable consisted of two levels, boys and girls. The treatment variable had three levels: (1) maximum color (MC), (2) vanishing color (VC), and (3) no color (NC).

There were three dependent variables: (1) the Match to Form From Memory (12 items), (2) Naming (24 items), and (3) Pairs (12 items). (See Table 1.)

Table 1.--A multivariate analysis of variance.

	B			G		
	MC	VC	NC	MC	VC	NC
T_1	n = 20			n = 20		
T_2	n = 20			n = 20		
T_3	n = 20			n = 20		

n = 120

Observed Cell Means

	1. Match	2. NAT	3. Pair
1	7.90000	17.65000	7.60000
2	7.70000	16.65000	6.95000
3	8.60000	20.00000	9.70000
4	9.40000	22.30000	10.70000
5	7.75000	14.05000	5.70000
6	8.20000	15.35000	6.70000

MANOVA Table

Source of Variation	F-Ratio	df	p less than
Sex effect	.6043	3	.6036
Treatment effect	9.3648	6	.0001*
Sex x treatment	1.0043	6	.4234

*Significant at .05 level.

Key: B = boys; G = girls
MC = maximum color; VC = vanishing color;
NC = no color

With 95% of confidence neither interaction between sex and treatment nor sex main effect is significant. However, the treatments main effect is significant. At this step, the conclusion is that at least one of the dependent variables produced the significant treatment main effect among the three groups.

The treatment effects on the table show that an F-ratio of 9.3648 was attained which, with 6 and 224 degrees of freedom, had a significance level of p less than .0001. This provides strong evidence that significant differences exist between groups as a result of the treatments. Thus, on the basis of this multivariate analysis of variance test, Hypotheses 1, 4, and 7 were rejected.

Accordingly, the sex variable had an F-ratio of .6043 with 3 and 112 degrees of freedom and had a significance level of p less than .6136, which is greater than .05 (the control level), confirming a no sex main effect. Therefore, Hypotheses 2, 5, and 8 cannot be rejected.

Finally, the interaction between sex and treatment received an F-ratio of 1.0043 with 6 and 224 degrees of freedom with p less than .4234, which is also greater than .05 (the control level). Thus, Hypotheses 3, 6, and 9 were rejected.

Identifying Differences

The univariate F-test was employed to find out which dependent variable produced the treatments main effect, whether it was the Match to Form From Memory, Naming, or Pairs (Table 2).

At this step, with 99% of confidence, all three dependent variables are significant. The conclusion here is the Match to Form From Memory, the Naming, and the Pairs tasks were influenced by the treatments main effect.

To find out which group is statistically different from all other groups, four contrasts were constructed and were tested by the t-test. The four contrasts are (1) VC-MC, (2) VC-NC, (3) MC-NC, and (4) $V - \frac{MC+NC}{2}$.

Table 3 shows the comparison between VC and MC. The t-value of 3.045 is significant at .003, which is less than .01 (the critical level). Therefore, there is a significant difference between the two groups. Moreover, the magnitude of the difference between the two groups is 1.2. Thus on the average the VC group can Match to Form approximately 1.2 words more than the MC group.

The comparison between the VC group and the NC group reveals a t-value of 2.601, which is significant

Table 2.--Results of the univariate F-test for each variable.

Variable	df	Hypothesis Mean Sq.	Variance Within Cells	Univariate F	p less than
Match	2	16.8083	3.11	5.4045	.0058 <.01*
NAT	2	424.0333	24.323	17.4336	.0001 <.01*
Pairs	2	171.4083	6.864	24.9704	.0001 <.01*
(degree of freedom for the error term is 114)					

*The test is significant at .01 level. (We made them more conservative because they are the post-hoc test.)

Table 3.--The results of the four contrasts on the Match to Form From Memory task.

	Magnitude of the Difference	Standard Error	T-Value	df	T. Probability
VC - MC	1.2000	.3941	3.045	117.0	.003*
VC - NC	1.0250	.3941	2.601	117.0	.010*
MC - NC	-.1750	.3941	-.444	117.0	.658
VC - $\frac{MC+NC}{2}$	1.1125	.3413	3.260	117.0	.001*

*The test is significant at the .01 level.

at .010, which is less than .01 (the critical level). Therefore there is also a significant difference between the two groups. Accordingly the magnitude of the difference between the two groups is 1.0. Thus, on the average, the VC group can Match to Form approximately 1.0 words more than the NC group.

In checking the comparison between MC and NC the t-value is -.444. However, the .658 level of significance exceeds the .05 control level established for the study. Thus there is no significant difference between the MC group and the NC group.

Further, the table shows the comparison between the VC group and the average of the combined means of the MC group and the NC group with a t-value of 3.260 is significant at .001, which is less than .01, the critical level. Therefore, there is a significant difference between the VC group and the other two groups.

The means of three treatments on Match to Form from Memory, Naming, and Pairs are displayed in Figure 7a-c. The histograms in Figure 8a-c display their magnitudes.

Naming

Table 4 shows that the comparison between the VC and MC groups has a t-value of 3.623 and is significant

THE OBSERVED MEANS OF THREE TREATMENTS ON MATCH TO FORM FROM MEMORY

(12)

(a)

T_1 (MC)	T_2 (VC)	T_3 (NC)
7.8	9.0	7.98

1.2 1.0

THE OBSERVED MEANS OF THREE TREATMENTS ON NAMING

(24)

(b)

T_1 (MC)	T_2 (VC)	T_3 (NC)
17.15	21.15	15.70

4 5.45

THE OBSERVED MEANS ON THREE TREATMENTS ON PAIRS

(12)

(c)

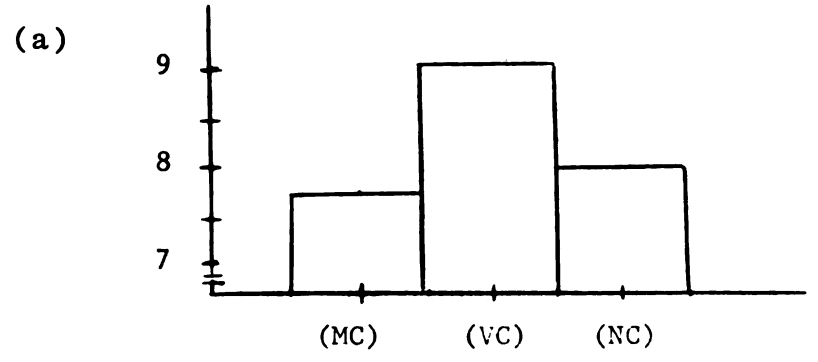
T_1 (MC)	T_2 (VC)	T_3 (NC)
7.5	10.2	6.2

2.7 4.0

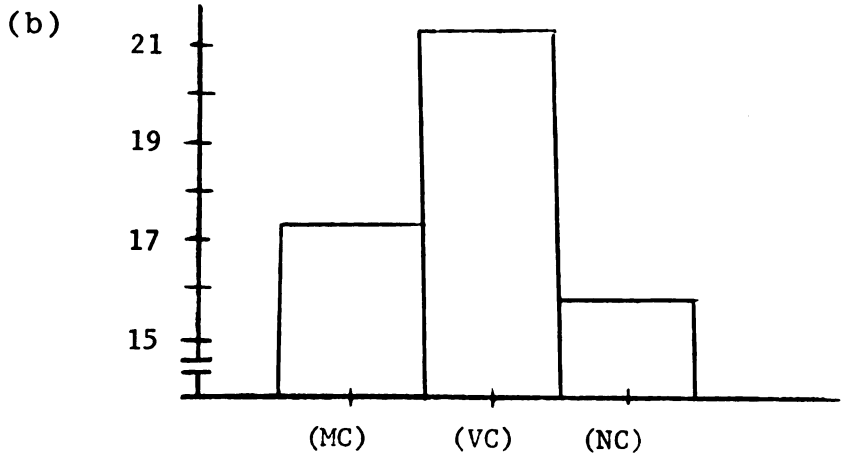
MC = Maximum Color, VC = Vanishing Color, NC = No Color

Figure 7.--Observed means on three treatments on three tests.

THE OBSERVED MEANS OF THREE TREATMENTS ON MATCH TO FORM FROM MEMORY



THE OBSERVED MEANS OF THREE TREATMENTS ON NAMING



THE OBSERVED MEANS ON THREE TREATMENTS ON PAIRS

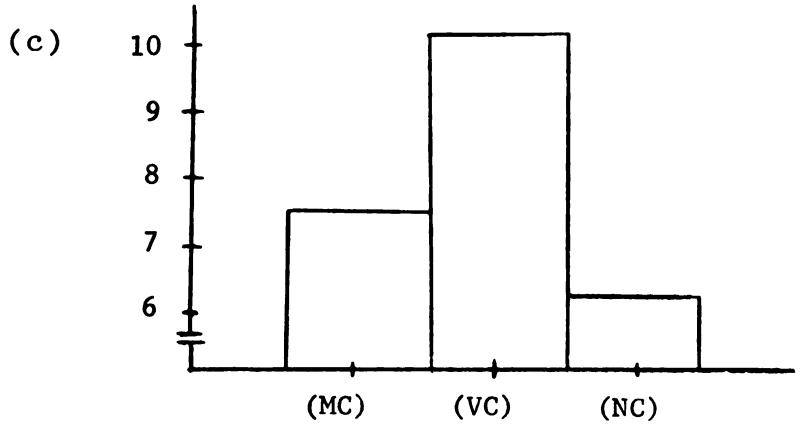


Figure 8.--Histograms of observed means on three tests.

at .000, which is less than .01. Therefore there is a significant difference between the two groups. Moreover, the magnitude of the difference between the two groups is 4.0. Thus on the average the VC group can name approximately 4.0 words more than the MC group.

The comparison between the VC and NC groups has the t-value of 5.842; this is significant at .000, which is less than .01. Therefore, there is a significant difference between the two groups. Moreover, the magnitude of the difference between the two groups is 6.4. Thus on the average the VC group can name approximately 6.4 words more than the NC group.

The table shows that the comparison between the MC and NC groups has the t-value of 2.219, significant at .028, which is greater than .01 (critical level). Thus with 99% confidence there is no difference between the MC and NC groups.

The table also shows the comparison between the VC group plus the average of the means of the MC and NC groups has a t-value of 5.464, which is significant at .000, less than .01 (the critical level). Therefore there is a significant difference between the two groups. Moreover, the magnitude of the difference between the two groups is 5.2. Therefore on the average the VC group can name approximately 5.2 words more than the other two groups combined.

Table 4.--The results of the four contrasts on the Naming task.

	Magnitude of the Difference	Standard Error	T-Value	df	T. Probability
VC - MC	4.0000	1.1041	3.623	117.0	.000*
VC - NC	6.4500	1.1041	5.842	117.0	.000*
MC - NC	2.4500	1.1041	2.219	117.0	.028
VC - $\frac{MC+NC}{2}$	5.2250	.9562	5.464	117.0	.000*

*The test is significant at the .01 level.

Table 5 shows that the comparison between the VC and MC groups has a t-value of 4.981; this is significant at .000, which is less than .001, the critical level. Therefore there is a significant difference between the two groups. Moreover, the magnitude of the difference between them is 2.9. Thus on the average the VC group can name approximately 2.9 more pairs of words than can the MC group.

The comparison between the VC and NC groups has a t-value of 6.812, which is significant at .000, less than .01. Therefore there is a significant difference between the two groups. Moreover, the magnitude of the difference between the two groups is 4.0 pairs of words. Thus on the average the VC group can name approximately 4.0 more pairs of words than the NC group.

Table 5 also shows that the comparison between the MC and NC groups has a t-value of 1.831. This is significant at the .070 level, which is greater than .01 (the critical level). Thus with 99% of confidence there is no significant difference between the MC and NC groups on the Word Pairs task.

The table also shows a comparison of the VC group with the combined means of the MC and NC groups. The t-value is 6.809, which is significant at .000, less than .01 (the critical level). Therefore there is a significant difference between the two groups. Moreover,

Table 5.--The results of the four contrasts on the Pairs task.

	Magnitude of the Difference	Standard Error	T-Value	df	T. Probability
VC - MC	2.9250	.5872	4.981	117.0	.000*
VC - NC	4.0000	.5872	6.812	117.0	.000*
MC - NC	1.0750	.5872	1.831	117.0	.070
VC - $\frac{MC+NC}{2}$	3.4625	.5085	6.809	117.0	.000*

*The test is significant at the .01 level.

the magnitude of the difference between the two groups is 3.4. Thus on the average the VC group can name approximately 3.4 more pairs of words than the MC and NC groups combined.

Summary

The multivariate analysis of variance shows that the treatment main effect is significant at .05 levels; however, neither interaction between sex and treatment nor sex main effect was found to be significant.

The univariate F-test was employed to specify on which dependent variable the treatment main effect was found to be significant. The conclusion drawn from the univariate test was that all three dependent variables were influenced by the treatment main effect. The three univariate F-tests were found to be significant at the .01 level.

Four post-hoc contrasts were constructed to find where the significant differences existed among the three groups. They were vanishing color minus maximum color, vanishing color minus no color, maximum color minus no color, and vanishing color minus the combined means of maximum color plus no color divided by two. As a result of using the t-test to test all four contrasts on the three dependent variables at the .01 level, vanishing color minus maximum color, vanishing color

minus no color, and vanishing color minus maximum color plus no color divided by two were found to be significant on all three dependent variables. However, maximum color minus no color was not found to be significant on any of the three dependent variables.

CHAPTER V

SUMMARY AND CONCLUSIONS

A brief summary of the study is presented at the beginning of this chapter, followed by the conclusions, implications of the study, and suggestions for further research.

Summary

The subject of this research was the effect of color cues as a facilitator of visual discrimination on paired-associate learning. Specifically, the effectiveness of the use of color cues to teach low-achieving second graders visual discrimination in paired-associate learning of previously encountered sight vocabulary words was explored. The study was designed to test the effect of employing a single color as a cue for a variety of stimuli. It was felt that the use of a single color might eliminate the problems previously associated with the use of multiple color cues while still focusing subjects' attention on the distinctive features of the stimuli.

The sampled population for the study included 15 schools from one school district. A random sample

was taken to generate three groups of 20 boys and 20 girls from second grade classes for each of the three treatments. The total number in the sample was 120 children.

Three sets of cards were prepared for use in the instructional episode. The first set had maximum color cues added to the stimulus word, the second set had maximum color cues added and gradually vanished from the stimulus word, and the third set had no color cues added to the stimulus word.

This instructional episode was used with 120 children enrolled in the second grade classrooms of 15 schools in the Lansing school district. Each subject was taken through the instructional episode individually. Upon completion of the instructional episode each subject was administered a posttest on the ability to name the words, to name the pairs of words, and to match the word to form from memory.

The multivariate analysis of variance showed a treatment main effect of $p < .0001$. It also showed the test to be significant at the .05 level. However, it did not identify the dependent variable that produced the significant treatment main effect.

The univariate F-test was employed to find out which dependent variable produced the treatments main effect. The conclusion drawn from the univariate F-test

was that with 99% confidence all three dependent variables influenced the treatments main effect. The test was significant at the .01 level.

Four post-hoc contrasts were constructed and were investigated to find where the specific significant difference existed. They were: (1) VC-MC, (2) VC-NC, (3) MC-NC, and (4) VC- $\frac{MC+NC}{2}$. The t-test was employed to test at a .01 level.

The univariate analysis of variance on the dependent variable Match to Form From Memory indicated a significant treatment effect at the $p < .0058$ level. The t-test was significant at the .01 level, favoring the vanished color treatment over the MC and NC treatments.

The univariate analysis on the dependent variable Naming indicated a significant treatment effect of $p < .0001$ level. The post-hoc contrasts identified a significant difference ($T < .01$) between the vanished color and no color treatments and between the maximum color and the vanished color treatments.

The univariate analysis of variance on the dependent variable Pairs indicated a $p < .0001$ level. The post-hoc contrast t-test indicated a $t < .01$ level on the Pairs test between vanishing color and maximum color and vanishing color and no color, both significant differences favoring the vanishing color treatment.

The results of the post-hoc analyses indicate that the vanished color treatment was superior to the maximum color and the no color treatment on each of the three learning tasks. Further, the vanishing color treatment was superior when the means of maximum color plus no color divided by two minus vanishing color were evaluated.

Conclusion

The conclusions drawn from the analysis of the data of this study are that children who received instruction that utilized vanished color cues learned the tasks of visual discrimination, visual memory, and association of a verbal response at a significantly higher level of achievement than children who received instruction with maximum color cues or those who received instruction with no color cues.

Finally it is concluded that the use of vanished color cues serves to focus attention on the distinctive features of the words to be learned without producing interference at transfer.

Implications of the Study to Education

Much emphasis in the 1970's has been focused on reading and the right of all individuals to be provided with the opportunity to learn how to read. However, much is needed in the realm of methods and techniques

to reach the needs of the diverse populations of which our schools are composed. In the area of orientation difficulties, teachers appear to be as confused as the researchers as to the causes of these problems and how best to meet the needs of the children who manifest them.

In presenting the study to the reading specialists of the schools involved and other individuals who were indirectly connected with its implementation, responses were positive. From the superintendent down the hierarchical ladder of authorization, interest in the study and its possible contribution to the body of already existing knowledge in the area of reading was without exception.

Because of the impression made on the children by the treatments, some teachers in some of the schools came out of the classroom and asked, "What are you doing to my children? They are so excited when they leave you."

The results of this study indicate that attending to appropriate features of visual stimuli improves performance on visual discrimination, visual memory, and paired-associate tasks. Specifically, this study demonstrates that vanished color cues facilitate attention in learning these three basic tasks. In contrast to previous studies using multiple hue color cues, a single hue color cue that is vanished seems to facilitate

attention to the distinctive features of words without producing interference on a transfer task. Color cues were useful because they directed the learner's attention to salient information. A vanishing hue eliminates the possibility of responding on the basis of the color cue alone. It forces the learner to sit up and analyze the words in terms of what is different rather than just looking for similarities. By printing the letter or letters that are different in a bright red color, attention can be focused on the distinctive features of the words while allowing the printed form of the word to remain the same regardless of the color. Vanishing the color gradually in subsequent presentations, combined with verbal directions, increases the effectiveness of the cue by forcing the subject to attend more to the distinctive feature of the stimulus and less to the color cue.

The results of the study revealed a significant difference in achievement favoring the vanished color treatment over both the no color treatment and the maximum color treatment. These data indicate that the effectiveness of visual discrimination training depends upon the technique employed and the information presented. Even though it is not unusual for young children to experience difficulties with discrimination tasks involving reversals or letter rotations, it is felt that

the use of vanishing hue color cues should assist these children in mastering the discrimination tasks more efficiently, rather than wait for some mysterious, undetermined period of maturation. This is not to deny the importance of maturation; however, it would appear that if instruction is to be provided then it should be on tasks that have relevance to the reading process and can be transferred without confusion to the child. Thus, the use of vanishing color cues to focus attention on distinctive features of visual stimuli should help eliminate those perceptual confusions that are not of organic etiology. Finally, from the analysis of the data of this study it would appear that children who are experiencing either kinetic or static reversals will both respond to the treatment of vanishing hue color cues.

Recommendations

The recommendations gleaned from the study include the following.

Further study is needed regarding the application of vanished color cues to other instructional tasks and methods of adaptation of a technique for use in published materials for primary grades. The effect of vanished color cues needs to be investigated experimentally under the following conditions:

1. Replication of the present study under the same conditions.

2. Present the three conditions, maximum color, vanishing color, and no color; for each treatment add another criterion trial and compare the treatments under these conditions.

3. Test the effect on other words that are confused using the vanishing color technique presented here with older children who are making reversals.

4. Publishers should try the technique with beginning reading material.

5. Research should be undertaken in a school setting using materials that employ the vanishing hue color technique for one group and materials with no color for one group for a specified period of time. Comparison of the achievement of the two groups would provide information concerning the relative potency of the vanished color cues.

Teachers of reading should use vanished hue color cues to assist children with the following tasks:

1. Learning to visually discriminate between words that are confusing.

2. Learning to visually discriminate between words that have all or many common letters.

3. Learning words that contain letters that are rotations of each other.

4. Learning directionality, e.g., where to look first in reading words.

5. Using the procedure with kindregarten and first grade children to prevent confusions.

In summary, this study has demonstrated that vanished color cues can enhance the learning achievement of children who are making reversals that are either kinetic or static reversals. However, more research is needed utilizing this technique. That attention can be appropriately focused with the use of vanished color cues has been demonstrated by this research.

APPENDICES

APPENDIX A

INTRODUCTION TO AND VERBAL DIRECTIONS FOR THE INSTRUCTIONAL EPISODE

APPENDIX A

INTRODUCTION TO AND VERBAL DIRECTIONS FOR THE INSTRUCTIONAL EPISODE

Introduction to Instructional Episode

Instructions to subjects:

"Good morning. My name is Mrs. Sims, and you're _____. How do you like school? Do you have any sisters? Brothers? What subjects do you like best? Really! Well, do you like to read? The reason why I asked is that I have some words that I would like for you to read for me. It isn't going to be hard, because I am going to tell you what they are. All you have to do is listen closely to what I say and look carefully at what I show you and you'll be able to read the words."

Verbal Directions for Instructional Episode

A pointer was used in emphasizing differences and showing the child how to discriminate between the words. It was also used to show the direction from which the child should begin to read the words.

Want-Went

Investigator: This word says "want"; say want. This word says "went"; say went. The difference between want and went is that want has an "a" after the "w" and went has an "e" after the "w." Now you tell me the difference.

Subject: This one has "nt" at the end and "w" at the beginning, and this one has "nt" right there and "w" right here (child points to letters).

Investigator: Yes, what you said was right but you told me how they were alike. Now look again and tell me how they are different.

Subject: This one has an "a" and this one has an "e."

Investigator: What does the one with the "a" say?

Subject: I forgot.

Investigator: What does this one say?

Subject Want.

Investigator: No, the one with the "a" says want; say want. The one with the "e" says went; say went.

Note: Subject is taken through directions again on second trial if he does not know the words.

Investigator: What does this word say?

Subject: Answer.

Investigator: All right, what does this word say?

Subject: Answer.

Investigator: What does this word say?

Subject: Answer.

Investigator: My, but you are really paying attention, aren't you? Now, what does this word say?

Subject: Answer.

Investigator: What does this word say?

Subject: Answer.

Investigator: What does this word say?

Subject: Answer.

Investigator: OK, what does this word say?

Subject: Answer.

Investigator: My, but you are doing a good job! What does this word say?

Subject: Answer.

Investigator: What does this word say?

Subject: Answer.

Investigator: What does this word say?

Subject: Answer.

Book Two: no-on

Investigator: All right, let's look at this one. This word says "on"; say on. This word says "no"; say no. The difference between no and on is that no begins with an "n" and on begins with an "o." Now you tell me the difference.

Subject: Answers.

The same procedure for Book One is followed for the remainder of the instructional episode.

APPENDIX B

WORDS USED AND METHODS OF HIGHLIGHTING FOR EACH TREATMENT IN THE INSTRUCTIONAL EPISODE

APPENDIX B

WORDS USED AND METHODS OF HIGHLIGHTING FOR EACH TREATMENT IN THE INSTRUCTIONAL EPISODE

Maximum Color Highlighting

1	2	3	4	Criterion
want	want	want	want	want
no	no	no	no	no
they	they	they	they	they
sit	sit	sit	sit	sit
every	every	every	every	every
always	always	always	always	always
many	many	many	many	many
saw	saw	saw	saw	saw
those	those	those	those	those
boy	boy	boy	boy	boy
where	where	where	where	where
been	been	been	been	been

No Color Easily Confused and Look-Alike Words

1	2	3	4	Criterion
went	went	went	went	went
on	on	on	on	on
that	that	that	that	that
its	its	its	its	its
very	very	very	very	very
away	away	away	away	away
may	may	may	may	may
was	was	was	was	was
these	these	these	these	these
dog	dog	dog	dog	dog
were	were	were	were	were
be	be	be	be	be

No Color Highlighting

1	2	3	4	Criterion
want	want	want	want	want
no	no	no	no	no
they	they	they	they	they
sit	sit	sit	sit	sit
every	every	every	every	every
always	always	always	always	always
many	many	many	many	many
saw	saw	saw	saw	saw
those	those	those	those	those
boy	boy	boy	boy	boy
where	where	where	where	where
been	been	been	been	been

Vanished Color Highlighting

1	2	3	4	Criterion
want	want	want	want	want
no	no	no	no	no
they	they	they	they	they
sit	sit	sit	sit	sit
every	every	every	every	every
always	always	always	always	always
many	many	many	many	many
saw	saw	saw	saw	saw
those	those	those	those	those
boy	boy	boy	boy	boy
where	where	where	where	where
been	been	been	been	been

APPENDIX C

DIRECTIONS FOR POSTTESTS

AND POSTTEST SHEETS

APPENDIX C

DIRECTIONS FOR POSTTESTS

Naming Task--24 words

Instructions:

The subject studied 24 words contained in 12 booklets. The words were arranged in pairs. After completion of the Instructional Episode the student was given a score of one for each word that he named correctly on the criterion trial.

Pairs Task--12 pairs of words

Instructions:

The subject studied 12 pairs of words contained in booklets. Upon completion of the Instructional Episode, the student was given a score of one for each pair of words named correctly. No score was given if either of the two words was missed.

Match to Form From Memory

Instructions:

"I am going to place an answer sheet on your desk with some words written on it. The words will be covered with a sheet of tag board paper. Then, I am going to show you a word on a flash card for about one-half second,

like this. What did you see? Nothing? Yes, I know, because that card was blank. The next card is going to have a word on it. As soon as you see the word I want you to move the cover sheet down until you see all the words on the first line. Look very carefully at each word and find the one which looks exactly like the one that you saw on the card. Draw a circle around the word that you think is the correct one. Be sure to look at all of the words before you make a selection. A score of one will be given for each scoring word circled."

NAME	SEX		GROUP
	Yes	No	
1. want			
2. went			
3. every			
4. very			
5. boy			
6. dog			
7. always			
8. away			
9. where			
10. were			
11. saw			
12. was			
13. those			
14. these			
15. sit			
16. its			
17. been			
18. be			
19. many			
20. may			
21. they			
22. that			
23. no			
24. on			

Name_____ Sex_____ Group_____

wont	went	were	want*
on	one	no*	only
very	year	every*	ever
god	boy*	dog	box
always*	way	away	among
were	here	where*	ever
as	saw*	sat	was
those*	the	they	these
its	set	sit*	isnt
be	bet	bee	been*
many*	any	may	man
that	they*	hat	them

*Refers to words on flash cards; students were to circle on this sheet the word that matched the one shown on the flash card.

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