The University of San Francisco
USF Scholarship: a digital repository @ Gleeson Library | Geschke Center

Doctoral Dissertations | Theses, Dissertations, Capstones and Projects

1987

The relationship of short-term visual memory to written spelling : in average fifth-grade readers when sequential and simultaneous presentation is compared

A. Terry Richardson

Follow this and additional works at: https://repository.usfca.edu/diss

Recommended Citation

Richardson, A. Terry, "The relationship of short-term visual memory to written spelling : in average fifth-grade readers when sequential and simultaneous presentation is compared" (1987). *Doctoral Dissertations*. 400.
https://repository.usfca.edu/diss/400

This Dissertation is brought to you for free and open access by the Theses, Dissertations, Capstones and Projects at USF Scholarship: a digital repository @ Gleeson Library | Geschke Center. It has been accepted for inclusion in Doctoral Dissertations by an authorized administrator of USF Scholarship: a digital repository @ Gleeson Library | Geschke Center. For more information, please contact repository@usfca.edu.

The author of this dissertation has agreed to make
available
to the University community and the public a copy of this thesis project.

Unauthorized reproduction of any portion of this thesis is prohibited.

The quality of this reproduction is
contingent upon the quality of the original copy submitted.

University of San Francisco
Gleeson Library/Geschke Center
2130 Fulton Street
San Francisco, CA 94117-1080 USA

The University of San Francisco

THE RELATIONSHIP OF SHORT-TERM VISUAL MEMORY TO WRITTEN SPELLING IN AVERAGE FIFTH-GRADE READERS WHEN SEQUENTIAL AND SIMULTANEOUS PRESENTATION IS COMPARED

A Dissertation

Submitted to

The Faculty of the School of Education

Counseling and Educational Psychology Program

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

by

A. Terry Richardson

San Francisco, California

December, 1987

This dissertation, written under the direction of the candidate's dissertation committee and approved by the members of the committee, has been presented to and accepted by the Faculty of the School of Education in partial fulfillment of the requirements for the degree of Doctor of Education.

Terry Richardson 11/20/87

Candidate Date

Dissertation Committee

Patricia L. Burk Nov. 20, 1987

Chairperson

Elizabeth D. Bigelow 11/20/87

Ellen Calvin 11/20/87

Dorothy S. Messerschmitt

Dean, School of Education

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	ii
DEDICATION	v
ACKNOWLEDGEMENTS	vi
LIST OF TABLES	vii
CHAPTER	
I. OVERVIEW OF THE STUDY	1
Background of the Study	1
Statement of the Purpose	4
Definitions	5
Organization of the Study	7
II. REVIEW OF THE LITERATURE	9
Spelling Achievement when Reading Ability is Considered	9
Spelling Errors and Processing Style	11
Spelling Stages	14
Visual Memory Related to Spelling	16
Rote Short-Term Memory Related to Spelling	19
The Relationship Between Spelling and IQ	21
The Relationship Between Visual Memory and IQ	22
Research on Imagery and Visualization	23
Spelling Recognition and Written Spelling	25
Research on Sequential and Simultaneous Processes	27
Summary of the Review of Literature	28
III. METHODOLOGY	31
Purpose of the study	31
Research Design	31
Subject Selection	31

Site Selection. 32
Potential Subjects. 33
Recruitment of Subjects. 35
Instrumentation. 35
The Visual Aural Digit Span. 36
Torgesen, Bowen, and Ivey Visual Sequential Addition to the VADS. 40
The Graham Kendall Memory for Designs Test. . . 42
The Wide Range Achievement Test - Revised. . . . 45
Data Collection. 46
Test Session. 47
Blind Scoring of the Protocols. 47
Protection of Human Subjects. 47
Research Questions. 48
Data Analysis. 48

IV. RESULTS. 51

Research Question 1. 51
Research Question 2. 54
Research Question 3. 55
Research Question 4. 57
Research Question 5. 58
Research Question 6. 59
Additional Analyses. 60
Additional Question 7. 61
Additional Question 8. 62
Additional Question 9. 63
Summary of Results and Additional Analyses. 64

V. SUMMARY, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS. 69

Summary and Discussion of Findings. 70
Limitations of the Study. 77
Conclusions. 78
Implications for Educational Practice. 79

Suggestions for Future Research. 81

REFERENCES. 83

APPENDICES. 95

Appendix A: Parental Permission Slip. 95
Appendix B: Example of Parental Letter After the Assessment. 97
Appendix C: VADS Score Sheet. 99
Appendix D: VADS2+ Score Sheet. 101

DEDICATION

This dissertation is dedicated to my parents, Billie F. Richardson and Dr. Edward J. Richardson.

ACKNOWLEDGEMENTS

Without the encouragement and help of my dissertation committee this dissertation could not have been completed. Dr. Patricia Busk, my dissertation chairperson, provided knowledge, support, and expertise throughout the study which helped to shape, not only this dissertation but my own personal understanding. Dr. Elizabeth Bigelow encouraged me from the time that I first entered U.S.F. and helped me to continue my momentum when relocation to Southern California made doctoral study difficult. Dr. Allen Calvin gave suggestions and extended my knowledge of the application of computers to psychological research and statistics.

LIST OF TABLES

Table		Page
1.	Demographic Characteristics of Two Groups of Fifth-Graders Employed in This Study.	34
2.	Means, Standard Deviations, and T-Test Results for Two Groups of Spellers on VADS.	52
3.	Koppitz (1977) VADS Mean Scores and Standard Deviations for Fifth-Grade Students (N=88).	53
4.	Results of Comparing Good and Poor Spellers on VADS2+.	56
5.	Means, Standard Deviations, and T-Test Results for Two Groups of Spellers on the MFD Test.	58
6.	Frequency of Phonetic and Nonphonetic Errors Made by Good and Poor Spellers.	59
7.	Means, Standard Deviations, and T-Test Comparisons of Good and Poor Speller's Spelling Errors on the WRAT-R.	60
8.	Means, Standard Deviations, and T-Test Comparisons of VSI and VI for 2 Groups of Spellers. . .	62
9.	Means, Standard Deviations, and T-Test Comparisons of AI and VI for 2 Groups of Spellers. . .	63
10.	Means, Standard Deviations, and T-Test Comparison of VS and AI for 2 Groups of Spellers. . . .	64

Chapter I

Overview of the Study

Background of the Study

Hanna, Hodges, and Hanna (1971) simply defined spelling as "the process of encoding, or of rendering spoken words in written symbols" (p. 4), but, as countless children and disgruntled adults will admit, spelling is anything but simple. Traditional spelling education has proven ineffective in the creation of spelling success for a surprisingly large number of otherwise well-educated and intelligent children and adults.

Frith (1980) noted that, although there is a positive correlation between reading and spelling ability, even the highest estimates of correlation are unable to accounted for a third or more of the variance. Correlations between reading and spelling have been found to range from +.30 to +.80 (Ehri & Wilce, 1982; Frith, 1980; Malmquist, 1958; Newton, 1961; Spache, 1941; Townsend,1947). Several of these studies have further discovered that the correlations decrease with age. Because of these findings, a prediction of spelling performance in individual cases, on the basis of reading, would not be accurate. Frith (1978a) noted that the incidence of spelling handicap was greater than that of reading handicap.

Although there have been repeated acknowledgements (Camp & Dolcourt, 1977; Fay, 1971; Frith, 1980; Gould, 1976; Plessas & Dison, 1964) that many poor readers in the grade levels above third or fourth grade are poor spellers and that good readers may or may not be poor spellers, few studies have investigated specific dimensions of spelling ability in good readers who are not good spellers. By failing to isolate spelling difficulties from reading difficulties, generalizations cannot be made about spelling difficulties that are not in combination with reading problems.

Despite this lack of research in the good-reader-poor-speller area, Dilts and Meyers-Anderson (1980) theorized that in general good spellers utilized a predominante visual as opposed to a predominate auditory or kinesthetic strategy. Dilts, Grinder, Bandler, Bandler, and Delozier (1980), writing in Neurolinguistic Programming, Volume I, stated that "it has been our experience that, since the visual coding of the English language frequently does not follow phonetic rules, individuals with a visual strategy are consistently much better spellers" (p.32). Their theory, an extension of neurolinguistic programming theory, is further elaborated in the pamphlet, Neurolinguistic Programming in Education, which stated that "sequences of letters may be stored and accessed visually. The best spellers that we have come across will almost invariably look up and left to see the whole word written or printed out" (Dilts & Meyers-Anderson, 1980, p. 13).

A number of theorists (Cooper, 1975; Frith, 1978a; Henderson, 1974; Hoeman, Andrews, Florian, Hoeman, & Jensema,1976; Housner & Griffey, 1983; Kintsch, 1972; Paivio,1969; Richardson, 1975a; Shepard & Feng, 1972) have researched and speculated about the nature of visual memory, the visual image, and visualization abilities. Although the majority of theorists in this area admit the existence of a human memory system that at least partially utilizes a quasi-visual approach, the specifics of this visual system are uncertain, controversial, and beyond the scope of this research. Frith (1978b) and Henderson (1974) would both agree with Henderson's questioning, "But what is excellent visual memory made of, pray tell? Are people equipped with little ' Brownie' cameras in their heads? Obviously not!" (Henderson,1974, p.158).

Elena Boder (1973) presented a somewhat related but varied theory of spelling. After studying the reading and spelling errors of dyslexic children, she suggested that spelling errors due to poor memory for the visual spatial characteristics of letters and words (as reflected in a very limited sight-word vocabulary) characterize one subgroup (dyseidetic) and spelling errors due to poor auditory skills (as reflected in very limited phonetic word-analysis skills) characterize another group (dysphonetic).

According to Boder's theory, the dyseidetic speller spells in a phonetically accurate manner whereas the dysphonetic speller spells by sight alone. In the case of the dysphonetic speller, spelling may include bizarre misspellings and word substitutions. Boder also included a dyslexic group of mixed dysphonetic-dyseidetic children in her research. She noted that this group is the most severely educationally handicapped.

Although Luria (1971) and Das (1984a) did not comment specifically on spelling acquisition and retention, their analysis of brain function and learning process has specific application for the interpretation of spelling and learning styles. Luria (1971) theorized that incoming information undergoes synthesis into either a simultaneous or successive system. This paradigm of learning or brain function is an alternative to theories that postulate visual and auditory processing as the primary duality in learning. According to Luria and Das, visual and auditory tasks can be evaluated to be examples of either sequential or simultaneous processing. Das (1984a) further stated that

> the same task may be approached either simultaneously or succesively (and within each mode of coding, there may be variation in strategies for solution). This would be determined by the interaction of the subjects' : a) competence in one mode of

> coding; b) habitual mode of coding when he or she is competent in both modes; and c) task demands that can be modified by instructions. (p.65)

Proponents of Luria's and Das' view have begun to evaluate tests of visual and auditory processes as examples of successive and simultaneous process. In light of their theory, no study of visual and auditory processing would be complete without an examination of the successive (sequential) and simultaneous variables that are intrinsic in all learning tasks.

Statement of the Purpose

The purpose of this study was to determine how several areas of short-term visual memory and simultaneous processing related to written spelling achievement for 60 fifth-grade students whose reading achievement was at least average. In particular, the short-term memory for number presented visually and auditorily as well as sequentially and simultaneously was assessed. Short-term visual memory for line drawings that must be copied from memory was also examined.

The participant fifth-grade students from the Torrance Unified School District of Southern California, whose scores on the Reading subtest of the Comprehensive Test of Basic Skills (CTBS) were at least at the 50th percentile for their grade level, were divided into good and poor spelling groups in accordance with their scores on the spelling subtest of the Wide Range Achievement Test-Revised (WRAT-R). Fifth-grade students were chosen for study because of the importance that Piaget's theory places on the transition from concrete to formal processing at the 11-year-old level. The transitional nature of fifth grade made it a particularly important and relevant developmental stage to study.

All children in the study were individually administered the Visual Aural Digit Span Test (VADS), The Torgesen, Bowen, and Ivey Visual Sequential Addition to the VADS (VADS2+), and Graham-Kendall Memory for Designs Test (MFD), as measures of short-term visual memory and simultaneous processing.

Definitions

Definitions of specific terms utilized within this dissertation are included in this section to provide a consistent frame of reference.

Spelling is the process of encoding and of rendering spoken words into written symbols (Hanna, Hodges & Hanna, 1971). For the purpose of this study spelling achievement was determined by scores on the Spelling Subtest of the Wide Range Achievement Test - Revised.

Phonetic Spelling occurs when a word string is read and can be pronounced plausibly to give the originally correct sound of a word regardless of whether the letter to letter correspondance with the original word is exact (Frith, 1980).

Unphonetic Spelling occurs when a word string is read and cannot be pronounced plausibly to give the originally correct sound of the word (Frith, 1980).

Phoneme is a bundle of phonetically similiar sounds in language that are distinguishable in that the substitution of one for another changes the meaning of a word, for example, sounds presented by b, m, or the e in bet (Blake, 1970).

Grapheme is an alphabetical symbol (letter) representing a phoneme (sound), for example, a, A (Blake, 1970).

Grapheme-phoneme correspondence is the relationship between a phoneme (sound) and a grapheme (letter) in writing (Blake, 1970).

Successive (sequential) information processing refers to processing of information in a serial order (Das, Kirby, & Jarman,1975). When numbers are presented sequentially they are presented one by one.

Simultaneous information processing means that any portion of the information being processed is at once surveyable without dependence upon its position in the whole (Das, Kirby, & Jarman, 1975). When numbers are presented simultaneously, they are presented all at once.

Short-term simultaneous memory is the process of immediately remembering items presented simultaneously and then removed from vision.

Short-term sequential memory is the process of immediately remembering items presented in a sequence.

Dysphonetic dyslexia occurs in the dyslexic child who attempts to read and spell using a visual rather than an auditory approach. The dysphonetic dyslexic reads words globally as instantaneous visual gestalts rather than analytically. He or she is unable to sound out and blend the component letters and syllables of a word. Because the individual cannot read phonetically, he or she cannot spell phonetically. The dysphonetic child attempts to spell by sight alone and not by ear (Boder,1973).

Dyseidetic Dyslexia occurs when the dyslexic child attempts to read and spell using an auditory rather than a visual approach. He or she is an analytic reader who reads by ear through a process of phonetic analysis and synthesis, sounding out familiar as well as unfamiliar combinations of letters, rather than whole-word visual gestalts. The dyseidetic child has poor memory for visual gestalts. His or her misspellings, therefore, are phonetic (Boder, 1973).

Modality is any sensory avenue through which information is input or output such as the visual, auditory, and kinesthetic modalities.

English Orthography is concerned with the two basic patterns underlying the English language. The first is the internal structure of the orthography: the classes of letters (graphemes) and the allowable sequences of these classes. The second, and the most complex, is the set of patterns that relate spelling to sound (Venezky, 1967).

Organization of the Study

In the first chapter, the research question of how several areas of short-term visual memory and simultaneous processing relates to written spelling achievement was presented. Background information relevant to a study of spelling, short-term memory, and sequential and simultaneous processing was discussed. Definitions of terms utilized throughout the dissertation also were generated.

Literature pertaining to spelling achievement when reading ability is considered is reviewed in the second chapter. The research that has been conducted on short-term memory related to spelling is also analyzed. Additional research in the areas of sequential and simultaneous processes and other pertinent areas are included.

Detailed description of the methodology used to address the research question is provided in chapter three. The information is provided in such a manner as to make a replication of the study feasible, and, at the same time, to answer any possible methodological concerns.

The fourth chapter contains a presentation of the results of the research as well as additional questions that were analyzed. Data are presented in table form and a summary of results is given.

Within the fifth and final chapter conclusions are discussed, limitations are explored, and recommendations are made.

Chapter II

Review of the Literature

Research on spelling is extensive but fragmented because of the complexity of the spelling process and the varied directions that researchers have pursued in their attempt to understand how people spell. To find information on any one area of spelling research, lengthy exploration is required. Because this research attempted to explore the relationships of short-term visual memory and simultaneous processing to spelling, the review of literature included these areas as well as the relationships of rote memory, of a more general sort, and sequential processing to spelling. Additionally, research on good readers who are poor spellers, the relationship of spelling errors to processing style, and spelling-stages theory was included.

Because the intelligence of the students participating in this study was not assessed, the correlations that have been found between spelling and intelligence and visual memory and intelligence were reviewed. A section on visualization and visual imagery is contained in this review because of their speculated role in spelling and short-term visual memory. Adequate test instuments are not available to test visualization and visual imagery for this age group, or they would have been included in this research.

Spelling Achievement When Reading Ability is Considered

There has been minimal research on spelling achievement with good readers. The results of the few studies that have been completed suggest that good readers who are poor spellers differ from good readers who are good spellers and from poor readers who are poor spellers.

In a complex comparison of 30 twelve-year-old children, Frith (1980) compared the spelling errors, phonetic spelling of nonsense words, reading strategies, reading ability when only partial letters were left intact in a word, the reading of misspelled words, and the detection of misspelled words. She found that children in group 1 who were good in reading and spelling and children in group 2 who were good in reading and poor in spelling were better phonetic spellers than children in group 3 who were poor in both reading and spelling.

Additional findings by Frith (1980) with groups 1 and 2 demonstrated differences between the visual attention to individual letters, in each group's reading process. Her results suggested that children in group 2 read with a whole word or simultaneous approach rather than a sequential approach. In her study, children in group 1 demonstrated more attention to individual letters as well as being better able to read nonsense words aloud than the good-readers-poor-spellers. These findings suggest that there is a difference in sequential and simultaneous processing in these two groups, which provides additional credence to Luria's theories of information processing.

Linguistic difficulties and a verbal IQ decrement of 15 or more points on the WISC were associated with a reading and spelling difficulty but not with a spelling difficulty alone in 121 eight- to fourteen-year-old children (Nelson & Warrington, 1974). The children with a reading and spelling difficulty made more phonetically inaccurate errors than did the children with only a spelling deficit.

Plessas and Dison (1964) found that, when phonic cues in spelling were held reasonably constant, 76 third-grade good-readers-good-spellers were better able to choose and fill in the correct vowel from several vowel choices than were 55 third-grade good-readers-poor-spellers. The authors concluded that good readers who are good spellers have better visual memory ability for certain words.

The results of studies on good-readers-poor-spellers and poor-readers-poor-spellers cited in this section indicate that these groups have distinct and different characteristics. Studies that have attempted to look specifically at correlations between visual-memory tasks and spelling ability in good readers were not available.

The research of Nelson and Warrington cited above discovered that good readers with spelling difficulties do not have specific language deficits. Results of the investigations of Plessas and Dison and also Frith indicate that children who are good readers but poor spellers make less phonetic errors than do poor spellers who are poor readers. Although Frith made no direct mention of Luria's theory, her results suggest that the good reader- poor- speller reads with a whole word approach and might have sequential processing deficits.

Spelling Errors and Processing Style

The previous section documented research by Frith (1980), Plessas and Dison (1964), and Nelson and Warrington (1974) that found differences in the phonetic and nonphonetic errors of spellers whose reading and spelling ability varied. In this section, research is cited that focused on differences in spelling errors as a means of classifying children and as a reflection of learning style.

Early attempts were made by Carroll (1930) and Spache (1940a) to classify children on the basis of spelling errors. In his comparison of bright and dull children's spelling errors, Carroll (1930) noticed that bright students made more phonetic errors whereas the dull made errors with little or no phonetic foundation. Spache (1940) noted a definite tendency for the average speller to make more phonetic errors and for the poor speller to make more errors of the nonphonetic variety.

Boder (1973) developed a test and theory that specifically grouped children according to their spelling and reading errors. She found that of 107 dyslexic children assessed utilizing her tasks of reading and spelling 7 had to be placed in an undetermined group. The largest number, 67, fell within the dysphonetic group, who could not spell phonetically, 10 fell into the dyseidetic group, and 23 fell into the mixed dysphonetic-dyseidetic group. Her results demonstrated specific differences in spelling errors among specific groups, and she concluded that visual learners with auditory processing difficulties make more unphonetic errors than do auditory learners with visual processing difficulties who make more phonetically accurate errors.

Further studies of Boder's test were completed by Camp and Dolcourt (1977). They indicated that the diagnosis of dyseidetic appeared to be based primarily on spelling performance whereas the diagnosis of dysphonetic was based on both the reading and spelling tests. Normals were found to have more trouble with nonphonetic words than phonetic words, and the authors indicated that "perhaps the closeness of dyseidetic patterns to normal accounts for the fact that Boder reports seeing such a small percentage of dyseidetics" (Camp & Dolcourt, 1977, p. 306).

This similarity of spelling patterns in the dyseidetic and normal spellers suggests that normal spellers have spelling errors that reflect a lack of visual memory rather than limited phonetic word analysis skills. These results also suggest that the poor reader and poor speller would have auditory processing problem and be dysphonetic whereas the good reader and poor speller would make phonetically accurate errors and have visual-processing problems.

Horn (1957) pointed out that a vast number of English words are not phonetic and must be remembered individually rather than sounded out and spelled by phoneme to grapheme association or orthographic structure. If this is true, it might be expected that the largest number of errors in normal spellers would reflect errors of the visual rather than phonetic type.

When Hanna, Hanna, Hodges, and Rudolf (1966) used a computer program with more than 300 rules to spell words, the computer could spell 17,000 English words with only 49% accuracy. Phoneme by phoneme analysis of the words by the computer resulted in only 84% accuracy. These results may look somewhat high until it is noted that each word spelled with 84% accuracy is still incorrect. Again, these results support the importance of visual memory in spelling. The majority of words in Hanna et al.'s study could not be spelled by rule or phoneme by phoneme analysis.

Additional substantiation for the idea that spelling errors reflect learning style is suggested in the study by Cromer (1980), who found characteristic nonphonetic spelling errors in language-disordered children that were clearly accounted for by auditory and phonological deficits.

As an opponent of the notion that spelling errors can suggest processing styles, Nelson (1980) with support from Seymour and Porpodas (1980) stated that poor spellers' errors should be compared with the spelling errors of younger children of the same spelling ability rather than with those of the same age. She found that dyslexic subjects' spelling errors did not differ from the normals at the same level of spelling ability. The validity of her findings must be questioned because neither dyslexia nor the types of errors compared were defined operationally in her study.

Goyen and Martin (1977) also concluded that there is no diagnostic value in classifying students according to the phonetic accuracy of their misspellings. They suggested that more frequently used words tended to be spelled correctly regardless of their phonetic regularity. It is clear that Goyen and Marten' s findings have application to the study of spelling, but their interpretation of these findings do not. A number of theorists (Fehring, 1983; Horn, 1926; Wilson & Bock,1985) are in agreement that more frequently spelled words tend to be spelled correctly, but these findings do not suggest that there is no diagnostic value in classifying students according to their misspellings. The number of previously cited studies that have explored characteristics of various spellers and spelling errors do in fact suggest that the type of errors children make can be predictive of their learning style or stage of development.

Spelling Stages

When completing spelling research on a particular age group, it is important to take the concept of spelling stages into account. If in fact spelling stages exist, research completed at one age level may not generalize to another age level because of the difference in the child's spelling stage. The research on spelling stages suggests that students in the primary grades progress through several stages in the development of spelling strategies (Beers, 1974; Gentry, 1979; Graham & Miller, 1979; Henderson, 1974).

They reported that, at first, students omit crucial sound features of the words such as vowels. During the second stage, spelling follows a phoneme-to-grapheme association (i.e., spelling is phonetic). At the next level, English Orthographic awareness is included in the spelling. At the fourth level, students recognize and recall the correct lexical representations of the word.

The theory that children learn to read and spell independently of each other, in early reading and spelling, was proposed by Bryant and Bradley (1980). They suggested that young children age 6 and 7 cannot necessarily read what they can spell or spell what they read. In early reading, they indicated that for reading the child uses mainly visual and for spelling mainly phonological cues. As time goes on, this specialization declines and, although not specifically stated by the authors, the later stages mentioned above may evolve.

Russell (1955) noted that spelling ability was more closely related to auditory and visual ability around the third- and fourth-grade level than around the seventh- and eighth- grade levels of ability. Beers (1974) suggested that spelling strategy might be based on Piagetian levels of cognitive development.

When utilizing this theory of spelling stages to analyze spelling errors, one might determine that a child was functioning at an earlier level of spelling development than their age would suggest. Auditory phonological-phonemene-to-grapheme association difficulties and nonphonetic spelling would be considered to represent difficulty at the second stage whereas failure to recall the visually correct spelling would reflect fourth-level errors.

An understanding and awareness of level-3 errors was reflected by Bryant and Bradley (1980) when they stated that another reason that spelling is difficult is that a student can often think of two or more apparantly equally valid ways of spelling a word and not know which to correct.

Although spelling stages were not analyzed in this current research, Russell's (1955) research on spelling stages, cited in this section, may have had direct impact on the results of this research. It is uncertain how Russel's findings that auditory and visual ability related more closely to third- and fourth-grade spelling than to spelling at the seventh- and eighth-grade levels related to the fifth-grade spellers in this study. It is possible that at the fifth-grade level there is less relationship between visual memory than at younger ages.

Visual Memory Related to Spelling

In addition to the number of researchers that have studied spelling errors as an indication of a child's predominant visual or auditory processing style and the research that has looked at different processes utilized at different stages of development, there are a number of researchers who attempted to correlate visual-memory tasks with spelling ability. The majority of the researchers cited in this section did not differentiate poor spellers who are good or poor readers so it is uncertain how their findings generalize to good readers who are poor spellers and how much of their findings relate more specifically to poor reading and spelling ability.

The finding that basic visual-memory tasks using words appeared to discriminated good from bad spellers at the third-grade level but only the additional requirement of visual memory tasks with a written component discriminated at the sixth-grade level was made by Lesiak, Lesiak, and Kirshheimer (1979). At the third-grade level, one visual and two auditory tests discriminate, but, at the sixth-grade level, one auditory and one visual discriminated.

Bannatyne and Wichiarojote (1969) found written word spelling in nonlearning-disabled third graders to be significantly correlated with the accurate visual-motor drawing of memorized unit designs but not correlated with auditory closure, visual memory for sequences in designs, auditory discrimination, or visual memory for unit designs when they are not drawn.

After assessing 26 different factors, Newton (1961) found that visual memory discriminations were 2 of 8 factors that contributed to prediction of achievement in spelling. Additionally, Mcleod and Greenough (1980) found that short-term visual-written memory for letters and oral memory for spoken words was significantly better for good spellers in grades one and four. They also found that the difference in short-term visual-oral memory for pictures was not statistically significant for good and poor spellers.

The results of two experiments by Farnham-Diggory and Simon (1975), in which 64 and 72 third-grade children were given either visual or auditory cues and either visual or auditory interference tasks, indicated that correct spelling depends primarily on visual cues. Coberly (1985) found that CTBS total achievement scores, CTBS total reading, gender, sight-word identification, knowledge of word meaning, and phonic ability were not predictive of spelling scores in third- and fifth-grade students but that the visual written memory for words was predictive of spelling scores.

There is agreement that visual-written memory discriminated good from poor spellers in all studies that are cited here thus far. Visual-memory tasks that required oral response did not disciminate good from poor spellers at all age groups in Lesiak et al. (1979), Bannatyne and Wichiarojote (1969), and Mcleod and Greenough (1980) studies.

Apparently contradictory results were found by Weislogel (1954). In her study, of 142 college students, Weislogel found that short-term visual-written memory following a two-second presentation of numbers, letters, and line drawing of geometric figures was not correlated with success on a dictation spelling test.

Her results may not contradict the other cited studies if it is assumed that a college student's spelling ability may reflect a different level and stage of spelling and cognitive ability than elementary-school-aged children. Weislogel's use of previously unstandardized tests and only a two-second presentation time may also have affected her results.

Hartmann (1931) administered 8 tests to 636 college students, who were best spellers, poorest spellers, and average spellers. A correlation of . 78 was reported between a test of visual-memory span for unknown words and written spelling, but the type of correlational statistics used were not documented. A letter-digit substitution code distinguished the good from the mediocre group but failed to discriminate the latter and the poor-spelling group. No significant differences were found for the variables of visual recognition, silent reading, word identification, auditory memory for digits, and auditory recognition.

Visual-memory span tasks used by Hartmann differed from the visual-memory tasks given by Weislogel because Hartmann's task included words rather than the letters, numbers, and line drawings utilized inWeislogel's study. Hartmann's letter-digit substitution task may have had more similarity to Weislogel's tasks than the other subtests used in Hartmann's study, because the letter-digit substitution task required speed in learning and copying substituted digits.

Findings on the letter-digit substitution task in Hartmann's study more closely approximated Weislogel's results than did Hartmann's findings with other subtests, but performance on the letter-digit substitution task discriminated between good and mediocre spellers whereas Weislogel's tasks did not discriminate.

The results of the research cited in this section and the specific tests administered varied from study to study making generalizations difficult. The majority of studies cited found that visual-memory tasks that included a written component discriminated good from poor spellers. Visual-memory tasks that required oral response varied in their discrimination ability. It should also be noted that some studies assessed visual memory for words whereas other research looked at the visual memory for designs, letters, and numbers.

All studies that looked at the the visual memory for words found that spelling ability was discriminated by visual-word memory. Studies that looked at the visual memory for designs, letters, and numbers were not as consistent in their findings, although variables such as age of subject and standardization of the tests used may have influenced results. The majority of researchers cited in this section did not differentiate poor spellers who were good or poor readers. It is uncertain whether these results generalize to good readers who are poor spellers or merely to poor readers who are poor spellers.

Rote Short-Term Memory Related to Spelling

In addition to the researchers who have looked at either visual or auditory short-term memory's relationship to spelling, there are a number of researchers who have looked at rote memory's relationship to spelling without taking the visual or auditory aspects into account. This group of investigators generally believed that overall rote memory is the factor in primary relationship with spelling rather than either visual or auditory memory alone.

Reid and Hughes (1974) found a high loading of written spelling and spelling recognition (.64) as well as two memory variables that involved the reproduction of sequences of visually (.65) and aurally presented letters (.92) on the rote memory for verbal material factor in a factor analysis of 420 primary and intermediate students. None of the other memory variables (associative memory, sentence completion, sentence recall, or consequences) loaded on this factor. Sloboda (1980) noted that

> good spellers achieve their results, not by virtue of particular skills like imagery or application of linguistic rules, but by virtue

> of their memory for the way individual words are spelled. One might say that whilst average spellers spell by rule, good spellers spell by rote. (p. 247)

Beers and Beers (1981) also concluded that spelling is primarily a rote memorization process.

Jensen (1962) compared the location of spelling errors within words to a serial-learning curve. He found that spelling errors appear to be a function of serial position, which is what would be expected in a rote-memory task. Jensen's findings were corroborated by Kooi, Schutz, and Bakeer (1965) and Glanzer and Cunitz (1966). Wilson and Bock (1985) found that spellability was related to word length and the grade placement of a word.

Goyen and Martin (1977) found that the difficulty of spelling a word was in fact more related to frequency of use than to the phonic regularity or the word. More frequently used words were spelled correctly regardless of their phonetic regularity. If word spelling is learned by rote memory, it would be expected that more frequently used and presented words would be spelled correctly than less frequently used words.

Horn (1957) also suggested that rote memory is a crucial component of spelling when he stated that there is little justification for the claim that pupils can arrive deductively at the spelling of most words they can pronounce. He noted that there is no escape from the direct teaching of the large number of common words that do not conform in their spelling to any phonetic or orthographic rules.

Because the theorists cited in this section did not discriminate between visual and auditory rote memory in their findings, it is not certain that they are equally reporting on both types of memory when they have determined that rote memory plays an important role in spelling ability.

The Relationship Between Spelling and IQ

Over the years, numerous studies have looked at the relationship of IQ to spelling, with the majority of researchers concluding that there are many poor spellers who are average or above average in mental ability and vice versa. Furness (1958) noted that the relationship between IQ and spelling ability is much lower than the relationship found between intelligence and most other school subjects. Reid and Hughes (1974) found that reading comprehension loaded on a general verbal reasoning factor strongly (.98) but that spelling loaded much less strongly (.36).

Low correlations of .17 and .42 between spelling and IQ were found as early as 1926 by Gates (1926), whereas correlations of .45 to .60 were found by Omwake (1925), .08 to .72 by Williamson (1933), .20 to .55 by Russell (1937), and .49 to .61 by Townsend (1947). Spache (1941) found 57 correlations between IQ and spelling in the literature with a median correlation of .44 and a mean correlation of .46. Some of the correlations were as low as .01. Spache concluded that there are many poor spellers who are average or above average in mental ability and vice versa. Newton (1961) found a correlation of .68 between spelling and verbal IQ and a correlation of .39 between spelling and nonverbal IQ.

No research that correlated IQ with spelling when reading ability was held constant has been located at the present time. Nelson and Warrington (1974) found that a verbal IQ decrement of 15 or more points was associated with reading and spelling difficulties but not with a spelling difficulty alone. The lowest correlations between spelling and IQ may be found in the poor spellers who were good readers to be studied in this research, as well as good spellers who were poor readers. This hypothesis is supported by the findings of Furness (1958) and Reid and Hughes (1974). McManis, Figley, Richert, and Fabre (1978) found that reading-disabled students scored significantly lower on all 6 WISC-R verbal subtests as well as the coding subtest than did the average or above- average reader.

The Relationship Between Visual Memory and IQ

In comparison to the large number of studies that have assessed spelling ability's relationship to intelligence, a small number of studies have investigated visual memory's relationship to intelligence. During his study of 114 adult subjects with confirmed brain-dysfunction and 71 controls, King (1981) found only a correlation of .38 between the full scale IQ scores on the Wechsler Adult Intelligence Scale (WAIS) and the ability to copy from memory the line drawing on the Rey-Osterrieth Complex Figure Test. In this same study, he found a correlation of .34 between full scale IQ on the WAIS and the visual recall score on the Wechsler Memory Scale.

Powell (1979) similiarly found that the percent recall of the Rey-Osterrieth had a correlation of .30 with the verbal IQ score on a shortened version of the WAIS and a correlation of .38 with the performance IQ score on a shortened version of the WAIS. His research included 64 adults without brain damage, 25 adults as having predominantly left lesions, 28 adults diagnosed as having right sions, and 33 diagnosed as having diffuse bilateral lesions. Powell also found that the digit span subtest of the WAIS, which assesses auditory short-term memory for numbers, had a correlation of .33 with performance IQ on a shortened version of the WAIS and a correlation of .45 with verbal IQ on a shortened version of the WAIS.

These results in addition to other findings indicate that, although visual memory and other memory processes correlate with intelligence, the correlation is not high enough to confound the findings of the current study. Therefore, visual memory and intelligence were considered distinct variables.

Research on Imagery and Visualization

Although visualization and visual imagery was not assessed within this research, a survey of the literature in this area was relevant to this study of visual memory, because of the role that each of these skills may play in memory functioning. Controversy over the nature of visual memory, visual imagery, and visualization ability has been addressed by a number of researchers (Barsh, 1967; Carmen, 1900; Cooper, 1975; Ehri & Wilce, 1982; Hoeman, Andrews, Florian, Hoeman, & Jensema, 1976; Omwake, 1925; Richardson, 1975; Sheehan, 1966; Shepard, 1966; Shepard, 1972). A central question frequently asked, is whether visual memory and imagery are actually pictures in the head. Ehri and Wilce (1982) found that students had a greater difficulty chosing correct word spelling when presented with a mixed capital and lower-case format. They concluded that evidence for orthographic images, pictures in the head, existed.

An absence of phonetic errors in the spelling of deaf children was interpreted by Hoeman, Andrews, Florian, Hoeman, and Jensema (1976) to suggest that deaf children may be forced by their handicap to represent words to themselves by means of visual imagery that would reduce the incidence of phonetic errors. Barsch (1967) stated that "spelling efficiency is significantly correlated with individuals ability to visualize spatial orientations and relationships across a broad spectrum of behaviors not necessarily confined to academic activity" (p. 7). He also wrote that " the ability to visualize the word before expressing it and essentially 'copying' the visualization is the critical component in spelling" (p. 6).

Shepard (1966) noted that, in certain memory tasks, no amount of verbal association and search of verbal categories in the mind will suffice and that subjects instead must mentally picture items. He used as his example an instance when someone asks the number of windows on the front of a familiar house. Instead of remembering the house in a verbal way, individuals usually pictured the specific house in their mind in a visual way and counted the windows directly.

High imagers retained and reproduced spatial locations with less errors than low imagers in the research of Housner and Griffey (1983). Paivio and Csapo (1969) suggested that visual imagery is a parallel processing system that is not specialized for serial processing unless linked to an integrated (symbolic) response sequence as in certain mnemonic techniques. The verbal symbolic system is assumed to be specialized for serial processing.

The use of imagery was demonstrated to be effective in the learning of spelling words in research completed by Radaker (1963). Imagery groups had better recall than a control group a year after teaching was completed. Caban, Hambleton, Coffing, Conway, and Swaminathan (1978) found that their mental-imagery group showed only slightly greater learning than the practice groups that used drill or that were given no directions.

An opponent to the notion of pictures in the head, Frith (1978b) wrote that people do not have pictures of words in their memory that they retrieve like slides. McKeller (1957) said that visual images tend to be creative rather than accurate in any photographic sense. Although Bower (1970) viewed specific visualization techniques as useful mnemonic devices, he said that imagery of verbal symbols, words, digits, and number is generally very poor.

The attempts of a group of third- grade Australian children to spell a selection of words containing silent consonants were examined by Fehring (1983). The author assumed that the children's inclusion of the silent letter in even incorrect spelling was a reflection of their visual-memory process in spelling. Spellings such as "knowticing" for "noticing," however, suggested to the author that children could not have been using visual memory in the form of a visual image of the word. These misspellings suggested that the children used a memory of known orthographic letter patterns, that is, a combination of strategies rather than visual memory or a phoneme-grapheme strategy alone.

Pylyshyn (1973) theorized that visual images do not go into the memory raw but are modified by the viewer. He said that

> We may assume, then, that the representation differs from any conceivable picture - like entity at least by virtue of containing only as much information as can be described by a finite number of propositions. Note that any representation having the properties mentioned above is much closer to being a description of the scene than a picture of it. (p. 24)

The nature of visual memory as well as the role that visualization and visual imagery play in visual memory could impact on the visual memory for spelling words. If visual memory is more photographic, that is, pictures in the head, less impact might be expected by knowledge of the orthographic structure of words because an awareness of orthographic structure would not impact on the visual memory. If, instead, visual images are modified by the viewer before entering memory storage, a knowledge of orthographic structure could enhance the visual-memory process.

Spelling Recognition and Written Spelling

Different types of spelling ability have been discovered through research.

Both written spelling and spelling recognition require related but different skills. A child may detect misspellings among words he or she cannot actually spell or fail to detect misspellings in familiar words due to distractions provided in a proofreading context.

Out of 131 third-grade students, good readers who were good at written spelling and good readers who were poor at written spelling were equally able to use correct spelling recognition and identify correctly spelled words in research completed by Plessas and Dison (1964). After a review of literature focusing on spelling recognition, Valmont (1972) concluded that people of all age levels show a lack of ability to correctly identify misspelled words. Reid and Hughes (1974), after completing a factor analysis of reading and spelling and such variables as verbal reasoning and various short-term memory assessments in 420 primary and intermediate students, found that both written spelling achievement and spelling recognition loaded on a factor described as rote memory for verbal material.

The interconnection between written spelling and spelling recognition has been shown by Simon and Simon (1973). They listed three spelling approaches that are used to spell in different circumstances. They suggested that (a) highly overlearned words are spelled via direct recall, (b) less well-learned words are spelled using a generate and test process, and (c) unknown words are spelled using a direct phonemic spelling process. The generate and test process listed here clearly utilizes both written spelling and spelling recognition skills. The other two types of spelling approaches do not specifically utilize spelling recognition.

The results of Plessas and Dison (1964) and Reid and Hughes (1974) suggest that there should not be a difference between the good and poor speller's spelling recognition in this current research. Valmont (1972) and Simon and Simon (1973) postulated that spelling recognition abilities are only one aspect of spelling and, therefore, may deviate from written spelling ability. The results of this current study can be assumed to generalize to written spelling only. Spelling recognition was considered to be a separate skill which was not assessed in this research.

Research on Sequential and Simultaneous Processes

The theories of Luria (1971) and Das (1984a, 1984b) that the sequential-simultaneous processing duality accounts for learning more than the visual-auditory processing duality have been researched, but the results of these studies are contradictory and do not provide a clear direction for theoretical interpretation.

Symmes and Rapaport (1972) studied 54 dyslexic children with unexpected reading problems. Their poorer scores on the WISC Digit Span and coding subtests as opposed to simultaneous tasks such as the Bender Visual Motor Gestalt Test provided a basis for the authors to conclude that these children had problems sequencing symbols. Although Symmes and Rapaport discovered these sequential problems in the reading disabled, Torgesen, Bower, and Ivey (1978) found only a visual simultaneous short-term memory difference in good and poor readers' performance on a modified version of VADS when both visual sequential and visual simultaneous short-term memory tasks were administered.

These finding were interpreted by the researchers to indicate that the simultaneous presentation caused the poor reader difficulty rather than a visual aspect of the task. Torgesen et al. concluded that the sequential-simultaneous processing duality accounted for difference in processing style rather than the visual-auditory processing duality. The conflicting findings resulting from these two studies raises questions as to why one set of students would have sequential processing difficulties and the other would have simultaneous problems. The difference in results may be accounted for in part by specific noted inconsistencies between the two relative populations as well as the variety of assessment instruments used.

Nelson's (1980) findings provided an alternative interpretation of the results of Symmes and Rapaport (1970). Nelson stated that dyslexics' difficulty on the digit span and coding subtests of the WISC reflect short-term and primary memory difficulties rather than sequencing difficulty.

Bannatyne and Wichiarojote (1969) found that written word spelling was statistically significantly correlated with the accurate visual-motor drawing of memorized unit designs presented simultaneously (.33) but that spelling was not correlated with visual memory for unit designs presented in a sequence (.06).

Although Frith (1980) did not specifically comment on sequential and simultaneous processing in good readers who are either good (group 1) or poor (group 2) spellers, her conclusions that group 1 spellers read with greater detailed attention to the letter-by-letter structure of words whereas group 2 spellers read whole words could have direct application to theories of sequential and simultaneous processing. Frith's results would then be interpreted to imply that group 1 spellers utilize more of a sequential reading approach whereas group 2 spellers utilize more of a simultaneous reading approach.

Summary of the Review of Literature

The research cited in this review of literature found that the vast number of English words are not phonetic and that normal spellers as well as good readers who are poor spellers made more phonetically accurate errors than nonphonetic errors. These findings suggested to several researchers greater visual-memory difficulties than auditory difficulties. Good readers with spelling difficulties were not found to have specific language deficits, which further supports the idea that they might instead have visual processing difficulties. It is apparent that the majority of spelling research has grouped reading and spelling together. Investigations with good readers who are poor spellers is minimal.

Spelling errors have been theorized to reflect processing style, but a child's age and spelling stage also account for the type of spelling errors that a child makes. According to the spelling-stage theory, children's spelling errors change with age. As they mature, previous types of errors are outgrown. The crucial variables in processing style were thought by many theorists to focus on the visual-auditory processing duality, but the notion that the sequential-simultaneous processing duality may instead account for learning difficulties was presented here.

The idea that neither spelling ability nor visual memory have a strong correlation with IQ was supported by the results a number of studies. The correlations of visual memory for words and written spelling ability have been consistently strong, but the correlations of visual memory for letters, numbers, and designs have varied. This lack of consistency between these research findings can be accounted for by variability in the ages of the subjects tested, in the inclusion of a written component on the assessment tasks, and in the tests and standardization of the tests given. Several theorists also were presented who postulated that rote memory in general plays the crucial role in spelling. They have not commented on the visual or auditory nature of this memory.

The nature of visual memory, visualization, and the visual image was also addressed, but it is clear that research has not yet discovered whether or not pictures in the head exist. One theory suggested that visual memories are modified by the viewer and are closer to a visual description of the scene than a picture of it.

Good readers who were good at written spelling and good readers who were poor at written spelling were equally able to use correct spelling recognition in the limited number of studies that were cited here.

The need for additional research on good readers who are poor spellers was substantiated by this review of literature. Visual memory's relationship to spelling has been supported here, but results are inconsistent enough to make further research in this area worthwhile. Because the theory of a sequential-simultaneous processing duality has been postulated in addition to or in opposition to a visual-auditory processing duality, this theory will also be assessed in the current research. Overall short-term memory will be tested to provide more information about general rote memory's relationship to spelling ability within this population. Likewise, spelling error differences and written spelling's relationship to spelling recognition skills will be assessed.

Chapter III

Methodology

This chapter includes a statement of the purpose of the study, a detailed description of the research sample, the procedures employed in obtaining the subjects for the study, the instrumentation used, an explanation of the procedures for the data collected, and the procedures used to analyze the data

Purpose of the Study

The purpose of this study was to determine how several areas of short-term memory and simultaneous processing ability related to written spelling achievement for 60 fifth-grade students whose reading achievement was at least average. The Comprehensive Test of Basic Skills was employed in determining the reading achievement and the Wide Range Achievement Test - Revised for spelling achievement of students included in this study. Short-term memory and simultaneous processing abilities were assessed with The Visual Aural Digit Span Test (VADS), The Graham Kendall Memory for Designs Test, and variations on the VADS suggested by Torgesen, Bowen, and Ivey (1978).

Research Design

An ex post facto study was employed where spelling achievement was the independent variable and short-term memory for numbers was the dependent variable.

Subject Selection

The population under study were fifth-grade students from 6 elementary schools in the Torrance Unified School District of Southern California. Torrance is a suburb in Los Angeles County with an approximate population of 130,000.

Administrators from the Torrance School District estimate that 0.5% of Torrance students are Black, 9% are Hispanic, 22.5% are Asian, and 68% are Caucasian. Only fifth-grade students from the 6 selected elementary schools whose scores on the 1985-1986 administration of the Comprehensive Test of Basic Skills (CTBS) were at or above the 50th percentile in Reading were included in this study.

Permission was granted by Richard Ducar, the director of special education in the Torrance School District in September, 1986, to conduct a file search for fifth-grade children whose 1985-1986 CTBS scores were at or above the 50th percentile. The CTBS is given to each child in the school district, in their regular classrooms. Individual profiles are machine scored. Results for individual children are returned to the school district reporting grade equivalent scores and national percentiles. All fifth-grade students at the selected schools were subsequently given a Wide Range Achievement Test- Revised (WRAT-R) spelling test so that an appropriate sample of good and poor spellers could be selected for this research from the previously selected good readers on the CTBS.

Site selection. School cites were selected so that all geographical locations in Torrance would be represented in the study. One school was chosen from the north, south, east, west, and central Torrance areas. An additional school was chosen from South Torrance due to the relatively small size of the first school in the southern area that was included in the study.

The mean of reading grade equivalency scores from the 1985 - 1986 administration of the CTBS for fourth graders at the schools that were included in this study was fifth-grade, fifth-month (5.5). This is higher than the national mean of 4.6 for students at this grade level but only slightly higher than the Torrance School District mean of 5.3. This comparison of mean scores further substantiates the selection of these specific school sites as representative of Torrance Schools. It is also obvious that Torrance is above the national average in reading achievement.

Potential subjects. Upon completion of site selection and approval by the director of special education, superintendent of schools, school administrators, and classroom teachers, the WRAT-R spelling subtest was administered to 387 fifth-grade students at the participating schools between October 1986 and April 1987 by a school psychologist. All fifth-grade students at each school were included. All WRAT-R protocols for student who scored at or above the 50th percentile in reading on the CTBS were scored by a retired teacher or school psychologist unless the student had been previously assessed by the school district and found to have limited English proficiency.

From this group, the final group of 30 good readers-poor spellers were selected based on a WRAT-R spelling score that was between 25 and 70 percentile points below their CTBS reading score. A comparison group of 30 good readers-good spellers (as determined by the WRAT-R and CTBS) was selected whose spelling scores were within 11 percentile points below their CTBS reading score or 22 percentile points above their CTBS reading score. The two groups were comparable in age, gender, ethnicity, and CTBS reading scores as is determined by inspection of the data in Table 1.

The percent of Asian students included in the study was smaller than the percent of Asian students in Torrance as a whole, because students with limited English proficiency had to be excluded from the study. A number of Asian

Table 1

Demographic Characteristics of Two Groups of Fifth-Graders Employed in This Study

Demographic Characteristics		Good readers and good spellers (N=30)	Good readers and poor spellers (N=30)
Gender: Females		46.7%	43.3%
Males		53.3%	56.7%
Age (in months):	mean	126.3	129.1
	SD	4.8	4.1
	range	119 to 136	122 to 138
CTBS Reading percentile:	mean	78.9	79.7
	SD	14.1	14.9
	range	51 to 99	51 to 99
WRAT-R Spelling percentile:	mean	83.4	38.5
	SD	11.5	18.2
	range	50 to 96	3 to 73
Ethnicity:	Caucasian	76.7%	80.0%
	Asian	10.0%	10.0%
	Hispanic	10.0%	10.0%
	Other	3.3%	0.0%

students in Torrance have limited English proficiency. Because limited English proficiency would affect directly spelling acquisition and performance on the tests given in this study, children in this category were excluded so as not to confound the study's results.

Recruitment of subjects. The parents of each of 82 subjects were sent a letter, via their child, which requested permission for their child to participate in the study (Appendix A). After the passage of a week, an additional request was either mailed to the parent or sent home with the child. Of the 82 consents that were sent home, 69 were returned. Nine of these subjects were later excluded from the study when it was discovered that 4 of the students had limited English proficiency and 5 of the comparison students could not be adequately matched with other students in this research.

Instrumentation

After an examination was made of various tests used in previous research to assess visualization abilities, none of the tests could be utilized with the population to be investigated in this research primarily because of the age of the subjects. Tests such as The Spatial Relations Subtest of the Differential Aptitude Test (Bennett, Seashore, & Wesman, 1959), Betts' Questionnaire Upon Mental Imagery (Betts, 1909), Attneave and Arnoult's random shapes as studied by Cooper (1975), Mental Paper Folding (Shepard & Feng, 1972), and the Paper Folding Subtest of the Stanford Binet, 4th Edition (Thorndike, Hagen, & Sattler, 1986) were designed to be used with older children or adults. Because of the lack of an adequate instrument to assess visualization and mental imagery for this age group, no specific information about the role of these skills' in short-term visual memory were able to be assessed by this research.

The Visual Aural Digit Span Test (Koppitz, 1977), The Graham Kendall Memory for Designs Test (Graham & Kendall, 1960), and The Torgesen, Bowen, and Ivey Sequential Addition to the VADS (Torgesen, Bowen, & Ivey, 1978) were all selected for use in the current study.

The Visual Aural Digit Span Test. The Visual Aural Digit Span Test (VADS) was developed by Elizabeth Koppitz in 1968 and published in 1972. The VADS was developed as a short-term memory test, taking into account both visual and auditory input as well as oral and written output modalities. On each of four subtests, 3 to 7 digits are presented on successive trials. Two trials are given for each number series. The subject is required to remember a series of numbers of increasing length. The subtest is discontinued when a child fails both trials on a given number series.

The four VADS subtests are (a) aural-oral (AO) auditory presentation and oral recall of digits, (b) visual-oral (VO) visual presentation and oral recall of digits, (c) aural-written (AW) auditory presentation and written reproduction, and (d) visual-written (VW) visual presentation and written reproduction. The various subtests and combination scores allow clinicians to compare differences in a student's short-term memory for numbers that are presented in a visual or auditory manner and require written or oral expression. Standard administration procedures as specified by Koppitz (1977) were used in this study.

The score for a given VADS subtest equals the longest digit sequence that a child is able to recall without error. The VADS yields three different types of test scores--the scores for the four subtests, the six scores for the various combinations of the subtest scores, and the total VADS test score.

The VADS combination scores include (a) aural input (AI)--the combination of AO and AW scores (aurally presented numbers that require oral and written expression), (b) visual input (VI)--the combination of VO and VW scores (visually presented numbers that require oral and written expression, (c) oral expression (OE)--the combination of AO and VO scores (auditory and visually presented numbers that require oral expression), (d) written expression (WE)--the combination of AW and VW scores (aurally and visually presented numbers that require written expression), (e) intrasensory integration (Intra)-- the combination of AO and VW scores (the modality that a number is presented in is the same modality that it must be expressed in), (f) intersensory integration (Inter)-- the combination of VO and AW scores (the student is required to recall numbers across different modalities), and (g) total score (TS)-- the sum of AO, VO, AW, and VW scores. For this research, the Intra and Inter scores were not utilized. The scores of the four VADS subtests range from 0 to 7. The six combination VADS scores range from 0 to 14. The TS ranges from 0 to 28.

The normative data for the VADS were derived from 810 public-school children who represented a socioeconomic cross-section of the United States. The VADS normative data are presented in five different ways: (a) means and standard deviation by age level for children ages 5 1/2 to 12, (b) percentile scores for age level, (c) age equivalents for total VADS test scores, (d) means and standard deviations by grade level, and (e) percentile scores by grade level.

Carr (1974) investigated the degree of interrelatedness of 10 of the 11 VADS measures (the Intra score was not included in the study). He correlated the VADS scores of 26 fourth-grade pupils. The extent to which the VADS measures were interrelated depended on the mode of presentation of the digit sequences. The correlations between the VADS measures with only auditory presentation (AO, AW, AI) and the VADS measures with only visual presentation (VO, VW, VI) were positive but low (.25 to .37). None of the correlations were significant at the .05 level, which is due to the small sample employed in the study. The sample size is inadequate to establish a representative correlation. The relationship that would exist in an adequate sample size is left to speculation.

The reliability of the VADS was determined by the test-retest method. The subjects for the study were two groups of children with learning and behavior problems. Koppitz reasoned that because children with behavior and learning difficulties tend to be more unstable than well-functioning pupils the VADS is also reliable for average school children.

One group of 35 six- to ten-year-olds and one group of 27 eleven- to twelve- year-olds were administered the test twice with the interval between the first and second administration ranging from one day to 15 weeks. The mean interval for both groups was six and a half weeks. Pearson product moment coefficients ranged from a low of .72 for the AW subtest in eleven- to twelve-years-olds to a high of.92 for the total VADS scores in six- to ten-year-olds. Visual input had a correlation of .90 in six- to ten-year-olds and .88 in eleven- to twelve-year-olds.

In a test of predictive validity, the VADS was administered to 100 kindergarten children (Koppitz, 1977). Three years later the CTBS scores of 46 of these children were located, and chi-square tests were computed in the areas of total reading, total language, total arithmetic, and total battery with each of the 11 scoring areas of the VADS. The VADS scores statistically significantly predicted the CTBS scores in all areas except AW and total math, WE and total math, and WE and total reading.

Koppitz reported on the correlations between performance on the VADS and concurrent school achievement that was obtained in six different studies. Two of these will be cited here. Witkin (1971) found a statistically significant relationship between the VO and VW subtests and reading comprehension scores on the Gilmore Oral Reading Test for 272 second-grade students.

Using the chi-square statistic, Koppitz compared the 11 VADS measures with the following CTBS scores: total reading, total language, spelling, total arithmetic, total battery, and total IQ score for 26 fifth-grade students. There was a statistically significant relationship among 9 of the 11 VADS measures and the spelling and total language scores of the CTBS. The total arithmetic and total battery scores of the CTBS were closely related to eight of the VADS measures. The CTBS total reading score measures mainly reading comprehension and vocabulary so it is not surprising that the CTBS total reading score correlated statistically significantly with only four of the VADS measures. The sample sizes are small, and the results may not be indicative for large samples.

One final study that demonstrates VADS' usefulness in spelling research was completed by Curley and Reilly (1983) with third- to fifth-grade students whose spelling ability was one or more grade levels below average but whose IQ scores ranged from 90 to 109, that is, average intelligence. Students were divided into strong visual, auditory, or combination modality group if their input score on the VADS was 25 percentile points higher in one modality. Each of these groups was equally divided and placed in remedial spelling groups that utilized either a predominate visual, auditory, or mixed-modality teaching approach.

All three experimental groups required fewer trials to criterion when the teaching approach corresponded to their dominant perceptual modality. The visual-modality group required fewer trials to achieve criterion with visual teaching than with either of the other two approaches. The unexpected lack of statistically significant differences on trials to criterion for the auditory-modality group was described by the author as being most likely reflective of the increased difficulty for all subjects in mastering spelling material utilizing an auditory approach.

Torgesen, Bowen, and Ivey Visual Sequential Addition to the VADS.

After questioning the construct validity of the VADS because of its differing sequential and simultaneous presentation of numbers in visual and auditory subtest, Torgesen et al. (1978) included two additional subtests. They queried whether differences on VADS subtest scores reflect differences in visual or auditory and oral or written processing or whether they instead reflect differences in sequential and simultaneous processing.

The two additional subtests they included are (a) visual- sequential-oral (VSO) and (b) visual-sequential-written (VSW). In the VSO subtest, digits were exposed sequentially using a flattened tube of paper board with a 2 X 2 cm. window cut in it. A strip of paper containing sequences of digits was inserted into the tubular strip and pulled past the window at the rate of one per second. Recall was taken orally. The VSW subtest was administered in the same way as VSO subtest except that recall was written.

The subtests follow the same format as VADS subtests. Each child began with the shortest sequence, and each successive sequence was increased in length by one digit. The score for each task was the largest number of digits recalled correctly. The score range of the two subtests extended from 2 to 7.

No reliability studies were completed. No studies of the validity of the VSO and VSW subtests were completed, but the VSO and VSW subtests in addition to the VADS test were administered to 60 boys, with a mean age of 112 months (SD = 4.1), who were divided into groups of good and poor readers. Correlations of .42 and .44 were found between tasks of the same sequential or simultaneous structure but different visual or auditory modality in good and poor readers, whereas correlations of .07 and .28 were found between tasks of the same modality but different structure in good and poor readers. Correlations of -.18 and .25 were found between tasks of different modality and different structure. These results support the use of VADS and VADS2+ subtests as valid assessments of simultaneous and sequential processing rather than visual and auditory processing.

Differences between the performance of good and poor readers on the various subtests were statistically significant only for the VO and VW. Both of these subtests utilize a simultaneous visual rather than sequential visual presentation. After reviewing all findings, the authors concluded that, because only simultaneously presented visual numbers discriminated between good and poor reading groups and because only the same structure-different modality groups were significantly correlated, task structure is an important variable in accounting for the greater sensitivity of the visual subtests of the

VADS to psychological differences between good and poor readers.

Because specific administration instructions were not provided in the Torgesen et al. (1978) research, modifications of the VADS instructions were utilized in the current research. During the current administration of the VADS+2, instructions for the VSO subtest were given as follows: I am going to show you some numbers one at a time. When I have shown you all the numbers on a card, I want you to tell me the numbers in the same order that they were on the card. Similiarly, instructions for the VSW were given as follows: I am going to show you some numbers one at a time. When I have shown you all the numbers on a card, I want you to write the numbers that were on the card.

The Graham Kendall Memory For Designs Test. The Graham Kendall Memory For Designs Test (MFD) involves the presentation of 15 straight-line geometric designs and the written reproduction of these designs from immediate memory. The designs are presented separately each for 5 seconds. Since the MFD was created, several different scoring systems and levels of diagnostic categorization have been utilized.

For this research, the scoring of the MFD test followed the standard method provided by the Memory-for-Designs Test: Revised General Manual (Graham & Kendall,1960). In the standard scoring method, reproductions are scored individually as follows: 0 for satisfactory or omitted reproductions, 1 for more than two easily identifiable errors but with the general configuration retained, 2 when the general configuration of the design has been lost, and 3 when the figure is reversed or rotated. A total raw score is obtained from the sum of the 15 separate scores, with higher scores indicating poorer performance.

It was noted in a number of studies (Grundvig, Needham, & Ajax, 1970; Korman & Blumberg, 1963; Marsh & Hirsch, 1982; Quattlebaum, 1968; Singh, 1971) that the MFD's original levels of diagnosic categorization yielded few false positives and many false negatives. Due to these findings, several different scoring systems and levels of diagnostic categorization have been utilized (Grundvig, et al., 1970; Korman & Blumberg, 1963; Lyle, 1968; Rosen, 1971; Walters, 1961).

Korman and Blumberg (1963) and Rosen (1971) advocated an optimum diagnostic cutting score between 5 and 6 rather than the Graham-Kendall cutting score between 11 and 12. When Korman and Blumberg reanalyzed their data on brain-damaged (BD) patients, they found that 90% of the BD group was correctly identified with only 10% false positive scores. Prior to the reanalysis, 32.5% of their BD patients were misclassified whereas 2.5% of their controls were misclassified. Walters (1961) found that, when a division for the MFD test was arbitrarily taken at a raw score of 8, the mean difference between good and poor second-grade readers' MFD scores was significant. The MFD test differentiated the good from poor readers in Walter's study.

The authors, Graham and Kendall (1960), reported a split-half reliability of .92 and total test-retest reliability scores of .89 in a group of 70 controls and 70 mixed brain-disordered patients. The test-retest reliability scores ranged from .81 in the control group of 30 normal children to .90 in 98 special adults when subjects were retested during the same examination session or within 24 hours.

A study of the validity of the MFD was completed with the same 140 individuals cited in the reliability section. Both the differences in variance and in mean scores between controls and brain-disordered patients were statistically significant, indicating that the MFD test can discriminate between the controls and brain-disordered patients.

Although the MFD was developed in 1946 for use in research and as an adjunct to a test battery for the clinical study of possible brain damage, research and its subsequent application have broadened the MFD's use. Lyle (1968) found that the MFD test statistically significantly discriminated between 54 poor and 54 adequate readers (with at least average WISC-R IQ scores) at the 6.5 to 12.5 age levels. The author noted that the standard scoring method and a modified scoring method both made statistically significant discriminations between each group.

Walters (1961) found that, when a division for the MFD test was arbitrarily taken at a raw score of 8, the mean difference between good and poor second-grade readers' MFD scores discriminated between the groups. Bannatyne (1969) found that MFD scores statistically significantly correlated with written spelling (.33) in 50 third-grade, eight-year-old children.

The visual-motor component of the MFD that requires the copying of line drawings is similiar to the Bender-Gestalt Test, but the addition of a memory component provides the test with even greater applications and diagnostic potential than the Bender. The Bender has been used extensively as part of test batteries that are employed to qualify children as learning disabled due to processing problems and severe discrepancies between intellectual ability and academic achievement. In at least one study (McManis, Figley, Richert, & Fabre, 1978), the Bender Gestalt Test and the MFD have demonstrated similiar results when utilized with good and poor readers.

Due to the nature of this current research, Das, Kirby, and Jarman's (1975) and Jarman and Das' (1977) findings that the MFD had an extremely high loading on a simultaneous factor whereas an oral digit span test loaded on a sequential factor in first- and fourth-grade children have direct application to the interpretation of current results with the MFD and oral subtests of the VADS.

The Wide Range Achievement Test - Revised. The Wide Range Achievement Test-Revised (WRAT-R) is the 1984 revision of the WRAT that was first published in 1936. The WRAT-R includes a level 1 edition for 5-year-olds to 12- year-olds and a level 2 edition for ages 12 through 75 years. Both tests include a reading, spelling, and arithmetic subtest. Only the spelling subtest was employed in this study.

The spelling subtest is defined in the manual as "copying marks resembling letters, writing the name, and writing single words to dictation" (Jastak & Wilkinson, 1984, p.1). The first two parts of the spelling subtest, Copying Marks and NameWriting, are given routinely to all children between the ages of 5 years 0 months and 7 years and months and to all older children who do not correctly spell at least 6 words from the dictation list. In this study, these two subtests only were administered to children who spelled less than 6 words correctly.

The manual notes that the Dictation of Words (section 3) may be administered to large groups. In this study, it was administered to fifth- grade classes with an average size of approximately 32. The WRAT - R provides grade equivalent scores, age equivalent scores, and standard scores for each raw score.

Specific studies addressing the validity of the test were not cited in the

WRAT-R Administration Manual (Jastak & Wilkinson, 1984). The authors stated that in more than 20 different concurrent validity studies involving a total of over 1,000 subjects the WRAT-R correlated with the Peabody Individual Achievement Test-Spelling Subtest (.75), California Achievement Test-Spelling Subtest (.85), The Stanford Achievement Test-Spelling Subtest (.71), and Previous WRAT editions (.99). These results indicate that the WRAT-R spelling subtest is an adequate test of spelling.

The test-retest reliability for 81 children from 7 years to 10 years and 5 months of age on the WRAT spelling subtest at level 1 was .97. The test-retest reliability coefficients were determined on children from the normative sample. The time between tests was not given.

Data Collection

Each of the 60 participating fifth-grade students was individually administered the 4 subtests of the VADS; the 2 Torgesen, Bowen, and Ivey visual sequential subtests modified from the VADS (VADS2+); and the Graham-Kendall Memory for Designs Test (MFD). These three tests were given in random order to avoid a confounding of the test results by the ordering of instruments. The test order for each subject was determined by first listing the order of test instruments and then randomly assigning a test order to each subject.

After selection of participants was completed, they were assigned a number. Because the tester did not know the reading and spelling scores of the students, this procedure provided a control for experimenter bias. Each subject was tested in the school psychologist's office for 20 to 35 minutes in the morning of a school day. All assessment were completed by a retired teacher who was fully trained in the administration of each test. Examples of the answer sheets used to record students' responses on the VADS and VADS2+ are included in Appendix C and Appendix D.

Test session . A note was sent to the subject's teacher with the request that a particular student be sent to the psychologist's office as had been previously arranged. The subject, after arriving from his or her classroom, was met by the examiner, and greetings were exchanged. The examiner said, "We are going to do 3 tests. Most kids think they are fun. You won't get any grades on these tests but try to do your best." The three tests were then administered in a previously selected random order. The test examiner was observed to carry out the assessments in this consistent specified manner. After the study was completed, that is, all subjects were tested and the tests scored, a personalized letter was sent to each of the subject's parents, including specific test results (Appendix B).

Blind scoring of protocols. As testing at each school was completed, the test protocols of all subjects were given to a school psychologist for scoring. The school psychologist who blind scored the protocols was a doctoral student, as well as being a licensed and credentialed educational psychologist in the state of California. Additionally the psychologist was thoroughly familiar with the scoring procedures for each test. The psychologist had no way of ascertaining which group the test protocols represented.

Protection of Human Subjects

The fundamental human rights of all subjects were protected and preserved in consonance with the ethical standards of the American Psychological Association (1981). Information and test scores obtained remain confidential.

A letter of intent was sent to all parents of participating children, and a signed consent was obtained prior to the assessment of the 60 participating pupils (Appendix A). Each subject was assigned a number in order to assure confidentiality. Only means and standard deviations for each group are reported in this study.

Research Questions

This study posed the following questions:

1. Is there a significant difference in the good- and poor-spelling groups visual and auditory short-term memory for numbers?

2. Is there a significant difference in the good- and poor-spelling groups' short-term memory for numbers overall?

3. Is there a significant difference in good- and poor-spelling groups' short-term visual memory for numbers presented sequentially and simultaneously?

4. Is there a significant difference in good- and poor-spelling groups' visual written memory for designs?

5. Is there a significant difference in the spelling errors of the good- and poor-spelling groups?

6. Is there a significant difference in the short-term visual memory for numbers that must be recalled in an oral or written form between good- and poor-spelling groups.

Data Analysis

In order to answer the research questions, a number of analyses were performed. Because there were six research questions and multiple comparisons were performed to answer several of the research questions, the

Type I error was controlled for each research question. Although such control may result in a number of Type II errors, measure of explained variance were computed and used to assess practical importance. In particular, point biserial correlations were obtained for the t-test comparisons.

A comparison of the good- and poor-spelling groups' scores on the 3 combination VADS scores (AI, VI, and TS) and the 4 VADS subtests were accomplished through the use of the independent t test, while controlling the error rate at the .05 level. Because the subtests are not highly correlated, the data were not treated in the multivariate manner. The results of these comparisons determine whether there are differences between the groups in visual and auditory short-term memory for numbers, which address questions 1 and 2.

The comparison of the two spelling groups on the subtests of VADS2+ and VO and VW subtests of the VADS answer question 3 concerning short-term visual memory for numbers presented sequentially and simultaneously. Because only two groups are compared, the independent t test was employed for the analysis.

Written memory for designs was assessed by the MFD test. The average total raw scores was compared for the two groups using the t test. The results of this test provide an answer to question 4.

Both the number and type of spelling errors on the WRAT-R were analyzed to address question 5. The type of errors for the two groups of spellers was compared by a chi-square test, whereas the number of errors was tested for differences using the t test.

A comparison of the good- and poor-spelling groups' written and oral short-term memory scores, as assessed on the OE and WE combination VADS scores, was accomplished through the use of the independent t test, while controlling the error rate at the .05 level. The results of this comparison provide an answer to question 6.

Chapter IV

Results

The present study was designed to determine how the short-term memory for numbers presented in visual, auditory, sequential, and simultaneous ways and requiring expression in either a written or oral manner would relate to written spelling achievement for fifth-grade students whose reading achievement was at least average. To accomplish this purpose, six research questions were addressed. The data analyses for each of these questions are included in this chapter as are the analyses for three additional questions. These three questions provide information related to the auditory-visual versus sequential-simultaneous issue about the presentation and processing of information presented on the VADS and VADS2+. This chapter also includes a summary of the results of this study. In addition to reporting the statistical significance of the results, a measure of explained variation, the point biserial, is included as a way to interpret the practical relevance of the findings.

Research Question 1

Question 1 was concerned with the differences in the good- and poor-spelling groups' visual and auditory short-term memory for numbers. In order to answer this question, a comparison of the good- and poor-spelling groups' scores on the 2 combined VADS scores (AI, VI) and the 4 VADS subtests (VO, VW, AO, AW) was accomplished through the use of the independent t test, while controlling the error rate at the .05 level. Because the subtests are not highly correlated, the data were not treated in a multivariate manner. To utilize a t test, the underlying variable must have a normal distribution and the population variances must be equal. Because there are equal numbers in each group and because the sample sizes are large, the t test is robust with respect to violation of these assumptions.

Before t tests were computed, the means and standard deviations for the good- and poor-spelling groups were compared to the mean scores for fifth graders reported by Koppitz (1977). When the average scores for aural-oral (AO), visual-oral (VO), aural-written (AW), visual-written (VW), aural

Table 2

Means, Standard Deviations, and T-Test Results for Two Groups of Spellers on VADS

	Good Spellers (N=30)		Poor Spellers (N=30)			
Subtest	$\bar{X}$	SD	$\bar{X}$	SD	t df=58	rpb
AO	6.50	0.63	5.87	0.86	3.25*	.15
VO	7.00	0.00	6.77	0.43	2.97*	.14
AW	6.50	0.63	6.27	0.94	1.13	.02
VW	6.90	0.31	6.73	0.52	1.51	.04
AI	13.00	0.91	12.06	1.36	3.12*	.14
VI	13.90	0.31	13.57	0.73	2.04*	.07
OE	13.50	0.63	12.63	1.00	3.57*	.18
WE	13.40	0.77	13.00	1.11	1.62	.04
TS	26.90	1.00	25.60	1.85	3.39*	.17

* Significant when the Type I error rate was controlled at the .05 level.

Table 3

Koppitz's VADS Mean Scores and Standard Deviation for 5th-Grade Students (N=88)

Subtest	$\overline{X}$	SD	$\overline{X}$ + 1 SD
AO	5.9	0.94	5.0-6.8
VO	6.5	0.73	5.8-7.2
AW	5.5	1.08	4.4-6.6
VW	6.6	0.64	6.0-7.2
AI	11.4	1.78	9.6-13.2
VI	13.0	1.13	11.9-14.1
OE	12.3	1.39	10.9-13.7
WE	12.1	1.54	10.6-13.6
TS	24.4	2.65	21.8-27.1

input (AI), visual input (VI), oral expression (OE), written expression (WE), and total score (TS) for both the good- and poor- spelling groups in this study were compared to those reported by Koppitz, the mean scores for this study were within one standard deviation of those reported by Koppitz, but in all cases the mean scores in the current study were higher than Koppitz's values. (See Tables 2 and 3.) The standard deviations for all of the reported VADS scores in this study were lower than those reported in Koppitz results. For all the subtests that were compared, the standard deviations for the good-spelling group in this study were lower than those for the poor-spelling group in this study, indicating that the good spellers' scores were more homogeneous then the Koppitz sample. All average scores for the poor-spelling group were lower than those for the good-spelling group. Because this current study selected only students who were average or above- average readers, it was expected that the means would be higher and the standard deviations lower than in the Koppitz sample. The subjects in the current study have less variability in their scores than in Koppitz's norms because of the specific criteria used to select the subjects for this study. The subjects in this study are also somewhat higher in their short-term memory skills as assessed on the VADS than the subjects included in Koppitz's sample.

The results of the t tests subsequently determined that the good-spelling group had statistically significantly higher scores at the .05 level in their aural-oral, visual-oral, visual intake and aural intake on the VADS than the poor-speller group. There was no significant difference between the groups' aural-written or visual-written VADS scores.

The results of these t tests support the idea that a difference in short-term memory exists between the good- and poor-spelling groups. This difference in short-term memory for numbers was present in both visual and auditory areas when oral expression was required but not when written expression was required. The greatest difference was for OE, which accounted for 18 percent of the variation between the two groups. The remaining four variables AO, VO, AI, and VI account for 15, 14, 14, and 7 percent of the variation between the two groups of spellers, respectively.

<u>Research Question 2</u>

The difference in the good- and poor-spelling groups short-term memory for number overall was considered in this research question. In order to answer this question, a comparison of the good- and poor- spelling groups scores on the VADS total score (TS) was accomplished through the use of the independent t test.

The good-spelling group was statistically significantly higher than the poor-spelling group at the .05 level in their short-term memory for numbers overall (see Table 2). This finding supports the idea that good readers who are good spellers have stronger short-term memory than good readers who are poor spellers, particularly because the difference between the two groups of spellers accounted for 17 percent of the total score variability.

Research Question 3

This question pertained to differences in the good- and poor-spelling groups visual short-term memory when numbers were presented sequentially and simultaneously. Good- and poor-spelling groups' visual sequential short-term memory for numbers was contracted by comparing scores on the combination VADS2+ score (VS) and the VADS2+ subtests (VS-O, VS-W) through the use of the independent t test. The visual simultaneous short-term memory for number of the two groups was compared by utilizing the combination VADS score (VI) and the VADS subtests (VO, VW). The results for the simultaneous short-term memory comparisons were given in the results section for research question 1.

The good-spelling group was statistically significantly higher than the poor-spelling group on the visual sequential-oral subtest (VS-O) (see Table 4). This same statistical difference was found on the combination visual sequential score (VS), where the good-spelling group was higher than the poor-spelling group. There was no statistically significant difference between the groups on the visual sequential-written subtest (VS-W). The two statistically significant differences accounted for 15 and 14 percent of the variation in scores of the two spelling groups, respectively.

Table 4

Results of Comparing Good and Poor Spellers on VADS2+

	Good Spellers (N=30)		Poor Spellers (N=30)			
Subtest	$\overline{X}$	SD	$\overline{X}$	SD	t df=58	rpb
VS-0	6.27	0.79	5.67	0.80	2.93*	.15
VS-W	6.30	0.95	5.87	0.94	1.78	.07
VS	12.60	1.61	11.63	1.13	2.69*	.14

*Significant when the overall rate was controlled at the .05 level.

As reported in the results section for research question 1 and in Table 1, the good-spelling group was significantly higher than the poor-spelling group on the visual simultaneous-oral subtest (VO) and on the combination visual simultaneous score (VI). There was no statistically significant difference between the groups on the visual simultaneous-written subtest (VW).

The results of these t tests indicate that the good-spelling group was stronger than the poor-spelling group in both visual sequential and visual simultaneous short-term memory for numbers when the numbers must be remembered in an oral manner. When the numbers must be recalled in a written manner, there is no statistically significant difference between the two groups.

Research Question 4

Differences in the good- and poor- spelling groups' visual-written memory for designs was addressed by this research question. The results of the comparison of the good- and poor- spelling groups' total raw scores on the MFD test was completed using the independent t test and are reported in Table 5. The means and standard deviations for the good spellers and poor spellers in the current study are remarkably similiar.

No specific norms were provided for fifth-grade students in Graham and Kendall's (1960) previous research, but the mean score for children from grade 1 through 9 was 4.34. The mean scores for the two groups of fifth-grade spellers in this research were lower than the first- through ninth-grade spellers reported in Graham and Kendall's previous research. This lower mean score indicated that the students in the current research made less errors than the students studied previously.

The inclusion of only good readers in the current sample probably accounts for their lower mean scores. Graham and Kendall sampled students regardless of their reading ability. Because Graham and Kendall did not list the standard deviation or individual grade norms for their sample, it is also possible that the difference in means between their sample and the current sample might suggest that students younger than fifth grade made such a large number of errors that the mean score in the Graham and Kendall study was inflated by their errors.

There was no statistically significant difference between the good- and poor-spelling groups' visual-written memory for line drawings on this test, suggesting that there is no difference between the short-term memory of these good- and poor-spelling groups when a written component is included in the short-term memory task. This compares to the same finding of no differences on VADS when the written component was included.

Table 5

Means, Standard Deviations, and T-Test Results for Two Groups of Spellers on the MFD Test

Good Spellers (N=30)		Poor Spellers(N=30)			
$\overline{X}$	SD	$\overline{X}$	SD	t df=58	r pb
1.50	1.70	1.40	1.75	0.22	.00

Research Question 5

The spelling errors of the good- and poor-spelling groups were analyzed in regard to this question. In order to answer this question, both the number and type of spelling errors were investigated. The type of errors for the two groups of spellers were compared by a chi-square test, whereas the number of errors and the percentage of phonetic errors of each students total errors were tested for differences using the independent t test.

When the phonetic and nonphonetic errors for the two spelling groups were compared using the chi-square test, no statistically significant differences were found between the type of errors of the good or poor-spelling groups (see Table 6). Overall the poor spellers made more errors (71% compared to 29% for the

Table 6

Frequency of Phonetic and Nonphonetic Errors
Made by Good and Poor Spellers

Spellers	Phonetic	Nonphonetic	Total
good	92 (57.1%)	69 (42.9%)	161
poor	190 (48.2%)	204 (51.8%)	394
total	282	273	555

$X^2 = 3.29$

good spellers). Almost half of the total errors were phonetic. As was expected, the total number of spelling errors between the good- and poor-spelling groups was statistically significant at the .05 level and accounted for 57% of the variance in errors (see Table 7). The good spellers had a higher percentage of phonetic errors (57%) than did the poor spellers (48%), but, when the type of error was tested, they did not differ on this variable.

Research Question 6

Group differences in the short-term memory for numbers that must be recalled in an oral or written manner were addressed by this question. To provide an answer to this question, a comparison of the good- and poor-spelling group's written and oral short-term memory scores, as assessed on the Oral Expression (OE) and Written Expression (WE) combination VADS scores, were completed through the use of the independent t test (see Table 3 for these results).

The good-spelling groups' short-term memory for numbers that must be

Table 7

Means, Standard Deviations and T-Test Comparisons of Good and Poor Spellers Spelling Errors on the WRAT-R

	Good Spellers (N=30)		Poor Spellers (N=30)			
Number of errors	$\overline{X}$	SD	$\overline{X}$	SD	t df=58	r pb
Phonetic	3.07	2.21	6.33	2.54		
Nonphonetic	2.30	2.30	7.13	2.94		
Total	5.37	3.70	13.47	3.49	8.72	.57

expressed in an oral form was statistically higher than the poor-spelling group. There was no statistically significant difference between the good-spelling groups short-term memory for numbers that must be expressed in a written form.

The results of this question and those of question 4 consistently indicate that at the fifth-grade-level short-term memory tasks that include a written component do not discriminate good and poor spellers who are average or above-average readers. The oral form does, however, differentiate the two groups, and the deficiency accounts for 17% of the difference in the scores. The lack of statistically significant difference between spelling groups when written expression was required was due to higher scores by the poor-spelling group rather than lower scores by the good-spelling group.

Additional Analyses

Three additional questions concerning the VADS construct validity first presented by Torgesen, Bower, and Ivey (1978) and the legitimacy of the sequential-simultaneous paradigm in learning theory as opposed to the auditory-visual paradigm were posed. These questions include the following:

7. Is there a significant difference in short-term memory for numbers presented in a visual sequential manner and in a visual simultaneous manner for either or both of the spelling groups?

8. Is there a significant difference in short-term memory for numbers presented in a visual simultaneous manner and in an auditory manner for either or both of the spelling groups?

9. Is there a significant difference in short-term memory for numbers presented in an auditory sequential manner and in a visual sequential manner for either or both of the spelling groups?

Additional question 7. This question pertaining to differences in visual short-term memory for numbers presented in either a sequential or simultaneous manner was addressed by a comparison of scores on the VADS2+ combination score (VSI) and the VADS combination score (VI) for the good-spelling group and poor-spelling group separately (see Table 8).

Visual simultaneous short-term memory for numbers was found to be statistically significantly stronger than visual sequential short-term memory for numbers at the .05 level for both the spelling groups. If this assessment of sequential and simultaneous short-term memory was a valid assessment, it must be assumed that the sequential or simultaneous presentation of numbers have a specific effect on the short-term retention of numbers presented visually, because both good- and poor-spelling groups have stronger visual simultaneous short-term memory than visual sequential short-term memory.

Table 8

Means, Standard Deviations, and T-Test Comparisons of VSI and VI for 2 Groups of Spellers

	Visual Sequential		Visual Simultaneous			
Group	$\bar{X}$	SD	$\bar{X}$	SD	t df=58	r pb
Good Spellers	12.60	1.61	13.9	0.31	-4.34*	.33
Poor Spellers	11.63	1.13	13.57	0.73	-7.88*	.50

*Significant when the Type I error rate was controlled at the .05 level

Additional question 8. Auditory short-term memory for numbers and visual simultaneous short-term memory for numbers differences in both the good- and poor- spelling groups were addressed here. A comparison of the Visual Intake (VI) and Aural Intake (AI) combination scores on the VADS for the good-spelling group and poor-spelling group was accomplished through the use of the independent t test (see Table 9).

As with the previous question, visual simultaneous short-term memory for numbers was found to be statistically significantly stronger but, in this good- and poor-spelling groups. Based on the assumption that these tests are a valid assessment of visual simultaneous and auditory sequential short-term memory for numbers, the results then are indicative of a stronger visual simultaneous short-term memory for numbers than of an auditory short-term memory for numbers. Only after answering additional Question 9 can it be determined whether it is the visual versus auditory presentation of these numbers that accounts for this difference or whether it is simultaneous versus sequential presentation that accounts for this difference.

Table 9

Means, Standard Deviations and T-Test Comparisons of AI and VI for 2 Groups of Spellers

	Visual Simultaneous		Auditory Sequential			
Group	$\overline{X}$	SD	$\overline{X}$	SD	t df=58	r pb
Good Spellers	13.90	0.31	13.00	0.91	5.13*	.31
Poor Spellers	13.57	0.73	12.06	1.36	5.32*	.33

*Significant when the Type I error rate was controlled at the .05 level

Additional question 9. Differences in visual sequential short-term memory for numbers and auditory sequential short-term memory for numbers in both the good- and poor-spelling groups were investigated for this question. Comparison of the results of the VADS2+ combination score (VS) and the VADS combination score (AI) for good-spelling and poor-spelling groups was accomplished through through the use of the independent t test and are found in Table 10.

A statistically significant difference was not indicated between auditory sequential short-term memory and visual sequential short-term memory for either of the spelling groups. These results when taken together with those from additional questions 7 and 8 indicate that differences in sequential and simultaneous presentation account for differences in

Table 10

Means, Standard Deviations and T-Test Comparisons of VS and AI for 2 Groups of Spellers

	Visual Sequential		Auditory Sequential			
Group	$\bar{X}$	SD	$\bar{X}$	SD	t df=58	r pb
Good Spellers	12.60	1.61	13.00	0.91	-1.18	.24
Poor Spellers	11.63	1.13	12.06	1.36	-1.45	.03

*Significant when the Type I error rate was controlled at the .05 level.

short-term memory for numbers rather than auditory versus visual presentation.

Summary of Results and Additional Analyses

Statistically significant differences between the good- and poor-spelling groups' short-term memory for numbers were discovered when oral expression was required but not when written expression was required. These differences were found within visual sequential, visual simultaneous, and auditory sequential areas. The lack of statistically significant difference between spelling groups when written expression was required was due to higher scores by the poor spellers rather than lower scores by the good spellers. There was more similarity between the poor- and good- spellers' written short-term memory scores than there was between their oral short-term memory scores.

When spelling errors were compared, the poor-spelling group had more errors than the good-spelling group, but, when the type of errors were compared in the good- and poor-spelling groups, there was no statistically significant difference between phonetic and nonphonetic errors.

The results from the three additional questions indicate that in both good- and poor- spelling groups students were better able to recall visually presented numbers that were presented in a simultaneous rather than sequential manner. Students in both good- and poor- spelling groups were better able to recall numbers that were presented in a visual simultaneous manner rather than an auditory manner. Students in both good- and poor-spelling groups did not demonstrate a statistically significant difference in their ability to recall numbers presented in a visually sequential or auditory manner.

Because material that is presented in an auditory manner must be presented sequentially, when the Visual Sequential combination score was compared to the Aural Intake score, two areas of sequential processing were compared. The lack of statistically significant difference between students' performance on these subtests that required visual sequential and auditory sequential presentations suggests that the similarity in their sequential presentation had greater impact on the student's ability to recall the numbers than did the difference between their visual and auditory presentation. If auditory versus visual presentation had made the major difference in student's memory for these two subtests rather than their sequential versus simultaneous presentation, there would have been a statistically significant difference between student's performance on these subtests.

The statistically significant difference in visual sequential versus visual simultaneous short-term memory for numbers indicates that there is a significant difference in student's visual short-term memory for numbers presented in a sequential and simultaneous manner. If the major component of these subtests was the visual nature of their presentation rather than the sequential versus simultaneous components, it would have been expected that that there would not be a statistically significant difference between students' performance on these subtests.

These results indicate that the difference in sequential versus simultaneous presentation accounted for a specific difference in memory ability that is not merely visual memory but rather different forms of visual memory, that is, visual sequential and visual simultaneous. These results indicate that the VADS test assesses visual simultaneous rather than visual short-term memory for numbers. The statistically significant difference between visual simultaneous versus auditory sequential short-term memory for numbers shown in these additional analyses further substantiates these findings.

The differentiation of visual sequential short-term memory from visual simultaneous short-term memory in this research is important. In previous research (Boder, 1973; Carmen, 1900, Curley & Reilly, 1983; Day & Wedall, 1972; Dilts & Meyers-Anderson, 1980; Edgington, 1967; Hendrickson, 1967; Koppitz, 1975; Lesiak, Lesiak, & Kirchheimer, 1979; McGovney, 1930; Newton,1961a; Palmer, 1930; Rourke & Finlayson, 1978; Russell, 1955; Schonell, 1942; Spache, 1941; Sweeney & Rourke, 1978; Torgesen, 1977; Weislogel, 1954), no comment is made as to whether visual short-term memory is presented in a sequential versus simultaneous manner. If within any research, visual material is presented simultaneously while auditory material is presented sequentially and the authors do not comment on the sequential versus simultaneous nature of their presentation a significant confounding variable is present in their study. The results of this current research suggest that the sequential versus simultaneous presentation of numbers is more significant to the child's ability to recall the numbers than is the visual versus auditory presentations.

Because the manner of presentation was documented in this current study but visual cues about the child's processing style were not documented, generalizations can only be made about the contribution that sequential versus simultaneous presentation has to learning theory. Differences in the child's sequential versus simultaneous processing cannot be generalized from these results. Kaufman and Kaufman (1983) equated the method of presentation with a child's style of processing the information in their creation of the The Kaufman Assessment Battery for Children(1983), but Das (1984b) did not.

Kaufman's interpretation of this sequential and simultaneous paradigm caused Das (1984b) to comment that the method of presentation and the child's style of processing are not necessarily interchangeable. A task, for example, may be presented in a simultaneous manner and be processed in either a sequential or simultaneous manner. In a figure copying task, for example, Das (1984b) said that although the picture is presented simultaneously it is important to record the number of times the child looks at the figure while copying. If the child looks at the figure a number of times the child's processing would be considered to be sequential but if the child looked only once, the child's processing would be considered to be simultaneous.

Generalizations from this current study can focus on how numbers were presented not how they were processed when Das' interpretation of the sequential versus simultaneous paradigm is used. Differences in sequential versus simultaneous presentation made a difference in the short-term memory for numbers of the students in this sample.

Chapter V

Summary, Discussion, Conclusions, and Recommendations

Although there have been repeated acknowledgements (Camp & Dolcourt, 1977; Fay, 1971; Frith,1980; Gould,1976; Plessas & Dison, 1964) that many poor readers in the grade levels above third or fourth grade are poor spellers and that good readers may or may not be poor spellers, few studies have looked specifically at good readers who are not good spellers. The purpose of the present research was to determine how the short-term memory for numbers presented visually and auditorily as well as sequentially and simultaneously and the short-term visual-written memory for line drawing related to written spelling achievement in fifth-grade students whose reading achievement was average or above but whose spelling was lower than their reading achievement.

This investigation was completed with 30 fifth-grade students who were good readers - poor spellers and 30 fifth-grade students who were good readers - good spellers by comparing their performance on the Visual Aural Digit Span Test (VADS), The Torgesen, Bowen, and Ivey Visual Sequential Addition to the VADS (VADS2+), The Graham-Kendal Memory for Design Test (MFD), and their number of phonetic errors on the Wide Range Achievement Test - Revised (WRAT-R).

Additionally both groups were contrasted on visual sequential versus visual simultaneous, auditory sequential versus visual sequential, and auditory sequential versus visual simultaneous short-term memory for numbers, which could be assumed to address the learning theory controversy over which duality of information processing actually underlies learning, that is, sequential-simultaneous or visual-auditory information processing. The current research is limited in this application because the method of presentation was documented but visual cues from the child's processing style were not documented. The comparisons of visual sequential versus visual simultaneous, auditory sequential versus visual sequential, and auditory sequential versus visual simultaneous short-term memory for numbers also related to questions presented by Torgesen, Bowen, and Ivey (1978) regarding the construct validity of the VADS.

This chapter includes a summary of the results of the study. Conclusions based on the findings of Chapter IV and a discussion of the suggested implications are presented. The contributions and limitations of the present study as well as areas of future research conclude the chapter.

Summary and Discussion of Findings

The primary question of this study was whether a group of fifth-grade students who were good readers and good spellers would differ from a group of fifth-grade students who were good readers but poor spellers in their visual, auditory, sequential, and simultaneous short-term memory for numbers. The current study discovered that the short-term memory for numbers of the good-spelling group was statistically significantly higher than that of the poor-spelling group in all areas that required oral expression rather than written expression. This difference was consistently observed when numbers of increasing length were presented all at once, in a visual simultaneous manner; one by one, in a visual sequential manner; and one by one, in a auditory sequential manner.

These results indicate that the memory differences between the two groups are due to a general difference in rote memory rather than an auditory, visual, sequential, or simultaneous processing difference. Reid and Hughes (1974) similarly concluded that spelling achievement in primary and intermediate students had a relatively high loading on the factor "rote memory for verbal material" but also stated that there is a general ability component related to spelling achievement.

The lack of statistically significant difference in the short-term memory of the two spelling groups in this current study, when written expression was required, may be due to a number of factors. Previous studies (Bannatyne & Wichiarojote, 1969; Hartmann, 1931; Lesiak, Lesiak, & Kirchheimer, 1979; Mcleod & Greenough, 1980; McGovney, 1930; Reid & Hughes, 1974; Schonell, 1942; Williamson,1933) have discovered visual-motor and written-expression differences in good and poor spellers but the reading proficiency of each spelling group was not documented.

The visual-motor and written-expression difficulties documented in these previous studies may have been due to reading difficulty rather than spelling problem. Koppitz (1975), Torgesen (1977), and Torgesen, Bowen, and Ivey (1978) all discovered visual-motor weakness in poor readers. The poor spellers in the current study were not different from the good spellers in their written expression and visual- motor skills. Sterne (1969) found that normal subjects and brain-injured subjects statistically significantly differed in their performance on The Revised Visual Retention Test (Benton,1963), which is a test of written memory for line drawings, but did not differ in their aural-oral short-term memory for numbers. The results of the current research suggest that the current group of good readers but poor spellers were more similar to the normal group in Sterne's study but the poor readers in Koppitz's and other listed studies were more similar to the brain-injured group in Sterne's study. Children who are poor readers appear to have more impairment in the visual-motor area than children who are good readers but poor spellers.

Another interpretation of the lack of statistically significant difference in the short-term written memory of students in this study is related to the specific spelling stage and level of maturation of the typical fifth- grade student. The lack of difference in the good- and poor-spelling groups performance on tasks that required written expression may be due to their maturational development and spelling stage. At least one other test of visual-motor copying, The Bender Gestalt Test, has limited application and discrimination ability for children who are 11 years old and above. This is most probably due to specific maturations in visual-motor integration that have normally occurred around this age. The mean age of students within this current study was close to the upper limit of the Bender, 10 years and 6 months. It seems more likely that written-expression and visual-motor differences would be discovered between good and poor spelling groups at younger ages, if they exist at all in a similar population of good readers.

In support of this theory, Mcleod and Greenough (1980) found a statistically significant difference between the visual-written short-term for letters in good and poor spellers at the first- and fourth- grade levels. When studying an older population of college students, Weislogel (1954) found that short-term visual-written memory for numbers, letters, and figures did not correlate with spelling performance. The contradictory results of Mcleod and Greenough and Weislogel would be expected if the theory of spelling stages was accepted.

A third interpretation of the absence of statistically significant difference in the short-term written memory of the two spelling groups relates to the MFD test. Because this test was developed for a brain-damaged population, it is likely that its scoring method was unable to accomodate the fine discriminations that would be required to differentiate between differences in the good spellers and poor spellers specific visual-motor skills and memory for designs in this study. The VADS and VADS2+ tests are appropriate for this population so this interpretation has no application to those tests.

A fourth interpretation of the lack of statistically significant difference in the good- and poor-spelling groups performance on tasks that required written expression relates to the nature of a written task. When a task is written, the child is more easily able to correct their responses than when an oral response is given. By looking at their written answer, they have time to review their response and, thereby, increase their performance. Because correction of written expression was allowed during the current research, this could have provided a confounding variable. Although correction of oral expression was also allowed during the current research, the very nature of a written task allows greater review than does an oral task.

An additional question within the present study compared the type of errors made by the good and poor spellers. Comparisons of spelling errors in former research were completed by Boder (1973), Camp (1977), Carroll (1930), Frith (1980), Goyen and Martin (1977), Hahn (1960), Nelson (1980), Spache (1940), Sweeney and Rourke (1978), and Walker (1984). The results of these studies were inconsistent.

The lack of statistically significant difference in the type of errors made by the study's good readers who are good or poor spellers were consistent with the results of Frith (1980). Frith found that good readers-good spellers and good readers-poor spellers were more similar in the larger precent of phonetic errors they produced in their overall errors than where poor readers-poor spellers who made more unphonetic errors. The results of Camp and Dolcourt (1977) similarly found that students who had spelling difficulty rather than both reading and spelling difficulty tended to make more phonetically accurate spelling errors and to be more similiar to normal readers and spellers than were students who were poor readers and poor spellers. It would not be inconsistent with these results if it were later discovered that higher percentages of unphonetic errors in a child's overall errors reflect a more severe processing deficit than those observed in our good reader-poor spellers who have merely a rote memory deficit.

The primary question that was addressed by the three additional analyses of this study focused on whether the crucial variables in the presentation of information on VADS and VADS2+ are actually visual and auditory presentation or sequential and simultaneous presentation. To answer these questions, student's short-term memory for visually presented numbers that were presented all at once, simultaneously, or one by one, sequentially were compared. It was found that student's short-term memory for visual numbers presented simultaneously was stronger than visual numbers presented sequentially for both good- and poor-spelling groups. These results indicate that the two areas measured are not assessing the same thing, that is, visual processing. When numbers are presented in a sequential or simultaneous manner, it made a difference in the amount of information that was retained.

To further support this finding, student's short-term memory for numbers presented in a visual sequential and auditory sequential manner were investigated. The lack of statistically significant difference between either the good- or poor-spelling groups' scores in these area supports the idea that the students scored in a similiar manner in these areas because material was presented in a sequential way. To be sure that this lack of difference in the visual sequential and auditory sequential areas was not due to a lack of difference between visual and auditory processing, students' scores in the visual simultaneous area were compared with scores in the auditory sequential area. There was a statistically significant difference between these area.

This finding further confirmed that the students in this study scored more similarly in areas that had a continuity in their sequential versus simultaneous manner of presentation rather than a likeness in their visual versus auditory method of presentation. These findings support the learning theories of Luria (1981) who emphasized sequential and simultaneous variables rather than visual versus auditory variables. Additionally, these results support the postulations of Torgesen, Bowen, and Ivey (1978) that questioned the construct validity of the VADS.

The student's strength in short-term memory for simultaneously presented versus sequentially presented numbers in this study is probably due to the process of "chunking" information described by Miller (1956). Although Miller found that the average adult can recall 7 items, plus or minus 2 items, he noted that, when information is organized into chunks composed of individual bits of information that are grouped together, the amount of information can be increased. Information that is presented simultaneously allow greater opportunity to chunk information together than does sequential presentation. This greater opportunity to chunk information accounts for the student's greater simultaneous short-term memory than sequential short-term memory in this study. Bergan, Zimmerman, and Ferg (1971) found that memory for sequences involving groups of stimuli represent a separate ability from memory for sequences of single stimuli.

There are two confounding variables that would warrant further research before the findings from this research can be truly accepted. One in the rate of presentation and the amount of time that a child sees a configuration of numbers. Using the standard method of administration from the VADS and VADS2+ on both the visual sequential and auditory sequential subtests, numbers were presented one per second. On the visual simultaneous subtests, each card was presented to the child for a total of 10 seconds. This difference in presentation time allowed the child to see the simultaneous material for a longer period of time than the sequential information. A longer presentation could obviously affect a child's retention of the numbers.

The second confounding variable has to do with the inclusion of the number 7 in the number sequences. The number 7 is the only number under 10 that has two syllables. Due to this variable in syllable length, the number 7 was excluded from an auditory short-term memory for numbers task that Kaufman included on the Kaufman Assessment Battery For Children. Obviously an increase in the numbers of syllables presented in any number item could affect a child's retention of the numbers due to variable length and would be considered a confounding variable.

Limitations of the Study

The following limitations of this study should be considered when interpreting the results:

1. The study includes only fifth-grade students from a school district that had1985-1986 CTBS reading scores for students in their grade of 6 months above the national average; therefore, the results may not generalize to districts with different achievement profiles.

2. Only students whose reading achievement was at or above the 50th percentile and who demonstrate a discrepancy between reading achievement and spelling achievement were included in the study. A group of good readers-good spellers and good readers-poor spellers were included in the study but poor reader-poor spellers were not included. The study's results are not expected to generalize to below-average readers.

3. The subjects were from a suburban community of 130,000 located in Los Angeles County. The results, therefore, may not be appropriate for individuals from other types of communities. Administrators from the Torrance School District have stated that Torrance has the second highest median income of any city over 100,000 in The United States. Based on the last census 1% of Torrance's population is now Black, 10% is Hispanic, 28% is Asian, and 61% is Caucasian.

4. The norming of MFD with brain-damaged individuals may have limited its application to the current population because of its ability to discriminate subjects without brain damage has only been tested on small variable samples.

5. The difference in the rate of presentation of numbers on the VADS

sequential and simultaneous subtests may have produced a confounding of all test results that utilized these subtests.

6. The inclusion of the number 7 in the number sequences on the VADS may have affected children's retention of some of the number items because the number 7 is the only number that has two syllables. If a number item has numbers of different numbers of syllables, it may be the number of syllables that effect the retention ability rather than the number of numbers.

Conclusions

There is no previous research that is identical to the current study; therefore, any conclusions should be accepted with reservation until additional validation is available.

At the fifth-grade level, general differences in rote memory for numbers that must be remembered in an oral manner exist between good readers who are either good or poor spellers. These differences existed in numbers presented in a visual sequential, visual simultaneous, and auditory manner. The lack of statistically significant difference in the two groups when written expression was required appears to be due to the maturational level of the children or the absence of impairments in visual-motor areas more typically found in children who have reading and spelling deficits but not spelling deficits alone.

The absence of statistically significant difference in the type of errors made by the two spelling groups again appears to indicate that when fifth graders are good readers they demonstrate less difference in the type of spelling errors between the good spellers and poor spellers than do students who are poor readers and poor spellers as has been discovered in past studies.

Both good spellers and poor spellers scored more similarly in areas that had a similarity in their sequential versus simultaneous manner or presentation rather than a similarity in their visual versus auditory method of presentation. These results support the theory of Luria (1971) that sequential and simultaneous processing are more central to learning than visual and auditory processing. They also cast doubt on the construct validity of the VADS. Before these conclusions can be fully accepted, the confounding variables of length of time of number presentation and the number of syllables in number presentations must be isolated and further tested.

Implications for Educational Practice

Findings from this study, if generalized, can suggest useful academic prescriptions. Horn's (1957) idea that there is no escape from the direct teaching of the large number of common words that do not conform in their spelling to any phonetic or orthographic rules is supported by the results of this study. The poor spellers not only had poorer spelling performance than the good spellers but also had worse short-term oral memory for nonmeaningful information (i.e., an unsystematic list of numbers), whereas their number of phonetic errors was not statistically significantly different from the good spellers. If a difference in their phonetic knowledge and the knowledge of the good spellers had existed, it would have been expected that the percent of phonetic errors would have differed.

Hahn (1961) analyzed the misspellings of two groups of third through sixth graders. Although one group received phonics instruction and the other group did not, there was no statistically significant difference in their number of phonetic errors. Fitzsimmons and Loomer (1977) and Hillerich (1977) similarly wrote that the effectiveness of teaching spelling via phonic generalizations is highly questionable. In combination with these findings, the results of the current research gave no indication that the good reader who are poorer spellers had less knowledge of phonics than the good readers who are good spellers. The teaching of additional phonics is not recommended for good readers who are poor spellers. It is beyond the scope of this research to comment on the possible benefits of teaching phonics to poor readers who are poor spellers.

Recommendations to improve spelling have been given by a variety or researchers and theorists (including Applegate, 1967; Beers & Beers, 1981; Block, 1976; Distefano & Hagerty, 1983; Fehring, 1983; Fitzsimmons & Loomer, 1977; Hahn, 1961; Hendrickson, 1967; Horn, 1957; Personke & Yee, 1966; Plessas, 1963). Personke and Yee (1966) indicated that reinforcement of correct responses enlarges the store in the memory. They further stated that the internal input of the immature spellers are subject to constant change.

Assuming that good readers who are poor spellers have rote memory weaknesses for nonmeaningful material, such as an unsystematic list of numbers or possibly the spelling of words that are nonphonetic, the reinforcement of correct responses and repetition of words seems crucial to learning to spell. The need for repetition and the increased frequency of the use of the spelling words by the speller is supported by Hillerich (1982) who stated that in normal spellers longer words, less frequently used words, and homophones are the most often misspelled words. In poor spellers, the need for reinforcement and repetition appears even more crucial because it is likely that they must overcome short-term memory deficits.

Distefano and Hagerty (1983) and Fitzsimmons and Loomers (1977) recommended that teachers create their spelling tests from misspelled words in the student's writings and the words used most frequently by the learner. This approach would also be useful in the teaching of spelling to good reader who are poor spellers. It would utilize high frequency words and provide repetition and reinforcement.

Personke and Yee (1966) suggested that all channels be utilized in teaching spelling rather than one channel. Although the poor spellers in this current study were statistically significantly lower in their oral short-term memory for nonmeaningful material rather than their written short-term, memory following Personke and Yee's recommendations, all channels should be utilized. Children should have the opportunity to spell orally as well as in a written manner with repetition and reinforcement. By utilizing both oral and written spelling and memorization techniques, the good readers-poor spellers might strengthen their oral skills and best use their relative strength in the area of written short-term memory. Fitzsimmons and Loomers' (1977) recommendation that sudents self-correct their work and learn words in a test-study-test format also appears to have strong face validity.

Suggestions for Future Research

It has been cited numerous times in this study that research on good readers-poor spellers is limited. Spelling difficulty in otherwise well-educated Americans is relatively common. A replication of this study with a larger representative population for the United States would be worthwhile to determine whether the findings would be consistent for good readers-poor spellers across the country.

A study that modified the administration instructions on the VADS visual simultaneous subtests to allow presentation for only one second per number would eliminate the possibility that the speed of presentation might have accounted for the difference in sequential versus simultaneous processing scores. That study should also eliminate the inclusion of the number 7 so that the number of syllables would be kept constant between number presentations. Additionally each child's visual sequential versus simultaneous processing style might be further investigated according to Das' (1984b) model by documenting the number of times a child looks up at a simultaneously presented picture or series of numbers. Further replication of this study at each elementary grade level would also provide additional information about spelling stages and learning theory.

References

American Psychological Association. (1981). Ethical principles of psychologists (revised). American Psychologist, 36, 633-638.

Applegate, E. (1967). Perceptual aids in the classroom, suggestions for spelling. Academic Therapy Quarterly, 3(1), 64-66.

Bannatyne, A. D. (1969). A comparison of visuo-spatial and visuo-motor memory for designs and their relationship to other sensori-motor and psycholinguistic variables. Journal of Learning Disabilities, 2(9), 21-36.

Bannatyne, A.D., & Wichiarojote, P. (1969). Relationships between written spelling, motor function and sequencing skills. Journal of Learning Disabilities, 2(1), 6-18.

Barsch, R. H. (1967). A visual-spatial concept of spelling. Academic Therapy Quarterly, 3(1), 5-8.

Beers, J. (1974). First and second grade children's developing concepts of tense and lax vowels (Doctoral Dissertation, University of Virginia, 1974). Dissertation Abstracts International, 35, 4972A.

Beers, C. S., & Beers, J. W. (1981). Three assumptions about learning to spell. Language Arts, 58, 573-580.

Bennett, G. K., Seashore, H. G., & Wesman, A. G. (1959). Differential aptitude test manual (3rd ed.). New York: The Psychological Corporation.

Benton, A. L. (1974). Revised Visual Retention Test Manual (4th ed.). New York: The Psychological Corporation.

Bergan, J. R., Zimmerman, B. J., & Ferg, M. (1971). Effects of variations in content and stimulus groupings on visual sequential memory. Journal of Educational Psychology, 62, 400-404.

Betts, G. H. (1909). The distribution and function of mental imagery

(Contributions to Education Series, No. 26). New York: Columbia University, Teachers College.

Blake, H. E. (1970). Some spelling facts. Elementary English, 47(2), 241-249.

Block, K. K. (1976). Studies in spelling: Theory and practice. Paper presented at the annual meeting of the American Psychological Association, Washington, DC.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading - spelling patterns. Developmental Medicine and Child Neurology, 15(5), 663-687.

Bower, G. H. (1970). Analysis of a mnemonic device. American Scientist, 58, 496-510.

Bryant, P. E., & Bradley, L. (1980). Why children sometimes write words which they do not read. In U. Frith (Ed.), Cognitive processes in spelling (pp. 355-373). New York: Academic Press.

Caban, J. P., Hambleton, R. K., Coffing, D. G., Conway, M. T., & Swaminathan, H. (1978). Mental imagery as an approach to spelling instruction. Journal of Experimental Education, 46(3), 15-21.

Camp, B.W., & Dolcourt, J. L. (1977). Reading and spelling in good and poor readers. Journal of Learning Disabilities, 10(5), 300-307.

Carr, (1974). Relationships between the bender visual motor gestalt test, the visual aural digit span test, and the arithmetic subtests of the wechsler intelligence scale for children and the wide range achievement test. Unpublished manuscript, Texas Christian University, Texas.

Carmen, E. K. (1900). The cause of chronic bad spelling. Journal of Pedagogy, 13, 86-91.

Carroll, H. A. (1930). Generalization of bright and dull children, a comparative study with reference to spelling. Journal of Educational Psychology, 21, 489-499.

Coberly, D. (1985). Predicting children's spelling performance, relevant factors (Doctoral Dissertation, University of Idaho, 1985). Dissertation Abstracts International, 46(6), 1575A.

Cooper, L. A. (1975). Mental rotations of random two-dimensional shapes. Cognitive Psychology, 7, 20-43.

Cromer, R. F. (1980). Spontaneous spelling by language-disordered children. In U. Frith (Ed.), Cognitive Processes in Spelling (pp. 405-423). New York: Academic Press.

Curley, J. F., & Reilly, L. J. (1983). Sensory process instruction with learning disabled children. Perceptual and Motor Skills, 57, 1219-1226.

Das, J. P. (1984a). Intelligence and information integration. In J. Kirby (Ed.) Cognitive Strategies and Educational Performance (pp. 13-35). New York: Academic Press.

Das, J. P. (1984b). Simultaneous and successive processes and K-ABC. The Journal of Special Education, 18(3), 229-237.

Das, J. P., Kirby, J., & Jarman, R. F. (1975). Simultaneous and successive syntheses: An alternative model for cognitive abilities. Psychological Bulletin, 82(1), 87-103.

Day, J. B., & Wendall, K. (1972). Visual and auditory memory in spelling: An exporatory study. British Journal of Educational Psychology, 42, 33-39.

Dilts, R., Grinder, J., Bandler, R., Bandler, L., & DeLozier, J. (1980). Neuro-linguistic programming (Vol.1). Cupertino, CA: Meta Publications.

Dilts, R., & Meyers-Anderson, M. (1980). Neurolinguistic programming in education, building blocks for learning. Santa Cruz, CA.: Not Limited Division of Training and Research.

Distefano, P., & Hagerty, P. (1983). An analysis of high-frequency words found in commercial spelling series and misspelled in students' writing. Journal of Educational Research, 76(3), 179-185.

Edgington, R. (1967). "But he spelled them right this morning". Academic Therapy Quarterly, 3(1), 58-61.

Ehri, C., & Wilce, L. (1982). Recognition of spellings printed in lower and mixed case: Evidence for orthographic images. Journal of Reading Behavior, 14(3), 219-230.

Farnham-Diggory, S., & Simon, H.A. (1975). Retention of visually presented information in children's spelling. Memory and Cognition, 3(6), 599-608.

Fay, L. (1971). Readings and spellings: How are they related? (No. 1). Washington, DC: National Reading Center Foundation.

Fehring, H. (1983). Learning to spell: The role of visual memory (Research report, January 1983). Victoria, Australia: Victoria Education Department.

Fitzsimmons, R. J., & Loomer, B. M. (1977). Spelling Research and Practice. Des Moines, IA: Iowa State Department of Public Instruction and the University of Iowa.

Frith, U. (1978a). Annotation, spelling difficulties. Journal of Child Psychology and Psychiatry, 19, 279-285.

Frith, U. (1978b). From print to memory and from print to sound, or how to read without knowing how to spell. Visible Language, 12, 43-54.

Frith, U. (1980). Unexpected spelling problems. In U. Frith (Ed.), Cognitive Processes in Spelling (pp. 495-517). New York: Academic Press.

Furness, E. L. (1958). Psychological determinants of spelling success. Education, 79, 234-239.

Gates, A. I. (1926). A study of the role of visual perception, intelligence and certain associative processes in reading and spelling. Journal of Educational Psychology, 17, 433-445.

Gentry, J. R. (1979). A study of the orthographic strategies of beginning readers (Doctoral Dissertation, University of Virginia, 1977). Dissertation Abstracts International, 39(7), 4017A.

Glanzer, M., & Cunitz, A. R. (1966). Two storage mechanisms in free recall. Journal of Verbal Learning and Verbal Behavior, 5 , 351-360.

Gould, S. M. (1976). Spelling isn't reading backwards. Journal of Reading, 20(3), 2220-225.

Goyen, J. D., & Martin, M. (1977). The relation of spelling errors to cognitive variables and word type. British Journal of Educational Psychology, 47, 267-273.

Graham, F. K., & Kendall, B. S. (1960). Memory-for-designs test: Revised general manual. Perceptual and Motor Skills, Monograph Supplement, 2-VII.

Graham, S., & Miller, L (1979). Spelling research and practice: A unified approach. Focus on Exceptional Children, 12(2), 1-16.

Grundvig, J. L., Needham, W. E., & Ajax, E. T. (1970). Comparison of different scoring and administration procedures for the memory-for-designs test. Journal of Clinical Psychology, 26(3), 353-357.

Hahn, W. P. (1961). Comparative efficiency of the teaching of spelling by the column and contextual methods (Doctoral Dissertation, University of Pittsburgh, 1960). Dissertation Abstracts, 21(8), 2214.

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 Health, Education and Welfare.

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

Hartman, G. (1931). The Relative influence of visual and auditory factors in spelling ability. The Journal of Educational Psychology, 22, 321-336.

Henderson, E.H. (1974). Correct spelling - an inquiry. The Reading Teacher, 28, 176-179.

Hendrickson, H. (1967). Spelling: A visual skill. Academic Therapy Quarterly, 3(1), 39-42.

Hillerich, R. (1977). Let's teach spelling - not phonetic misspelling. Language Arts, 54(3), 301-307.

Hillerich, R. (1982). Spelling: what can be diagnosed? Elementary School Journal, 83, 138-147.

Hoemann, H. W., Andrews, C. E., Florian, V. A. Hoeman, S. A., & Jensema, C. (1976). The spelling proficiency of deaf children. American Annals of the Deaf, 121(5), 489-493.

Horn, E. (1926). A basic writing vocabulary (Monographs in Education, 1[4]). Iowa City, IA: University of Iowa.

Horn, E. (1954). Phonics and spelling. Journal of Education, 136 , 234.

Horn, E. (1957). Phonetics and spelling. Elementary School Journal, 57, 424-432.

Horn, T. D. (1969). Spelling. In R. L. Ebels (Ed.), Encyclopedia of Educational Research (4th ed.) (pp.1282-1299). New York: Macmillan.

Housner, L., & Griffey, D. (1983). Effects of imagery ability and instruction on recall of information on spatial location. Perceptual and Motor Skills , 57, 1087-1092.

Jarman, R. F., & Das, J. P. (1977). Simultaneous and successive syntheses and intelligence. Intelligence, 1, 151-169.

Jastak, S., & Wilkinson, G. S. (1984). The Wide Range Achievement Test-Revised administration manual. Wilmington, DE: Jastak Associates.

Jensen, A.R. (1962). Spelling errors and the serial-position effect. Journal of Educational Psychology, 53(3), 105-109.

Kaufman, A.S. & Kaufman, N.L. (1983). The Kaufman Assessment Battery for Children interpretive manual. Circle Pine, Minn.: American Guidance Services.

King, M. C. (1981). Effects of non-focal brain dysfunction on visual memory. Journal of Clinical Psychology, 37(3), 638-643.

Kintsch, W. (1972). Abstract nouns: Imagery versus lexical complexity. Journal of Verbal Learning and Verbal Behavior, 11, 59-65.

Kooi, B. Y., Schutz, R. E., & Bakeer, R. L. (1965). Spelling errors and the serial-position effect. Journal of Educational Psychology, 56(6), 334-336.

Koppitz, E. M. (1972). The visual aural digit span test. Mount Kisco, NY: Grune and Stratton.

Koppitz, E. M. (1975). Bender gestalt test, visual aural digit span test and reading achievement. Journal of Learning Disabilities, 8, 154-157.

Korman, M., & Blumberg, S. (1963). Comparative efficiency of some tests of cerebral damage. Journal of Consulting Psychology, 27, 303-309.

Lesiak, J. , Lesiak, W.J., & Kirchheimer, J. (1979). Auditory and visual factors related to spelling success. Psychology in the Schools, 16(4), 491-494.

Luria, A. R. (1971). The origin of cerebral organization of man's conscious action. Proceedings of the Nineteenth International Congress of

Psychology, 19, 37-52.

Lyle, J. G. (1968). Performance of retarded readers on the memory for designs test. Perceptual and Motor Skills, 26(1), 851-854.

Malmquist, E. (1958). Factors related to reading disabilities in the first grade of the elementary school. Stockholm, Sweden: Almquist and Wiksell.

Marsh, G. A., & Hirsch, S. H. (1982). Effectiveness of two tests of visual retention. Journal of Clinical Psychology, 38(1), 115-118.

McLeod, J., & Greenough, P. (1980). The Importance of sequencing as an aspect of short-term memory in good and poor spellers. Journal of Learning Disabilities, 13(5), 255-261.

McGovney, M. (1930). Spelling deficiency in children of superior general ability. Elementary English Review, 7, 146-148.

McKellar, P. (1957). Imagination and Thinking. New York: Basic Books.

McManis, D. L., Figley, C., Richert, M., & Fabre, T. (1978). Memory-for-designs, bender-gestalt, trail making test and WISC-R performance of retarded and adequate readers. Perceptual and Motor Skills, 46, 443-450.

Miller, G. A. (1956). The magical number seven plus or minus two: some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Nelson, H. E. (1980). Analysis of spelling errors in normal and dyslexic children. In U. Frith (Ed.), Cognitive Processes in Spelling (pp. 475-495). New York: Academic Press.

Nelson, H. E., & Warrington, E.K. (1974). Developmental spelling retardation and its relation to other cognitive ability. British Journal of Psychology, 65(2), 265-274.

Newton, B.A. (1961). A Study of certain factors related to achievement in spelling. Alberta Journal of Educational Research, 6(4), 202-208.

Newton, B. A. (1961). Abilities and skills affecting achievement in spelling. Alberta Journal of Educational Research, 7(3), 121-133.

Omwake, K. T. (1925). Relation of abstract intelligence to ability to spell. Public Personnel Studies, 3, 197-201.

Paivio, A. (1969). Mental imagery in associative learning and memory. Psychological Review, 76(3), 241-263.

Paivio, A., & Csapo, K. (1969). Concrete image and verbal memory codes. Journal of Experimental Psychology, 80(2), 279-285.

Palmer, M. E. (1930). Abilities possessed by the good spellers. Elementary English Review, 7, 149-150.

Personke, C., & Yee, A. H. (1966). A model for the analysis of spelling behavior. Elementary English, 43(3), 278-284.

Plessas, G. P. (1963). Children's errors in spelling homonyms. Elementary School Journal, 64, 163-168.

Plessas, G. P., & Dison, P. A. (1964). Spelling performance of good readers. California Journal of Educational Research, 16(1), 14-22.

Powell, G. E. (1979). The relationship between intelligence and verbal and spatial memory. Journal of Clinical Psychology, 35(2), 335-340.

Pylyshyn, Z. W. (1973). What the mind's eye tells the mind's brain: A critique of mental imagery. Psychological Bulletin, 80, 1-24.

Quattlebaum, L. F. (1968). A brief note on the relationship between two psychomotor tests. Journal of Clinical Psychology, 24(2), 198-199.

Radaker, L. D. (1963). The effect of visual imagery upon spelling performance. Journal of Educational Research, 56(7), 370-372.

Reid, N. A., & Hughes, D. C. (1974). A factorial analysis of the P.A.T.: Reading comprehension, reading vocabulary and listening comprehension tests. New Zealand Journal of Educational Studies, 9, 18-30.

Richardson, J. T. (1975). Concreteness and imageability. Quarterly Journal of Experimental Psychology, 27, 235-249.

Rosen, H. (1971). A comparison of two scoring systems for the memory-for-designs test. Journal of Clinical Psychology, 27(1), 79-81.

Rourke, B., & Finlayson, A. (1978). A neuropsychological significance of variations in patterns of academic performance: verbal and visual spatial spatial abilities. Journal of Abnormal Child Psychology, 6(1), 121-133.

Russell, D. H. (1937). Characteristics of good and poor spellers: A diagnostic study (Contributions to Education Series, No. 727). New York: Teachers College, Columbia University.

Russell, D. H. (1955). A second study of characteristics of good and poor spellers. The Journal of Educational Psychology, 46(3), 129-141.

Schonell, F. (1942). Backwardness in the Basic Subjects. London: Oliver and Boyd.

Seymour, P. H., & Porpodas, C. D. (1980). Lexical and non-lexical processing of spelling in dyslexia. In U. Frith (Ed.), Cognitive Processes Spelling (pp. 443-475). New York: Academic Press.

Sheehan, P. W. (1966). Functional similarities of imagery to perceiving: individual differences in vividness of imagery. Perceptual and Motor Skills, 23, 1011-1033.

Shepard, R. N. (1966). Learning and recall as organization and search. Journal of Verbal Learning and Verbal Behavior, 5, 201-204.

Shepard, R. N., & Feng, C. (1972). A chronometric study of mental paper folding. Cognitive Psychology, 3, 228-243.

Simon, D. P., & Simon, H. A. (1973). Alternative uses of phonemic information in spelling. Review of Educational Research, 43(1), 115-137.

Singh, S. C. (1971). The clinical usefulness of the memory for designs test. Indian Journal of Applied Psychology, 8(2), 49-52.

Sloboda, J. (1980). Visual imagery and individual differences in spelling. In U. Frith (Ed.), Cognitive Processes in Spelling (pp. 231-251). New York: Academic Press.

Spache, G. (1940). Characteristic errors of good and poor spellers. Journal of Educational Research, 34(3), 182-189.

Spache, G. (1941). Spelling disability correlates: 1. Factors probably causal in spelling disability. Journal of Educational Research, 34, 561-586.

Sterne, D. M. (1969). The benton, porteus, and WAIS digit span tests with normal and brain-injured subjects. Journal of Clinical Psychology, 25, 173-175.

Sweeney, J. E., & Rourke, B. R. (1978). Neuropsychological significance of phonetically accurate and phonetically inaccurate spelling errors in younger and older retarded spelling. Brain and Language, 6, 212-225.

Symmes, J. S., & Rapaport, J. L. (1972). Unexpected reading failure. American Journal of Orthopsychiatry, 42, 82-91.

Thorndike, R. L., Hagen, E. P. and Sattler, J. M. (1986). The Stanford-Binet Intelligence Scale: 4th Ed. guide for administration and scoring. Chicago, IL: The Riverside Publishing Company.

Torgesen, J. K. (1977). Memorization processes in reading disabled children. Journal of Educational Psychology, 69, 571-578.

Torgesen, J. K., Bower, C., & Ivey, C. (1978). Task structure versus modality of presentation: A study of the construct validity of the visual aural digit span test. Journal of Educational Psychology, 70(4), 451-456.

Townsend, A. (1947). An investigation of certain relationships of spelling with reading and academic aptitude. Journal of Educational Research, 40(6), 465-471.

Valmont, W. J. (1972). Spelling consciousness: A long neglected area. Elementary English, 49(8), 1219-1221.

Venezky, R. (1967). English orthography and its graphical structure and its relation to sound. Reading Research Quarterly, 2(3), 75-105.

Walker, B. S. (1984). Vividness of imagery and spelling errors. Perceptual and Motor Skill, 39, 823-825.

Walters, C. E. (1961). Reading ability and visual-motor function in second grade children. Perceptual and Motor Skills, 13, p. 370.

Weislogel, M. H. (1954). The relationship between visual memory and spelling ability. (Doctoral Dissertation, University of Pittsburg, 1954). Dissertation Abstracts Intenational, 14(12), 2398.

Williamson, E., (1933). Mental abilities related to learning and spelling. Psychological Bulletin, 30 , 743-751.

Wilson, M., & Bock, R. D. (1985). Spellability: A linearly ordered content domain. American Educational Research Journal, 22(2), 297-307.

Witkins, B. R. (1971). Reading improvement through auditory perceptual training. Unpublished manuscript.

Appendix A

Parental Permission Slip

For the past year and a half, I have worked for the Torrance School District as a school psychologist. Prior to that time I worked as a school psychologist in the San Francisco Bay Area for four years. I am currently engaged in research in order to obtain my doctorate degree, and I need your permission for your child to participate in my study. The study will investigate spelling and how children learn. The information obtained from this study will provide useful information for spelling education. If you give permission for your child to participate, I assure you that no where in the study will your child's name appear. The information will be confidential and your child's right of privacy will be respected.

By giving your permission for your child to participate in my study, you will be agreeing that I or my assistant may meet with your child for one 30 minute session. During that time, your child will be given three brief tests. Most children find testing of this type to be fun. The tests will not be spelling tests but may provide further information about how your child learns. In return for your child's participation in this study, I will share and explain specific information about your child's learning style.

I have devoted my career to helping children, and I now hope you will consent to help me conclude my current studies. If you have any questions, I will certainly be willing to discuss them with you. Please return the bottom portion of this letter to school with your child. Thank you for your consideration of my request.

Sincerely Yours,

Terry Richardson

I hereby give permission to have my son or daughter participate in the study conducted by Terry Richardson, school psychologist.

Child's Name ____________________

Parent's Signature ____________________

Date ____________________

Appendix B

Example of Parental Letter After the Assessment

To the parents of

Thank you for allowing to participate in my study. Each child who participated in the study was given brief tests of short term memory. The scores that each child received may give us clues about the child's strengths and weaknesses in areas of short term memory. The tests were brief so our results cannot provide any definitive conclusions. Remember that if your child did not pay attention or try during the tests it is certain that the information provided by these test results cannot provide a true picture of actual skills in these areas.

's current test results indicate that her short term memory for numbers is within the average or above range in all areas tested. No weaknesses were demonstrated in either visual or auditory short term memory areas.

Terry Richardson
School Psychologist

Appendix C

VADS Score Sheet

Name: ____________________

Date: ____________________

Ethnic Group: ____________________

Aural-Oral (read one digit per second)

1st trial	2nd trial
259 ______	547 ______
8493 ______	7296 ______
37852 ______	41357 ______
367194 ______	165298 ______
4579281 ______	8591342 ______
71658432 ______	56824139 ______

A-O ________ Aural Intake ________

V-O ________ Visual I. ________

A-W ________ Oral Exp. ________

V-W ________ Wr. Exp. ________

total score: ____________

Visual-Oral (show each card for 10 seconds)

1st trial	2nd trial
573 ______	216 ______
3147 ______	8516 ______
93148 ______	68725 ______
471983 ______	374697 ______
8324715 ______	7964835 ______
14985376 ______	57124398 ______

Aural-written

532 ______	295 ______
5826 ______	4937 ______
96183 ______	38159 ______
473859 ______	148352 ______
8372951 ______	7294156 ______
39512486 ______	61274935 ______

Visual-Written

426 ______	538 ______
9178 ______	7624 ______
29763 ______	16459 ______
517423 ______	985216 ______
3891742 ______	5618329 ______
42583619 ______	61435287 ______

Appendix D

VADS2+ Score Sheet

Visual Sequential - Oral (show each number for one second each)

1st trial	2nd trial
347 ________	952 ________
8256 ________	9732 ________
32791 ________	69387 ________
596184 ________	456279 ________
7964835 ________	5712389 ________
58314629 ________	37256981 ________

Visual Sequential - Written (show each number for one second each)

1st trial	2nd trial
682 ________	356 ________
9751 ________	7469 ________
26479 ________	68593 ________
618432 ________	482135 ________
4953821 ________	2158736 ________
63174895 ________	96284715 ________

VS-O ________

VS-W ________

Visual Seq. ________