THE EFFECT OF COLOR-CODING ON SPELLING PERFORMANCE AND ATTITUDE TOWARD SCHOOL OF SIXTH GRADE STUDENTS

By

LINDA SUE BROWN

Bachelor of Science
Oklahoma Baptist University
Shawnee, Oklahoma
1966

Master of Education
Xavier University
Cincinnati, Ohio
1969

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 1989

THE EFFECT OF COLOR-CODING ON SPELLING
PERFORMANCE AND ATTITUDE TOWARD
SCHOOL OF SIXTH GRADE STUDENTS

Thesis Approved:

Paul O. Ward
Thesis Adviser

Paul M. Miller

David Slack

John M. Kirk

Martha Combs

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

The author wishes to express her appreciation to her thesis advisor, Dr. Paul Warden, for his guidance and encouragement throughout this study. Appreciation is also expressed to the remaining committee members, Dr. Paul Miller, Dr. David Lane, Dr. Jim Seals, and Dr. Martha Combs, for their invaluable assistance.

Appreciation is also extended to the elementary building principals and sixth grade teachers who agreed to have their classrooms involved. Gratitude is also given to Dr. Wendell Sharpton, Julia Martin, Dr. Bonnie Johnson, Dr. Susan Bowen, Dr. Cathy Burden, Mr. Richard Berumen, and the Pratt faculty, for their patience, understanding, and encouragement. A special note of thanks is given to Ho, who assisted with the SYSTAT statistical procedures, and Southwest School Supply, Tulsa, Oklahoma, for procurement of the colored pencils.

Warm appreciation is expressed to my family for their support. I share the excitement of completing this project with my husband, Bob, my son and daughter-in-law, Rob and Lisa, and my mother, Ruby.

Finally I dedicate this work to the memory of my father, Stanley, my uncle, Gene, and my nephew, Shane. From each of them I received the inspiration to help others.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The purpose of this study was to investigate the effect of color-coded spelling intervention on the spelling performance and attitude toward school of sixth-grade students. The color-coded spelling intervention was incorporated into the existing school district-adopted spelling curriculum and teacher instruction was not modified. Only the visual presentation and motorical reproduction of the spelling words was altered.

This study's investigation was based on the supposition that a color-coded intervention might allow increased attentive behavior and increased attending time when a student viewed and motorically reproduced a color-coded spelling word. Additionally, it was speculated that increased attentive behavior and increased attention time might strengthen encoding, visual imagery, visualization, and recall skills and might, therefore, enable the student to reproduce correct sequences of the letters of spelling words from memory. Thus, spelling performance might be enhanced and the resulting improvement in spelling grades might be associated with a more positive attitude toward school. Color-coding appears to be of significance to

study as an information-acquisition intervention since the active learner involvement using the visual-sensory modality is employed to attend to, encode, and visualize both tangible and imagined spelling words. In order to develop this thesis a comprehensive research of the literature in regard to color, attention, color vision, encoding, visual imagery, visualization, spelling, failure, and attitude was conducted. An introductive overview of each of these areas, beginning with color, is offered in this preface.

Color is widely used in instructional materials with the assumption by publishers that more knowledge will be learned and retained from colored materials than from black and white materials (Peterson, 1976). This assumption for the use of color relates to several theories of attention, learning, and memory (Anderson, 1976; Bandura, 1977; Hebb, 1955; Sperling, 1960; Thorndike, 1932;). Color has been found to aid in the retention of and the direction of attention to learning (Peterson, 1976; Zentall & Kruczek, 1988). Berlyne (1960) found color, among other stimulating determinants, to be responsible for increased attention. Johnston and Winograd (1985) suggest that the use of appropriate strategies tends to make tasks more readily accomplished. Salomon (1979) found that there was a direct relationship between the learning intervention and the sensory modality that was used to acquire the skill. Instruction using interventions has been found to improve

academic performance by inefficient learners (Harris & Graham, 1985; Pressley & Levin, 1986). Overall, children are unable to effectively ignore color (Black, 1967). However, intermediate grade level and primary grade level students responded to color for dissimilar reasons. Intermediate grade level students attended to color for its differentiating effect while primary grade level students responded to color its excitable effect (Black, 1967). Green and Anderson (1956) found that students were able to distinguish among symbols through increased attention due to the use of color.

There seems to be general agreement that efficient learning is a function of the level of attention to a presented stimulus (Berlyne, 1960; Dwyer, 1971; Zentall & Kruczek, 1988). Visual elements of a stimulus have been found to be important in processes of attention (Zentall & Kruczek, 1988), encoding, memory, and recall (Hintzman, Block & Inskepp, 1972; Light et al., 1975). Research by Dwyer (1971) and Zentall (1975, 1986), among others, found that color did increase the attractiveness of materials and, thereby, evoked more attentive behavior on the part of the learner.

Spelling is an encoding process that is dependent on recall of visualized imagery of words (Hanna, 1971). Hendrickson (1988) found that visualization aided spelling. Bruce and Cox (1983) found that poor spellers neglected a useful strategy of memorizing. Dean, Yekovich and Gray

(1988) found that orthographic features such as color differentially affected memory for spelling words. Kirsner (1974) showed that visually presented words were recognized significantly better than orally presented words.

Meichenbaum (1977), found that attitudes do, in fact, influence learning capabilities. Zentall (1986), among others, found that interference with initial learning resulted in academic failure. Academic failures were related to inabilities to employ efficient and organized (Wong, 1988) task-appropriate (Diener & Dweck, 1978; Torgesen, 1977, 1982), goal-oriented strategies (Winograd, 1984). Johnston and Winograd (1985) found that children experienced academic failure due to cognitive, or motivational, or affective deficits.

Past studies of color have focused generally on the effects of behavior, single-case or small group instruction, and the relationship of demographics such as gender and age to use of, or response to, color (Berlyne, 1960; Dwyer, 1971; Green & Anderson, 1956; Peterson, 1976; Zentall, 1975, 1986). Most of the evidence regarding color used in instruction has been obtained with adults rather than children (Black, 1967).

Proficient spelling and spelling words with equal facility are often elusive achievements for individuals (Allred, 1977; Paivio, 1971). Although spelling ability has been correlated with both reading skill and intelligence (Hillerich, 1976; Horn, 1969) adequate

intelligence and reading ability alone have not been able to guarantee success with spelling (Ehri, 1985; Firth, 1980; Ormond, 1985; Perin, 1983).

In regard to the present study it was wondered if sixth-grade students could be attentive to color and benefit from the differentiating effect of color-coding, as suggested by Black (1967), when taught spelling with a color-coding intervention. Could less interference occur during initial learning due to increased attention to the color stimulus? Could a color-coded intervention to teach spelling be task-appropriate, be goal-oriented, and allow for efficiency and organization? Could a student's orthological knowledge base, which has developed by sixth-grade (Henderson, 1977; Templeton, 1979; Zutell, 1979) be related to new spelling information (Gagne, 1985), through the use of color-coding spelling intervention? Could interest in a novel spelling technique increase motivation on the part of the learner to be actively involved in the learning process? Could color-coding serve as an intervention to develop information-acquisition? Could a more positive attitude toward school be the result of increased student involvement and performance success?

Findings by Dean (1983), Nilsson (1973, 1974), Paivio (1971), and Wicker and Everston (1972) question instructional interventions which rely totally upon auditory/semantic presentations and suggest that both orthographic and semantic features are encoded

simultaneously. Dean, Yekovich, and Gray (1987) recommend the addition of visual components to instruction to improve encoding and retrieval skills.

Spelling instruction using interventions has received little attention in the research (Harris et al., 1988). Allred (1977) and Paivio (1971) suggest that, because of the significant role of recall in spelling performance, strategies to train recall appear to have theoretical and practical implications for the teaching of spelling and merit research. It has been suggested that children could be trained to spell based on visualized orthographic information held in memory (Dean, Yekovich, & Gray (1988). Teaching children to focus on the process of using color to enhance attention, encoding, and recall might produce a concentration on the application of an intervention. However, the potential of focusing childrens' attention on the effectiveness of interventions has been neglected in the literature (Johnston & Winograd, 1985).

Attitude related to academic performance, for the most part, has not been directly measured (Greenwood, et al, 1987). More research directed at identifying specific instructional practices to increase a student's active involvement in the classroom that can increase academic performance and improve attitude toward school has been suggested by Greenwood (1987). Because of the implication of attitude on achievement it appears that attitude toward school is an important phenomenon to study (Greenwood,

1988; Klausmeier, 1985).

How to increase accuracy and achievement in spelling in the regular classroom was addressed by the introduction of a color-coded intervention into the existing spelling curriculum. Weekly spelling words or the letters of spelling words were colored in an attempt to increase a student's attention to, encoding of, and recalling of spelling words. Color-coding intervention was intended to facilitate the instructional process of spelling. The intervention used in the present study contained two color-coding interventions that were based on attentional aspects of learning theory. The color-coded intervention was an attempt to place a strategic intervention into an unsuccessful learning situation at an appropriate time in order to facilitate successful learning. The color-coded spelling intervention was meant to be an intervention incorporated classwide by a teacher with a minimum of intervention training. The visual component of color-coding was added as an intervention to develop encoding and retrieval skills. Visual-sensory modalities, in addition to auditory and semantic modalities were employed to motorically manipulate, encode, store, and recall spelling words. Students viewed color-coded words on wall charts as teachers presented the weekly spelling lesson from the current curriculum. Instructions presented by the teachers during this time were based on the current spelling texts with the addition of the color intervention.

Additionally, how to increase attitude toward school was addressed also by the color-coded spelling intervention as it related to spelling performance. It was presumed that affective deficits might bear a relationship to a more negative attitude toward school. If students were able to improve spelling performance when using a color-coded intervention then, perhaps, they would develop a more positive attitude toward school.

Statement of the Problem

The problem to be examined in this study was: How is the spelling performance and attitude toward school of sixth-grade students affected by a color-coded spelling intervention? Two experimental groups of sixth-grade students participated in the study. Two color-coding interventions were employed. One group was treated with a color-coding intervention that used color to highlight letters (vowels) of spelling words. This experimental group colored vowels of spelling words with colored pencils during the treatment. The other experimental group received a day color-coded treatment. This experimental group used one color per day to write all spelling activities. This day color-coded treatment was meant to be a placebo and was included to offset a threat to validity that might have been caused by one group of students being aware that a group was receiving special treatment. A control group of sixth graders did not receive either of

the color-coded treatments. A spelling achievement test and an attitude toward school survey were administered at the conclusion of the study and analyzed for significant differences between the groups. Scores on a normed group achievement test of spelling were used as a covariate. Spelling performance was operationally defined as scores on weekly classroom written spelling tests and the Test of Written Spelling (TWS) posttest. Attitude toward school was operationally defined as scores on the Survey of School Attitudes (SSA) posttest.

Limitations

This researcher acknowledged the limited generalizability of this study's results to sixth-grade students in regular classrooms and from similar communities.

Definition of Terms

Definitions of terms specific to the present study are represented in this section. Definitions at the conceptual level are presented first. Definitions at the operational level are presented in the second part.

Conceptual Level

attention -- a readiness to respond to stimuli.

attitude -- a learned, emotionally toned predisposition

to react in a consistent way toward persons, objects, and ideas.

imagery -- formation of an internalized model of sound, pictures, graphic representation, or movement upon presentation of a stimulus.

information processing -- a computer-simulation theory of behavior generally described as postulating the existence within the organism of an array of information-processing mechanisms, each of which performs a certain elementary function and is assumed to be organized and sequenced in some particular way.

intervention -- an interference that acts as an influencing force to offer mediation or modification.

memory -- the faculty of retaining and recalling information to mind or thinking of it again; the ability to remember.

spelling -- encoding speech or thought into written words.

visual processing -- interaction of the physical vision system with the nervous system and light rays to generate visual experience.

visualization -- the process of seeing or experiencing

again previously seen or experienced objects or events.

Operational Level

attention - for the purpose of this study, attention was the student's ability to attend to, to concentrate on the color intervention.

attitude - the student's like, uncertainty, lack of interest in, or dislike for school subjects as measured by performance on a school attitude survey.

intervention - the treatment of color-coding applied to the existing spelling curriculum and instruction during this study. Two levels, letter color-coding and day color-coding were used.

spelling - the student's ability to write words from oral dictation and the performance of this task as measured by performance on a spelling test.

Rationales

color:

- Color has increased attention to a stimulus to enable encoding (Green & Anderson, 1956; Zentall, 1988).
- Hebb's (1555) optimal stimulation theory, neurological

information processing theory, Thorndike's (1932) salience of stimulus theory, and Sperling's (1960) visual memory theory, appear to offer justification for the use of color in educational materials to allow for learning and retention to occur.

attention:

- Support for a verbal plus a visual color-coded spelling intervention comes from Jensen's and Rohwer's (1970) finding that audio-visual instruction with mnemonic elaboration and imagery are likely to maximize the amount of learning.
- A study which involves the use of color-coded spelling intervention to increase attention for learning appears warranted.
- Engagement in attention to task while copying words with colored pencils might assist recall.
- The use of color-coding to distinguish orthographic features of words might enable the attention of sixth grade students to increase during spelling.
- Sixth graders have been found to spell at a morphemic and syntactic level (Henderson, 1977; Sutell, 1979; and Templeton, 1979).

visual processing:

- Visual processing was found to be used even by poor spellers (Harris, 1988).

- Color might assist visual processing.
- A color-coded spelling intervention that used visual cues to organize colored letters of vowels might allow for visual information to be applied to a task.
- Invariant sound-spelling relationship difficulties might be lessened with additional visual information presented by color-coded words. memory:- Visual instruction plus imagery might maximize learning. - Sequencing memory might be trained through the use of color. - Visual memory might be enhanced by the addition of color to a task.

imagery:

- A relationship between the use of visual imagery and recall can assist learning (Paivio, 1971).
- Recall using visual imagery has facilitated spelling (Klinger, 1980).
- Few examples of spelling and the use of visual imagery are present in the literature.
- Imagery during the impress process of encoding and retrieval might be enhanced by color-coding.
- Imagery has enabled memory within the least time and with the least repetitive drill (Jensen & Rohwer, 1970); Paivio, 1971; Rohwer, 1970).
- There is a lack of existent research on methods for improving visual imagery (Allred, 1977).

visualization:

- Color-coding might assist the occurrence of visualization.
- Memorization of spelling patterns might be assisted by the presence of visualized, orthographic information.

information processing:

- Time involved in processing which colored pencils to use to write vowels of words might allow increased time for metacognition to occur.

intervention:

- A growing body of research indicates that instruction using interventions results in improved academic performance by inefficient learners (Hallahan, Lloyd, Kauffman & Loper, 1983; Harris 1986 a, 1986 b; Harris & Graham, 1985; Harris, Wong & Keogh, 1985; Pressley & Levin, 1986; Wong, 1985).
- Bruce and Cox (1983) have suggested that poor spellers should use the intervention of memorizing items.
- Salomon (1979) has found a direct relationship between sensory modality and learning interventions.

attitude:

- Attitudes have been found to influence learning (Klausmeier, 1985; Meichenbaum, 1977).

Research Hypotheses

1. Both a letter color-coded intervention and a day color-coded intervention used in spelling instruction will be more effective than traditional spelling instruction without color-coded intervention to increase spelling performance.
2. Both a letter color-coded intervention and a day color-coded intervention used in spelling instruction will be more effective than traditional spelling instruction without color-coded intervention to increase a positive attitude toward school.
3. A letter color-coded intervention used in spelling instruction will be more effective than a day color-coded intervention used in spelling instruction to increase spelling performance.
4. A letter color-coded intervention used in spelling instruction will be more effective than a day color-coded intervention to increase a positive attitude toward school.
5. A letter color-coded intervention used in spelling instruction will be more effective than traditional spelling instruction without color-coded intervention to increase spelling performance.
6. A letter color-coded intervention used in spelling instruction will be more effective than traditional spelling instruction without color-coded intervention

to increase attitude toward school.

7. A day color-coded intervention used in spelling instruction will be more effective than a traditional spelling instruction without color-coded intervention to increase spelling performance.
8. A day color-coded intervention used in spelling instruction will be more effective than traditional spelling instruction without color-coded intervention to increase attitude toward school.

Summary

In summary, the purpose of this study was to investigate the effect of color-coded spelling intervention on the spelling performance and attitude toward school of sixth-grade students. This inquiry was developed from the researcher's supposition that a color-coded intervention might allow increased attentive behavior and increased attending time when a student viewed and motorically reproduced a color-coded spelling word. Additionally, it was speculated that increased attentive behavior and increased attention time might strengthen encoding, visual imagery, visualization, and recall skills and, therefore, enable the student to reproduce correct sequences of the letters of spelling words from memory. Thus, spelling performance might be enhanced and the resulting improvement in spelling grades might be associated with a more positive attitude toward school.

This color-coded spelling activity would be meant only as an intervention into the existing spelling curriculum. The classroom teacher would maintain current instructional methods for spelling while continuing to use the school district-adopted text and teacher's manual during the study.

The problem of spelling performance has been consistent in its resistance to a simple solution for both students and educational scholars. While changes in curricula have been made, based on much previous research on spelling, questions remain concerning the importance of color and its relationship to the issue of spelling. The role of color in terms of its relationship to other factors in the learning process and methods to specifically access attention have yet to be defined in such a way to allow so teachers to use color methods for instructional purposes. The present study attempted to determine the relationship of color to spelling performance and attitude toward school. Specifically, color and the ability to access the color factor as related to the use of black and white (non-color) was researched. In addition, the relationship of an academic intervention to attitude toward school was investigated. A review of literature relative to color, spelling, and attitude toward school was conducted to offer empirical support for these relationships.

The present study will add to the existent research on the utilization of color and attention in spelling. The

visual sensory modality will be utilized with a color-coded spelling intervention. Focus will be on the process (color-coding) of obtaining the product (spelling performance). Color-coding to provide stimulus distinctiveness, to provide symbolically represented coding, to offer motoric reproduction opportunity, and to offer motivation and external reinforcement will be addressed by the present study.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This chapter contains a review of historical and current literature relative to color, spelling, and attitude toward school. Included in this review are theories of attention, spelling, information processing, and attitude. Empirical support for relationships between color and attention, attention and learning, learning and performance, and performance and attitude toward school are cited. The review's findings, are then summarized and suggestions are given to warrant the investigation of the present problem: the effect of color-coding on spelling and attitude toward school.

Relationship of Color to Attention

Although color has increased the production costs of instructional materials, publishers continue to use color in instructional materials based on the assumption that more knowledge will be learned and retained from colored materials than from black and white materials (Peterson, 1976). Most supplementary color found in printed materials

is in the form of color cues in children's materials (Peterson, 1976). One assumption for the use of color is that it increases the effectiveness and the attractiveness of the material (Zentall, 1985, 1986, 1988).

Theoretical justification for attention to instructional material affecting learning and retention may be found in theories of information processing, iconicity, visual memory, optimal stimulation, and salience of stimulus (Bruner, 1966; Hebb, 1955; Sperling, 1960; Thorndike, 1932). Two of these theories, optimal stimulation theory (Hebb, 1955) and salience of stimulus theory (Thorndike, 1932), appear to relate specifically to the use of color to create attention. Optimal stimulation theory suggests that there exists a biological need for an optimal level of stimulation while salience of stimulus theory suggests that attention is necessary for element selection within a stimulus. Each of these theories provide suggestions that efficient learning is a function of the presence of, and the level of, attention to a presented stimulus and its elements (Berlyne, 1960; Bower & Hilgard, 1981; Dwyer, 1971; Zentall, 1988).

Several studies, based on these theories, have researched the ability of color, as well as other variables, to facilitate attention and learning. Dwyer (1971) suggested that it was color which increased the attractiveness of visual material and thereby evoked attentive behavior which resulted in efficient learning

In support of this assumption, Berlyne (1960) found that color, among other stimulating determinants, was responsible for increases in attention to novelty. In relation to neurological processing, a novel stimulus evokes response in the relays of the input channel in the primary sensory cortex for that input channel (Bower & Hilgard, 1981). This response allows for perception to occur.

Children, as well as adults were found to be responsive to color (Brown & Campion, 1971; Corah, 1966; Corah & Gospodinoff, 1966; Katz, 1971; Katzman & Nyenhius, 1972). Black (1967) found that children were unable to effectively ignore color when responding to other cues and that the use of supplementary color with consideration of instructional practice conditions improved performance in training and transfer tasks. Peterson (1976), along with Zentall and Kruczek (1988), found that color aided in the retention of and the direction of attention to learning. Color was found to increase retention by Katzman and Nyenhius (1972) and Vandermeer (1954). Dean, Yekovich, and Gray (1988) found that orthographic features such as color may differentially effect what is remembered. The application of these findings to a color-coded spelling intervention to increase attention for learning appears warranted.

Zentall and Kruczek (1988) found sixth grade children to be less distractable than younger children. While younger children attended to color due to their

impulsivity, older children attended to color for its differentiating effect (Peterson, 1976; Zentall, 1988). Color has been found to direct and to increase attention (Katzman & Nyenhius, 1972) and facilitate task acquisition (Bourne & Restle, 1959; Peterson & Peterson, 1957; Saltz, 1963; Weiss & Margolius, 1954). When one component of a multiple compound stimulus was presented in color, in Bourne's and Restle's (1959) study, it facilitated task acquisition such as concept identification and paired-associative learning (Weiss & Margolius, 1954). Color also reduced search time and increased correct response time in visual tasks (Poock, 1969; Smith, 1963).

Color was proven to be more effective than black and white when used to emphasize differences (Vandermeer, 1954). Color was found to be superior to shape in tasks which involved locating displayed data (Christner & Ray, 1961; Hitt, 1961). McGeoch and Irion (1952) cautioned, however, that color cues would need to help differentiate and to not distract the learner's attention. Green and Anderson (1956) suggested that distinctions among symbols could be made by using color to increase attention. The use of color-coding to distinguish orthographic features of spelling words might enable sixth graders' attention to increase during spelling instruction.

Learning

It is generally agreed that one prerequisite for

efficient learning is to have the learner attend to the information being presented. Guthrie (1935) noted that learning appeared to accumulate with repetition. Active learning time (Bloom, 1974; Rosenshine & Berliner, 1978) and color usage (Dwyer, 1971; Smith & Thomas, 1964). were found to contribute to improved achievement (Frederick & Walberg, 1980). Miller (1957) described learning as a change in perception. Hale and Lewis (1979) defined the ability to pay attention and to allocate attentional resources effectively as the capacity to resist distraction, to selectively attend to certain aspects of the stimulus array, to maintain vigilance, or to engage in goal directed behavior. Similarly, Hunt (1980) stated that the capacity to learn was dependent on the availability of attentional resources to carry out processes of encoding in a brain-behavior relationship.

Simple methods may prove effective in dealing with children who have deficiencies in concentration. Bandura's (1977) theory of component processes, which he contends govern observational learning, provide a rationale for the variables and research design used in the present study. Bandura emphasized four interrelated subprocesses in his analysis of observational learning:

1. Attentional processes: the model stimulus must be attended to by the learner for learning to occur. A number of factors are known to influence this attention, including sensory abilities of the subject-observer as well as

stimulus distinctiveness of the model. Color-coding might provide stimulus distinctiveness.

2. retention processes: the model must be coded, symbolically represented and retained over time in order to exert influence upon the subject's behavior. Bandura and Jeffery (1973) and Gerst (1971) demonstrated that subjects taught a special verbal code for specific components of the model segmented, labeled, rehearsed, and were far superior to controls in their later ability to recall and reproduce the model. Color-coding might provide symbolically represented coding.

3. motoric reproduction processes: considerable motor practice through "cognitive rehearsal or "imaginary practice" is necessary to enable performance. Writing vowels of spelling words with colored pencils might offer motoric reproduction opportunities.

4. motivational processes: performance of responses would be perceptually reinforced externally, vicariously, or by self-reinforcement. An optimal training program could use this observational method in conjunction with differential reinforcement (Bandura, 1977). Improved spelling performance due to increased attention and encoding, which would be facilitated by color-coding, might enhance motivation through external reinforcement.

Information Processing

Research relating to brain-behavior relations in the

past was, at best, confusing. (Bastian (1898), and Hinshelwood (1900, 1909) provided evidence for neurodevelopmental deficits in an attempt to present a strict localizationist perspective of encoding/ decoding problems. Lashley's (1938) work, however, suggested that the brain acted as a whole. Orton (1937) refuted both localization and whole-brain notions by suggesting that the two cerebral hemispheres competed in the interpretation of visual stimuli as a result of incomplete establishment of cerebral dominance. A psycholinguistic-information-processing model was then developed and has been refined more recently by Newcombe (1973). In the psycholinguistic-information-processing model processing is defined in terms of encoding, processing, long-term and short-term memory storage, and retrieval. A rudimentary neuropsychological system has been theorized to explain these neurophysiologic-neurolinguistic processes. In this system visual stimuli is registered in the occipital lobes, where associations are made between visual stimuli and letter strings which form words. Although the left and right occipital lobes both have this function, it is believed that the right occipital lobe processes imageable or concrete words while the left may have more abstract processing abilities. In support of this concept, Galin and Ornstein (1972) showed that there was relatively greater EEG activity from the right to the left hemisphere when the subject was doing a task involving mental imagery.

Visual information is then shared with input from other sensory modalities in the angular gyrus, where the temporal, occipital, and parietal lobes juncture. This area is thought to be the region where phoneme-grapheme correspondence takes place (Figure 1). Although this neurolinguistic model may appear to be sequential, Hynd (1986) suggests that feedback loops probably exist which make the system recursive and that the efficiency of certain neural pathways varies considerably from one brain to the next allowing weak links to possibly result in impaired processes (Hynd, 1986). Physiological-neurological processing relates to perceptual information processing which is another aspect of brain-behavior interfacing.

Much of the earlier theoretical work regarding learning problems sought to identify a single deficiency factor. These single-factor theory models included deficits in cerebral dominance (Orton, 1937; Satz, Rardin, & Ross, 1971; Goldstein, 1975), perceptual processes (Lyle, 1969), temporal-order recall (Bakker, 1972), bisensory memory (Senf & Freundl, 1971; Seng, 1969), perceptual-motor matching (Kephart, 1967), and crossmodal integration (Birch & Belmont, 1964, 1965). Current research and theory regarding neuroanatomical correlates of learning now includes aspects of both neuroanatomical function and aptitude-treatment interactions.

Information processing theory suggests that visual

information requires attention and that memory storage and later recall will be more successful if mental imaging is employed (Bower & Hilgard, 1981; Anderson, 1976). Hunt (1983) wrote of three dimensions of information processing. The first dimension involved the ability to engage in basic mental operations of storage and retrieval. Information processing strategies of problem solving made up the second dimension. Verbal versus spatial encoding of information accounted for the third dimension. According to information processing theory, attention is a requirement for visual information to be processed by the brain. Information that is attended to enters into short-term memory storage through an input process called encoding. Neurological processes involved in retrieval or recall of encoded information are thought to be responsible for learning and memory (Anderson, 1976; Gagne, 1985). In order for the stored information to be retrieved it must first have left a sufficient memory trace in long-term storage. The encoded information, or memory trace, is retained in long-term memory if the bonding has been sufficient (Figure 2).

When a failure or breakdown occurs in the input and/or output phases of information processing it is theorized that the child (1) has interference with the bonding, (2) poor attentional behavior, (3) has learned the connections incorrectly, (4) exhibits poor visual figure-ground discrimination, sequencing, depth perception processing

and/or perceptual involvements, or (5) has not been sufficiently reinforced for responses (Gagne, 1970; Owens, 1987). Hynd (1986) theorizes that the load on the neurological system may make it difficult for a weak localized area to perform at an optimal level.

Owens (1987) suggests that short-term memory may be impaired due to poor attentional behavior on the part of the child. Several studies addressed possible factors for this poor attention behavior. Attention appeared to be related to the attentional effort to process target information and the kind of information used (Ackerman, 1987 a.). Lane and Pearson (1982) found that the more effortful and capacity-consuming the processing of the target, the less the residual capacity available to devote to inattention. Patterns of efficient selective attention were found to differ depending on whether the context was conceptually related or unrelated to the target (Ackerman, 1987 b.). Efficient recall was achieved by processing context and target information in an effortful interactive manner (Jacoby & Craik, 1979). Zentall & Kruczek (1988) found that copying tasks required sustained attention. The findings of these studies suggest that engagement in attention to task appears to be critical to recall and, therefore, a significant instructional variable to study. Since the use of color and copying tasks have been cited as being helpful to engagement in attention, perhaps the use of a color-coded intervention used when copying spelling

words might be viable to study.

Visual Processing

The central nervous system is one of two nervous systems of the human body that carries out communication functions of reception, processing, and storage through points of interaction between the nerve synapses. The highly organized cerebral cortex of the human brain is composed of nerve cell bodies and their synaptic connections that orchestrate the processes of focusing and shifting attention. Modality-specific alerting functions and memory functions are also contained in the cerebral cortex (Block & Miller, 1986). The recognition of visual stimuli is first set up in the inferotemporal cortex (Gross, 1973). An associating mechanism is present in the brain that allows for cross-modal associations so that, for example, a visual concept node may be connected to a touch concept node.

In the primary visual pathways, information is transmitted from the lateral geniculate nucleus to the cerebral cortex first, at the primary visual area (striate cortex or Brodman's area 17) and from there to the prestriate cortex (areas 18 and 19) (Haapasalo, 1982). Through a bilateral visual system, visual information is picked up by the retina of each eye and transmitted along separate optic tracts. These tracts meet at a juncture called the optic chiasm. After the juncture, the tracts

separate again, the left one projecting onto the left cerebral hemisphere and the right one projecting onto the right cerebral hemisphere. Fibers from the two entering tracts crossover at the chiasm. Approximately half the fibers of each tract cross over to the opposite tract as they emerge from the chiasm juncture. The fibers that cross are those that arise mainly from the half of the retina nearest the nose (Figure 3). Because of this cross-over of fibers at the chiasm, information from the nose side of the left retina is projected mainly to the right cortex, whereas information from the lateral left retina is projected to the left cortex. Visual information then moves on to the cerebral cortex where the two hemispheres are in direct communication with one another through a series of commissures, the fiber bundles that connect homologous structures on the two sides. The largest of these connecting commissures is the corpus callosum, a massive bundle of fibers interconnecting many parts of the two hemispheres.

Receptive fields of neurons in the striate cortex are the central mechanisms of vision. The receptive field of a cell in the visual system may be defined as a region of the retina (or visual field) which, when stimulated, can influence the firing of that cell (Motokawa, 1970) (Figure 4). The fibers which carry signals to these visual areas at the back of the brain produce the sensation of light (Padgham & Saunders, 1975). Padgham proposes that much of

the important information the brain receives comes through the visual sensory channel by way of the eye. It has been estimated that 85 percent of all information comes through this visual channel (Shapiro, 1988) (Figure 5). During meaningful vision the brain carries out at least five functions: integrating nervous signals, checking feeling, comparing steps with past experience, redirecting actions for the most constructive response, and abstracting representations or symbols and information from current experience (Hynd & Hynd,1984).

Related to neuroanatomical functioning, visual processing relies more on the right hemisphere of the brain (Hynd & Hynd, 1984) than on the left hemisphere. Neurophysiological components important to visual processing of information include the medial occipital areas of both hemispheres, the angular gyrus and Wernicke's Area of the left hemisphere (Hynd & Hynd, 1984).

Although less researched, evidence suggests that visual elements of a stimulus play a prominent role in both the encode and recall processes (Hintzman, Block & Inskepp, 1972; Light et al., 1975). Dean, Yekovich, and Gray (1988) suggested in findings from several investigations, that both the orthographic and semantic features of a given stimulus are simultaneously encoded by learners. Smith (1963) found that visual search was used extensively by subjects in practical situations. Dwyer (1971) found that the more qualities a visual shared with the object or

situation to be depicted, the more realistic the visual and, therefore, the easier to learn. These shared qualities included shape, size, color, etc. (Dwyer, 1971). Learners were found to have flexible search strategies that were easily modified by interventions or by practice (Haygood & Bourne, 1965). Dean, Yekovich, and Gray (1988) found that learners retrieved stimulus words on the basis of visual features. Subjects presented with a series of visual letter-like forms were able to remember pattern, and therefore, showed a processing capability to organize stimuli (Cermack & Craik, 1978; Anderson & Reder, 1979). Mandler (1967) and Tulving (1968) believe that learning and memory are accomplished by organization. Visual processing (Hanna & Hodges, & Hanna 1971) is used to determine the accuracy of an encoding process. Waters, Bruck, and Malus-Abramowitz (1988) believes that children are more sensitive to visual rather than to linguistic properties of spellings and so children do not use linguistic information in spelling but, instead, read out orthographic forms from visual memory. Although poor spellers relied on visual information, they did not sufficiently attend to it. Therefore, the visual information was not adequately processed into memory (Waters et al., 1988). Perhaps a color-coded spelling intervention that used visual cues to organize colored letters in spelling words would allow a practical way for visual information to be applied to a task.

Color Vision

Color, a subaspect of vision (Haapasalo, 1982), requires light energy and an intact visual system (Hurvich, 1981). The perception of color ordinarily derives from an interaction between physical light rays and the visual system of the living organism to see objects and perceive color (Hurvich, 1981). Color is effective as a coding dimension for information transmission in the visual domain (Smith, 1962). Possessing color vision means an organism can receive and handle a greater amount of information concerning its environment (Padgham & Saunders, 1975). The fundamental mechanism for color vision lies at the retinal level. The human eye has three cone receptors, blue, red, and green (Abramov, 1972). Almost all colors stimulate all three of these cone mechanisms to some degree Haapasalo, 1982) (Figure 6).

The visual field can be divided into zones. In the most central portion of the eye all colors are seen. Moving to the sides, the eye loses sensitivity to red and green. Hues are no longer seen at the periphery. Six fundamentally different colors are seen by the human eye: red/yellow/green/blue (the four unitary hues) and black and white (the two extremes of the series of hueless colors (Hurvich, 1981) (Table I).

The visual cortex of the brain further elaborates the color information with which it is supplied (Motokawa,

TABLE I

INCIDENCE OF COLOR CONES IN THE HUMAN EYE

cone color	wavelength absorbed	incidence
blue	short (450 nm)	1 million
green	medium	6-7 million
red	long (650 nm)	6-7 million

FREQUENCIES AND WAVELENGTH OF LIGHT
AND CORRESPONDING COLOR PERCEPTIONS

color	wavelength (nm)	frequency Hz x 10
violet	400	7.5
	450	6.7
blue	480	6.2
blue-green	500	6.0
green	540	5.6
yellow-green	570	5.3
yellow	600	5.0
orange	630	4.8
red	750	4.0

Source: Padgham, C.A. & Saunders, J.E. (1975). The perception of light and color. San Francisco, CA: Academic Press, p. 63

1970). Michael (1978 a, b, c) has classified the color-coded cells of the brain's visual cortex into four hierarchical classes, concentric, simple, complex, and hypercomplex cells: 1. concentric - first cortical stage in the integration

of color-contrast information receiving direct geniculate inputs,

2. simple - have direct connections from the opponent color concentric cortical cells and are sensitive to the stimulus presentation of two complementary color,

3.,

4. complex and hypercomplex - respond best to moving monochromatic bars or edges and are found in layers II, III, V, and VI and the most cells are driven with both eyes.

Two classical theories of color vision, trichromatic and opponent, have been verified by modern research and are useful in explaining color receptors and higher levels of the visual system (Haapasalo, 1982). Trichromatic theory (Young-Helmoltz Theory) is based on the fundamental assumption that at least three kinds of receptors are necessary for understanding of human color vision (Motokawa, 1970). Hering's Opponent Color theory assumes three pairs of visual substances are necessary for sensation, white-black, yellow-blue, and red-green (Motokawa, 1970).

Color Blindness

Because the present study employed color, prospective subjects were screened with pseudo-isochromatic charts for color defect. Fourteen of these subjects were found to be color defective and were not included in the final sample of the study. Physiological, genetic and actuarial information regarding color blindness is discussed here as additional literature research relevant to this study. Color blindness is divided into two categories, total and partial. Partial color blindness is further divided into three categories, protanopia (red blindness) deuteranopia (green blindness) and tritanopia (blue blindness) The first two are sometimes called red-green blindness (Motokawa, 1970).

It has been known for over 200 years that color deficiencies run in families (Hurvich, 1981). Grandsons seem to inherit the deficiency from color-normal daughters whose fathers were color-defective (Hurvich, 1981). The sex linkage of the inheritance of color deficiency accounts for the fact that there are more color defectives among males than among females (Hurvich, 1981) (Table II). Indeed in the present study, of the fourteen color defectives found through screening, ten were males.

Color defective persons lack an attribute of perception which may take on varying degrees of importance. Those who are color blind distinguish a fewer number of

TABLE II

INCIDENCE OF COLOR DEFICIENCY

	Incidence in Males	Incidence in Females
Caucasians		
Northern European American Australian	8.08 ± 0.26%	0.74 ± 0.11%
Asiatics		
Japanese Chinese Others (e.g., Korean, Philippino)	4.90 ± 0.18%	0.64 ± 0.08%
Other racial groups		
American Indian Mexican American Blacks Eskimo	3.12 ± 0.40%	0.69 ± 0.07%

VISUAL DEFECTS IN THE CAUCASIAN POPULATION

	Male	Female
Protanopes	1.0	0.02
Protanomalous	1.0	0.02
Deuteranopes	1.1	0.01
Deuteranomalous	4.9	0.38
Tritanopes	0.0001 (0.002?)	
Monochromats	0.003	0.002

Source: Hervich, L.M. (1981) Color Vision. Sunderland, MS: Sinauer Associates, Inc.

additive reds and greens. A mixture of many wavelengths appear different in color to the normal subject but appear identical to the color defective (Padgham & Saunders, 1975). Individuals who are color blind are at a severe disadvantage in situations where color is used to facilitate the communication of visual information or where color is used to stimulate (Padgham & Saunders, 1975). It is for these reasons that prospective subjects screened and found to be color defective were not included in the final sample.

Visual Perception and Color

Visual sensory input, known as perception, is interpreted in light of one's conscious experience of the environment (Padgham & Saunders, 1975). Perception encompasses the awareness of external surroundings, symbols, events, and objects by means of sensory processes. Perception is influenced by such things as prior experiences, knowledge, orientation (Shapiro, 1988), and emotions (Padgham & Saunders, 1975). Gestalt theory suggests that perceptual or conceptual groupings of material become the "psychological" units" in memory and recall (Bower & Hilgard, 1981; Padgham & Saunders, 1975). A theoretical justification for perception can be drawn from iconicity theory (Bruner 1966). The iconicity theory ("icon", image, standing for something) is a theory of cognitive development devised by Bruner that is based on

representation (imagery) through perceptual memory. Neisser (1967) relates iconicity theory to visual imagery. Tulving and Thompson (1973) believe that specific encoding operations performed on what is perceived determine what is stored, and what is stored determines what retrieval cues are effective in providing access to what was stored. Sevush (1983) postulates that visual-nonvisual components of perception are aspects of a pattern which also includes imageability components.

Imagery

Imagery is a popular research topic due to the acceptance of the cognitive view of information processing and memory (Singer, 1981). Imagery is recognized as one of the primary modes of representation of information in memory (Bower, 1972; Coopert & Shepard, 1973; Paivio 1971; Richardson, 1969). Mental imagery refers to internal representations which mimic sensory experiences in the absence of the actual sensory stimulus Gardner & Kurtz, (1979). Imagery is thought to be helpful in the impress process in both the encoding phase and the retrieval, or recall, phase of memory traces (Gagne, 1970; Gardner & Kurtz, 1979; Bower, 1985; Sarason & Sarason, 1987). Paivio (1972) identified five factors which relate to imagery and recall in regard to spelling. Four of these factors include: vividness, dual-coding (imaginal and verbal processing), organization processes (spatial and

sequential), and interference. A color coding process which creates vividness of vowel patterns in written spelling words might assist in imaginal and verbal dual-coding by spatially and sequentially organizing words. The use of imagery for recall was found to be subject to manipulation and was related to both the method of input of information and the subject's internal cognitive structures (Davis & Annis, 1980; Radaker, 1963; Canelos, 1982-83; Kuhn & Schroeder, 1971). Bakker (1972) contends that a shifting of attention occurs from one cerebral hemisphere to another, developmentally, as children employ different encoding/decoding (spelling) strategies. The right hemisphere is considered to be more perceptually oriented (Gazzaniga & Sperry, 1967). Ackerman (1987 b) found that sixth grade children preferred to receive information in perceptual form. Horng (1976) demonstrated that even those who had poor ability to form images themselves could perform almost as well as those who were able to form images with ease when imagery suggestions were provided to them. Horng's finding suggests that the use of visual imagery with color-coding might be effective since imagery suggestions could be provided through colored spelling words.

Kosslyn (1980) theorizes that images generated from long-term memory are not necessarily in pictorial form. Kosslyn's theory offers support for the imagery of abstract symbols such as letters rather than "pictures in the brain"

theories. Visual imagery was found to correlate with the meaningfulness of an item (Bersted (1983), Day & Bellezza, 1983; Masson & Miller, 1983), the items' concreteness or abstraction (Pezdek & Miceli, 1982), the rate of presentation for encoding, and the method of evoking a response through recall (Anderson & Bower, 1972). Imagery was found to enable memory within the least time and with the least repetitive drill and difficulty (Jensen & Rohwer, 1970; Paivio, 1971; Rohwer, 1970). Levin (1983) reviewed research on visual imagery strategies and found that, to be effective, a visual imagery intervention needed to be directly related to the learning task. Levin (1983) found that individuals displayed differences in their ability to successfully employ visual imagery. Radaker (1963), Kuhn & Schroeder (1971), and Canelos (1982-83) also researched effects of visual imagery. Radaker (1963) studied effects of visual image training on spelling with fourth graders. One group practiced imaging words printed in dark, glossy letters while the control group was given a period of socializing and conversation. Spelling achievement scores were found to be greater for the experimental group than the control group ($F = 5.18$ $p < .05$) over a treatment interval of one year. Kuhn & Schroeder (1971) combined oral and visual modes with a multi-sensory approach for a self corrected test method with fourth-grade and sixth-grade students. Results indicated that the visual test method was significantly superior to the oral test method.

Canelos studied the effects of three visual imaging instructional strategies on recall of free content materials. The nature of the materials were found to affect the subjects ability to abstract and internalize an image. Canelos (1982-83) concluded that reduction of irrelevant data in pictorial materials significantly affected recall.

Tulving (1968) recommended that students should image key concepts when learning initially and should recall those imaged key concepts during subsequent retrieval of the related information. Visual memory and imagery might be enhanced by the addition of color to the task. Support for a visual color-coded spelling intervention is lent by the suggestion that visual instruction plus imagery is likely to maximize learning (Jensen & Rohwer, 1970; Paivio, 1971; Rohwer, 1970).

Visual Memory

Three theories of visual memory have been utilized in research: iconic, memory cueing, and dual trace. Sperling (1960) believes there is a rapidly-decaying memory system which has an impressive capacity to store visual information, and Neisser (1967) calls this visual sensory memory or "iconic" memory. Sperling's (1960) theory correlates with Shapiro's (1988) finding that the majority of information received by the brain comes from the eye. The basic assumption of Neisser's (1967) iconic memory

theory is that learning will be more complete as the number of cues in a learning situation increase. Gagne (1985) advocates Neisser's theory and further states that when information is divided into subsets, the subsets, being fewer than the individual items, provide a way of keeping track of much information without actually having all of it in working memory at once (Gagne, 1985). Miller (1957) supports this assumption and proposes that the chance of an individual learning increases as the number of cues increase. Cued recall was found to be effective for strong part-whole relations (Watkins, 1974). In their memory cueing hypothesis, Cox and Griggs (1982) suggest that people reason better with realistic rather than abstract materials and have been found to perform better with a realistic version of the selection task. The third visual memory theory, the dual trace hypothesis, has been described by Bower (1972) and Paivio (1971). In this hypothesis there are two distinguishable, closely connected but different forms of representation, the imaginal and the verbal. Bower and Hilgard (1981) suggests that when a word to be remembered is shown, the subject enters a memory trace of it in verbal storage. A duplication of the imagined or heard word is remembered with two, redundant copies of the memory trace encoded into memory.

A current hypothesis for cognitive skills memory is that a complex memory is localized in the association cortex connected to the sensory cortex that was dominant

during the learning experience (Bower & Hilgard, 1981). Anderson (1976) and Bower (1972) theorize that recognition memory for an item depends on association established in long-term memory between the item and the contextual ideation in which the item was presented. McGinnis (1963) utilized an association method to emphasize the association of written forms of words with letter symbols.

Visualization

Visualization is the process of seeing or experiencing again previously seen or experienced objects or events. Processed visual information allows visual recognition that is developed through visual comparison, visual memory or recall, and visual imagery. These three components create the ability to visualize and is necessary for spelling skill (Hendrickson, 1988; Waters et al., 1988). Neurological information processing theory suggests that visual presentation enables visualization from memory. Gesell and Ilg (1949), Getman (1957-1965, 1960, 1962), and Henry (1965) argue that visualization is covert, abstract, learned, and thus trainable. Successfully spelling a word becomes a process of matching the word seen with the word visualized (Hendrickson, 1988). A spelling intervention might train letter sequencing memory through the use of color.

Padgham's and Saunders' (1975) and Shapiro's (1988) argument, that much of the information that comes to the

brain comes from the eye, correlates to Sperling's (1960) theory, which parallels neurological information processing theory and suggests that visual presentation enables visualization from memory. The use of visualization training by way of color-coded words might serve to allow unfamiliar or difficult spelling patterns to be read out of visual memory.

Spelling

A historical review of spelling does not relate directly to the purposes of this review of the literature and will be limited in scope. The purpose of this review is to demonstrate that although spelling has been carefully studied, there is limited information regarding the relationship of spelling performance and color. The review of literature provides a rationale for the examination of visual imagery, cuing, attention, neurological processing, and attitude as these factors relate to spelling performance.

Spelling was among the first curriculum areas to be critically evaluated Noah Webster (1857), the author of spelling texts used in American schools, sought, but failed, to simplify and standardize spelling in the hope of creating one-to-one correspondence between letter and sound. Research advanced by Thorndike (1944), Gates (1937), and Horn (1969), created the development of word lists based on word frequency. Study-test versus test-

study-test methods and the application of linguistic analysis in regard to spelling became the issues of the 1940's and 1950's (Fitzgerald, 1951). During the 1960's a federal project, Project 1991, developed spelling rules and programed a computer to spell based on those rules. Both the regularities and the inconsistences of American English spelling was revealed through the results of the Project 1991 effort. Historical research in spelling has focused on curriculum, spelling patterns, instructional methods and developmental patterns of error. Analyses of spelling have resulted in study lists, study activities and a systematic teaching of spelling generalizations. Hanna (1971) states that spelling is a systematic structural activity of awareness of patterns. Hodges (1971) and Allred (1977), along with Hanna, suggest that the spelling process is a system of rule generalization and that learning the generalizations will improve the spelling performance. Hendrickson (1967) suggests, however, that spelling is more a process of visualization or visual recall rather than one of learning rules. Templeton (1979) supports Hendrickson's suggestion that spelling acquisition is due to the development and use of a visual structure.

Neurologically, the left cerebral hemisphere is relatively specialized for active speech including reading, writing, and spelling, whereas the right hemisphere is more specialized for nonverbal perception and spatial reasoning (Gazzaniga & Sperr, 1967). The right hemisphere has

capability for passive visual recognition and comprehension.

Beers and Beers (1981) found that three assumptions are generally held regarding learning to spell. Two of these assumptions relate to the purpose of the present study: (1) the assumption that spelling success is based primarily on phonics knowledge, and (2), the assumption that spelling success is primarily a rote memorization process.

Isaacson (1987) cites four methods used traditionally to teach spelling: (1) auditory approach, (2) a visual approach, (3) a meaning approach, and (4) a combination of any of these approaches that might also include kinesthetics. The auditory method teaches a student to use phonetic skills or letter sounds to spell words. The visual approach teaches a child to look at word shapes (configurations) and letter clusters (morphemes). The meaning approach to spelling presents words grouped by the way they look (a common morpheme) or by a common topic or rule. The combination approach may use linguistics (word families) or a morphographic approach that involves meaning and/or syntax. The kinesthetic approach involves tracing on sandpaper, shaping letters out of clay, touch typing, or writing missed words several times. The present study involved the use of a color-coded intervention and combined the visual and kinesthetic approaches to teaching spelling.

Spelling ability appears to be a developmental

process. Waters (1988) found that the use of morphological information for spelling emerges relatively late with exposure to written language. Good spellers have knowledge of spelling conventions regarding orthographic words by 4th grade and this knowledge is a major determinant of spelling ability in children (Waters, et al, 1988). Beers and Henderson (1977) and Gentry and Henderson (1978) found that beginning writers used knowledge of phonetics but not phonics when they spelled. Henderson (1977), Zutell (1979), and Templeton (1979) concluded that there are developmental stages of learning to spell and those stages are prereading (less than six years of age); phonetic (first to third grade); orthographic (fourth grade); and morphemic and syntactic (fifth grade and on). It is generally agreed, therefore, that no single theory adequately explains the spelling process (Allred, 1977; Hanna, 1966; Hodges, 1971; Dolch, 1960; Gates, 1931; Fitzgerald, 1952).

Characteristics of Poor Spellers

Although interrelationships between reading and spelling problems are cited (Boder, 1970, 1973; Finucci, Isaacs, Whitehouse, & Childs, 1983), disorders of spelling do not continually correlate with problems in reading (Hynd & Hynd, 1984; Roeltgen, 1984). Research has yielded two subtupes of disabled spellers (Naidoo, 1972; Nelson & Warrington, 1974; Sweeney & Rourke, 1978). One subtype

exhibits reading and spelling deficiencies while the second manifests only spelling problems. These spellers are described as not utilizing lexical, or letter-by-letter, processing (Firth, 1983). Boder (1971) identifies three groups of poor readers by analysis of spelling patterns: dysphonetic, dyseidetic, and mixed dyslexia. Dysphonetic reader/spellers are also called auditory dyslexics by Johnson and Myklebust (1967). Students in this group tend to demonstrate bizarre spellings except for those words in their sight vocabulary (i.e.: mysife for myself; pleaol for people). These students seem to have primary deficits in auditory processing and do not respond to phonics training as a primary teaching mode. A whole-word strategy approach appears to be helpful for this type of processing deficit. Dyseidetic reader/spellers spell correctly only those words which are phonetically consistent. Many of their words are identifiable even though incorrectly spelled (i.e. huspetel for hospital). Johnson and Myklebust identify this group as visual dyslexics and recommend reading instruction which emphasized phonetic training. A systematic, highly structured phonetic approach appears to be helpful for this type of processing deficit. Boder's third group is termed mixed dyslexics and are most often nonreaders. Mixed dyslexics reflect characteristics of both the former two groups and tend to have difficulties resistant to most typical remedial techniques. Inability to read for this group will probably persist throughout adult life.

Multisensory strategy approaches appear to be helpful for this group (Boder, 1971). A. W. Young and Ellis (1981) are critical of labeling such as Boder's and suggest that, rather than being deficient, the poor speller may approach the task with quite different information-processing strategies and quite different knowledge bases.

Poor spellers appear to exhibit characteristics not associated with proficient spellers. Poor spellers were found to differ from good spellers in knowledge of sound-spelling correspondences (Treiman, 1984; Waters, et al, 1988) and of spelling conventions (Schwartz & Doehring, 1977; Schwartz, 1983). Bruck (1988) suggests that poor spellers rely on phonological information for word recognition because they have incomplete knowledge of spelling-sound correspondences. Poor spellers do not build up word-specific associations but, instead, continue to use phonological processes and to rely on inadequate spelling sound correspondence information for word recogniton (Bruck, 1988). Waters, Bruck and Abramowitz (1988) found that children have the most difficulty with spellings based on morphological information and the least difficulty with spellings based on invariant sound-spelling relationships. This difficulty might be lessened with the application of additional visual information to the child in the form of color-coded words. It has been found that poor spellers do rely on visual information but they do not sufficiently attend so visual information is not adequately processed

into memory. Bruce and Cox (1983) found that poor spellers neglect rote strategies in favor of rule strategies. They looked for rational characteristics of the task where none existed and, thereby, neglected the more useful strategy of memorizing the items. Even though rules are generally taught to facilitate spelling conceptualization, this finding by Bruce and Cox (1983) has shown limitations on the effectiveness of rules. If children could be trained to base spelling decisions on the presence of visualized orthographic information held in memory as Dean's (1988) research suggests, useful memorization might facilitate success in spelling.

Spelling Interventions

Despite its importance, there has been less research on spelling than on reading (Waters, 1988), and spelling interventions have received little attention in the research (Harris, et al, 1988). Research to date on spelling has focused on the degree to which children and adults use visual information (Waters, et al, 1988). It is considered by spelling researchers that a variety of approaches should be used in teaching spelling (Allred, 1977; Donoghue, 1979). Hanna (1966, 1971) describes spelling as an encoding process (while reading is a decoding process) that is dependent on recall of the visualized imagery of the word in the absence of visual clues. Klinger (1980) found that recall using visual

imagery facilitated spelling. Organization has been found to facilitate recall (Anderson, 1976; Gagne, 1978; Levin, et al., 1979; Stein, et al., 1982). It might be useful, during spelling instruction, to increase the probability that organization would occur (Gagne, 1985) by organizing vowel types by color. However, Stevens (1987) notes that the weekly spelling quiz format, used as a sole means of learning spelling words, often does not provide the spelling structure needed for spelling achievement. Hendrickson (1967) sees little opportunity for students to use their knowledge about written words because copiers do not have to think about what they are writing; they merely execute correct eye-hand coordination. It would appear that taking the time to change colored pencils to write various vowels of spelling words would allow for some amount of metacognition on the part of the learner. In regard to the writing process and its effect on spelling, spelling failure may be attributable to dysgraphia. For this reason sixth grade students presenting with dysgraphia due to poor fine-motor coordination were eliminated from the sample for the current study. Barsch (1974) suggests that visual imagery can be incorporated into an instruction strategy. Fitzgerald (1951) agrees that the student must develop some type of image in order to spell a word. Hynd (1986) suggests that if the grapheme-phoneme correspondence system is deficient, utilization of another word recognition pathway will be necessary. Harris and others

(1988) found that students recalled the correct spelling of more words when taught by a verbal-visual-kinesthetic study strategy. Visual-processing deficits can be strengthened by adding a kinesthetic component to the word-recognition task (Hulme & Bradley, 1984). The rationale for visual representation is that more spatial processing will be involved and would rely on right hemisphere processing strategies (Hynd, 1986). Visual-language methods rely on the use of strong visual clues which comprise various patterns of written spelling (Fitzgerald, 1966). McGinnis (1963) utilized an association method to emphasize the association of written forms of words with letter symbols. Although this research supports the contribution of visual imagery to spelling performance, there is a paucity of existent research on the utilization of imagery in spelling.

Failure

Relationship to Attitude

Because academic instruction places heavy demands on verbal abilities (Taylor, Fletcher & Satz, 1986), students in elementary school often begin to experience academic failure as early as kindergarten or first grade. This failure may continue through ensuing grades and may present with somatic, stress-related behavior and phobic reaction to school. Students who find themselves in vapid learning

environments may meet with few opportunities to respond and with little that is stimulating and challenging enough to hold their attention. Harris (1988) researched metacognition by investigating the effects of strategy training and differing strategy-use conditions on the development of specific metacognitive skills among learning disabled children. More research directed at identifying specific instructional practices to increase active involvement of the learner in the learning environment has been suggested by Greenwood (1987).

Relationship to Spelling

School subjects including spelling are often targets of failure for children. For a child, spelling difficulties may cause a negative association with writing, an attempt to shun writing situations, or to prolong written work production. The measurement of comprehension and skill in school is usually collected from a student in written form. When a student provides less written evidence of comprehension and skill, or provides written evidence riddled with misspellings, the result may be lowered marks. If grades continue to wane the student may become disinterested in school. An inferior skill, combined with declines in schoolwork, grades and school interest may result in learning failure.

For some children academic successes remain elusive. The extent to which social and environmental variables

contribute to manifest failure often present in anxiety, frustration, and lack of self-confidence in children. Repeated failure at school may partially contribute to low self-esteem, but the family's reaction to the child's learning problem is also critical. Excessive pressure at home, a curriculum that does not take limitations in basic competencies into account, or teasing from friends all potentially contribute to the child's poor performance. Theories regarding these neurological and environmental implications in learning failure may be applicable to spelling in the classroom (Taylor, Fletcher & Satz, 1986). It may be possible, then, that the cause lies either with the child, a pathological dysfunction, or with the child's amount of interaction with the school environment (Flavell, 1971; Gagne, 1985). Several theoretical explanations for failure have been proposed.

Theories of Failure

Failure theorists have suggested that inferior academic performance may evolve from the learning environment or the student. These possible causes for learning failure could be applicable to an academic learning environment for spelling. Johnston and Winograd (1985) suggest that poor students respond passively to interactive tasks rather than actively (Brown, 1980). An understanding of the concept of passive failure has evolved from research on attribution (Frieze & Weiner 1971;

Weiner, 1974), achievement motivation (Atkinson, 1957; Maehr, 1983; Weiner, 1972), and learned helplessness (Abramson, Garber & Seligman, 1980; Dweck, 1975; Seligman, 1975). Wong (in press) considers that some children may be better characterized as inactive learners whose major problems stem from their failure to use efficient and organized strategies to perform school tasks. Winograd (1984) believes that individuals fail, not because of a lack of ability to do the task, but because goal-oriented strategies are not employed flexibly and efficiently. Gagne (1985) theorizes that the cause of failure might be due to interference with initial learning. Torgesen (1977, 1982) suggests that some children are inactive learners who fail to spontaneously use efficient and organized strategies to perform school tasks. Brown (1980) suggests that the successful student is an active participant in his/her own learning. Johnston and Winograd suggest that the focus should be on the process rather than the product to offset passive failure in students. Delquadri (1983) has theorized that poor academic performance may be due to a lack of active involvement on the part of the learner in the classroom that occurs as a result of incomplete learning. He further postulates that poorly achieving students may not be able to learn due to a lack of opportunities provided in the classroom and, as a result of this, they grow to dislike school (Delquadri, et al, 1983). Torgensen (1977) suggests that learning failure does not

necessarily indicate a specific psychological process deficit in attention, short-term memory, or perception. Rather, performance decrements are viewed in different task settings as due to the student's failure to employ efficient strategies to accomplish the task (Torgensen, 1977; Flavell, 1971). Slavin (1984) agrees with both Delquadri's and Torgensen's theories and additionally hypothesizes that incentives are diminished by the repetitiveness of the tasks and lack of interaction with and feedback from the teacher or others.

These theoretical conditions of failure may result in practical spelling difficulties for students. Investigations of strategies that take into account neurological processing of information as well as classroom environment interaction may serve to foster positive attitudes and combat school failure.

Attitude

Because of its inherent implication on failure, attitude toward school appears to be an important phenomenon to study (Greenwood, 1988; Klausmeier, 1985). Negative experiences associated with school failure often occur to children (Jersild, 1963).

Students who appear resistant to learning are often described as being unmotivated, but Gagne (1985) counters that the lack of motivation might be a result rather than a cause. The cause of the lack of motivation might be due to

the cognitive domain, assisted by the affective domain, interfering with initial learning. Gagne proposes that this interference spawns resistance which operates as an obstacle, inhibits learning, and presents as a lack of motivation on the part of the student. Gagne's (1985) solution to this dilemma is to determine a student's knowledge of the subject and relate that knowledge to new information through the use of strategies. Gagne (1985) feels that much could be done through instruction or supplemental materials to increase elaboration and organization.

Klausmeier (1985) defines attitudes as learned, emotionally toned predispositions that are capable of becoming stronger and changing direction and are used to react in a consistent way toward persons, objects, and ideas. Klausmeier, too, suggests, as does Meichenbaum (1977), that attitudes influence students' learning capabilities and behaviors and that students are less likely to engage in inappropriate behaviors when they are actively engaged in academic behaviors. Klausmeier (1985) suggests that attitudes are capable of becoming stronger and changing in direction and contain an affective component which relates to the emotionality aspect of an object, person or idea and a cognition component which refers to one's knowledge about an entity. Affect is the first stage of reaction to stimuli and is also the first element retrieved from memory according to Zajonc (1980).

Therefore, perhaps failure experiences create negative attitudes and success experiences create positive attitudes to school subjects. If a color-coding spelling intervention improved spelling performance and, therefore, a success experience, perhaps a positive attitude toward spelling would have been created. The affect experienced at the time of the original learning is the first element to emerge during the retrieval process according to Zajonc (1980). Klausmeiers' (1985) affective components of attitude and Gagne's (1985) resistance theory, which were discussed earlier, and Zajonc's (1980) conception that original learning could be influenced by environmental affect appears to merit the study of color effects on spelling performance and attitude toward school. Since the interaction between a student and the classroom environment may provide some understanding of school failure, Harber (1980) has suggested that the ecological system and antecedent components involved in spelling instruction appear to be important variables to study.

Summary

Although this literature review supports the contribution of visual imagery to spelling performance, there is a paucity of existent research on the utilization of imagery employing color to teach spelling.

Teaching children to focus on process, through the use of color, might produce a focus on the application of an

intervention. Johnston and Winograd (1985) suggest that the use of appropriate strategies tends to make tasks more readily accomplished. The potential of focusing childrens' attention through the use of color has been neglected in the literature, although the importance of the intervention emerges in various studies (Peterson, Swing, Braverman, & Buss, 1982; Diener & Dweck, 1978). Salmon (1979) found that there was a direct relationship between the learning strategy and the sensory modality that was used to acquire information. Color coding appears to be of significance to study as an information-acquisition intervention since the active learner involvement using the visual-sensory modality is employed to attend to, encode, and visualize both tangible and imagined spelling words.

CHAPTER III

METHOD

Introduction

The primary purpose of this research study was to provide empirical evidence regarding the effect of color-coded spelling intervention on spelling performance and attitude toward school. Two color-coding treatments, one of which was a placebo, were studied. The spelling performance and attitude toward school of the students was measured by weekly spelling tests, the Test of Written Spelling-2 (TWS-2), and the Survey of School Attitudes (SSA), Intermediate Level, Form B. Scores on the Metropolitan Achievement Test (MAT) spelling subtest were used as a covariate. This chapter contains descriptions of the sample, instrumentation and research design. Data collection procedures and methods of analysis are described and discussed.

Sample

The research sample was comprised of sixth-grade students enrolled in a public school district in a town with an estimated population of 26,000 which is near a large southwestern city. The total student population of

the district was 5,000 and included students in grades preschool through twelve. Three hundred and forty-three (343) sixth-grade students were enrolled in 15 classes in one of five elementary buildings. Two of these classes were homogeneous while the other 13 were heterogeneous.

TABLE III

SIXTH-GRADE CLASSROOM DISTRIBUTION

Building	Total Number of Classrooms
1	2
2	6
3	2
4	4
5	1
Total = 5	Total = 15

All of the educational staff assigned as teachers for the sixth-grade were certified elementary education teachers. The established sixth-grade spelling curriculum is under the direction of the director of education for the school system.

Sixth-grade students had previously been assigned to one of the 13 heterogeneous classrooms by administrative

procedure. Enrollment in the heterogeneous sixth-grade classrooms was 291 at the time of this study. The basis of classroom assignment for the heterogeneous classrooms was not relevant to this study and therefore it was not considered to be a biasing variable. Current heterogeneous sixth-grade classroom assignments and 1988 Metropolitan Achievement Test (MAT) spelling subtest raw scores were made available by the school administration prior to the selection of the final sample for the current research. The 13 heterogeneous classrooms containing 291 sixth-grade students became the prospective candidates. A minimal sample of 160 was deemed necessary for statistical analysis.

Written permission to participate was requested for each of these 291 students. A parental consent form, along with a cover letter explaining the research study, and an addressed envelope (Appendixes A, B) were mailed to all parents of the 291 candidates. A return deadline of one week was requested. This sampling procedure yielded 222 replies (206 consents, 16 refusals) with a return rate of 76 percent. Demographic information from parental consent forms was collected to be used at the conclusion of the study to inform parents of each subject's testing results and implications for the treatment group of which he/she was a member. In addition, the following information was gathered and recorded on data collection pages for each of the 206 candidates by each of the 13 classrooms: student's

name, 1988 MAT spelling subtest raw score, sex, age, school, classroom teacher.

The 206 subjects who had parent permission were then screened with the Dvorine Pseudo-Isochromatic Plates Test for color blindness. Fourteen students (10 males and 4 females) were found to have abnormal color vision. A percentage of .0679 (.0485 males, .0194 females) was found in this population. None of the 206 potential subjects had auditory or fine motor-graphic disabilities, as reported by the school nurse or teacher, respectively. Twelve prospective subjects had no 1988 Metropolitan Achievement Test spelling subtest raw score. Two prospective subjects were receiving spelling instruction outside their respective classrooms in a learning disabilities resource lab. The distribution of the exclusions from the prospective sample elicited by screening is referenced in Table IV. The exclusion of these 28, therefore, created a final sample (Table V) of 178 sixth-grade students (74 males, 104 females), who met the following criteria:

(1) signed parent permission to participate in study
(2) enrollment in a heterogeneous sixth-grade class
(3) not receiving spelling instruction in learning disabilities
(4) 1988 Metropolitan Achievement Test spelling raw score
(5) found to have normal color vision and auditory acuity

(6) ability to print or write in cursive

TABLE IV

DISTRIBUTION OF EXCLUSIONS FROM
PROSPECTIVE SAMPLE BY CLASSROOM

exclusion	classroom												
	1	2	3	4	5	6	7	8	9	10	11	12	13
-L.D.	0	0	0	0	0	0	0	1	0	0	1	0	0
spelling instruction													
-no MAT	1	1	0	0	1	3	0	0	2	0	3	1	0
score													
screened for:													
abnormal color													
vision	0	0	2	2	0	1	0	1	3	1	1	1	2
Totals = ...	1	1	2	2	1	4	0	2	5	1	5	2	2

The resulting sample showing distribution by sex is referenced in Table V.

TABLE V

FINAL SAMPLE DISTRIBUTION BY SEX

	classroom												
	1	2	3	4	5	6	7	8	9	10	11	12	13
sex:													
Male	5	5	6	8	3	5	7	5	9	5	7	3	6
Female	6	7	8	8	10	3	10	15	5	11*	9	6	5
Subtotal	11	12	14	16	13	8	17	20	14	16	16	9	11

Total Males = 74
Total Females = 104

(* included one set of female twins)

The racial composition of the sample was White (139), Black, (4), Oriental (3), Native American (27), and Hispanic (5). The distribution of the sampled population by racial composition is referenced in Table VI.

TABLE VI

FINAL SAMPLE DISTRIBUTION BY RACE

	classroom												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Race:													
White	8	10	10	13	10	4	13	17	12	13	14	6	8
Black	0	0	0	0	0	1	0	1	0	1	0	1	0
Oriental	0	1	1	0	0	0	1	0	0	0	0	0	0
Native American	3	1	2	3	1	2	2	2	2	2	2	2	3
Hispanic	0	0	1	0	2	0	1	0	0	0	0	0	0

Total White =139
Total Black = 4
Total Oriental = 3
Total Native American = 27
Total Hispanic = 5

Age range of the final sample was 10-2 to 13-10 (mean age = 11-9) is referenced in Table VII.

TABLE VII

FINAL SAMPLE CLASSROOM AGE RANGES
AND SAMPLE MEAN AGE

day color-code class	x age	letter color-code class	x age	control class class	x age
1	11- 8	6	11-11	10	11- 8
2	11- 9	7	11- 8	11	11- 9
3	11-7	8	11- 2	12	12- 3
4	11-11	9	11-10	13	11- 9
5	11-10				
Total:		Total:		Total:	
5	11- 5	4	11- 3	4	11- 7

Age range 10-2 to 13-3
Total mean age = 11-9: (Total CA/N)

Instrumentation

Survey of School Attitude

The Survey of School Attitude (SSA); T.P. Hogan, 1972) was used as a pretest and posttest measure for this study (Appendix C). The SSA is a group-administered attitude test designed to measure whether students like, dislike, or are neutral toward a sample of curricular activities that they normally encounter in school. The test measures their affective reaction toward four major areas of the school curriculum - reading and language arts, mathematics, science, and social studies. Respondents indicate whether they like, dislike, or are neutral toward fifteen activities in each of the four areas.

Two levels (Primary Level for grades one through three and Intermediate Level for grades four through eight) and two parallel forms (A and B) are available. The Intermediate Level booklet, which is for students in grades 4-8, was used for this study. Form A of the Intermediate Level booklet was used as the pretest instrument and Form B was used as the posttest instrument. Both Form A and B have 60 items each and each form can be given in one sitting of 30 minutes.

Students may record their answers in the Intermediate Level booklets. Each written statement about the objective being illustrated (e.g., reading detective stories, doing difficult addition problems) is accompanied by a face with either a smile, frown, or a neutral or straight face. Each face is described in words, such as "Like," "Not Sure" or "Don't Care," and "Dislike." Students are guided in how to answer the sample items, but the examiner does not read the test to the examinees. A blank page is also included and contains a set of twelve blank boxes. On this page teachers are given the opportunity to add their own items, which enable users to supplement the type of information assessed on the test. The theory behind the SSA is that knowing a student's attitude toward a particular objective or topic area of a given subject is a valuable tool in examining the interests of a class.

The SSA was developed and field tested in 1972. During the initial development, Hogan experimented with

various response modes, presentation procedures, approximate timing, various content, and scale lengths, as well as having the students react to the pictured items in a test booklet and using a face format for students to record their answers on the answer sheets. During standardization in October, 1973, the SSA was administered to a sample of 13,500 students who approximated the natural school population on the variables of geographic region, socioeconomics, minority populations, and community size.

The SSA has been used in numerous correlational studies comparing attitude variables to achievement variables. The SSA could be used by psychologists in an educational context to assess the attitudes of students toward the content of what they are being taught. The test may be either hand or machine scores. The "Like" responses are scored 2, "Dislike are scored 0, and "Don't Know" or "Don't Care" are scored 1. A test can be scored in less than two minutes. The scorer calculates the total score for each of the four scales by multiplying "Likes" by 2 and "Uncertains" by 1.

The interpretation of the SSA is based on the objective scores made by the students on the test. There are two approaches. There is a criterion-referenced system in which the scores can be translated to "Level Scores' that indicated the degree to which a student likes or dislikes a curricular area. Percentile ranks are used in the norm-referenced interpretation which indicates whether

a student "likes" or "dislikes" a curricular area more or less than students in the same grade (Hogan, 1975, p. 19). The percentile rank corresponding to a given raw score represents the percentage of students in the norm group who obtain scores equal to or less than the given scores.

The split-half reliabilities corrected by the Spearman-Brown formula on the Primary Level range from a low of .80 for science to a high of .91 for mathematics in the fourth grade. The Alpha coefficients are slightly higher with a few coefficients in the .90'3. Most coefficients fall in the .80's.

Test-retest results across forms were on a ten-day interval across grade levels for one school district. The coefficients ranged from a low of .58 for science to a high of .85 for reading and mathematics sections of the Primary Level. On the Intermediate Form and the alternate form the coefficients ranged from a low of .74 on social studies to a high of .83 on mathematics.

The construct validity of the test is supported through results from the factor analysis of the instruments and the intercorrelations between the scales. The achievement SSA correlations reported across grades seldom exceeded .30, indicating that the scale is independent of student achievements. The test functions effectively with minority groups and, therefore, is not considered to be culturally or sexually biased (Drummond, 1985, in Educational Testing Service Test Critiques, Vol. II,

p. 663-639).

The SSA was selected for its emphasis on attitudes toward school. Pre and posttesting using the SSA was conducted in each of the 13 classrooms by the author prior to and at the conclusion of the treatment phase of the study.

Test of Written Spelling-2

The Test of Written Spelling-2 (TWS-2, Larsen & Hammill, 1986) was used as both a pretest and a posttest in this study. The TWS is a norm-referenced test designed to assess the spelling of students in grades one through twelve. The TWS-2 is comprised of two subtests. The first subtest assesses spelling for "predictable" words (those which conform to common English orthographic rules), while the second subtest assesses spelling for "unpredictable" words (those which do not conform to orthographic rules). Test results are reported in terms of standard scores and percentiles. The TWS-2 is a revision of an earlier test, The Test of Written Spelling (TWS), (Larsen & Hammill, 1976). The TWS-2 is based on the correct written spelling of words. The TWS-2 employs a dictated words format in which the student spells the test words from oral dictation.

The TWS-2 item were selected from a pool of 17,000 frequently occurring words which had been studied for extent of phoneme-grapheme correspondence (Hanna, Hanna,

Hodges, & Rudorf, 1966). It was found that the correct spelling of approximately one-half of the 17,000 words could be predicted using 2,000 orthographic rules. The remaining words were unpredictable in terms of orthographic rules. The authors of the original TWS then compared spelling words commonly taught in elementary and junior high schools with the words from the Hanna study (Hanna et al., 1966). They identified the words in the original pool that were taught in all ten of the most commonly used basal spelling series of the mid 1970's. These procedures yielded 126 possible spelling words for an experimental version of the TWS. The experimental TWS-2 was given to 878 students in grades one through eight, and the 126 items were analyzed for validity and difficulty. Based on these analyses the final version of the TWS-2 was reduced to 60 spelling words grouped into the two subtests.

The TWS was revised for two reasons: to expand the test for use with upper-level students and to strengthen the weak reliability for the test at the lower age ranges. For the TWS-2, various words were selected from current basal readers and a reading core vocabulary list (Taylor et al., 1979) for use with the lower grade levels, and from the English Dictionary of Language lists for the upper grade levels (for which basal readers are not written). A total of 145 predictable and unpredictable words were originally selected. These were reduced through item analysis to a final version of the TWS-2 that contained 100

words (50 predictable and 50 unpredictable).

The experimental words in the TWS-2 were administered students in first through twelfth grade using the dictated word test format. Two measures of item analysis were used: through item discrimination procedures, words that did not have a point biserial correlation with the total test score of greater than .3 were eliminated; through item difficulty procedures, words that could not be spelled correctly by 15% of the sample , or were spelled correctly by more than 85% of the sample, were eliminated.

The final 100-word version of the TWS-2 was standardized on 3,805 students in first through twelfth grade in 15 states. Characteristics of the normative population were roughly comparable to national characteristics with respect to sex, race, ethnicity, geographic area, and urban versus rural residence. The resulting normative tables are reported in the manual in terms of standardized scores (also referred to as quotients) with a mean of 100 and a standard deviation of 15, and in terms of percentiles based on scores obtained from the normative population.

Test validity of the TWS-2 was established through measures of content, criterion-related, and construct validity. Content validity of the test was examined using a sample of first- through twelfth-grade students drawn from the standardization population. Median item discrimination for predictable and unpredictable words

combined ranged from .48 (for the first-grade words) to .70 (for the twelfth-grade words). Median item difficulty for the total test ranged from 0 percent (for the first-grade words) to 83 percent (for the twelfth-grade words). In general, item discrimination coefficients were comparable for the predictable and unpredictable words, whereas item difficulty measures were slightly higher for predictable words than they were for unpredictable words.

The item discrimination values indicate that the TWS-2 words can be used to discriminate between good and poor spellers. The mean percentages of item difficulty are generally in the acceptable range for fourth through tenth grade. However, the content validity at the lower and upper age ranges is suspect due to extreme values of item difficulty.

Measures of concurrent validity were used to evaluate the criterion-related validity of the TWS-2. Correlations for spelling words used in both the TWS and the TWS-2 were .91 for the predictable words subtest, .93 for the unpredictable words subtest, and .93 for the total test.

When the TWS-2 was compared with four other standardized spelling tests, correlations ranged from .82 to .97 for the spelling subtests of the Durrell Analysis of Reading Difficulty, the Wide Range Achievement Test, and the California Achievement Test. The correlation of the TWS with the SRA Achievement Series Spelling Test ranged from .72 to .81. These lower correlations are possibly the

result of the format of the SRA test used in determining concurrent validity, which uses a multiple-choice proofreading rather than a dictated-word format. The TWS-2 has been found to have a higher correlation with the criterion of correct spelling in written work than recognition tests such as the SRA (Croft, 1982).

Construct validity for the TWS-2 between age and predictable subtest scores, unpredictable subtest scores, and total test scores are .62, .63, and .64, respectively. The TWS-2 is also reported to discriminate between ability groups.

Test reliability for the TWS-2 was examined with measures of internal consistency, standard errors of measurement, and test-retest reliability. Internal consistency coefficient alphas from the normative data range from .86 to .97 for the separate predictable and unpredictable subtests, and from .92 to .98 for total test performance. Standard error of measurement accounted for a maximum of 85 percent of the variance in the scores and ranged from one to three words for the separate predictable and unpredictable words scores and from two to four words for the total score. Test-retest reliability ranges from .86 to .98 for the separate subtests and from .91 to .99 for the total score. The magnitude of these correlations of reliability demonstrate good reliability for the TWS-2. The TWS-2 may, therefore, be considered to be a reliable assessor of spelling ability (Varhagen, 1985, in

Educational Testing Service Tests Critiques, Vol. II, p. 485-493). The TWS-2 was selected to administer to measure spelling skill (Appendix D).

Weekly Spelling Tests

Six weekly spelling tests given in the 13 classrooms during the treatment phase were taken from the basic word lists of the Spelling Words and Skills, 6th grade level (Scott, Foresman, & Company, 1985) spelling textbook Only words from the content words (words from content areas of social studies, math, health, science, the arts, language arts, and physical education) and the "wild words" (unpredictable) lists were scored for the purposes of this study. The spelling instruction and text were part of the normal sixth-grade curriculum for the school district.

The basic word lists are a result of a study conducted by Scott, Foresman, and Company in 1976 with a sample of 4800 students' composition samples in grades one through eight and representing 49 states. The following procedures were used to develop the basic word lists: a random 50-word sample from each paper was marked off; each misspelled word was noted and the correct spelling was written in front of the misspelled word; the material was put on a computer; the print-out was studied to determine words children used in their writing, words they misspelled, and how they misspelled the words. In addition

to phonics and structural analysis, some lessons in each grade feature words whose spelling problems are related to usage problems, such a homophones. Spelling lessons 12 through 17 were used for this study.

Dvorine Pseudo-Isochromatic Plates

The Dvorine Pseudo-Isochromatic Plates, Second edition, (DP-I), (1953), was used to screen the potential sample for color blindness. The DP -I, by Israel Dvorine, is published by The Psychological Corporation. The DP-I consists of two sections. Section one contains one demonstration plate (number 48 in red on a blue background) and 14 plates made up of eight different color combinations arranged in pairs of identical colors. Section two contains one demonstration plate (a blue trail on a red background) and 7 plates featuring trails instead of digits; each of these plates consists of different color combinations, but similar to the color combinations of the first section. The second section may be used to test pre-school-age children and illiterates, or as a corroborative test when an individual fails to identify the plates of the first section. Best results are obtained when the illumination of the plates approximates that of daylight. The plates are held about 30 inches in front of the patient. After being shown the red number 48 of the demonstration plate, the patient is instructed to call off the numbers of the 14 plates that follow. No more than 5

seconds are allowed for the identification of each plate; and hesitant, studied responses, or tilting and turning of the head should be noted and recorded. Behavior of this nature is generally associated with defective color vision. A similar procedure is to be followed with the second section is used, with one exception. The patient should be furnished with a thin brush or other non-scratching pointer and directed to outline or trace the trail on the demonstration plate and the seven trails that follow it.

The Nomenclature Test of the DP-I is given to test the patient's knowledge of names of colors. The Nomenclature Test is given by rotating the disk to expose each of the eight circles of color. The responses, both to saturated and unsaturated colors, should be recorded. If a patient names the colors on the disk correctly but fails the general color test, he still is to be classified as color blind; for many color blind individuals learn to name the colors correctly by their brightness instead of their hue. Occasionally, a patient may pass the color discrimination test but fail to name correctly the colors of the circles on the rotating disk. This indicates that the patient is not color blind but that his/her knowledge of color names is faulty.

The advantages in the use of pseudo-isochromatic plates as a color-blind test are many, the chief ones being: ease of operation, convenience and the saving of time. There are also disadvantages, as in all tests. The

most frequent error is figure-ground confusion by otherwise normally seeing individuals. The exact cause of this antipathy to certain color combinations is not known. Incorrect grouping by the patient may be a contributing factor. It may also indicate slight variations from typical sensitivity. The identification of one digit in a plate which has two digits shall constitute an incorrect response. Tracing only one part of a trail instead of the entire trail shall also constitute an incorrect response. Incorrect responses to two or less plates of the first section are probably due to figure-ground confusion and the individual is to be considered as having normal color vision. Incorrect responses to three or more plates of the first section of this screening test indicates red-green defective vision. Incorrect response to one plate of the second section of this test is to be considered normal color vision. Incorrect responses to two or more plates of the second section is to be considered defective color vision.

There are two types of red-green defective vision known as protanoid and deuteranoid types: the first is associated with abnormal appreciation of luminosity, the second with normal. Plates 6, 7, and 19 are diagnostic for these two types. The protanoid type identifies the digits five and six of these plates and can trace the right half of the trail, but fails to identify the first digits and the left half of this trail, or sees them only faintly.

The deuteranoid type identifies the digits 9 and 2 of the above named plates and can trace the left half of the trail, but fails to identify the second digits and the right half of this trail, or sees them only faintly.

Treatment Procedures

The 13 heterogeneous classrooms were randomly assigned to one of three treatments: a letter color-coded spelling intervention treatment, a day color-coded spelling intervention treatment, and no treatment. Random assignment of the 13 classes to the three treatments was made by the use of a random numbers table. As a result of this random assignment, four classes were assigned to the letter color-coding intervention treatment. There were 66 students (27 males, 39 females) in this treatment group. Five classes were randomly assigned to the day color-coding intervention treatment. There were 60 students (26 males, 34 females) in this treatment group. Fifty-two students (21 males, 31 females) made up the group of four classes randomly assigned to the control group which received no color-coding intervention treatment.

Although the 13 teachers who participated in this study had never instructed with a color-coding intervention, adaptations of color-coding intervention had been used previously in this school system by a school psychologist and several special education and regular classroom teachers. A learning disabilities teacher

reportedly adapted color-coding intervention to a math application for regrouping in addition, subtraction, and multiplication classwork with first through third grade students. Spelling and decoding adaptations included color-coding syllables, mini-words within a word, and prefixes and suffixes. Successes reported for these color-coding interventions had not been formally evaluated prior to this study.

The two experimental groups and the one control group were exposed to a total of 23 sessions (4 days for five weeks and three days for one week) and used one of three intervention treatments. All treatment sessions occurred during the subjects' regularly scheduled spelling period. Each of the 13 classrooms comprising the three groups in the study met in their respective classroom with their respective teacher daily. Each day of the study one group studied spelling using a letter color-coded intervention, one group studied spelling using a day color-coded intervention, and one group studied spelling using no color intervention. Posttests on all instruments used to measure the dependent variables were performed within one week following the end of the color-coded spelling training. Subjects were tested in their respective classrooms by the author.

The purpose of the color-coding intervention utilized in this research was to focus on color perception, attention, and recall as functions of information processing. Two

treatment methods, related to the attention factor were developed: letter color-coding and day color-coding. The treatment and the control procedures were carried out using identical procedures at each elementary building in the sample. A letter color-coding system, originally developed by Johnson (1977), used color to enhance vowel, syllable, or prefix/suffix patterns. Johnson's system was modified by the author (1988) to emphasize vowel patterns, since decoding dysfunction has been suggested to be indicative of vowel pattern mis-sequencing (Boder, 1970).

The modified letter color-coding spelling intervention used in this research consisted of writing the vowels of spelling words in color and is described in Table VII. Basic spelling words of weekly spelling lessons taken from the classroom spelling text were color-coded on large posters by the author according to the rules of the letter color-coding system. A manila poster containing the week's word list was used by the classroom teacher during spelling instruction and by the students during written spelling activities. Intervention for the letter color-coding group consisted of the following procedure. As students viewed the color-coded spelling words on the poster, the classroom teacher interacted by using normal spelling instruction. Independent practice consisted of students using colored pencils to write the vowels and graphite pencils to write the consonants of each word five times and to complete spelling workbook activities. A second level

of color-coding engaged students in color-coding all written activities associated with the weekly spelling word list by using only one color per day. The intervention consisted of four colors which were used, one per day. Words were presented on a large poster with all letters printed in the color for the day. Each poster was used by the classroom teacher during spelling instruction and by the students during written spelling activities. Intervention for the day color-coding group was meant to be a placebo. The use of one color per day resulted in elements of the color-coding embedded within this particular color-coding intervention. As students viewed the colored spelling words on the poster, the classroom teacher interacted by using normal spelling instruction. Students then used one color of colored pencil each day to write the vowels and the consonants of each word five times and then to complete spelling workbook activities. The treatment phase was conducted for a period of six weeks.

Letter Color-coding System

The Letter Color-coding System, comprised of six colors coded to vowels and vowel patterns, was designed for implementation with sixth-grade students. The six hues chosen for the system were selected based on ease of viewing within the visual field and on attentional value. The letter color-coding system was designed by the author (1988) to compliment the orthographic and phonetic

rules emphasized in the existing spelling text and curriculum which was being used by the teacher.

TABLE VIII

SELECTION OF COLORS FOR COLOR-CODING SYSTEM

hue	ease of viewing	attentional value
green	center	high
red	near-center	high-medium
orange	near-center	medium
yellow	near-center	medium
blue	outer center	medium-low
purple	outer	low

sources: Padgham, C.A., & Saunders, J.E. (1975). The perception of light and color. San Francisco, CA: Academic Press.
Hurvich, L.M. (1981). Color Vision. Sunderland, MA: Sinauer Associates, Incorporated.

TABLE IX

LETTER COLOR-CODING SYSTEM

*Green:	long vowel (eg: date)
*Red:	short vowel (eg: pencil)
*Orange:	double, twin long vowels (eg: seek)
*Yellow:	silent vowel at end of word (eg: time)
*Blue:	double, twin short vowels (eg: book)
*Purple:	silent vowel within word (eg: beach)
*Black:	all consonants

* Each of these colors were selected based on an analyses of data related to the spectrum of visible color and availability of pencils in these colors

source: Johnson, B.B. (1977).

Each subject in the letter color-coded intervention group was given a box containing seven colored pencils which were used for writing spelling words during the study. Replacement pencils were supplied by the author during the treatment when needed. At the conclusion of the study subjects were allowed to keep the colored pencils for their own use. Each week students used the appropriate colored pencils to coincide with the colors coded on the classroom spelling words chart. Subjects wrote each of the twenty spelling words three times on Day One of the

treatment. Days Two through Four subjects completed workbook pages using the colored pencils to write vowels of spelling words in the week's list. On Day Five all subjects who were receiving the word color-coding intervention treatment were administered an orally dictated written spelling test over the week's 20 spelling words by the classroom teacher. Subjects used black or blue pens or pencils to write words during the written test. The six letter color-coded spelling word lists used in the treatment appear in Appendix E.

Day Color-Coding System

The Day Color-coding intervention was intended to be a placebo treatment in the study to offset the effect of some subjects being aware that another group was being treated differently (Gay, 1981). The Day Color-coding System, comprised of four colors coded to days of the week, was designed for implementation with sixth-grade students. The four hues chosen for the system were selected based on ease of viewing within the visual field, and availability of the large number of pencils in the colors which were required. The day color coding spelling treatment consisted of a system of writing the spelling words in a different color each day. A large poster of the day and color assignments according to the rules of the day color-coding system was used by the classroom teacher during spelling instruction and by the students during written spelling activities.

TABLE X

SELECTION OF COLORS FOR
DAY COLOR-CODING SYSTEM

hue	ease of viewing	attentional value
green*	center	high
red*	near-center	high-medium
blue*	outer center	medium-low
purple*	outer	low

*Each color was selected based on an analyses of data related to the spectrum of visible color and the availablity of pencils in these colors.

Sources: Padgham, C.A., & Saunders, J.E. (1975). The perception of light and color. San Francisco, CA: Academic Press.
Hurvich, L.M. (1981). Color Vision. Sunderland, MA: Sinauer Associates, Incorporated.

TABLE XI

DAY COLOR-CODING SYSTEM

DAY ONE --- Green
DAY TWO --- Red
DAY THREE --- Blue
DAY FOUR ---Purple

Each of these colors were selected based on analyses of data related to the spectrum of visible color.

Colored pencils were used for writing the words. Each subject was given four pencils representing each of the four colors used in the treatment. Additional pencils were made available by the author when needed. Subjects were allowed to keep the colored pencils for personal use at the conclusion of the study. Subjects wrote each of the twenty spelling words three times on Day One of the treatment using red. During Days Two through Four subjects completed workbook pages and wrote spelling words using the assigned color of pencil for the day. On Day Five all subjects who were receiving the word color-coding treatment were administered an orally dictated written spelling test over the week's 20 spelling words by the classroom teacher. Subjects used black or blue pens or pencils to write words during the written test.

Creative Writing Samples

Nine informal creative writing samples were obtained from each subject by the teacher. A creative writing sample was elicited from each subject each week for nine weeks. Two creative writing samples were taken prior to the intervention treatment, six creative writing samples were taken during the intervention treatment phase, and one creative writing sample was obtained three weeks after the conclusion of the intervention treatment. Students were asked to write about topics of personal choice.

The creative writing samples were studied to determine if

the color-coding intervention might show generalizability to spelling when writing informally. The writing samples were taken to be analyzed at a later date for number of misspelled words compared to total number of words per writing sample. Comparisons would then be made of the pre- and post-treatment samples.

Topics for these informal creative writings were chosen by the students from a variety of suggestions given by the classroom teacher. The creative writing samples were not revised for misspellings. The writing samples were collected to measure the effect, if any, of color-coded intervention on spelling carryover. Sample numbers one, and nine were analyzed for pre-post differences.

Research Design

A quasi-experimental pretest-posttest-control-group design was used with three groups of classrooms randomly assigned to the conditions. The following is a representation of this design.

O	X_1	O
O	X_2	O
O		O

The combination of random assignment to treatment and the presence of a control group served to control for all sources of internal invalidity except mortality (Gay, 1981). Only sixth-grade students were included in the

sample to control for grade differences related to effects of experience and maturity (Zutell, 1979). Mortality was not considered to be a serious threat due to the study's relatively short treatment time of six weeks. Simultaneous experimental and control sessions and randomization of the experimental occasion were possible in this study and, therefore, history was not a threat to its internal validity. To accommodate a deprivation effect, one experimental group received a day color-coded treatment which was meant to serve as a placebo treatment in the study. A threat to external validity was considered to be limitation in this study. The experimental treatments of letter color-coded intervention and day color-coded intervention and the control treatment of traditional spelling instruction were administered by the classroom teachers in an effort to minimize a reactive arrangement effect. The students' awareness that they were participating in a research study, plus the somewhat artificial setting created by the color coding experiences may have been a threat to external validity. The student awareness of research participation and the artificial setting created by the color-coding may have had an additive effect on treatment results through novelty (Campbell & Stanley, 1963).

Procedure

The students met as a classroom unit with their

respective teachers to receive spelling instruction. The 178 students in the sample each attended one period of spelling instruction daily. The specific daily scheduling of the spelling instruction was flexible and allowed for consideration of the daily activities of the sixth-grade curriculum and the elementary building. All of the spelling instruction was given to students of the same grade level for an uninterrupted period of 30 minutes per day. Spelling instruction and weekly spelling tests were given by the same teacher. The role of the classroom teacher as the instructor using the intervention allowed for opportunities throughout the day when the teacher would naturally bridge between concepts discussed within the spelling instruction and a particular class activity. Weekly written spelling tests consisted of standardized words from the curriculum text and were intended to measure recall from orally presented words.

One experimental group in this study received letter color-coded spelling intervention, while the other experimental group received day color- coded spelling intervention. The control group was taught in the same manner as during the pre-treatment period, oral presentation of the week's spelling word list by the teacher, workbook assignments and individual study for the trial test and the final test over each word list.

The independent variable was treatment (letter color-coded intervention, day color-coded intervention placebo,

and no color-coded intervention). The dependent variables for the study were spelling performance and attitude toward school raw scores. To aid in generalization to other classroom situations, the letter color-coded training and the day color-coded training were carried out in the classroom by the regular teacher (Campbell & Stanley, 1963).

Procedural Steps

The procedural steps for this study began six weeks before the start of this project and concluded four weeks after the end of the treatment. A procedures schedule appears in Appendix F. From September 26, 1988 through October 31, 1988, copies of the TWS-2 and appropriate forms of the SSA were ordered as well as colored pencils to be used by the subjects in the treatment groups. Forms and instructions were constructed next, including: (a) informed consent forms, (b) an explanation of the project to be read by the classroom teacher before the consent forms would be sent home to parents or guardians, (c) four sets of 3' x 4' posters, each containing one week's spelling list of color-coded spelling words (printed in colored markers and black ink for each of the six weeks of spelling (120 words per set), (d) 4 sets of 3' x 4' posters containing each week's spelling list of words printed in black marker for the 6 weeks of spelling (120 words per set), (e) five 1' x 2' posters, each containing day and color assignments

four 1' x 2' posters, each containing day and color assignment.

Approval was obtained from the district's superintendent of schools and the director of elementary curriculum to conduct the study in the school district. The author met with each of the five building principals during the third week in October, 1988, to explain the study and request the participation of the necessary classrooms. After securing cooperation from each of the building principals an initial teacher staffing was held at each building to elicit teachers' willingness to participate in the research project and to provide them with information regarding the responsibilities of participants. Topics discussed during this initial session included goals of the research, a schedule of pretesting times and dates, data collection procedures, and the parent consent form. Once teacher cooperation had been secured random assignment of the participating classrooms was made to treatment groups. A total of five building principals and 13 teachers were involved in this project. Two weeks before the study began a packet of information on color-coding treatment procedures was given to each teacher who agreed to be in the study. These materials appear in Appendix G. Five principals and 13 teachers participated. second staffing was held with the 13 participating teachers. The purpose of this meeting was to give a presentation of the two treatments to be used and give out

the parent letters and consent forms. After this meeting and approximately two weeks before the study began, the 13 teachers read an explanation of the study to their students and passed out the parent permission forms to students who would serve as the experimental group population.

On Friday, October 31, 1988, all materials to be used in the treatments were delivered to the participating teachers. Returned permission forms were collected by the teachers and given to the author by November 2, 1988. Each of the students in the experimental groups received letter color-coded spelling intervention or word color-coded spelling intervention each week for six weeks during their respective spelling class period and participated in pre and post testing. Students who did not receive parent permission to participate in the study continued to be involved in spelling instruction and activities since the intervention was sanctioned by the school superintendent as part of the normal spelling curriculum for the district's students. Scores from those students, however, were not included in the final data collected and analyzed for this study.

Weekly visits were made by the author to the participating teachers in the study to lend support and to discuss progress. The week after the treatments ended (December 19, 1988), all students in the experimental and control groups were assessed using the SSA and the TWS-2.

At the conclusion of the study each participating

classroom was visited by the author to solicit the student's opinions in regard to the color-coded spelling strategies. Cokes were served to all students in the 13 classrooms as a token of appreciation for their assistance and cooperation during the study.

Testing Procedures

Students whose parents gave permission for them to be in the study were then screened by the author for color vision using the DP-I and pretested with the TWS-2 and SSA, Form A and screened for color acuity with the DP-I. A roster of participating students by school and classroom was prepared. All individual and group pretesting and screening at each school site was completed within a three day period from November 2 to November 7, 1988. Of the group measures, the TWS-2 was administered first, followed by the SSA. The DP-I was administered individually to each subject when he/she completed the SSA. An average of 30 minutes was required in administering the TWS-2 and the SSA. An average of 3 minutes was required to screen for color blindness using the DP-I. Pretesting and screening required a total testing time of one hour per student. All of the pretesting and screening was administered by the author in the respective classroom of the group being tested. Those who were absent for a group pretest were tested by the author, in a group, at a later date.

During the 6-week treatment phase each respective

teacher gave instruction in the appropriate spelling lesson, using the randomly-assigned intervention treatment, and administered each weekly written spelling test to his/her respective classroom, and collected a weekly creative writing assignment from each subject.

All individual and group posttesting at each school site was completed between December 19, 1988, and January 7, 1989. Of the group measures the SSA was administered first. The TWS-2 was administered last during posttesting in order to counterbalance testing effects between pretest and posttest sessions. Total time per subject for posttesting was one hour.

Data Collection

Demographic data (treatment group assignment, MAT spelling raw score, sex, chronological age, school and classroom enrollment) collected on subjects prior to the treatment phase was recorded on classroom data pages by the author. Each of the two pretests and the two posttests were administered and scored by the author according to prescribed instructions for the instruments. Results (6 scores) were tabulated on classroom data pages for each subject. The resulting data compilation yielded 18 data points for each subject which were subsequently examined. All derived scores permissible per test were recorded, i.e., standard scores, percent rankings, mental age or grade equivalents, and stanines.

The SSA total score of reading, the TWS-2 total score, and misspellings on weekly written spelling tests were summed and item tabulated for factor analysis in order to ascertain their validities as variables for subsequent statistical analyses.

The SSA posttest and TWS-2 posttest total raw scores were subjected to factor analysis using the SYSTAT computer program. All measures of dependent variables were analyzed by stepwise multiple regression. Residual analyses and cross-validation procedures were executed. Pearson correlations were computed between TWS-2 pre and posttest raw scores, SSA pretest and posttest scores, and MAT spelling subtest raw scores. Mean scores for each dependent measure (TWS-2 posttest and SSA posttest) and for the covariates, MAT, TWS-2 pretest and SSA pretest, were also calculated.

Dissemination of Information

The parents of all participants were informed of their child's testing performance on all measures via a form letter (Appendix H). These letters were mailed April 28, 1989. Individual conferences were held at the parent's request with the author for further interpretation.

Teachers were also given the results of the group and individual assessments of their students and the results of the treatment group their class represented.

A summary of the research conclusions bearing

significance in the instruction of spelling to sixth graders was conveyed in a written report to the Superintendent of Schools, The Board of Education, and the building principals and teachers who participated in the study.

Data Analysis

The major objective of this research project was to compare three educational interventions, one of which involved a letter color-coded spelling intervention, one of which involved a day color-coded spelling intervention, and the other of which involved traditional spelling instruction with no color-coded intervention. The color-coded intervention was presented as a tool for to assist attention, encoding, and recall components of the learning process. To carry out the purpose of this investigation the eight hypotheses, in null form, were tested at or beyond the .01 level of confidence.

Multivariate analysis of variance (MANOVA) which is a generalization of analysis of variance to a situation in which there are several dependent variables was used to investigate the eight hypotheses. Tabachnek and Fidel (1983) identify multivariate analysis of variance as appropriate for situations involving at least 2 levels of an independent variable and several dependent variables that are related. This design facilitated the investigation of the effects of three spelling training

techniques (letter color- coded spelling intervention X day color-coded spelling intervention X no color-coded spelling intervention) across varying instructional levels (experimental X control) using several criterion measures.

Computations were completed by using the SYSTAT program for MANOVA. The significance level for all statistical tests was set at a conservative alpha level of .01 to control for experimentwise error. The data analysis allowed for the examination of the eight variables which were yielded as a result of the assessment at the termination of the research study. The TWS-2 yielded two variable scores: the pretest total words misspelled and posttest total words misspelled. The SSA yielded two variable scores: the pretest total reading score and the posttest total reading score. Subjects to independent variable ratio was 178:1, exceeding the recommended minimum of 5:1 (Tabachnek & Fidell, 1977).

Data analysis was based on the raw scores which were yielded from the assessment at the termination of the research study. The scores were derived from the TWS-2 posttest and the SSA posttest, each of which were genuine interval scales. The TWS-2 and SSA scores were considered to be normally distributed in the population since the TWS-2 and the SSA were normed under that condition. The variance of the treatment groups was considered to be homogeneous due to the random assignment of treatment and control to classes. The raw scores of the MAT spelling

subtest were used as a covariate for analysis purposes. The use of covariates attempts to control statistically any initial differences in the students caused by ability, as measured by the TWS-2, gender and race. Kirk (1968) identifies analysis of covariance as particularly appropriate for situations involving the use of intact groups since the use of statistical control can remove bias that is impossible to eliminate by experimental control. Incorporating multiple covariates increases the power of the analysis and by adjusting for initial group differences on those variables reduces the bias in the estimate of treatment effects (Cook & Campbell 1979).

Of the three groups, containing 178 original cases, three cases, all from the day color-coding treatment group, were dropped from analysis. One case was dropped from the analysis because the subject transferred to another school during the study. The other two cases were dropped owing to missing data. It is recommended that the sample size of the smallest group should exceed the number of predictor variables (Tabachnick and Fidell, 1983, p. 299). The current research utilized three groups which included 63 subjects who received day color-coding treatment, 60 subjects who received letter color-coding treatment, and 52 subjects who were in the the control group and received no treatment. Each of these three groups exceeded the eight predictor variables analyzed in this study. Consequently the necessary assumptions have been met.

Summary

Thirteen heterogeneous classrooms of sixth-grade students were randomly assigned to one of two treatment groups or to a control group. Treatment subjects were exposed to either a letter color-coded spelling intervention or a day color-coded spelling intervention for four days a week for six weeks.

The dependent variables were spelling performance (as measured by the TWS-2) and attitude toward school (as measured by the SSA). Multivariate analysis of variance was used to test eight hypotheses concerning treatment effect on the two dependent variables across the three treatment conditions.

CHAPTER IV

RESULTS

Introduction

The major focus of the study was to examine the effect of color-coding intervention on spelling performance and attitude toward school of sixth-grade students. A quasi-experimental posttest, control-group design was utilized to analyze the data. The correlation between the covariate, the spelling subtest raw scores of the Metropolitan Achievement Test, and spelling performance was analyzed. Covariance of pretests of the two dependent variables was also examined.

Descriptive Statistics

At the termination of the research study, the students were administered the following assessment instruments: Test of Written Spelling - 2, (TWS-2), and Survey of School Attitudes, (SSA), Intermediate Level, Form B. Analyses were performed on the TWS-2 total scores and the SSA reading subtest scores. Descriptive statistics of raw scores included the means and standard deviations for the control (no color-coded intervention), the letter color-

coded treatment, and the day color-coded treatment groups on the covariate, Metropolitan Achievement Test (MAT), and the two dependent variables, on the independent variable, spelling performance, as measured by the TWS-2 posttest,and attitude toward school, as measured by the SSA. Means and standard deviations for the MAT, the TWS-2 posttest, and the SSA posttest are shown in Tables XII,, XIII, and IV, respectively.

TABLE XII

DESCRIPTIVE STATISTICS FOR METROPOLITAN ACHIEVEMENT TEST (MAT) SPELLING SUBTEST SCORES

Covariate		Control N=63	Letter color-coding N=60	Day color-coding N=52
Spelling	x	19.923	19.050	20.095
	SD	3.067	3.529	3.680

x = Mean Score (standardized score based on number of words correct)
SD = Standard Deviation of Mean (standardized score based on number of words correct)

TABLE XIII

DESCRIPTIVE STATISTICS FOR TEST OF WRITTEN SPELLING (TWS-2) POSTTEST

Scale		Control	Letter color-coding	Day color-coding
		N=63	N=60	N=52
Total	x	7.038	8.783	8.587
	SD	6.612	6.600	6.534

x = Mean Score (number of words misspelled)
SD = Standard Deviation of Mean (number of words misspelled)

TABLE XIV

DESCRIPTIVE STATISTICS FOR SURVEY OF SCHOOL ATTITUDES (SSA) POSTTEST

Scale		Control	Letter color-coding	Day color-coding
		N=63	N=60	N=52
Total	x	19.212	20.300	19.333
	SD	7.078	7.324	6.744

x = Mean Score (total item score: 3 = like; 2 = don't know, don't care; 1 = dislike)
SD = Standard Deviation of Mean (total item score: 3 = like; 2 = don't know, don't care; 1 = dislike)

Analysis of Treatment Effects

The SYSTAT (Wilkinson, 1987) computer procedure of multivariate general linear hypothesis (MGLH) was used to estimate and test the univariate and multivariate hypotheses.

Pearson correlation coefficients for the covariate, MAT, and the two levels of the two dependent variables, TWS-2 pretest/ posttest and SSA pretest/posttest for combined treatment groups are listed below in Table XV. Among all groups, the greatest strength of relationship was found between subjects and treatment (0.941). The weakest strength of relationship was found between treatment and spelling performance prior to treatment, as measured by the TWS-2 pretest (-0.002). Additionally, the pretest-posttest measures of spelling performance were more closely related than the pretest-posttest measures of attitude. The two measures of spelling ability and spelling performance were all moderately correlated but assumed negative relationships. All other correlations between the spelling and attitude measures for all treatment groups, combined, were of very weak correlation. In regard to strength of relationship involving the covariate, Pearson correlation coefficients for the covariate, MAT, and the two levels of the two dependent variables, TWS pretest/ posttest and SSA pretest/posttest for the day color-coding treatment group are listed in Table XVI.

TABLE XV

PEARSON CORRELATION MATRIX FOR MAT, TWS, AND SSA FOR COMBINED TREATMENT GROUPS

	SUBJECT	TREATMENT	MAT
SUBJECT	1.000		
TREATMENT	0.941	1.000	
MAT	-0.093	-0.028	1.000
TWS PRE	0.080	-0.002	-0.608
SSA PRE	-0.076	-0.035	0.185
TWS POST	0.006	-0.091	-0.663
SSA POST	-0.020	-0.003	0.126

	TWS PRE	SSA PRE	TWS POST	SSA POST
TWS PRE	1.000			
SSA PRE	-0.095	1.000		
TWS POST	0.844	-0.153	1.000	
SSA POST	-0.155	0.644	-0.119	1.000

For the day color-coding group, the greatest strength of relationship was found between spelling ability, as measured by the MAT, and spelling performance following treatment, as measured by the TWS-2 posttest (-0.770). The weakest strength of relationship was found between subjects

and attitude toward school following treatment, as measured by the SSA posttest (-0.006).

TABLE XVI

PEARSON CORRELATION MATRIX FOR MAT, TWS, AND SSA FOR DAY COLOR-CODING INTERVENTION TREATMENT

	SUBJECT	MAT	TWS PRE
SUBJECT	1.000		
MAT	-0.310	1.000	
TWS PRE	0.361	-0.567	1.000
SSA PRE	-0.026	0.227	-0.034
TWS POST	0.378	-0.770	0.768
SSA POST	-0.006	0.179	-0.135
	SSA PRE	TWS POST	SSA POST
SSA PRE	1.000		
TWS POST	-0.171	1.000	
SSA POST	0.640	-0.152	1.000

Pearson correlation coefficients for the covariate, MAT, and the two levels of the two dependent variables,

TWS-2 pretest/ posttest and SSA pretest/posttest for the letter color-coding treatment group are listed below in Table XVII.

TABLE XVII

PEARSON CORRELATION MATRIX FOR MAT, TWS, AND SSA FOR LETTER COLOR-CODING INTERVENTION TREATMENT

	SUBJECT	MAT	TWS PRE
SUBJECT	1.000		
MAT	-0.070	1.000	
TWS PRE	0.032	-0.648	1.000
SSA PRE	-0,188	0.222	-0.294
TWS POST	0.106	0.642	0.841
SSA POST	0.072	0.094	-0.254
	SSA PRE	TWS POST	SSA POST
SSA PRE	1.000		
TWS POST	-0.298	1.000	
SSA POST	0.606	-0.123	1.000

For the letter color-coding group, the greatest strength of relationship was found between spelling performance before prior to and following treatment, as measured by the TWS-2 pretest and posttest (-.841). The weakest strength of relationship was found between subjects and spelling performance prior to treatment, as measured by the TWS-2 posttest (0.032). Pearson correlation coefficients for the covariate, MAT, and the two levels of the two dependent variables, TWS pretest-posttest and SSA pretest/posttest for the control group are listed below in Table XVIII.

For the control group, the greatest strength of relationship was found between spelling performance prior to and following treatment, as measured by the TWS-2 pretest and posttest (0.941). The weakest strength of relationship was found between spelling ability, as measured by the MAT, and spelling performance following treatment, as measured by the TWS-2 posttest (-0,006).

A one-way analysis of variance (ANOVA) was used to determine homogeneity of treatment groups before the treatment (Linton & Gallo, 1975). The spelling subtest raw scores obtained from the 1988 Metropolitan Achievement Test (MAT). Data analysis indicates that there was no statistically significant difference between the three group means on the dependent variables when only dependent variables were considered.

TABLE XVIII

PEARSON CORRELATION MATRIX FOR MAT, TWS, AND SSA FOR CONTROL GROUP

	SUBJECT	MAT	TWS PRE
SUBJECT	1.000		
MAT	-0.172	1.000	
TWS PRE	0.326	-0.620	1.000
SSA PRE	-0.221	-0.559	0.941
TWS POST	0.339	-0.559	0.941
SSA POST	-0.299	0.140	-0.107
	SSA PRE	TWS POST	SSA POST
SSA PRE	1.000		
TWS POST	-0.099	1.000	
SSA POST	0.687	-0.099	1.000

TABLE XIX

DESCRIPTIVE STATISTICS FOR
MAT COVARIATE

Scale		Control	Letter color-coding	Day color-coding
		N=63	N=60	N=52
Total	x	19.923	19.050	20.095
	SD	3.067	3.529	3.680

x = Mean Score (total item score - number of words correctly spelled)
SD = Standard Deviation of Mean

Regular analysis of variance (ANOVA) indicated no significant effect for spelling (F=1.142 (2,172) p=0.322). There was a negligible percentage of total variation of spelling performance explained by the TWS-2.

TABLE XX

TEST OF WRITTEN SPELLING-2 POSTTEST
ANALYSIS OF VARIANCE

N: 175 MULTIPLE R: .114 SQUARED MULTIPLE R: .013

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
FACTOR	98.896	2	49.448	1.142	0.322
ERROR	7448.499	172	43.305		

No significant difference was found to exist for the treatment groups and the control group when the treatment effect on spelling performance was considered (F=1.926 (2, 171) p=0.149) or when the treatment effect on attitude was considered (F=0.662 (2,171) p=0.517). The results for the ANCOVA for treatment is shown in Table XXI. These results indicated that the treatment was uncorrelated to either of the dependent variable measures. In terms of the combined day and letter color-coded intervention treatments there was no significant effect at the .01 level for attitude toward school (F=0.662 (1,171), p=0.517).

TABLE XXI

SIGNIFICANCE TEST FOR TREATMENT EFFECT

Variable	SS	DF	MS	F	P
TWS posttest	93.131	2	46.565	1.926	0.149
ERROR	4143.077	171	24.176		
SSA posttest	64.833	2	32.417	0.662	0.517
ERROR	8378.894	171	48.999		

WILKS' LAMBDA = 0.971
F-STATISTIC = 1.278 DF = 4, 340 PROB = 0.278

CANONICAL CORRELATION

1	2
0.149	0.086

DEPENDENT VARIABLE CANONICAL COEFFICIENTS STANDARDIZED BY CONDITIONAL (WITHIN GROUPS) STANDARD DEVIATIONS

	1	2
TWS posttest	0.994	0.121
SSA posttest	-0.074	0.998

The canonical correlations for the day (1) and letter (2) color-coding groups indicate that the treatment covariate provides a very low degree of association between treatment and group. Less than 1/2% of the variance in the treatment

factor can be attributed to the intervention. The effect size was greatest for the day color-coding group on the spelling performance posttest measure, while it was largest for the letter color-coding group on the attitude posttest measure.

A significant difference was found to exist between the treatment groups and the control group when the covariate, MAT, was taken into account indicating initial group differences on the dependent variables prior to treatment. Analysis of covariance (ANCOVA) was used in the data analysis for this study to adjust posttest scores for initial pretest differences. When the covariate. MAT, was considered, there was a significant treatment effect at the .01 level for spelling ($F=137.050$ (1,171), $p=0.000$). The results of the analysis of covariance for the covariate, MAT, is shown in Table XXII. There was no effect on attitude toward school ($F=3.273$ (1,171), $p=0.072$). These results indicate that the MAT spelling covariate was significantly correlated ($p< .01$) with the dependent variable of spelling performance and was relevant to the objective of the experiment.

TABLE XXII

SIGNIFICANCE TEST FOR MAT EFFECT

Variable	SS	DF	MS	F	P
TWS-2 posttest	3313.299	1	3313.299	137.050	0.000
ERROR	4134.077	171	24.176		
SSA posttest	160.379	1	160.379	3.273	0.072
ERROR	8378.894	171	48.999		

WILKS' LAMBDA = 0.552 DF = 2, 170 PROB = 0.000

CANNONICAL CORRELATION

0.669

DEPENDENT VARIABLE CANONICAL COEFFICIENTS STANDARDIZED BY CONDITIONAL (WITHIN GROUPS) STANDARD DEVIATIONS

TWS-2 posttest	0.989
SSA posttest	-0.108

The canonical correlation of 0.669 for the MAT indicates that the covariate provides a moderately high degree of association between prior spelling skill and group membership. This means that approximately 67 percent of the variance in the treatment factor can be attributed to spelling skill rather than to the intervention, itself.

This result indicates that the MAT spelling covariate was significantly correlated ($p < .01$) with the dependent variable of spelling performance and was relevant to the objective of the experiment.

Regular analysis of variance (ANOVA) indicated no significant effect for attitude toward school ($F=0.680$ $(2,172)$, $p=0.508$). There was a negligible percentage of total variation of attitude explained by the SSA posttest.

TABLE XXIII

SURVEY OF SCHOOL ATTITUDE POSTTEST
ANALYSIS OF VARIANCE

N: 175	MULTIPLE R: .089		SQUARED MULTIPLE R: .008		
SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
FACTOR	67.277	2	33.639	0.680	0.508
ERROR	8513.580	172	49.498		

Two more variables were analyzed as covariates, the TWS pretest and the SSA pretest which are shown in Tables XXIV, and XXV, respectively. When the TWS-2 pretest was compared to the TWS-2 posttest and the SSA posttest the effect was found to be significant, at the .01 level, for

the TWS-2 pretest and the TWS-2 posttest but not for the TWS-2 pretest and the SSA posttest (F=218.793 (1,169), p=0.000); (F=3.746 (1,169), p=0.055). The variance between the TWS-2 pretest and the two, combined, posttest measures was 76 %, while the variance shared by the two posttest measures was 97 % for the TWS-2 posttest and 13 % for the SSA posttest. This means that the spelling pretest and posttest measures were highly correlated but that the spelling pretest and the attitude posttest measures showed negative and very low correlation, as would be expected.

TABLE XXIV

SIGNIFICANCE TEST FOR TWS PRETEST EFFECT

Variable	SS	DF	MS	F	P
TWS posttest	2328.159	1	2328.159	218.793	0.000
ERROR	1798.316	169	10.641		
SSA posttest	108.798	1	108.798	3.746	0.055
ERROR	4908.964	169	29.074		

WILKS' LAMBDA = 0.419

F-STATISTIC = 116.356 DF = 2, 168 PROB = 0.000

CANONICAL CORRELATIONS

0.762

TABLE XXIV (Continued)

DEPENDENT VARIABLE CANONICAL COEFFICIENTS STANDARDIZED BY CONDITIONAL (WITHIN GROUPS) STANDARD DEVIATIONS

TWS Posttest	1.001
SSA Posttest	-0.258

The canonical correlation indicates that the TWS pretest provides a moderate degree of association between the pretest and posttest measures of spelling performance and the posttest measure of attitude. The spelling performance measures show a stronger correlation.

TABLE XXV

SIGNIFICANCE TEST FOR SSA PRETEST EFFECT

Variable	SS	DF	MS	F	P
TWS Posttest	12.269	1	12.269	1.153	0.284
ERROR	1798.316	169	10.641		
SSA Posttest	3379.047	1	3379.047	116.330	0.000
ERROR	4908.964	169	29.047		

WILKS' LAMBDA = 0.579
F-STATISTIC = 60.958 DF = 2, 168 PROB = 0.000

TABLE XXV (Continued)

CANONICAL CORRELATIONS

0.648

DEPENDENT VARIABLE CANONICAL COEFFICIENTS STANDARDIZED BY CONDITIONAL (WITHIN GROUPS) STANDARD DEVIATIONS

TWS Posttest	-0.229
SSA Posttest	1.004

When the SSA pretest was compared to the TWS-2 posttest and the SSA posttest the correlation was found to be significant, at the .01 level, for the SSA pretest and the SSA posttest but not for the SSA pretest and the TWS-2 posttest (F=116.330 (1,169), p=0.000); (F=1.153 (1,169), p=0.284). The variance between the SSA pretest and the two, combined, posttest measures was 65 %, while the relationship shared by the two posttest measures was very weak for the SSA posttest but quite strong for the TWS-2 posttest. This means that the attitude pretest and posttest measures were highly correlated but that the attitude pretest and the spelling posttest measures showed negative and very low correlation.

TABLE XXVI

TABLE OF MEANS

groups:	Control	Letter Color-coding	Day Color-coding
MAT	x = 19.923	x = 19.050	x = 20.095
	SD = 3.067	SD = 3.529	SD = 3.680
TWS pretest	x = 8.442	x = 10.433	x = 8.603
	SD = 8.431	SD = 0.958	SD = 6.776
SSA Pretest	x = 19.962	x = 21.550	x = 20.619
	SD = 6.776	SD = 6.624	SD = 6.484
x TWS posttest	x = 7.038	x = 8.783	x = 8.587
SD	SD = 6.612	SD = 6.600	SD = 6.534
x SSA posttest	x = 19.212	x = 20.300	x = 19.333
SD	SD = 7.078	SD = 7.324	SD = 6.744

x = Mean score (number misspelled words)
(number correct words)
(number points)
SD = Standard deviation

An analysis of the Table of Means indicates that the three groups were unequal in spelling ability prior to the treatment. The day color-coding group displayed the

highest mean while the letter color-coding group attained the lowest score of the three groups. In regard to the TWS-2 pretest, the control group did not misspell as many words as the other two groups prior to the treatment. The SSA pretest was used to measure positive attitude toward school as it related to reading and spelling. The control group was found to have the more positive attitude toward school of the three groups. On the two dependent measures, the control group achieved the best mean score for number of words misspelled while the letter color-coding group misspelled the greatest number of words. Attitude toward school was most positive for the letter control group following the treatment intervention and least positive for the control group. Even when the covariate was considered, no significant intervention treatment effect was found for attitude toward school at the .01 level ($F=3.273$ (1,171), $p=0.072$).

The effects of the TWS-2 spelling and the SSA attitude pretests were also analyzed. This analysis was conducted on the combined day and letter color-coded intervention treatment groups. When the TWS-2 spelling pretest was tested for its effect on the TWS-2 posttest, a significant correlation ($F=218.793$ (1,169), $p=0.000$) was found. In terms of the TWS-2 spelling pretest, correlation was found at the .05 level but not at the .01 level for the SSA attitude posttest ($F=3.746$ (1,169), $p=0.055$). When the SSA attitude pretest was tested for its effect on the SSA

posttest, a significant correlation (F=116.330 (1,169), p=0.000) was found.

Findings Related to Hypotheses

In terms of treatment, for hypothesis one, when the covariate was not considered, no significant difference was found between sixth-grade students who were exposed to color-coded spelling intervention and sixth-grade students who were not exposed to color-coded spelling intervention in terms of spelling performance (F=1.926 (2,171) p=0.149). The null hypothesis was not rejected. The canonical correlations of 0.149 and 0.086 for the day color-coding group and the letter color-coding group, respectively, indicate that the treatment function provides low degrees of association between treatment and group membership with the lowest degree of association occurring for the letter color-coding group (day color-coding variance = 14 %; letter color-coding variance = .08 %). However, when the covariate, MAT, is taken into account, the null hypothesis is rejected. The level of significance (F=137.050 (1,171), p=0.000), indicates that the treatment function provides a high degree of association between spelling scores and group membership when prior spelling ability is considered. Canonical correlation provides (a) first a choice of an initial pair of dimensions (a linear combination of variables) - one from the group of criterion measures and the other from the group of predictor variables - that

affords the highest possible degree of association or correlation and (b) the progressive selection of remaining pairs of dimensions until non-chance or reliable variance in scores has been almost entirely extracted. Each canonical coefficient portrays the maximum possible amount of association that yields the most nearly correct potential prediction of standing on the optimally but differently weighted numbers of the criterion composite. In the case of the TWS-2 and SSA posttests, the TWS-2 posttest is the posttest that is more closely associated and the posttest that gives the most nearly correct potential prediction of covariance with the MAT. The canonical correlation coefficient can be squared to identify what proportion of variance is shared by the pair of extracted dimensions (Isaac & Michael, 1985, p. 201). The resulting variance shared by the MAT and the TWS-2 posttest is 99 %, while the variance shared by the MAT and the SSA posttest is -02%.

For hypothesis two, in terms of treatment, even when the covariate was not considered, no significant difference was found between sixth-grade students who were exposed to color-coded spelling intervention and sixth-grade students who were not exposed to color-coded spelling intervention in terms of attitude toward school ($F=0.662$ (1,171), $p=0.517$). Therefore, the null hypothesis was not rejected.

Even when the covariate, MAT, is taken into account, the correlation is not significant at the .01 level. This

finding implies that the color-coded intervention treatment had no significant effect on attitude toward school, even when the scores were adjusted for initial group differences.

Since an analysis of variance found no significant differences between the groups hypothesis three was not rejected.

For hypothesis four, again, the earlier analysis of variance indicated no group differences on the dependent variable so this null hypothesis was not rejected.

Since there were no significant differences between the group means, null hypothesis five cannot be rejected unless the covariate, which did show significant differences, is considered in the statistical analysis.

Attitude toward school was not found to be significant for any of the groups, even when the covariate of spelling ability was taken into account. Therefore, the null hypothesis seven could not be rejected. In terms of differences between group means on the dependent variable of spelling significance differences were found only when the covariate was considered in the analysis. Attitude toward school was not a significant variable for any of the statistical analyses conducted in this research study.

TABLE XXVII

SIGNIFICANCE OF UNIVARIATE F TEST
FOR EFFECT OF TWS-2 PRETEST ON
TWS-2 AND SSA POSTTESTS

Variable	SS	DF	MS	F	P
TWS-2					
Posttest	2328.159	1	2328.159	218.793	0.000
ERROR	1798.316	169	10.641		
SSA					
Posttest	108.798	1	108.798	3.746	0.055
ERROR	4908.964	169	29.047		

SIGNIFICANCE OF MULTIVARIATE F TESTS
FOR EFFECT OF TWS-2 PRETEST ON TWS-2 AND SSA POSTTEST

WILK'S LAMBDA = 0.149
F-STATISTIC = 116.356 DF = 2,168 PROB. = 0.000

CANONICAL CORRELATIONS

0.762

CANONICAL CORRELATIONS BETWEEN CONDITIONAL DEPENDENT
VARIABLES AND DEPENDENT CANONICAL FACTORS

TWS-2 Posttest	0.967
SSA Posttest	-0.126

TABLE XXVIII

SIGNIFICANCE OF UNIVARIATE F TEST
FOR EFFECT OF SSA PRETEST ON
TWS-2 AND SSA POSTTESTS

Variable	SS	DF	MS	F	P
TWS-2					
Posttest	12.269	1	12.269	1.153	0.284
ERROR	1798.316	169	10.641		
SSA					
Posttest	3379.047	1	3379.047	116.330	0.000
ERROR	4980.964	169	29.047		

SIGNIFICANCE OF MULTIVARIATE F TESTS
FOR EFFECT OF SSA PRETEST ON TWS-2 AND SSA POSTTEST

WILK'S LAMBDA = 0.579
F-STATISTIC = 60.958 DF = 2,168 PROB. = 0.000

CANONICAL CORRELATIONS

0.648

CANONICAL CORRELATIONS BETWEEN CONDITIONAL DEPENDENT
VARIABLES AND DEPENDENT CANONICAL FACTORS

TWS-2 Posttest	-0.097
SSA Posttest	0.974

Summary

When the treatment effect for spelling performance and attitude toward school was analyzed in light of a regular ANOVA, no significance was found. However, when a a spelling ability covariate was considered, significant differences were found between the two color-coding groups and the control group for spelling performance. Even when the covariate was taken into account for attitude toward school effect there was no significant level of effect for either a regular analysis of variance of an analysis of covariance. The results of the treatment effects analyses indicate that the intervention does merit consideration as a possible interaction agent for attention and recall of spelling words. The results of the analyses suggest that extraneous threats to the validity of the methodology may have influenced the findings. These concerns will be discussed in the next chapter and will be accompanied by recommendations for those who wish to replicate or modify the study.

CHAPTER V

DISCUSSION AND SUMMARY

Discussion

The problem of spelling performance has been consistent in its resistance to a simple solution for both students and educational scholars. While changes in curricula have been made based on much previous research on spelling, questions remain concerning the importance of color and its relationship to the issue of spelling. Color-coding would appear to have theoretical and practical implications for inducing recall (Allred, 1977; Dwyer, 1971; Paivio, 1971). The role of color in terms of its relationship to other factors in the learning process and methods to specifically access attention have yet to be defined in such a way that teachers can use color methods for instructional purposes. Jensen and Rohwer (1970) discount the notion that spelling ability is primarily associated with a verbal stimuli. Templeton (1979) concludes that a higher order visual structure is at work among good spellers. Templeton implies that development of a basic underlying visual structure for American English words is related to the development of an internal visual

structure of word forms. Radaker (1963) supports the use of directed visual imagery to assist recall. Kuhn and Schroeder (1971) improved performance in spelling with additional visual imagery experiences for elementary students. There is general agreement that color is an important factor in attention (Green and Anderson, 1956; Zentall, 1986). Several studies found that color, as well as other variables have facilitated attention and learning (Dwyer, 1987; Berlyne, 1960; Zentall & Kruczek, 1988). Klausmeier (1985) and Meichenbaum (1977) suggest that attitudes influence students' learning capabilities and behaviors. It has been suggested that a measure of attitude toward school might be helpful to educational psychologists in order to assess the attitudes of students toward the content of what they are being taught (Hogan, 1972).

The problem for the present study was to determine the relationship of color to spelling performance and attitude toward school. Specifically, it was predicted that color would be a factor of spelling performance and that the ability to access the color factor would occur, due to increased attention. and would result in better performance than the use of black and white (non-color). In addition, it was predicted that the use of color-coding would result in better attitude toward school due to academic success experiences brought about by improved spelling performance.

Multivariate comparison of means between the levels of

day color-coding and letter color-coding and no color-coding resulted in nonsignificant differences in means. Statistical analysis, including simple correlation, regular analysis of variance, and multivariate analysis of variance, resulted in this nonsignificant effect for treatment on the performance test when only dependent variables were concerned. However, when the covariate of spelling skill, prior to treatment, was considered, the results were significant for the effect of treatment on spelling performance but not on attitude toward school.

One explanation for the insignificant results, when spelling ability prior to treatment was not considered, might be suggested from the fact that subjects came from existing classrooms rather than being randomly selected for classroom assignment at the beginning of the school year. Initially, the groups may have been so significantly disparate in spelling ability at the onset of treatment, that any effect that might have occurred as a result of intervention would not be capable of overcoming the group disparity and attaining significance.

Another explanation might be that the intervention was not capable of changing spelling performance because of poor intervention design. Color-coding of spelling words, carried out by the regular classroom teacher with no additional attempts to control for variability in instructional methods, might also explain why the intervention failed to achieve significant group mean

differences. Attention has been said to need underlying structure (Templeton, 1979). If the color-coding system had addressed patterns and structures of words, perhaps an alternative result would have been obtained.

Percentages of spelling words generalized is least for the letter color-coding group and highest for the control group. One explanation for this may be found in the post treatment comments of a significant number of the subjects in the study. Fatigue was the most common complaint. Students in the letter color-coding group complained of frustration at having to change pencils often while those in the day color coding group voiced opinions of having trouble writing with enough hand pressure to see the colored writing. Comments such as these were often followed by acknowledgments that the spelling word study technique was probably helpful in terms of learning the letter sequences for the weekly spelling words. Writing each word five times was not a favorite activity of many of the students. Some opposition to having spelling practice was also noted by the students. Modern technology of computers with spelling checkers was considered by some of the students to be an alternative to a need to learn to spell.

Limitations

The present study is limited by the single grade level used in the research. The Test of Written Spelling (TWS-2)

which was used to measure the dependent variable of spelling performance had only one question on each form that directly related to spelling. Research to determine the extent, if any, of color blindness on a visual, color spelling intervention might prove to be valuable. It is suggested that the subject pool be large enough to give the necessary power to a statistical test.

Also, an instrument more specifically designed to address attitude toward spelling would probably have yielded more conclusive information. Attitude toward school was not favorably affected by this color-coded intervention aimed at increasing performance in spelling. Posttest scores on the Survey of School Attitudes (SSA) were not significantly correlated with spelling treatment. It had been predicted that attitude toward school would manifest itself in a more positive student interest in the intervention of color-coding during spelling activities. In reality, quite the opposite occurred. The relatively short length of time that the color-coded intervention treatment was conducted might account for this. Research has shown that time is a function of attitude change (Marjoribanks, 1988). In one study, although attitude toward school was found to change over a relatively short span of four months, the change was in a negative direction (Marjoribanks, 1988). Student's complaints of fatigue and boredom might have been relieved by the use of markers instead of colored pencils. The lack of random selection

of subjects which influenced the disparity found between groups for spelling skill may also have influenced disparity between groups for attitudes toward school prior to the intervention.

Conclusions

Although the results of this study do not overwhelmingly support letter color coding over day color-coding they do indicate support for an intervention employing color versus no color for within an existing spelling curriculum. Several general conclusions can be drawn which have implication for practice and research.

A positive attitude toward a color-coded intervention may positively influence spelling performance while a negative attitude toward the color-coding intervention may negatively influence attitude toward school. Reported fatigue and boredom may have tended to negatively influence attitudes toward school during the intervention phase. This might offer a reason for the lower SSA posttest mean scores of the three groups when compared to the SSA pretest mean scores.

Students expressed various opinions concerning the relative merits and drawbacks of the color-coding technique. Having to change pencils from letter to letter was reported by the students to be time-consuming and tiring. This may partially explain the larger mean scores of misspelled words on the Test of Written Spelling (TWS-2)

posttest by the two experimental groups as compared to the control group which incurred no changes from status quo in spelling instruction and study. The color and use of colored pencils in the spelling activities may have actually served as a distraction rather than an attraction. In spite of dislike for the method, the letter color-coding group did achieve the highest adjusted mean score on attitude toward school. Several students commented that color coding took more time, that it was frustrating to have to change pencils, and that it was uncomfortable to write with the colored pencils. Unbeknown to the students, colored markers had originally been suggested for use but were vetoed by the teachers due to their "messiness". Perhaps the markers would have been more palatable to the students and would have eliminated the discomforts the students found with the use of colored pencils.

The use of color-coding may be adaptable to a variety of situations which require attending skills. The key element is to direct attention to a visual, on the part of the student, and to couple attention with kinesthetic involvement through the writing of the words with the colored pencils. Color-coded intervention may be functional as an aptitude-treatment interaction (ATI), as suggested by Cronback and Snow (1969), to address individual differences by employing different approaches to instruction for students of different aptitudes.

The results indicate that color can be a factor in

attention. Incorporating multiple covariates increased the power of the analysis and reduced bias in the estimate of treatment effects by adjusting for initial group differences on the spelling variable (Cook & Campbell, 1979). Logical or curriculum-based patterning to give meaning and significance to the color-coding process might serve as more of a motivation than just copying colors.

Suggestions for Further Research

This study attempted to research a color-coded spelling intervention to facilitate attentive behavior that could utilize regular teachers of average students in intact classrooms, that could be of nominal cost, and that could be incorporated into an already-present curriculum. Further research into applications of color to other academic areas and age levels might increase the understanding of how this intervention could be of value in the instructional setting. In fact, color-coding has been used, informally, to assist multiplication and long division sequence training with elementary learning disabled students. Greenwood (1988) suggested that more research should be directed at identifying specific instructional practices which would increase active involvement of the learner in the learning environment. This might be accomplished through the use of peer-tutoring (Greenwood, 1988; Greenwood et al, 1987) for a color-coded spelling intervention. Teaming an attentional intervention

with an affective intervention, such as weekly guidance sessions to develop positive self concept, might also be beneficial to address the affective area of attitude toward school. A face-to-face student interview, with the researcher's input, might be an alternative to the standardized survey instrument used in this study to allow closer alliance with the objective of attitude toward school as it relates to spelling. The scores from the writing samples and weekly spelling tests may be more powerful measures of spelling performance and transfer than the standardized spelling performance test utilized in this study.

Several suggestions are given for replication of the study:

(1) Replication of the study linking color to spelling patterns to combine a knowledge of English spelling patterns with a knowledge of the visibility spectrum of color related to attending behavior.

(2) Replication of the study utilizing weekly spelling test scores and creative writing samples as measures of spelling performance.

(3) Replication of the study utilizing a sample of second or third grade students.

(4) Replication of the study substituting coloring instruments such as markers and crayons for colored pencils in order to decrease the writing difficulty found for colored pencils.

The adjusted results (ANCOVA) support the notion that attention using color is an important factor in learning correct spelling and suggests that the use of color-coded intervention may be an easily implemented intervention for the classroom teacher in spelling.

BIBLIOGRAPHY

Abramov, I. (1972). Retinal mechanisms for colour vision. In Handbook of sensory physiology, 7(2), 567-607. Berlin: Springer-Verlag.

Abramson, L.Y., Garber, J., & Seilgman, M.E. (1980). Learned helplessness in humans: Attributional analysis. In J. Garber & M.E. Seligman (Eds.), Human helplessness theory and applications, 3-34. New York, NY: Academic Press.

Ackerman, B.P. (1987 a.). Attention and memory in children and adults in context-interactive and context-independent situations. Journal of Experimental Child Psychology, 4, 192-221.

Ackerman, B.P. (1987 b.). Selective attention and distraction in context-interactive situations in children and adults. Journal of Experimental Child Psychology 44, 126-146.

Allred, R.A. (1977). Spelling: the application of research findings. Washington, DC: National Education Association.

Anderson, J.R., & Bower, G.H. (1972). Recognition and retrieval processes in free recall. Psychological Review 79, 97-123.

Anderson, J.R. (1976). Language, memory and thought. Hillsdale NJ: Erlbaum.

Anderson, J.R., & Reder, L.M. (1979). An elaborative processing explanation of depth of processing. In L.S. Cermack & F.I.M. Craik (Eds.), Levels of Processing in Human Memory. Hillsdale, NJ: Erlbaum.

Atkinson, J.W. (1957). Motivational determinants of risk-taking behavior. Psychological Review, 64, 359-372.

Bakker, D.J. (1972). Hemispheric specialization and stages in the learning to read process. Bulletin of the Orton Society, 23, 15-27.

Bandura, A. (1977). Social Learning Theory. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A., & Jeffery, R.W. (1973). Role of symbolic coding and rehearsal processes in observational learning. Journal of Personal Social Psychology. 26, 122-130.

Barsch, R.G. (1974). ...and sometimes y. 109 Fun Ways to Enjoy and Improve Spelling in the classroom. Canoga Park, CA: The Ray Barsch Center for Learning.

Bastain, H.C. (1898). Apasia and other speech defects. London: H. K. Lewis.

Beers, C.S. & Beers, J.W. (1981). Three assumptions about learning to spell. Language Arts, 58(5), 573-579.

Beers, J., & Henderson, E. (1977). A study of developing orthographic concepts among first graders. Research in the Teacing of English., 11, 133-148.

Berlyne, D.E. (1960). Conflict, arousal and curiosity. New York, NY: McGraw-Hill.

Bersted, C.T. (1983). Memory scanning of described images and undescribed images: hemispheric differences. Memory and Cognition II(2), 129- 136.

Birch, H.G., & Belmont, L. (1964). Auditory and visual integration in normal and retarded readers. American Journal of Orthopsychiatry. 34, 852.

Birch, H.G., & Belmont, L. (1965). Audigory discrimination integration in brain damaged and normal children. Developmental Medicine Child Neurology. 7, 135-144.

Black, H.B. (1967). Relevant and irrelevant pictoral cues in discrimination learning. Final report. Washington, DC: United States Department of Health, Education, and Welfare., Office of Education, Bureau of Research, Project no. 1170, Grant no. 7-24-0210-227.

Block, R.W., & Miller, E.K. (1986). The Maladroit Adolescent: Learning Disorders and Attentional Deficits. Advanced Pediatrics. 33, 303-330.

Bloom, B.S. (1974). Time and Learning. American Psychologist 29, 682-688.

Boder, E. (1970). Developmental dyslexia: A new diagnostic approach based on the identification of three subtypes. Journal of School Health. 40. 289-290.

Boder, E. (1971). Developmental dyslexia: Prevailing diagnostic concepts and a new diagnostic approach. In H.R. Myklebust (Ed.), Progress in Learning Disabilities (Vol. 2). New York, NY: Grune & Stratton.

Boder, E. (1973). Developmental dyslexia. A diagnostic approach based on three atypical reading/spelling patterns. Developmental Medicine & Child Neurology, 15, 663-687.

Bourne, L.E., & Restle, F. (1959). Mathematical Theory of Concept identification. Psychological Review 66, 278-296.

Bower, L.E. (1972). Mental imagery and associative learning. In L.W. Gregg (Ed.), Cognition in learning and memory, New York, NY: Wiley.

Bower, L.E., & Hilgard, E.R. (1981). Theories of learning (5th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Brown, A.L., & Campion, J.C. (1971). Color dominance in preschool children as a function of specific cue preferences. Child Development, 42, 1495-1500.

Brown, E.N. (1980). Attention style, linguistic complexity, and treatment of reading difficulty. In R.M. Knights & D.J. Bakker (Eds.). Treatment of hyperactive and learning disordered children. Baltimore, MD: University Park Press.

Bruce, J.A. & Cox, M.O. (1983). Metamemory and structure: spelling. Educational Research Quarterly, 8(2), 38-43

Bruck, M. (1988). The word recognition and spelling of dyslexic children. Reading Research Quarterly, 23 (1), 51-69.

Bruck, M. & Waters, G. (1988). An alnalysis of the spelling errors of children who differe in their reading and spelling skills. Applied Psycholinguistics, 9(1), 77-92.

Bruner, J.S. (1966). Studies in Cognitive Growth. New York, NY: Wiley.

Campbell, D.T., & Stanley, J.C. (1963). Experimental and quasi-esperimental designs for research. Dallas, TX.: Houghton-MIfflin.

Canelos, J.J. (1982-83). The instructional effectiveness of three content-independent imagery learning strategies and visualized instruction of varying complexity. Journal of Experimental Education, 51(2), 58-68.

Cermack, L.S., & Craik, F.I.M. (1978). Levels of processing and human memory. Hillsdale, NJ: Earlbaum

Christner, C.A., & Ray, H.W. (1961). An evaluation of the effect of selected combinations of target and background coding on map-reading performance: Experiment V. Human Factors, 3, 131-146.

Cohen, J., & Cohen, P. (1983). Applied multiple regression/correlation analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Erlbaum.

Cook, T.D. & Campbell, D.T. (1979). Quasi-experimentation: design & analysis for field settings. Chicago, IL: Rand McNally College Publishing Company.

Coopert, L.A., & Shepard, R.N. (1973). Chronometric studies of the rotation of mental images. In W.G. Chase, (Ed.), Visual Information Processing. New York, NY: Academic Press.

Corah, N.L. (1966). The effect of instruction and performance set on color-form perception in young children. Journal of Genetic Psychology, 108, 351-358.

Corah, N.L. & Gospodinoff, E.J. (1966). Color-form and whole-part perception in children. Child Development, 37, 837-842.

Cox, J.R. & Griggs, R.A. (1982). The effects of experience on performance in Watson's selection task. Memory and Cognition, 10, 496-502.

Cramer, R.L., Hammond, W.D., Lim, L.F., Prejza, J., Jr., & Tripplett, D. (1985). Spelling Words and Skills, Book 6. Glenview, IL: Scott, Foresman, and Company.

Croft, A.C. (1982). Do spelling tests measure the ability to spell? Educational & Psychological Measurement 42, 715-723.

Davis, J.K., & Annis, L. (1980). The effect of study techniques,
study preferences, and familiarity on later recall. Journal of Experimental Education 4(2), 92-96.

Day, J.C., & Bellezza, F.S. (1983). The relation between visual imagery mediators and recall. Memory and Cognition, II(3), 251-257.

Dean, R.S., Yekovich, F.R., & Gray, J.W. (1988). The effect of modality on long-term recognition memory. Contemporary Educational Psychology, 13, 102-115.

Delquadri, J.C., Greenwood, C.R., Stretton, K, & Hall, R.V. (1983). The peer tutoring game: A classroom procedure for increasing opportunity to respond and spelling performance. Education and Treatment of Children 6, 225-239.

Diener, C., & Dweck, C. (1978). An analysis of learned helplessness: Continuous changes in performance, strategy, and achievement cognitions following failure. Journal of Personal and Social Psychology, 36, 451-462.

Dolch, E.W. (1960). Better Spelling. Champaign, IL: The Garrard Press.

Donoghue, M.R. (1979). The child and the English language arts, Third Edition. Dubuque, IA: William C. Brown Company Publishers.

Drummond, C. (1985). In Educational Testing Service Test Critiques, Vol. II. 633-639.

Dvorine, I. (1953). Dvorine Pseudo-Isochromatic Plates, 2nd Ed.). San Antonio, TX: The Psychological Corporation.

Dweck, C.S. (1975). The role of expectations and attributions in the alleviation of learned helplessness. Journal of Personality and Social Psychology, 31, 674-685.

Dwyer, F.M. (1971). Color as an instructional variable. Audio-Visual Communications Review, 19, 399-416.

Dwyer, C.A. (1987). The effect of varied practice activities on complementing visualized instruction. Paper presented at the Association for Educational Communications and Technology, (Atlanta, GA.), February 26 -March 1, 1987.

Ehri, L.C. (1985). Learning to read and spell. Paper presented at the American Educational Research Association (Chicago, IL.), April.

Fitzgerald, J.A. (1951). The teaching of spelling. Milwaukee: The Bruce Publishing Company.

Firth, U. (1980). Unexpected spelling problems. In U. Firth (Ed.), Cognitive Processes in Spelling. London: Academic Press.

Firth, U., & Firth, C. (1980). Relationships between reading and spelling. In J. Kavanagh & R. Venezky (Eds.), Orthography, reading, and dyslexia (pp. 287-295). Austin, TX: PRO-ED.

Fitzgerald, J.A. (1952). Research in spelling and handwriting. REview of Educational Research. 22, 89-95.

Flavell, J.H. (1971). What is memory development the development of? Human Development, 14, 272-278.

Frederick, W.C., & Walberg, H.J. (1980). Learning as a function of time. Journal of Educational Research, 73(4), 183-204.

Frieze, I., & Weiner, B. (1971). Cue utilization and attributional judgments for success and failure. Journal of Personality, 71, 788-794.

Gagne, E.D. (1978). Long-term retention of information following learning from prose. Review of Educational Research, 48, 629-665.

Gagne, E.D. (1985). The cognitive psychology of school learning. Boston, MA: Little, Brown & Company.

Gagne, R.M. (1970). The conditions of learning, revised ed. New York, NY: Holt, Rinehart & Winston.

Galin, D., & Ornstein, R. (1972). Lateral specialization of cognitive mode: An EEG study. Psychophysiology 9, 412-418.

Gardner, D.C., & Kurtz, M.A. (1979). Teaching technical vocabulary to handicapped students. Reading Improvement. 16, 252-257.

Gates, A.I. (1931). An experimental comparison of the study-test and the test-study methods in spelling. Journal of Educational Psychology, 22, 1-19.

Gates, A.I. (1937). Recent experimental attacks on certain spelling problems. Elementary English Review. 14, 6-10.

Gay, L. (1981). Educational Research. Columbus, OH: Merrill Publishing Company.

Gazzaniga, M.S., & Sperry, (1967). Language after section of the cerebral commissures. Brain, 90, 131-148.

Gentry, J., & Henderson, E. (1978). Three steps to teaching beginning readers to spell. The Reading Teacher, 31, 632-637.

Gerst, N.S. (1971). Symbolic coding processes for observational learning. Journal of Personal Social Psychology, 19, 7-17.

Gesell, A., & Ilg, F.L. (1949). Child development. New York, NY: Harper & Brothers.

Getman, G.N. (1957-65). Notes from visual development seminars. Section on child vision care and guidance. (Duncan, OK).

Getman, G.N. (1960). Operational vision, Series 4, no. 6. Duncan, OK: Optometric Extension Program.

Getman, G.N. (1962). How to develop your child's intelligence. Luverne, MN.

Goldstein, E.B. (1975). The perception of multiple images. Audio Visual Communication Review, 23(1), 34-68.

Green, B.F., & Anderson, L.K. (1956). Color coding in a visual search task. Journal of Experimental Psychology, 51 (1), 19-24.

Greenwood, C.R. (1988). The longitudinal effects of classwide peer tutoring on classroom ecology, student's academic behavior, and standardized achievement. Kansas City, KS. Juniper Hill Gardens Children's Project.

Greenwood, C.R., Dinwiddie, G., Bailey, V., Carta, J.J., Dorsey, D., Kohler, F.W., Nelson, C., Rotholz, D., & Schulte, D. (1987). Field replication of classwide peer tuturing. Journal of Behavioral Analysis, 20, 151-160.

Gross, G.C. (1973). Inferotemporal cortex and vision. In E. Stellar & J.M. Sprague (Eds.), Progress in Physiological Psychology. New York, NY: Academic Press.

Guthrie, E.R. (1935). The Psychology of Learning. New York, NY: Harper & Row.

Haapasalo, S. (1982). Relationships between perceptual mechanisms for color and pattern in human vision. Helsinki, Finland: Academia Scientiarum Fennica.

Hale, G.A., & Lewis, M. (Eds.). (1979). Attention and cognitive development. New York, NY: Plenum.

Hanna, P.R. (1966). Needed research in spelling. In T.D. Horn (Ed), Research on Handwriting. National Conference on Research in English, NCTE. 56-57.

Hanna, P.R. (1971). Printed materials will supplement videorecordings. College Management. 6, 30-31.

Hanna, P.R., Hodges, R.E., & Hanna, J.S. (1971). Spelling structure and strategies. Boston, MS: Houghton Mifflin.

Hanna, P.R. Hanna, J.S., Hodges, R.E., & Rudorf, E.H. (1966). Phoneme-grapheme correspondences as cues to spelling improvement. Washington, DC: Office of Education, United States Department of Health, Education, and Welfare.

Harber, J.R. (1980). Are auditory perceptural skills requisite for reading success? Reading World. 19(3), 272-279.

Harmon, D.B. (1958). Notes on a dynamic theory of vision. Vol. 1. 3rd rev. Austin, TX: D.B. Harmon, Publisher.

Harris, K.R., & Graham, S. (1985). Improving learning disabled student's composition skills: Self- control strategy training. Learning Disabilities Quarterly. 8. 27-36.

Harris, K.R., Graham, S., Freeman, S. (1988). Effects of strategy training on metamemory among learning disabled students. Exceptional Children, 54(4) 332-338.

Haygood, R., & Bourne, L.E. (1965). Attribute and rule learning aspects of conceptual behavior. Psychological Review. 72. 175-95.

Hebb, D.O. (1955). Drives and the CNS (conceptual nervous system). Psychological Review. 62. 243-254.

Henderson, M.A. (1977). Reading while becoming: Affective approaches. Journal of Reading. 20, 317-326 +.

Hendrickson, H. (1988). Spelling: A visual skill. Academic Therapy. 23(4), 389-395.

Henry, W.H. (1965). Child vision care. Series 10, no. 2-12. Duncan, OK: Optometric Extension Program.

Hillerich, R.L. (1976). Spelling: an element in written expression. Columbus, OH: Charles E. Merrill.

Hinshelwood, J. (1900). Congenital word blindness. Lancet, i, 1506-1508. 121. Hinshelwood, J. (1902). Congenital word blindness with reports of two cases. Opthalmic Review, 21, 91-99.

Hinshelwood, J. (1909). Four cases of congenital word blindness occurring in the same family. British Medical Journal, ii, 1229-1232.

Hintzman, D.I., Block, R.A., & Inskepp, N.R. (1972). Memory for input. Journal of Verbal Learning and Verbal Behavior, 3, 741-749.

Hitt, W.D. (1961). An evaluation of five different abstract coding methods: Experiment IV. Human Factors, 3, 120-130.

Hodges, R.E. (1971). Reaction to language acquisition and the reading process. International Reading Association Conference Papers (Theoretical Models & Processes of Reading). 14, 20-22.

Hogan, T.P. (1975). Survey of School Attitudes, Intermediate Level-Forms A & B: Manual for Administering and Interpreting. San Antonio, TX: The Psychological Corporation.

Horn, T.D. (1969). In R.L. Ebel (Ed.), Encyclopedia of Educational Research (4th Ed.). London: MacMillan.

Hulme, C., & Bradley, L. (1984). An experimental study of multi-sensory teaching with normal and retarded readers. In R.M. Malatesha & H.A. Whitaker (Eds.), Dyslexia: A global issue. 431-444, The Hague: Nijhoff.

Hunt, E. (1980). Intelligence as an information processing concept. British Journal of Psychology, 71, 449-474.

Hunt, E. (1983). On the nature of intelligence. Science, 219, 141-146.

Hurvich, L.M. (1981). Color vision. Sunderland, MA: Sinauer Associates, Incorporated.

Hynd, C.R. (1986). Educational intervention in children with developmental learning disorders. Child Neuropsychology, 2. New York, NY: Academic Press.

Hynd, C., & Hynd, G. (1984). Recent neuropsychological research: Do practical implications exist? Journal of Educational Neuropsychology, 5, 1-7.

Irwin, R.C. (1986). Attentional deficit disorder. Tulsa OK: Tulsa Developmental Pediatrics & Center for Family Psychology.

Isaac, S. & Michael, W.B. (1985). Handbook in Research and Evaluation. San Diego, CA: EdITS Publishers.

Isaacson, A.G., Rowland, T.D., & Kelley, P.A. (1987). A fingerspelling approach to spelling. Academic Therapy, 23(1), 89-96.

Jacoby, L.L., & Craik, F.I.M. (1979). Effects of elaboration of processing at encoding and retrieval: Trace distinctiveness and recovery of initial context. In L.S. Cermak & F.I.M. Craik (Eds.), Levels of Processing and Human Memory (pp 1-21). Hillsdale, NJ: Erlbaum

Jensen, A.R., & Rohwer, W.D. (1970). An experimental analysis of learning abilities in culturaly disadvantaged children. Final Report, Contract no. OEO-2402 to Office of Economic Opportunity. Berkley, CA: University of California (July).

Jersild, A.T. (1963). Child Psychology (5th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Johnson, B.B. (1977). Color-coding System. Sand Springs, OK: The Hissom Memorial Center, Sand Springs Public Schools.

Johnson, D.J. & Myklebust, H.R. (1967). Learning disabilities: educational principles and practices. New York, NY: Gruen & Stratton.

Johnston, P.H., & Winograd, P.N. (1985). Passive failure in reading. Journal of Reading Behavior, 27(4) 279-301.

Katz, J.M. (1971). Reflective-impulsivity and color-form sorting 2. Child Development, 42, 745-754.

Katzman, N., & Nyenhius, J. (1972). Color versus black and white effects on learning, opinion, and attention. Audio-visual Communications Review, 20, 16-28.

Kephart, N.C. (1967). Learning disabilities: an educational adventure. West Lafayette, IN: Delta Pi Press.

Kirk, R.E. (1968). Experimental design: Procedures for the behavioral sciences. Monterey, CA: Brooks/Cole.

Kirsner, K. (1974). Modality differences in recognition memory for words and their atttibutes. Journal of Experimental Psychology, 102, 579-584.

Klausmeier, H.J. (1985). Eucational psychology, (5th ed) Philadelphia, PA: Harper & Row, Publishers.

Klinger, A. (1980). Structured perception through hierarchical computation structures. S. Tanimoto & A. Klinger (Eds). New York, NY: Academic Press.

Kosslyn, S.M. (1980). Image & Mind. Cambridge, MS: University Press.

Kuhn, J.N., & Schroeder, H.H. (1971). Multi-sensory approach for teaching spelling. Elementary English. 48, 865-869.

Lane, D.M. & Pearson, D.A. (1982). The development of selective attention. Merrill-Palmer Quarterly, 28, 317-337.

Larsen, S. & Hammill, D. (1986). Test of Written Spelling - 2. San Rafael, CA: Academic Therapy Publishers.

Lashley, K.S. (1938). Factors limiting recovery of CNA lesions. Journal of Nervous & Mental Diseases, 88, 733-755.

Levin, J.R. (1983). Pictorial strategies for school learning: Practical illustrations. In M. Pressley & J.R. Levin (Eds.), Cognitive strategy research: educational implications. New York, NY: Springer-Verlag.

Levin, J.R., Pressley, M., McCormick, C.B., Miller, G.E., & Shriberg, L.K. (1979). Assessing the classroom potential of the keyword method. Journal of Educational Psychology, 71, 583-594.

Light, L.L., Berger, D. E., & Bardeles, M. (1975). Trade-off between memory for verbal items and their visual attributes. Journal of Experimental Psychology: Human Learning and Memory, 104, 188-193.

Linton, M., & Gallo, P.S., Jr. (1975). The practical statistician: A simplified handbook of statistics. Monterey, CA: Brooks/Cole Publishing Company.

Lyle, J.G. (1969). Reading retardation and reversal tendencies: A factorial study. Child Development. 40, 933-843.

McGinnis, M. (1963). Aphasic children: Identification and edcuation by the association method. Washington, DC: Volta Bureau.

McGeoch, J.A., & Irion, A.L. (1952). The psychology of human learning. In R.D. Luce, R.R. Bush, & E. Galanter (Eds.) Handbook of Mathematical Psychology (Vol 1). New York, NY: Wiley.

Maehr, M. (1983). On doing well in science: Why Johnny no longer excels; why Sarah never did. In S.G. Paris, G.M. Olson, & H.W. Stevension (Eds.), Learning and motivation in the classroom (pp. 179-210). Hillsdale, NJ: Erlbaum.

Mandler, G. (1967). Organization and memory. In K.W. Spence, & J.T. Spence (Eds.), The psychology of learning and motivation: Advances in research and theory. Vol 1. New York, NY: Academic Press.

Marjoribanks, T. (1988). Ability and attitude correlates of aspirations: Personality-group differences. Journal of Experimental Eduation. 56(4), 177-182.

Masson, M.E.J., & Miller, J. (1983). Working memory and individual differences in comprehension and memory of text. Journal of Educational Psychology. 75, 314-318.

Meichenbaum, D. (1977). Cognative Behavior Modification. New York, NY: Plenum Press.

Michael, C.R. (1978 a). Color vision mechanisms in monkey striate cortex: Dual-opponent cells with concentric receptive fields. Journal of Neurophysiology. 41(3), 572-588.

Michael, C.R. (1978 b). Color vision mechanisms in monkey striate cortex: simple cells with duel opponent-color receptive fields. Journal of Neurophysiology 41(5), 1233-1249

Michael, C.R. (1978 c.). Color-sensitive complex cells in monkey striate cortes. Journal of Neurophysiology 41(5), 1250-1266.

Miller, N.E. (1957). Graphic communication and the crisis in education. Special Issue of Audio-visual Communication Review. 5(3).

Motokawa, K. (1970). Physiology of color and pattern vision. Tokyo: Igaku Shoin, Limited.

Murdock, B.B. (1974). Human memory: Theory and data. New York, NY: Wiley.

Naidoo, S. (1972). Is she typical? Times Education Supplement. 3015(4), March 9.

Neisser, U. (1967). Cognitive Psychology. Englewood Cliffs, NJ: Prentice-Hall.

Newcombe, F. (1973). Patterns of paralexia: A linguistic approach. Developmental Medicine & Child Neurology. 2, 175-199.

Nilsson, L.G. (1973). Organization by modality in short-term memory. Journal of Experimental Psychology. 100. 246-253.

Nilsson, L.G. (1974). Further evidence for organization by modality in immediate free recall. Journal of Experimental Psychology. 103, 945-957.

Ormond, J.E. (1985). A learning strategy for phonetic spellers. Academic Therapy 22(2), 195-198.

Orton, J.E. (1937). Reading. writing and speech problems in children. New York, NY: Norton.

Owens, N. (1987). A study of 100 students diagnosed as attention deficit disordered. Richardson, TX: Educational Products.

Padgham, C.A., & Saunders, J.E. (1975). The perception of light and color. San Francisco, CA: Academic Press.

Paivio, A. (1971). Imagery and verbal processes. New York, NY: Holt, Rinehart, & Winston.

Perin, D. (1983). Phonemic segmentation and spelling. British Journal of Psychology. 74. 129-144.

Peterson, V.M. (1976). The effect of color versus black and white learning materials on academic achievement. Washington, DC: U.S. Department of Education.

Peterson, L.R., & Peterson, M.J. (1957). The role of context stimulus in verbal learning. Journal of Experimental Psychology. 53(2) 47.-53.

Pezdek, K., & Miceli, L. (1982). Life-span differences in memory integration as a function of processing time. Developmental Psychology, 18, 485-490.

Poock, G.K. (1969). Coding effects in compatible and noncompatible display-control arrangements. Journal of Applied Psychology, 53, 301-303.

Pressley, M., & Levin, J.R. (1986). Elaborative learning strategies for the inefficient learner. In S.J. Ceci (Ed.), Handbook of Cognitive, Social, and Neurological Aspects of Learning Disabilities. Hillsdale, NJ: Erlbaum.

Radaker, L.D. (1963). The effect of visual imagery upon spelling performance. The Journal of Educational Research. 56, 370-372.

Richardson, A. (1969). Mental imagery. London: Routledge & Kegan Paul.

Rohwer, W.D., Jr. (1970). Mental elaboration and learning proficiency. In J.P. Hill (Ed.), Minnesota Symposium on Child Psychology, Vol 4. Minneapolis, MN: University of Minnesota Press.

Rosenshine, B., & Berliner, D. (1978). Academic engaged time. British Journal of Teacher Education, 4, 3-16.

Salomon, G. (1979). Media and symbol systems as related to cognition and learning. Journal of Educational Psychology. 71(2), 131-148.

Saltz, E. (1963). Compound stimuli in verbal learning: Cognition and sensory differentiation versus stimuli selection. Journal of Experimental Psychology, 66, 1-5.

Sarason, B.R., & Sarason, I.G. (1987). Abnormal psychology, The problem of maladaptive behavior (5th Ed.) Englewood Cliffs, NJ: Prentice-Hall, Incorporated.

Satz, P., Rardin, D., & Ross, J. (1971). An evaluation of a theory of specific developmental dyslexia. Child Development, 42, 2009-2021.

Schwartz, S. (1983). Spelling disability: A developmental linguistic analysis of pattern abstraction. Applied Psycholinguistics, 4, 303-316.

Schwartz, S., & Doehring, D.G. (1977). A developmental study of children's ability to acquire knowledge of spelling patterns. Developmental Psychology, 13, 419-420.

Seligman, M.E.P., (1975). Helplessness: On depression, development, and death. San Francisco, CA: Freeman.

Senf, G.M., & Freundl, P.C. (1971). Memory and attention factors in specific learning disabilities. Journal of Learning Disabilities. 4, 94-106.

Seng, M.W. (1969). Overhead projection revelation techniques. Educational Screen Audio-Visual Guide. 48, 12-13.

Sevush, S. (1983). The neurolinguistics of reading: Autonomic and neurologic correlates. Paper presented at the annual conference of the International Neuropsychological Society, Mexico City.

Shapiro, S.R. (1988). What is developmental therapy? A rationale. Paper presented at Sand Springs Public Schools district conference, Sand Springs, OK. (February).

Singer, M.H., & Crouse, J. (1981). Relationship of context-use skills to reading: A case for an alternative experimental logic. Child Development. 52, 1326-1329.

Slavin, R.E. (1984). Component building: A strategy for research-based instructional improvement. The Elementary School Journal. 84(3), 255-268.

Smith, S.L. (1962). Color coding versus visual search, Journal of Experimental Psychology. 64(5), 434-440.

Smith, S.L. (1963). Color coding and visual separability in information displays. Journal of Applied Psychology. 47(6), 358-364.

Smith, S.L., & Thomas, D. (1964). Color versus shape coding in information displays. Journal of Applied Psychology. 48, 137-146.

Sperling, G. (1960). The information available in brief presentations. Psychological Monographs. 74(6), (Whole, No. 498).

Stein, B.S., Bransford, J.D., Franks, J.J., Owings, R.A., Vye, N.J., & McGraw, W. (1982). Differences in the precision of self-generated elaborations. Journal of Experimental Psychology: General 111, 399-405.

Tabachnek, B.G., & Fidell, L.S. (1983). Using multivariate statistics. New York, NY: Harper & Row.

Taylor, H.G., Fletcher, J.M., & Satz, P. (1986). Neuropsychological assessment of children. In Handbook of Psychological Assessment, 211-234.

Taylor, S., Frackenpohl, H., White, C., Nieroroda, B., Browning, C., & Birsner, E. (1979). EDL core vocabularies in reading, mathematics, science, and social studies. EDL, a division of Arista.

Templeton, S. (1979). Spelling first, sound later: The relationship between orthography and higher order phonological knowledge in older students. Research in the Teaching of English, 13, 255-264.

Thorndike, E.L. (1932). The fundamentals of learning. New York, NY: Teachers College.

Torgensen, J.K. (1977). The role of nonspecific factors in the task performance of learning disabled children: A theoretical assessment. Journal of Learning Disabilities, 10, 27-34.

Torgensen, J.K. (1982). The learning disabled child as an inactive learner. Topics in Learning and Learning Disabilities, 2, 45-52.

Treiman, R. (1984). Individual differences among children in spelling and rading styles. Journal of Experimental Child Psychology, 37, 463-477.

_____. (1972) Organization of Memory. E. Tulving & W. Donelson (Eds.), New York, NY: Academic Press.

Tulving, E. (1968). Theoretical issues in free recall. In T.R. Dixon and D.H. Horton (Eds.), Verbal behavior and general behavior theory. Englewood Cliffs, NJ: Prentice-Hall.

Tulving, E., & Thompson, D.N. (1973). Encoding specificity and retrieval processes in episodic memory. Psychological Review, 80, 352-373.

Vandermeer, A.W. (1954). Color versus black and white in instructional films. Audio-visual Communications Review. 2, 121-134.

Varhagen, C. (1985). In Educational Testing Service Tests Critiques, Vol. II, Princton, NJ: ETS, p. 485-493.

Waters, G.S., Bruck, M., & Malus-Abramowitz, M. (1988). The role of linguistic visual information in spelling: A developmental study. Journal of Experimental Child Psychology, 45, 400-421.

Watkins, M.J. (1974). When is recall spectacularly higher than recognition? Journal of Experimental Psychology. 102, 161-163.

Weiner, B. (1974). Achievement motivation and attribution theory. Morristown, NJ: General Learning Press.

Weiss, W., & Margolius, G. (1954). The effect of context stimulation on learning and retention. Journal of Experimental Psychology. 48, 318-322.

Wicker, F.W., & Everston, C.M. (1972). Pre-recall and post-recall imagery rating with pictoral and verbal stimuli in paired-associative learning. Journal of Educational Psychology. 92, 75-82.

Wilkinson, Leland. (1987). SYSTAT: The system for statistics. Evanston, IL: SYSTAT, Incorporated.

Winograd, P.N. (1984). Strategic difficulties in summarizing texts. Reading Research Quarterly. 19, 404-425.

Wong, B.Y.L. (1988). Basic research in learning disabilities: An introduction to the special series. Journal of Learning Disabilities. 21, 195.

Zajonc, R.B. (1980). Feeling and thinking: Preferences need no inferences. American Psychologist. 35, 151-175.

Zentall, S.S. (1975). Optimal stimulation: A theoretical basis of hyperactivity. American Journal of Orthopsychiatry. 45, 549-563.

Zentall, S. S. (1986). Effects of color stimulation on performance and activity of hyperactive and non-hyperactive children. Journal of Educational Psychology. 78(2), 159-165.

Zentall, S.S., Falkenberg, S.D., & Smith, L.B. (1985). Effects of color stimulation on the copying performance of attention-problem adolescents. Journal of Abnormal Child Psychology. 13, 501-511.

Zentall, S.S., & Kruczek, (1988). The attraction of color for active attention problem children. Exceptional Children. 54(4), 357-362.

Zutell, J.(1979). Spelling strategies of primary school children and their relationship to the Piagetian concept of decentration. Research in the Teaching of English. 13, 69-80.

APPENDIXES

APPENDIX A

COVER LETTER

COVER LETTER

Date_____

Dear_____

Your child has been selected as a possible participant in a research project to be conducted this fall through the Sand Springs Public Schools. The goal of this study is to compare the effect of two instructional interventions on spelling performance and attitude toward school of sixth graders.

All sixth grade students in regular classrooms have been selected as prospective participants in this research project. Given parental consent, each participant will be assigned to either a letter color-coded or a day color-coded spelling intervention for six weeks in the classroom. Each participant will be screened for color acuity. At the beginning and the conclusion of the study each participant will be administered the Test of Written Spelling in a group and the Survey of School Attitudes. Informal creative writing samples will also be collected from each student during the study. All assessments will be given during school time over a month's span of time and will require approximately one hour of testing time.

If you have any questions or concerns, I will be happy to discuss them with you. To give your permission for your child to participate in this research study, please complete these steps:

1. Sign the parent consent form;

2. Return the form in the enclosed envelope by November 1, 1988.

If you do not wish to have your child participate in this study, please check the appropriate place on the consent form and return the form in the enclosed envelope to your child's school.

Thank you,

encl: 2

APPENDIX B

PARENT CONSENT FORM

PARENT CONSENT FORM

Student:_____ Teacher: _____

School:_____

Parents:_____ Home Phone:_____

Address:_____ Work Phone:_____

_____

I hereby give permission for my child_____
to participate in this research project and to be
administered the following screenings and assessments:

Dvorine Isochromatic Plates Color Vision Screening
Test of Written Spelling
Survey of School Attitudes

_____ _____
(date) (signature)

You, as a parent, have the following rights:

1. to refuse permission for testing;
2. to have a copy of all testing results;
3. to have these results explained;
4. to know that all results are kept strictly confidential
5. to have these results destroyed upon parent request.

_____
(signature)

__\ I do not give my permission for my child to participate in this study.

APPENDIX C

EXAMPLES OF SSA READING SUBTEST ITEMS

EXAMPLES OF TWS WORDS

EXAMPLES OF SSA READING SUBTEST ITEMS

3. Getting a book as a gift.	LIKE NOT SURE OR DON'T CARE DISLIKE
7. Learning to spell.	LIKE NOT SURE OR DON'T CARE DISLIKE
12. Finding words that have the same meaning.	LIKE NOT SURE OR DON'T CARE DISLIKE
60. Choosing a good word for a sentence.	LIKE NOT SURE OR DON'T CARE DISLIKE

EXAMPLES OF TWS WORDS

up	myself
that	nineteen
spend	author
forty	political
hospital	agriculture

APPENDIX D

COLOR-CODED SPELLING WORD LISTS

LESSON 12

1. airmail
2. already
3. background
4. billboard
5. brainstorm
6. earthquake
7. eavesdrop
8. northwest
9. offshore
10. outlaw
11. proofread
12. rainfall
13. roommate
14. somebody
15. streamlined
16. throughout
17. touchdown
18. turnpike
19. whatever
20. workshop

LESSON 13

1. picnicking
2. frolicking
3. coasting
4. wondered
5. filtered
6. appeared
7. steering
8. referred
9. panicked
10. mimicking
11. squirting
12. finished
13. offered
14. watered
15. occurred
16. printing
17. touching
18. delivered
19. preferred
20. transferred

LESSON 14

1. hawk
2. dawn
3. walnut
4. stalk
5. fault
6. paus
7. caution
8. boss
9. broth
10. install
11. laundry
12. sausag
13. daughter
14. lawn
15. awful
16. applaud
17. haunt
18. faucet
19. frost
20. broad

LESSON 15

1. emergency
2. hurl
3. journe
4. nursery
5. ourtesy
6. courag
7. furnish
8. observ
9. deserv
10. flourish
11. journal
12. surfac
13. terminal
14. sturdy
15. search
16. pearl
17. concern
18. perch
19. flurries
20. murmur

LESSON 16

1. court
2. sports
3. cord
4. encor
5. mourn
6. cours
7. or
8. normal
9. chores
10. sourc
11. rester
12. igner
13. portion
14. hours
15. scorch
16. storm
17. ador
18. fortress
19. afford
20. chord

LESSON 17

1. ecology
2. natural
3. wildlif
4. forestry
5. survival
6. resurces
7. species
8. environment
9. conservation
10. energy
11. solar
12. nuclear
13. recycl
14. disposal
15. purify
16. antipollution
17. herbicid
18. pesticid
19. endangered
20. orginic

APPENDIX E

PROCEDURES SCHEDULE

PROCEDURES SCHEDULE

9/26/88 - 19/31/88:	received approval from superintendent to conduct study
	tests and pencils ordered
	forms, instructions, posters constructed
10/18-20/88:	meetings with five building principles
10/20/88:	initial teacher staffing held
10/25/88	teacher's given information regarding research project
10/27/88:	second teacher staffing held demonstration of interventions parent letters and consent forms distributed to teachers
10/31/88:	parent letters sent home with students pencils/posters delivered to teachers
11/2/88:	collected all returned permissions
11/2-7/88:	posttesting and vision screening conducted
11/7/88 to 12-/16/88:	treatment phase (6 weeks_
12/19/88 to 1/9/89:	posttesting conducted
1/12-16/89:	thank you and sodas for students
4/15/89:	parent testing results forms sent out

APPENDIX F

TEACHER INFORMATION

TEACHER INFORMATION

Dear_____ 10/28/88

Thank you for agreeing to participate in my research project. I will come to your classroom to give the group pretest on:

_____ at _____a.m. p.m.
(date) (time)

Your class has been randomly assigned to the

_____ treatment method during the 6 week treatment phase

Please continue to use your regular style of teaching to teach during the 6 week treatment phase which begins:

- Monday, Nov. 7 and continues through Friday, Dec. 16
- use lessons 12, 13, 14, 15, 16 and 17.
- containing 20 spelling words each week
- using the regular spelling textbook (HBJ 6th grade level)

I have also included in this packet:

___1. 20-word lists for the 6 spelling lessons;

___2. a large manila envelope in which to send me your students' written spelling tests (or number of words wrong for each student) and creative writing samples -the envelope will be returned to you weekly for reuse.

IN ADDITION---- posters of the spelling words, as well as the colored pencils, will be delivered to you by November 7.

Please call me if you have questions or items are missing from your packet! Thanks again for your expertise and assistance.

APPENDIX G

PARENT REPORTING FORM

PARENT REPORTING FORM

Dear Parent:

The testing portion of the spelling research project conducted by the Sand Springs Schools has been completed. To assist you in interpreting your child's scores the following information is offered. Your child was one of 178 sixth-graders in 13 classrooms from five elementary schools in Sand Springs.

Your child's classroom was randomly assigned to the _____group. Three other classrooms were assigned to this group, also. In this group your child received regular spelling instruction from his classroom teacher as he/she:

_____color-coded the vowels of weekly spelling words for six weeks
_____used an assigned color per day to write all spelling activities for six weeks
_____used no color-coded intervention

Your child was also screened for color acuity and found to have: _____no deficiency.
_____a color deficiency. Therefore, your child's scores were not included in the final data collection for this research. However, scores are being reported to you for your information. The effects, if any, of color deficiency on these test scores is unknown so you may wish to interpret the results with caution.

Your child was pretested and posttested with the Test of Written Spelling in a group session. Your child's scores are reported in raw score, grade level and percentile. In addition, the mean score, grade level, and percentile for the group in which your child participated are given for your comparison.

Your child was individually administered the Survey of School Attitudes, reading subtest, pretest and posttest. These scores are reported in raw score and percentile for your child and mean for the group.

If you have concerns, questions, or wish further interpretation of these results please contact me. Again, thank you for your willingness and permission to have your child participate in this research project.

Thank you,

REPORT OF SCORES FOR: _____
CHILD'S NAME

_____ _____
TEACHER SCHOOL

PARENTS: _____ PHONE: _____

ADDRESS: _____

_____

TEST OF WRITTEN SPELLING (TWS-2)

	child's	group x	
raw score*	_____	_____	(* no. misspelled of 60)
standard deviation	_____	_____	
grade level	_____	_____	
percentile	_____	_____	

SURVEY OF SCHOOL ATTITUDES (SSA)

	child's	group x	
raw score*	_____	_____	(* no. of points of 45)
percentile	_____	_____	

FIGURES

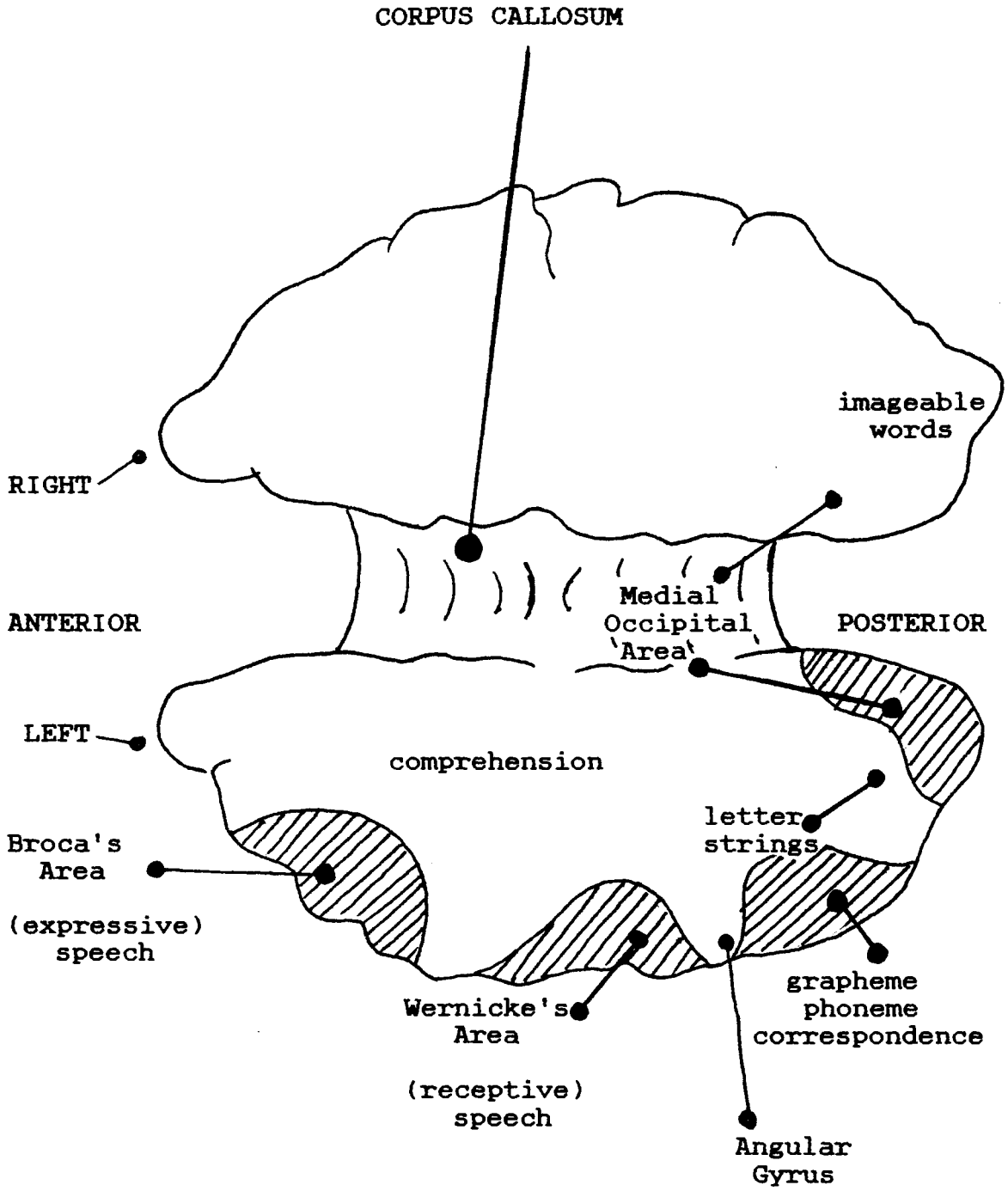

Figure 1. Major Pathways and Cortical Regions of Brain

Source: Hynd, C., & Hynd, G. (1984). Recent neuropsychological research: Do practical implications exist? Journal of Educational Neuropsychology, 5, 1-7.

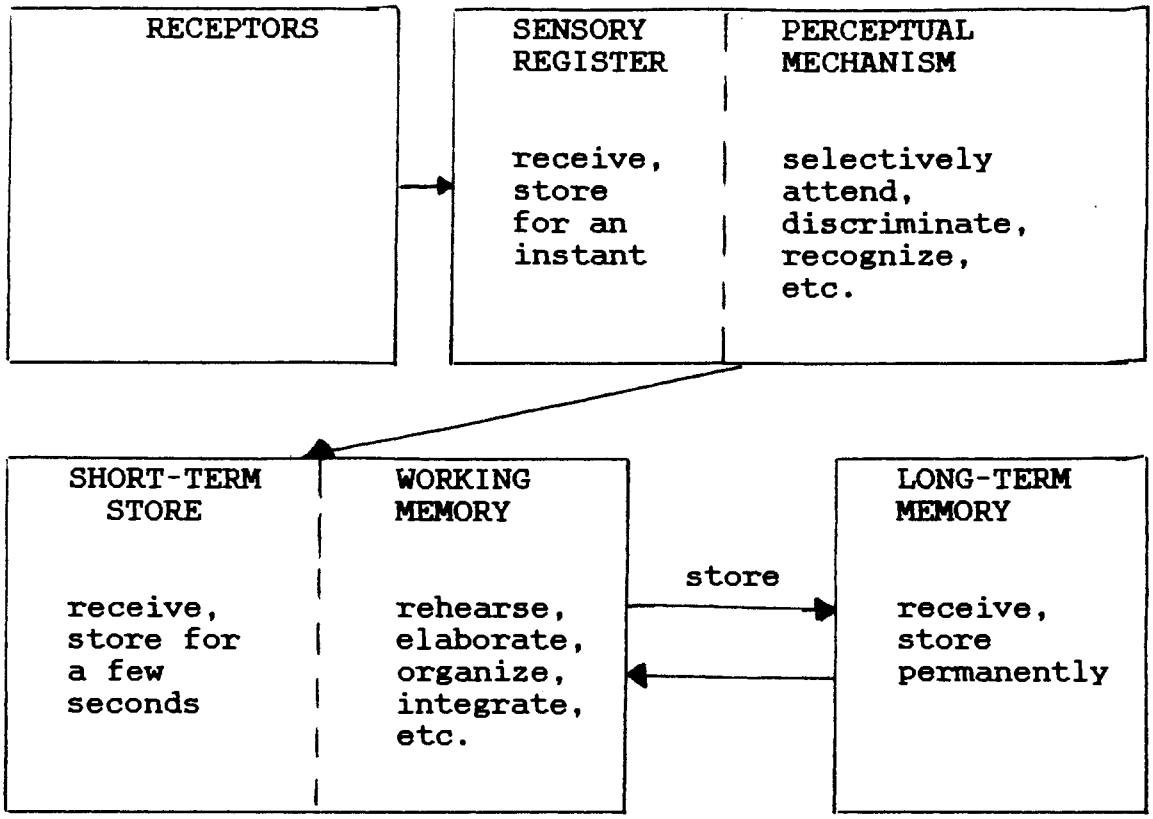

Figure 2. Phases and Mental Processes of Human Information Processing

Source: Klausmeier, H.J. (1985). Educational Psychology, 5th ed). Philadelphia, PA: Harper & Row, Publishers.

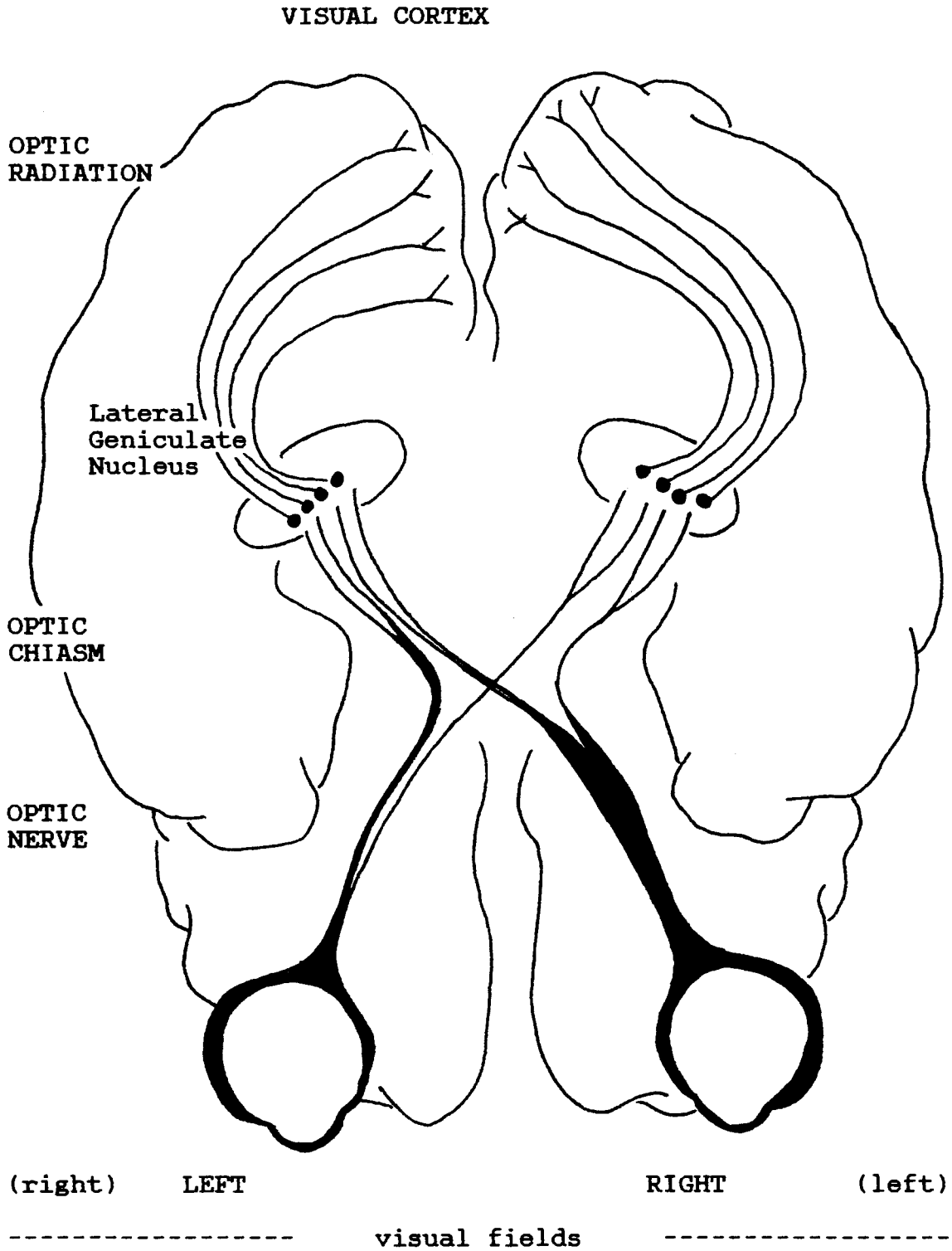

Figure 3. Neural Pathways from Retina Through Optic Nerve Tract to Brain

Source: Hurvich, L.M. (1981). Color vision. Sunderland, MA: Sinauer Associates, Incorporated.

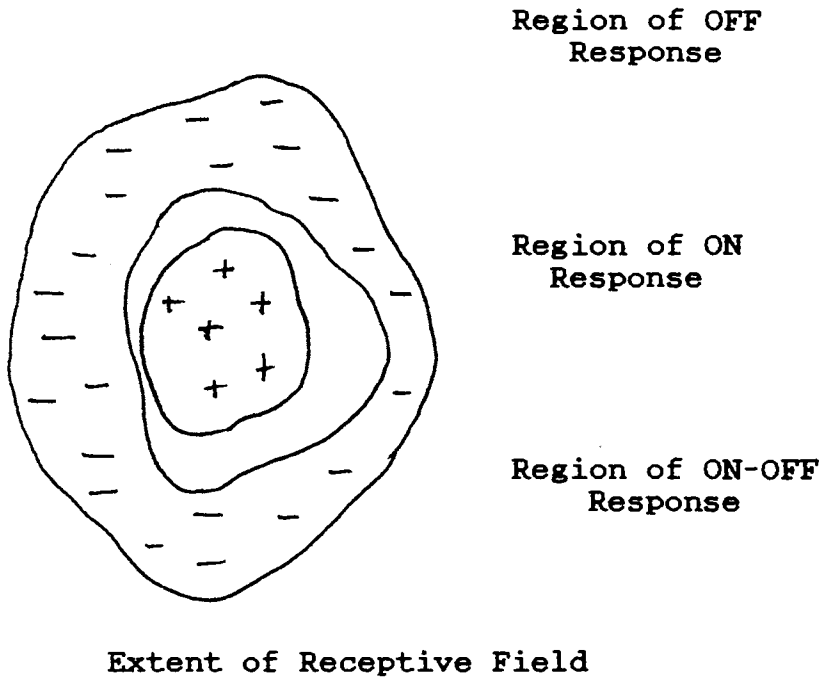

Figure 4. Eye and Brain

Source: Padgham, C.A., & Saunders, J.E. (1975). The perception of light and color. San Francisco, CA: Academic Press, p. 19.

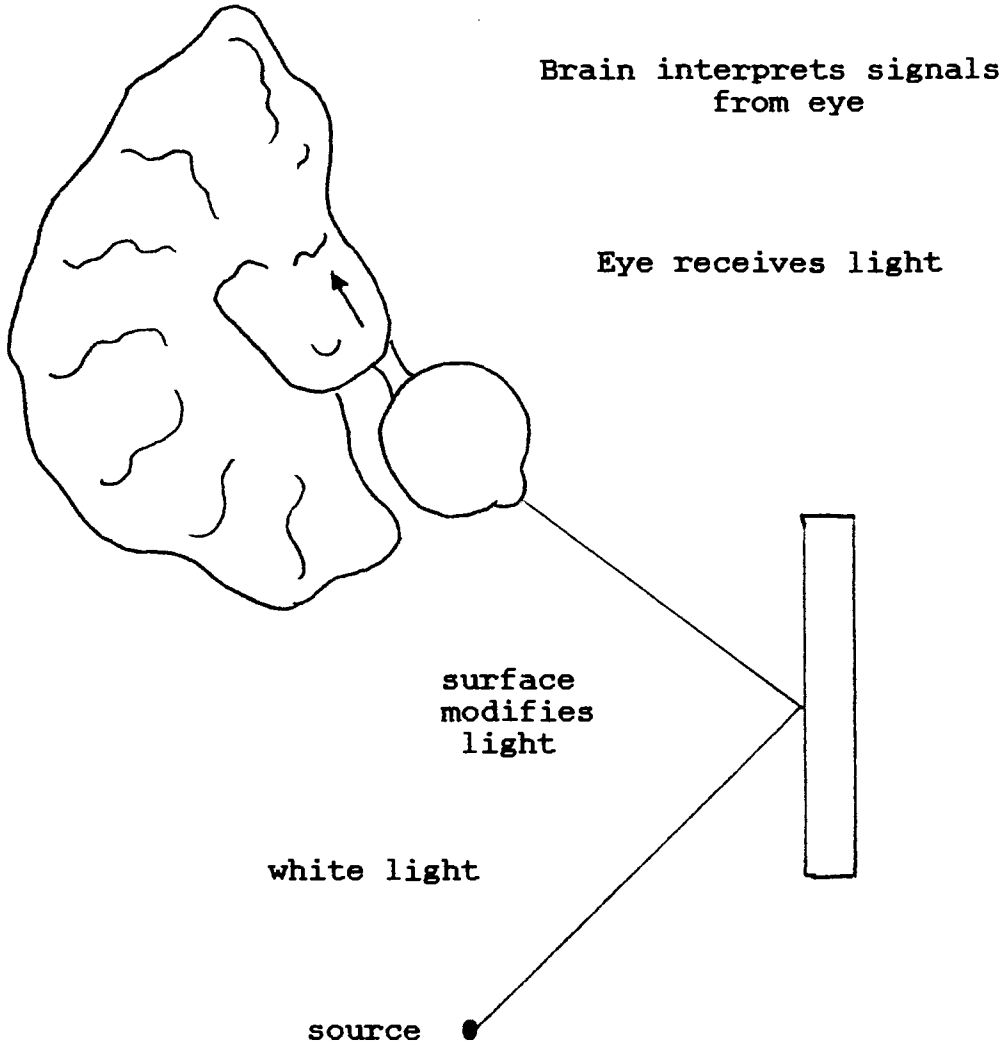

Figure 5. Path of Signals from Eye to Brain

Source: Padgham, C.A., & Saunders, J.E. (1975). The perception of light and color. San Francisco, CA: Academic Press, p. 19.

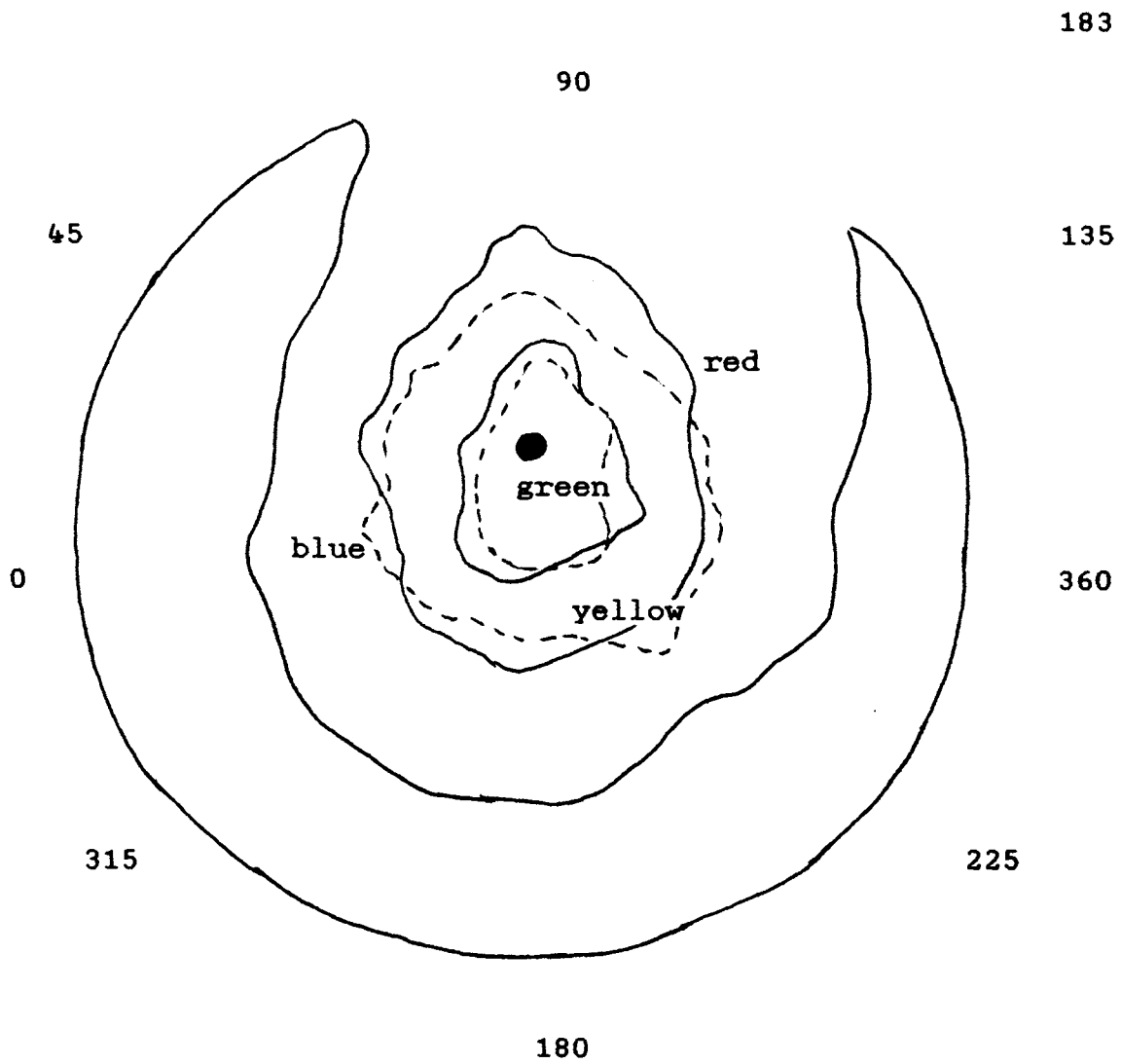

Figure 6. Retinal Color Fields of Right Eye

Source: Hurvich, L.M. (1981). Color vision. Sunderland, MA: Sinauer Associates, Incorporated.

VITA

Linda Sue Brown

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE EFFECTS OF COLOR-CODING ON SPELLING PERFORMANCE AND ATTITUDE TOWARD SCHOOL OF SIXTH GRADE STUDENTS

Major Field: Applied Behavioral Studies

Biographical:

Personal Data: Born in Tulsa, Oklahoma, April 2, 1942, the daughter of Stanley and Ruby Lee Brown, the wife of Robert E. Brown, mother of Robert E. Brown, II, and mother-in-law of Lisa (Gatlin) Brown.

Education: Graduated from Will Rogers High School, Tulsa, Oklahoma, in May, 1960; received Bachelor of Science degree in Secondary Education from Oklahoma Baptist University in 1966; received Master of Education degree in Guidance and Counseling from Xavier University (Ohio) in 1969; enrolled in the School Psychology certification program in 1986 at the Oklahoma State University; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in May, 1989.

Professional Experience: Junior high home economics teacher, Hillsboro, Ohio, 1965-1970; junior high home economic teacher, Dayton, Ohio, 1970-1972; career education specialist for Oklahoma Career Education pilot project, Sand Springs, Oklahoma, 1972-1974; Title IV-C program coordinator, Sand Springs, Oklahoma, 1974-1977; elementary school counselor, Sand Springs, Oklahoma, 1977 to present; member of the National Association of School Psychology, Oklahoma Association of School Psychology, Oklahoma Education Association, National Education Association.