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THE OHIO STATE UNIVERSITY, PH.D., 1978
AN INVESTIGATION OF HANDWRITING ACHIEVEMENT AND VISUAL-MOTOR-PERCEPTION ABILITIES OF FIRST GRADE STUDENTS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
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CHAPTER I

INTRODUCTION

No area of special education is receiving as much attention today as that of learning disabilities (Telford & Sawrey, 1972). In Ohio, in 1962, State Board of Education Standards were adopted to provide both a special class program and individual services for children with learning disabilities and behavior disorders. From the beginning experimental program of two classes serving eight children in the 1957-58 school year, the program has developed to its 1975-76 school year status involving 29,249 children. In 1,577 learning disabilities classroom units 14,090 students were served and 15,159 students were tutored by 2,053 tutors under these standards (Ohio State Department of Education, 1976).

An evaluation of the Columbus program's effectiveness indicated that the younger the child at age of entrance into the learning disabilities program, the more effective the program (Ohio State Department of Education, 1970). Thus, the need for techniques for earlier identification of learning disabled students was recognized in Ohio. The need for research in early identification of learning disabilities
has been recognized by many child development specialists and has resulted in an increased number of kindergarten and pre-kindergarten screening projects (de Hirsch, Jansky, & Langford, 1966; Hainesworth & Sigueland, 1969; Wilson & Robeck, 1966). It is recognized that if young children with potential difficulties could be reliably identified, it might be possible to reduce the large number of children who later manifest learning disabilities and concomitant behavioral-emotional reactions (Goldberg & Schiffman, 1972).

A five-year follow-up study of learning disabilities pupils was completed in New York state. It is significant to note that of the twelve conclusions drawn from the findings, seven dealt with the need for early preventive assessment and preventive teaching strategies (Koppitz, 1973).

The Educational Services Committee of Task Force II, the second of three task forces created by concerned voluntary and government agencies to establish a blueprint for action regarding educational and medical aspects of minimal brain dysfunction, or learning disabilities, concluded that educators concerned with learning disabilities have a primary responsibility to direct major efforts toward the prevention of disabilities whenever possible (Haring, 1969). They noted that this effort must partially be directed toward the diagnostic approach to the teaching process; that is, effort must be toward seeking increasingly better instruction for children and toward accurate evaluation of the effects
of this instruction on child performance (Bateman & Schiefelbusch, 1969).

This diagnostic approach to the teaching process can only begin with the proper educational diagnosis of the child's performance early in his school years and on a continuing basis thereafter. The need to identify the specific needs of a child is inherent in the educational diagnosis for remediation or prevention that is teacher-learner oriented. There must be a continuous, diagnostic, evaluative process if results are to be assured (Telford & Sawrey, 1972; Stephens, 1970). Thus, assessment devices become critical.

Criticism regarding the proliferation of tests available and employed in educational diagnosis centers around the problem of the efficiency-effectiveness ratio of instruments.

Within the diagnostic process as conducted by any one diagnostician, regardless of discipline, greater economy can usually be achieved by a continual focus on the question of what information about the child's functioning is being sought. Too often a test is given because "we always give it" or because "we thought it might show something." This is not to say there is no place for exploratory diagnosis, but rather that the tests should be carefully selected for that purpose when that is the intent. However, the diagnostic information being sought is usually quite specific, and can often be obtained more efficiently than is currently done. (Chalfant & Scheffelin, 1969)

Most significant to any investigation of assessment devices are the recommendations of the National Project on Learning Disabilities in Children (Haring, 1969) regarding
instruments for educational diagnosis:

1) It is recommended that greater attention be given to the careful evaluation of tests already in use and those being developed;

2) It is recommended that greater attention be given to the role of models of cognitive functioning in the development and selection of test instruments;

3) It is recommended that greater emphasis be put on the development and use of criterion-referenced, task specific tests and behavioral checklists to be administered by classroom teachers; and

4) It is recommended that the use of standard batteries for individual diagnostic purposes be carefully evaluated and consideration given to greater use of an individualized "branching" type of diagnosis. (Bateman & Schiefelbusch, 1969)

Thus, it is evident that educational diagnosis must be of the type that (a) provides early diagnosis of the problem, (b) provides task-specific information, and (c) whether standardized or criterion referenced, it provides for an "individualized" type of branching diagnosis to pinpoint the type of deficiency. It is also evident that the proliferation of diagnostic tests now in use be examined carefully to determine their efficacy and specificity.

Statement of the Problem

Many who devise and report theories explaining learning disabilities, methods for diagnosing, and even remediation programs for learning disabilities, recognize that problems may be evident in one or more of the processes of speech, language, perception, behavior, reading, spelling, writing,
or arithmetic (Kephart, 1960; Frostig, 1964; Strauss & Lehtinen, 1947; Strauss & Kephart, 1955; Cruickshank, 1967; Bannatyne, 1968). Yet, comparatively little has been done in the area of writing as compared with the other stated areas of deficiency (Chalfant & Scheffelin, 1969; Johnson & Myklebust, 1967).

The problem of poor handwriting skills is recognized as one area of concern for some learning disabled children. Children with poor handwriting have sometimes been regarded as careless, or lazy, or not trying. Work with learning disabled children has indicated that this often is not the case. Nonachievers in writing often are not lacking in motivation, but in skills (Myklebust, 1965).

Many of the more commonly noted behavioral correlates of learning disabled children are those involved in writing: reversal of letters or words in writing, lack of hand preference, illegible handwriting, confused spatial orientation, problems of laterality and directionality, memory disorders, and impaired visual perception (Myklebust & Johnson, 1962). The importance of writing is undisputed. In the large-group educational system, written responses are evaluated more than verbal responses. The naive teacher may estimate the quality of what has been learned, influenced by the quality of the handwriting, not the quality of the content. Markham (1976) found that papers with better handwriting consistently received higher scores than did
those with poor handwriting, regardless of the quality of the content. The child with a writing disability, then, is unfairly judged, if the measurement of achievement rests on the quality of the handwriting (Money, 1962).

Attempting to remediate poor handwriting skills, once established, is extremely difficult. "It is easier to teach correct ways from the very beginning than it is to change wrong ways once they have become well established as habit." (Enstrom, 1968) Remediation in handwriting is particularly difficult because while new handwriting strategies are being taught, no old habits must be practiced (Cole, 1955). Gillingham and Stillman (1956) state, "When new concepts are being acquired and new habits formed, it is better for all exercise of the old ones to cease." This is difficult to control since writing is a necessary tool for most school work, and poor habits are re-practiced daily.

Too, the difficulties and time involved in retraining must be considered in terms of the relative advantages of "mortgaging months of a pupil's crowded program in formal drill." It is far better to ensure correct initial learning (preventive teaching) than to attempt remediation. "It is always easier to build a new structure on a new foundation than to erect new walls alongside the old." (Gillingham & Stillman, 1956)

The identification of those children most likely to experience difficulty in learning correct letter formation and correct writing techniques, early in the instructional
process, would obviate the necessity of remedial instruction, so often difficult, inefficient, or neglected. Individualized, preventive teaching, could be initiated for the few "high risk" students.

Therefore, the problem involves the need for (a) a review of the available assessment instruments for handwriting ability, and (b) a validation of a selected few of these instruments for early identification and diagnosis of writing difficulties in children.

**Purpose of the Study**

The educator is probably most ill-equipped with respect to the availability of standardized diagnostic tests for writing disorders. There is a need to develop systematic procedures for assessing and treating disorders of written language. A review of the research dealing with the assessment and treatment of writing disorders (Chalfant & Schef-felin, 1969) cites the need to:

(a) conduct a survey of all tests and subtests which have relevance to the assessment of writing disorders, and

(b) construct a comprehensive diagnostic battery for children who have difficulty with handwriting.

Disorders of written language are most definitively categorized by types of disorders: (a) visual-motor integration or handwriting disorders, (b) revisualization or spelling disorders, and (c) deficiency in formulation and syntax or language or expression disorders (Johnson & Myklebust,
1967). This investigation is limited to one aspect of written language typically described as visual-motor integration or handwriting and a review of the tests and subtests relevant to this one area; and the validation of a selected few of these tests or subtests for early identification and diagnosis of handwriting difficulties in children.

There is a polarization involved in learning disabilities, in general, and the process of diagnosis and the selection of remediation techniques, in particular. This dichotomy exists in philosophical bases: (a) process orientation vs. (b) task orientation. (Strein & Ysseldyke, 1974; Ysseldyke & Salvia, 1974; Smead, 1977) Assessment instruments for learning disabilities and specifically the skill of handwriting might be classified, then, according to these orientations.

**Process-oriented methods.** The rationale for these techniques and methods is that the child possibly has some kind of correlated or underlying "process" disability which has prevented his adequate response to ordinary methods of teaching the skills. In other words, the diagnostician must "know" what "processes underlie complex behavioral products like . . . writing, and be prepared to assess them in as much depth as is required to find deficits and to plan strategies for reducing or circumventing these disabilities" (Bateman & Schiefelbusch, 1969). The processes presumed to underlie the complex skill of handwriting are visual
perception and discrimination, fine-motor coordination, memory, and visual-motor integration. The presumption of being able to isolate such abilities and further assess their level of development by some standardized instrument is evident in the literature and research (Kirk, 1966; Cohn, 1964; Cohen, 1969; Frostig, 1964; Boyd & Randle, 1970; Fretz, 1970; Bateman, 1968).

**Task-oriented methods.** A task-oriented philosophy necessitates a survey of the specific behavior to be learned—the tasks that a child needs to be taught. Thus, the diagnostician can say to the teacher, "Teach the failed test items as directly as you can." "They are viewed as important tasks which the child cannot yet perform and they seem to be next in line to be learned, either developmentally or in terms of priority due to the nature of the task" (Vallett, 1967). Thus, the skills involved in handwriting might be stated as the ability to draw a straight line, curved line, closed and open forms, make angles, copy numerals and letters correctly, and reproduce numerals and letters from memory, in isolation, in words, and in sentences.

Proponents of the task analysis model (Quay, 1973; Mann, 1971a, 1971b; Stephens, 1970, 1975), while firmly in favor of assessment as a component of the diagnostic-prescriptive teaching process, question both the efficacy and validity of the process approach. Mann (1971b) expresses vehement opposition "to present conceptualizations of abilities as processes that can be identified precisely by
existing tests for training purposes." And, Stephens (personal communication, August, 1977) sees the distinction as "fallacious since task analysis is used in both approaches."

To provide further illumination in this process-product controversy, this investigation reviews tests developed under each orientation. Available tests of visual perception, motor coordination, and visual-motor integration are reviewed as well as tests developed to evaluate handwriting as a learned skill. A selected few of these tests, administered to first graders, are examined to determine the validity and efficacy of such tests for early identification and diagnosis of handwriting difficulties in young children.

**Hypothesis**

It is hypothesized that a battery of tests can be determined which may be administered early in first grade to predict and identify handwriting difficulties:

a) Since achievement of the skill of handwriting requires adequate development of the subskills of visual perception, motor coordination, and visual-motor integration, a review of available task- and process-oriented tests will provide a selection of tests for investigation.

b) Handwriting evaluated in a testing situation through the use of a task-oriented test correlates with evaluations of handwriting done by first graders in the classroom.
c) First graders' performances on tests developed as process-oriented assessments to evaluate visual perception, motor coordination, and visual-motor integration, correlate with evaluations of handwriting done by first graders in the classroom.

d) First graders' performances on various tests of visual perception are significantly correlated.

e) First graders' performances on two tests of visual-motor integration are significantly correlated.

f) First graders' performances on the process tests and the task tests administered are significantly correlated.

Summary

There is a need to identify children who will experience handwriting difficulties, while they are still early in their educational careers. Since remediation in handwriting means changing of habits, it is desirable that initial teaching be successful. This can be implemented only if children who need individualized instruction or specialized instruction can be identified early in their school years.

Presently, handwriting is not receiving priority in the area of learning disabilities so assessment devices are limited—often included as subtests of larger batteries. A
survey of the available tests and subtests for handwriting assessment is needed and should include both process-oriented tests as well as task-oriented devices.

This investigation reviews the various instruments available and seeks to validate and correlate these different types of tests in order to determine which might be useful as part of a diagnostic battery for locating and helping children who have difficulties with handwriting.

The implicit aim of this investigation is to provide some information regarding specific diagnostic instruments which might be used for early identification of writing difficulties. Principally, the investigation is expected to provide information regarding the validity of these instruments so that they might be employed for early diagnosis and/or remediation planning for handwriting difficulties.
CHAPTER II

REVIEW OF THE LITERATURE

This chapter consists of a review of relevant literature concerning handwriting. First, handwriting as a series of tasks or skills is discussed and available assessment devices of writing skills are reviewed. Second, because handwriting has been established to be a perceptual-motor skill involving perceptual ability and muscular control (Freeman, 1954; Hildreth, 1936c; Myers, 1963), these abilities are discussed and process-oriented tests are reviewed. The tests reviewed are those which assess (a) visual perception and discrimination, (b) muscular control or fine-motor coordination, and (c) visual-perceptual-motor integration, in as isolated a manner as is presently available.

Handwriting—the Task Approach

The majority of the significant research concerning the teaching of handwriting was conducted during the 1920's and 1930's and dealt with the form and quality of the writing (Freeman, 1941, 1954; International Conference on Public Education, 1948). The first scale for judging handwriting was developed in 1910 (Thorndike) and has been refined by others (Ayres, 1912; Herrick & Erlebacher, 1963;
Bezzi, 1962) to measure both speed and quality of handwriting. Experiments have shown that the use of a scale "results in more reliable measurements than those which teachers assign without a scale, and that training in the use of a scale increases the reliability of the scores," (Freeman, 1941). However, little information is gained from the use of scales other than determining the need for improvement or remediation. Current research (Helwig et al., 1975) developing an objective, simple, and reliable method of measuring letter formation through the use of overlays may, in the future, provide the specific information to the student and teacher which is needed in order to improve each letter.

The assessment of handwriting through comparison with a uniform standard such as the handwriting scale, has as its aim a uniform type of cursive writing and, therefore, attention is focused, in the teaching of handwriting, exclusively on the form and quality of the writing and not on the learner (Gray, 1969). Some score cards or checklists of characteristics which attempted to isolate factors for remediation have been developed (Freeman, 1915; Gray, 1956), but have not proved sufficient to specify the necessary remedial approach.

A change of philosophy was heralded by Hildreth (1936b) as she wrote:
Children are no longer held to any one grade standard for handwriting skill. The child is more important than any writing system . . . We rely increasingly on inner maturation of the mental and motor capacities to take care of handwriting . . . Instead of teaching 'writing', we now teach 'children'.

Some studies have been conducted by Hildreth (1936b; 1936c) on the developmental course of writing behavior in the child. She described the posture and physical behavior of children from two through eight years of age, as well as the development of their writing product. Similarly, Ames and Ilg (1951) reported their observations of pre-school and school-age children at six-month intervals, from three to six years of age, and then yearly intervals through nine years of age. The writing behavior and resultant products were analyzed to determine the normal course of development. Their aim was to indicate where current practice was and was not "proceeding in accordance with developmental principles." Several recommendations for classroom teachers did result.

Gesell (Knoblock et al., 1974) also delineated the progression of writing skills as noted in his observations of children. This progression is viewed as unchangeable, merely unfolding when the individual is "ready." More current research (Gibson & Yonas, 1967) has sought to go beyond the mere descriptive reporting of the act and the product. Their research sought to disprove that scribbling is a purely motor activity or that it begins as one at 15 to 38 months of age. Their conclusion was that the
visual perception of the trace making was an important motivating force for the development of the graphic act. Perception, thus, as an integral part of the writing act will be reviewed later.

One indication of concern for the learner of the writing task, and for making differential provisions for growth and individual needs of the writer, was noted in the early research (Dottrens, 1931):

Rossgers . . . asked children to reproduce a model of the teeth of a handsaw in order to test their aptitude for writing and to evaluate their power of graphic expression. After analyzing these reproductions, he classified the children into four groups: those who reproduced the drawing accurately; those who reversed the direction of the teeth; those who reproduced only the vertical lines; and those who merely scribbled. He concluded that the fourth group were not yet ready for writing and the others required individual attention according to their classification.

No such scale or test for classification prior to instruction in handwriting is in use or advocated today, although the accepted principles in the current teaching of handwriting to children infer the necessity for such an indicator:

1. The learner is the chief focus of attention, and many adjustments are made in teaching procedures in recognition of individual differences.

2. Preliminary training is provided to promote increased readiness for writing whenever it is needed.

3. Skill in handwriting develops slowly as a result of both maturation and practice (Gray, 1956).
Assessment needs have been recognized and often met by individuals and groups in subjective terms:

Teachers should always examine children's readiness for handwriting, noting carefully the extent of each child's motor control and visual ability as he engages in regular classroom activities (Gray, 1956).

As a result of much experimental work with young children, Maria Montessori (1952) stated that:

. . . learning to write requires both intelligence and an efficient motor mechanism. The latter . . . involves both ability to hold the writing tool and ability to perform the movements required. A child acquires mental readiness through experiences that reveal the value of handwriting and promote interest in learning to write. He acquires motor readiness through activities that enable him to learn to hold the writing tools and engage in the simplest writing movements.

Stage One in handwriting programs, further stated Maria Montessori (1952), should be to prepare the child for writing, since many children are not prepared to acquire the technique of handwriting easily when they enter school. The identification of these children and the explanation of this readiness training is vague and subjective, however.

The need for specific activities in developing readiness for writing was noted summarily by Page (1964) as she pointed out that handwriting is dependent upon neuromuscular development, eye-hand coordination, visual discrimination, and recognition of the usefulness of writing. Experimental research in the area of readiness for writing has been limited, while the greater portion of the literature
is descriptive in nature, such as surveys of current practices (King, 1961; Freeman, 1946; Herrick & Okada, 1963) or reports of "successful practices" in the schools which often contradict each other (Karstadt, 1976; Foerster, 1972; Wright & Allen, 1975; Peterson, 1975) or which are based on opinion rather than research (Whitesel, 1976; Enstrom & Enstrom, 1972; Foerster, 1974; Early, 1969).

The simplified letter forms, manuscript, were introduced in 1923 to help children overcome some of the difficulties inherent in beginning writing instruction. The change was implemented, accepted by teachers and schools, and manuscript is now practically universally used in the primary grades (Herrick & Okada, 1963). Research has followed the change, but no definitive answers have resulted in the manuscript/cursive controversy which still continues. Research on the legibility advantages of each method has been inconclusive (Turner, 1930; Templin, 1963; Groff, 1960), while research on speed superiority has not supported one method over the other (Hildreth, 1944, 1945, 1960; Washburne & Morphett, 1937). Research and controversy continue over the best transition time, and even if transition is necessary (Hildreth, 1963; Enstrom, 1960; Otto & Rarick, 1969).

Studies continue which analyze handwriting legibility to determine the specific letter forms which account for most of the illegibility in handwriting (Newland, 1932;
Lewis & Lewis, 1964). Remediation of specific letter illegibilities through individualizing instruction (Cole, 1935; 1941) was successful and provided significant improvement, but positive transfer from one letter to another was not evident.

The methods and abilities employed by students in appraising their own handwriting as a basis for further improvement, were explored (Harris & Herrick, 1963) and found lacking. The need to develop perception skills for handwriting analysis and self-improvement, among elementary school children, was reported by Harris and Herrick (1963) and pursued by Furner (1969a; 1969b; 1970). She developed a method of instruction based on the perceptual-motor nature of handwriting which included the development of critical perception of the handwriting task. In grades one and two, the children using the experimental method were found to be superior in quality to the control group using the commercial method, emphasizing copying rather than perception. This three-year longitudinal study is significant because it is one of the rare instances of research directly involved in handwriting instruction.

Another research-based writing instruction program (Supple et al., 1972) for the schools has resulted from Hirsch and Niedermeyer's (1973) work with kindergarteners. Their work with four treatment groups used to investigate the effects of tracing prompts and discrimination practice
on kindergarten handwriting performance, is further dis-
cussed under the review of visual perception and discrimina-
tion research. Of more significance to handwriting instruc-
tion are the positive results they obtained from the pupil
preference inventory administered to determine children's
attitudes toward school activities that require handwriting
in kindergarten. The children involved in the experimental
program rated writing tasks significantly higher than the
comparison classes rated writing tasks. Not only did the
kindergarten children learn to print, but they also acquired
positive attitudes toward the tasks.

However, a review of current writing programs used in
regular elementary school classrooms shows that the pub-
lishers (Zaner-Bloser, 1969; Palmer, 1967; Seale, 1963;
Noble and Noble, 1966) are remarkably similar in their ap-
proaches. Basically, a "look-trace-copy" method is employed,
and all are lacking in any pre-testing, on-going diagnostic
assessment, or attempts to determine specific individual
differences and needs, with planned lessons or instructions
to teach certain skills so that remediation would not be
necessary.

A review of a recently revised and completely rewritten
program (Zaner-Bloser, 1975) may indicate the current trend
for handwriting programs. It does more to provide the
materials for differentiation in instruction. It provides
alphabet "models" on plastic overlays for "self-evaluation,"
plastic-laminated alphabet cards designed for tracing and writing with grease pencils (making them reusable), and plastic templates allowing for ingroove tracing of letter "models" in both manuscript and cursive. The emphasis of the program development is on motivation and providing an interesting program for the average child who experiences little difficulty with good handwriting when he tries. The emphasis, here too, is on tracing and copying and not on the visual perception which should precede the motor aspect of handwriting (Purner, 1969a; 1969b; 1970) nor on pre-assessment or on-going evaluation of skill development.

One series which has sought to provide lessons and teaching methods based on learning theory and modern technology (Skinner, 1968), uses immediate self-correction made possible through the use of special inks in the printing and an ink in the pen used by the child which only leaves a visible trace when the letters are correctly made. Many practice pages are provided with steps of approximation leading to the completed letters and words. There is, however, no opportunity for branching after assessment. It too, is a total program for all, undifferentiated, and is a "look-trace-copy" method with modern technology aiding the teacher and the learner, but with its efficacy untested.

Ames and Ilg (1951) noted that several practices in handwriting series used in regular elementary classrooms do not proceed in accordance with principles of child
development—involving consideration of chronological and mental age of the child and status of his visual-motor abilities. Some limited research has suggested innovations in the teaching of handwriting (Furner, 1969a; 1969b; 1970; Hirsch & Niedermeyer, 1973; Wiles, 1943; Tawney, 1967; Krzesni, 1971), but has yet to make its impact in the schools.

Literature relevant to identifying and remediating handwriting disorders comes in the main from investigators dealing with the extremes in writing disorders (Cruickshank, 1967; Myklebust, 1965; Orton, 1937; Johnson & Myklebust, 1967; Goldstein, 1948). The descriptions of the writing behaviors and disorders are labeled "dysgraphia, developmental dysgraphia, ataxia, apraxia, agraphia," etc. All of these diagnostic terms rely on comprehensive descriptions of the writing behaviors as well as medical investigations for diagnosis and identification of the difficulty.

Some handwriting remediation techniques commonly in use were developed as part of remedial reading, spelling, and writing programs (Fernald, 1943; Gillingham & Stillman, 1940; 1956; Spalding & Spalding, 1947; 1962). Several remedial procedures have been published (Cruickshank, 1967; Gardner, 1966; Agronowitz & McKeown, 1959; Orton, 1937; Goldstein, 1948) which are specific to various tasks determined to be involved in handwriting such as work in revisionalization, auditory memory, letter symbol/sound associations, language or grammar, handedness, the formation and structuring of
letters, and motor movements. However, the problem of determining the child's deficient area and selection of the appropriate remediation remains a subjective choice of the teacher.

Pragmatic and specific teaching suggestions for remediation of handwriting skills are presented in some publications (Arena, 1970; Wallace & Kauffman, 1973; Otto, McMenemy, & Smith, 1973; Smith, 1969; Lerner, 1971). These are practical, task-oriented approaches to remediation. Some research reports the use of behavior modification techniques to improve handwriting. McNees, et al. (1972) successfully used response prompts to improve spacing between words with good carryover to all classwork. Relaxation training has been successfully used to improve handwriting quality (Carter & Synolds, 1974).

Further, as a result of interest in learning disabled children, some investigations have begun to deal with the development of simplified writing models (Schnell & Burns, 1963; Mullins et al., 1972; Enstrom & Enstrom, 1972). Thus, remediation research continues, but assessment of handwriting disabilities remains a limited area of investigation. A comprehensive review of handwriting research (Chalfant & Scheffelin, 1969) listed steps of an informal, experimental approach for the educator who sought to assess writing disorders. The experimental approach was necessary because of the "absence of formal standardized tests."
The available devices for assessment of the handwriting task are limited (Appendix B). While some devices assess quality of writing through comparison with samples (Ayres, 1912; California, 1957; Freeman, 1975), and others score the writing speed (Ayres, 1912; Durrel, 1955), neither of these approaches does more than identify the problem after it has developed, and identify it in an extremely general manner. Other devices which are available for the assessment of handwriting are each quite different. One global-type assessment was part of an achievement test battery (California Achievement Test, 1957) and yielded merely a grade equivalent for handwriting. Another, a part of a comprehensive writing ability test (Myklebust, 1965) puts emphasis on the content of creative writing and yields no handwriting evaluation.

Two attempts at prediction and diagnosis can be found in the Predictive Screening Index (1972) and the Slingerland Screening Tests for Identifying Children with Specific Language Disability (1970). The Predictive Screening Index was developed to predict reading failures and contains only four tasks which deal with writing and/or use of the pencil. The Slingerland tests, however, require copying and writing under various specified conditions, and is the one assessment device devised as a screening instrument to detect visual, auditory, and kinesthetic-motor (writing) disorders.
Handwriting—the Process Approach

A review of the research and a survey of the tests which are available for assessment of primary-age school children are discussed under the divisions of (a) visual perception and discrimination, (b) muscular control or fine-motor coordination, and (c) visual-perceptual-motor integration.

Visual perception and discrimination. Visual perception is not a single process, identifiable as a unit. Piaget (Elkind & Scott, 1962) has stated, "Perception is not an immediately fixed mechanism for registering stimuli, but a developing system which becomes increasingly adaptive with age." Maturation alone, however, is not sufficient for full development. The importance of learning and eye movements in the early establishment of visual perception is generally accepted (Hebb, 1949). Form, meaning, and recognition all require experience and learning in order to develop. Newly-sighted adults were found to initially have available to them only gradients of light (Von Senden, 1932) with knowledgeable vision developing with experiences. It is also accepted that differentiation of elements of a form proceeds gradually and continues into adulthood (Werner, 1957; Gibson & Gibson, 1955; Kephart, 1960).

Visual perception of form, with and without tactual-kinesthetic cues, and color discrimination have been investigated in discrimination research with infants. These
studies (Fantz, 1963) indicated that form is the common basis for matching objects up to age three; between three and six, color becomes the basis; and thereafter, form again dominates as the basis of matching.

Part-whole integration appears to be a function of special significance in visual perception (Strauss & Kephart, 1955). It has been suggested that developmental stages might be delineated as (a) through three years of age, the whole is perceived with little differentiation of details, (b) four and five years old, react less to wholes than to larger parts, and (c) by age six, the perception of small details is typical. It is not until (d) about nine years of age, that the parts are synthesized into a perception of a well-differentiated whole.

Spatial relationships and body orientation are "among the first visual processing tasks which the infant and young child begin to acquire, and they are among the last to be fully developed" (Piaget, 1935). Children experience difficulty with orientation in space and visual-spatial disorientation and directional confusion are traits often associated with children who have difficulty in acquiring beginning reading skills. Rotations and reversals are very frequent with young children, but decrease rapidly with age (Gibson et al., 1962; Neisser, 1968).

The relevance of visual-perceptual ability in reading success, was explored as long ago as the mid-1920's. Gates'
(1926) findings supported the conclusion that visual perception ability is not a unitary factor but that it has many facets. Further, he found that perception involving letters, syllables, and words, was more closely related to reading achievement than nonword forms. This was supported by Barrett (1965a, 1965b) who concluded that naming of letters and of numbers, combined, were the best single predictors for reading achievement. Letter naming, which requires a higher degree of verbal symbolic functioning, as opposed to letter matching, which demands primarily a visual perception response, was demonstrated as a superior predictor for reading achievement (Olson, 1958; Gavel, 1958).

Often the term visual perception is applied to activities involving both nonverbal and verbal-visual competencies. The latter, however, requires symbolic functioning and is processed in a different part of the brain (Kolers, 1969). Kershner (1975) differentiates between "perceptual," visual-spatial ability developing in the preoperational (approximately below age 7) stage, and "cognitive," visual-spatial ability of the concrete operational (from age 7 to 11) stage of development. Recognizing that these stages are continuous functionally, but that they are separate in terms of effective teaching techniques and most efficient learning strategies, Kershner (1975) found that cognitive-spatial development is associated with reading ability at grade two level, whereas perceptual skills in themselves bear little, if any, influence on reading at this age.
Letter recognition investigated by Gibson et al. (1962) was determined to require discrimination of some "critical" features differentiating one letter from another. However, Gibson, too, noted that it is probable that symbolic functioning also contributes to what seems to be purely perceptual performance. Jansky and DeHirsch (1972) conclude that it might be expected that verbal visual tasks are better predictors for reading success than nonverbal tasks "because the closer in content a predictor variable is to a criterion measure, the closer will be the correlation between the two."

As the search for predictors for reading and academic success continues with early identification and preventive intervention as the goal, the investigations involve visual perception and, often, motor coordination factors. Both of these are of concern for handwriting success and, yet, only one study (Kaufman & Biren, 1976) was found which investigated visual perception and handwriting. Testing the hypothesis that children who make persistent spatial errors (reversals) after age seven will be poor readers, spellers, and writers, no correlation was found between percentage of spatial errors and the child's reading grade. They did find a high correlation between spatial disorientation and inability to spell and between spatial disorientation and poor handwriting. This investigation found the Slingerland Screening Tests (Subtest II-Visual Discrimination of Word Forms; and Subtest V-Visual-Motor/Visual-Perception Memory)
to be the most predictive of the spelling and handwriting disabilities.

The literature which currently treats visual perception as composed of separate and separable dimensions, such as figure-ground perception, perceptual constancy, perception of position in space, and visual closure, has encouraged the development of tests to separately assess each of the functions, and, concurrently, the materials for "training" for improvement of the functions. A recent review of research and instruments in the field of learning disabilities (Chalfant & Scheffelin, 1969) states part of the predicament:

because the figure-ground tasks in the classroom have not been carefully identified and described, little effort has been made to develop training programs to improve performance on a variety of these tasks . . . and . . . there is need to develop and evaluate training programs to determine whether or not dysfunctions in visual closure can be ameliorated.

Although the visual perception and discrimination abilities have been subdivided, specified, and categorized, and the recognition of these skills is evident in the content of the tasks constructed, the actual daily usage or future relevance is uncertain. In addition, the possibilities for remediation of these abilities are uncertain.

Research has been conducted to determine if perceptual training does result in improvement in the perceptual tasks trained. This is still, however, a controversial area, as indicated by the many articles devoted to counting, reviewing, and discrediting studies on both sides of the issue.
A few studies (Ball & Edgar, 1967; Maloney et al., 1970; Maslow et al., 1964; Rosen, 1966; Talkington, 1968; Tyson, 1963) found training beneficial in improving visual perception. Others, however, found "no significant improvement in visual perception as a result of the training" (Alley & Carr, 1968; Lewis, 1968; Lloyd, 1966), or reported no statistical difference between trained and nontrained subjects (Alley, 1968; Falik, 1969; Jacobs, 1968; Jacobs et al., 1968; Wiederholt & Hammill, 1971).

Not only do the various research studies vary in the types of training programs provided, both in content and duration, but the pre- and post-test measures vary considerably. In addition, some did not employ control groups. The composition of the experimental groups also varies from all students in a particular grade to only students already identified as having some learning difficulties. It is no wonder generalizations are nearly impossible.

Some research has sought to determine if perceptual training results in academic improvement. Reading achievement has often been a variable, but no research has been found relating perception training to handwriting achievement. For example, tachistoscopic training research (Goins, 1958) demonstrated improved perception of digits for the control group trained for speed recognition of digits, but
reading achievement for the two groups did not differ despite the ten weeks of training. In a study (Olson, 1969) using known words in speed exposures at a first grade level, errors increased significantly with increases in speed, so it was determined that increasing sight word vocabulary by tachistoscopic training was not viable on a first grade level. Robinson (1972) reports that "other investigators used tachistoscopic training for beginners, generally without evidence of improvement in reading." One exception noted is the study (Wheelock & Silvaroli, 1967) which trained kindergarten children of high and low socioeconomic levels on instant discrimination of capital letters. The authors report that children in the lower socioeconomic levels benefited most by the training, but it was not established whether the improvement in measure of visual perception would transfer to reading.

Programs and materials developed for improving visual perception have proliferated. Some, like the Frostig Developmental Test of Visual Perception (Frostig et al., 1966) and the accompanying remediation materials (Frostig, 1964), have been in use long enough to have generated a collection of research. Several factor analytic studies (Boyd & Randle, 1970; Corah & Powell, 1963; Allen, 1968) indicate that the five subtests of the Developmental Test of Visual Perception do not measure five different and relatively independent abilities. Boyd & Randle (1970) and Silverstein (1965)
found the test measured essentially one general visual perceptual factor. Smith & Marx (1972) confirmed this finding and, by including intelligence test scores and reading achievement scores, concluded that this single general factor of "perceptual organization" is weakly related to intelligence quotient and unrelated to reading ability. Relevance of perceptual assessment or perceptual training for handwriting or writing tasks in the classroom is not apparent in the literature.

The assessment devices for evaluating visual perception development are those devised specifically for assessing visual perception without any particular interest in writing abilities. The Benton Revised Visual Retention Test (1955) and the Memory-for-Designs Test (1960) both require the subject to reproduce various designs from memory. The Dennis Visual Perception Scale (1969) requires direct copying of designs but uses embedded figures, thus involving the factor of field-ground discrimination in the assessment of visual perception. An attempt to assess five "different" perceptual areas by the Marianne Frostig Developmental Test of Visual Perception (1966) is notable for its intent, but research indicates only one perception factor is being assessed. Each of these tests require a motor production by the student (copying of a stimulus) in order to assess the students' visual perception. The result then is an indication of visual perception and fine-motor coordination, integrated and inseparable.
Some tests have been developed with the intent of assessing visual perception, but eliminating the motor response and allowing for the production of a free response. The Word Discrimination Test (1949) is designed to test the child's visual perception of word form and requires only that the subject circle the one word in a line composed of groups of letters. Since handwriting most often is employed for making word forms, this test merits consideration for this investigation. Also considered were the Standard Progressive Matrices (1956) and the Colored Progressive Matrices (1963). These two tests of visual perception are unique among tests of visual perception in their content and demands made upon the student. It appears, however, that reasoning ability is more critical than visual-perception ability for success on these tests, since the student must determine a pattern in a series of abstract designs and complete the pattern by selecting the missing appropriate "cell" from a selection of four possibilities.

It is apparent that there are many variations in testing devices for assessing visual perception. These variations are further detailed in Appendix B, but most of the tests compound the task by requiring the motor response of drawing. Other assessment devices for visual perception involve the copying of geometric forms directly from a printed model and so have been included in the visual-motor-integration portion of this review, rather than in the
Muscular control or fine-motor coordination. A discussion of motor development as it is related to the activity of handwriting involves primarily manipulative motor development. Accepted are several general developmental trends, such as the development from generalized to specific activity. The progression in cephalo-caudal and proximo-distal directions is also recognized; that is, from the head downward and from the spine outward, with finger activity being the last refinement of the shoulder-arm-hand complex (Coghill, 1929). It has been cited that by 52 weeks, the child can reach and seize an object without resting his hand on the table and about this time can pick up a pencil or crayon and scribble (Griffiths, 1954).

Hand preference is highly unstable during the first year of life, but fairly well established by the end of the second year (Lederer, 1939). Mussen (1963) reports that sixty-five per cent of American children are right-handed by one year of age, 87 percent by two years of age, and 95 percent by six years of age.

Coordination and motor accuracy improvement is seen among American girls until age fourteen. Boys, however, improve until age seventeen, usually surpassing girls in motor ability (Mussen, 1963).

Any attempt to isolate the motoric component of the writing task becomes superficial. The simplest motor act
involving the visible result (tracing) of making a line between two points or between two lines, does not exclude the visual component. Thus, more than a motor component is being assessed in these tasks.

In a study (Gibson & Yonas, 1967) of the "fundamental graphic act" in young children 14 to 38 months of age, it was evident that, when the individual scribbles or begins to do so, the tracings are essential to the act. The motor act being insufficient for the individuals when they used a non-tracing pencil, they sought a pencil that would leave a trace or ceased the movements. Secondly, they were unwilling to "draw a picture in the air" when encouraged. They refused and asked for a pencil, indicating that the hand movements and other concurrent kinesthetic and visual feedbacks were insufficient for the act.

Proprioceptive development is an aspect of handwriting that is involved in the motor act of writing. This is the aspect of visual-motor functioning that is feedback from the tactual and kinesthetic senses. Kinesthesis is the sense that furnishes information about the position and movement of body parts. Sensors are located in muscles, tendons, joints, and the inner ear. Tactual sense is the sensitivity to pressure to some degree. An immature child, unable to copy a geometric form, is able to gain sufficient information from tracing his finger over the stimulus form to be able to reproduce it, in some instances.
Some learning research has investigated the efficacy of tactual learning (intramodal studies) and tactual-visual learning (intermodal studies). Most studies using normal children (Abravanel, 1972; Balter & Fogarty, 1971; Jones & Robinson, 1973; Rose et al., 1972; Siegel & Vance, 1970) have found that vision is superior to active or passive touch for learning. Conflicting results have been found in studying retarded children. O'Connor and Hermelin (1961), using a sample of severely or moderately retarded children from seven to sixteen years of age, found tactual recognition was superior to the other conditions. However, on a comparable sample, Hinshaw and Heal (1968) found the opposite to be true.

Research with learning disabled children is limited. Gaines and Raskin (1970) reported that vision led to better performance on a letter recognition task than did the use of touch. This was expanded upon by Baker and Raskin (1973) who found that vision and vision-plus-touch led to significantly better performance than did touch alone. However, it was evident that the touching did not significantly improve performance over that when vision was used alone. This finding raises the issue of multimodal learning and sensory integration research reviewed later.

One simple, "pure" motor task sometimes evaluated is the correct holding of the pencil by the young child (Smith, 1969; Rosner et al., 1968; DeHirsch et al., 1966). This is
usually scored as being present or absent.

Most assessment devices for muscular control (fine-motor or gross-motor development) or visual perception do not isolate these skill areas. They label the tests sensory-motor and include several types of tasks, most of which are integrative in nature rather than purely visual perception or purely motor involvement. The selection of motor tests reviewed here, therefore, includes either perceptual-motor tests with a motor emphasis or gross-motor tests which are believed to be related to the development of the fine-motor skills (Kephart, 1960).

The motor assessment devices which might be relevant for handwriting are limited, but detailed in Appendix B. Two of the tests, Frostig Movement Skills Test Battery (1972) and The Purdue Perceptual Motor Survey (1966), test a wide range of different types of motor activities and provide a program for remediation of any deficits located. The Southern California Motor Accuracy Test (1964) is a specific task test which requires an accurate drawing of a line 51 inches long through a prescribed pathway. The most comprehensive motor assessments are provided by The Southern California Perceptual-Motor Tests (1969), which assess body balance and coordination in six gross-motor categories, and the Oseretsky Test (1946), a redesigned scale which provides a year-by-year scale of the fine- and gross-motor development of children. Selection from these tests for an
assessment most relevant for fine-motor coordination is difficult.

Visual-motor development and visual-motor integration. It has been demonstrated that children can recognize and match geometric forms long before they can draw the outlines of these forms (Nelson & Bartley, 1962). In addition to the motor factor involved in copying forms, it is presumed that the "act of reproduction requires attention to and utilization of more visual attributes of a model than are necessary for mere discrimination between forms" (Harris, 1972). Thus, once the motor factor is involved, the visual factor becomes of even more concern. When the motor task becomes one involving a pencil and paper, the making of a trace, visual perception becomes an inseparable part of the act. Thus, the term becomes not only visual and motor development, but the integration or interaction of visual and motor components.

Visual-motor perception is a complicated integrative function which involves both visual perception and motor expression of the perception. Koppitz (1963) in her early work with children's drawings explained the process:

If the total process involved in visual-motor perception were divided into four steps they would include: (a) seeing a stimulus or VISION; (b) understanding what has been seen or PERCEPTION; (c) translating the perception into action or the motoric EXPRESSION; and (d) the actual motor action or COORDINATION.
It is recognized that among individual children, poor performance is sometimes due to perceptual deficits rather than motor deficits, and vice versa. Yet, these functions are subject to maturation in young children and so differences are common in young children without a specific disturbance necessarily being present in either the receptive or expressive function of visual-motor perception. Koppitz (1963) noted that "Differences in the two component parts of this integrative function are usually not pronounced and are difficult to recognize on the Bender records of young children." It is obvious that either poor visual perception or poor motor control will affect the level or quality of form reproduction, but in actual practice, such "pure" cases are identified infrequently. Koppitz (1963) has provided a rule-of-thumb in this regard:

If the difficulty is primarily motoric, the child will recognize his errors of reproduction; if it is perceptual, he will not recognize them as errors.

As a partial test of the trichotomy as defined by Beery (1967), he used the Developmental Test of Visual-Motor Integration (VMI) for each of the tasks, matching (visual perception), tracing (primarily motor), and copying (form reproduction involving integration of visual-motor abilities). Beery found these abilities to be separate but correlated. The rank order of performance on each task, for individuals, was about the same; if one was relatively proficient on one task, he also tended to perform well on the others. But,
Beery noted a significant difference beyond the .01 level of significance in the means for the three tasks indicating that form reproduction involves an ability beyond the visual (matching) and motor (tracing) components of the task.

Gillingham (1940) cautions that such abilities not be regarded as graded steps. Tracing, copying, and writing from dictation are recognized as separate elements in developing the ability to express ideas in writing. "Each is made possible by distinct mechanism in the nervous system. This is demonstrated by tests made after a brain injury in which one or another of these is impaired while others are intact . . . They are not one built upon the other."

Even though the component systems may function well independently, the visual-motor function or integration may not be adequately developed. It has been noted (Renshaw, 1930) that "multiple systems" that function adequately independently may actually interfere with, rather than enhance, the adequacy of a response. One study (Fico & Brodsky, 1972) considered this possibility, but noted that it is difficult to prove that multisensory input may be detrimental rather than beneficial. Myklebust (Johnson & Myklebust, 1967) postulated the concept of overloading. This implies that information received through one sensory modality may interfere with the integration of simultaneous information received through other modalities although independently the functioning may be unimpaired.
Birch and Lefford (1967) believe that during development, the intersensory integration among several modalities contributes directly to both improved perceptual differentiation and improved motor control. A parallel contention is held by some investigators (Durrell, 1958) who have demonstrated that reading instruction itself improves visual and auditory perception.

Upon reviewing the research on perceptual-motor training, it is evident that many different programs and materials have been used with very many different groups of children. In addition, the post-test evaluation instruments have varied considerably. Often, the investigations use combinations of programs and materials, making it even more difficult to make determinations regarding the efficacy of individual programs. In general, however, research using the various visual-motor training programs have sought to answer the question of whether such training results in improved reading readiness or improved reading achievement. No research relating the training to handwriting achievement could be located, except for the work of Pryzwansky (1972). Three experimental groups and three control groups were established at the kindergarten level. In addition to the Winter Haven Template Training (Sutphin, 1964) and the Frostig Visual Perception workbooks (Frostig & Horne, 1966), the Peterson Handwriting System (Peterson, Minister, Enstrom, 1961) was investigated. Inclusion of none of these significantly affected readiness skills
as measured by Gates-MacGinitie. However, the manuscript training produced greater gains than the template training or the Frostig Book exercises.

The research on perceptual-motor training programs is inconclusive, but indicates that "the claim that perceptual-motor development enhances reading achievement has been overstated" (Klesius, 1972). Some of the research has not even been able to show significantly improved perceptual-motor skills as a result of the training (Falik, 1969; Keim, 1972; O'Donnell & Eisenson, 1969).

A program of handwriting instruction which seeks to incorporate perception training and motor training is evident in the work by Furner (1969a; 1969b; 1970). In developing a program of instruction in writing for first graders, Furner focused primary attention on the perceptual aspect, which then serves as a basis for the development of the motor skill. The perceptual aspect deals directly with the letters and numerals being learned, and is realized through multi-sensory (visual, auditory, kinesthetic) means of stimulation. This is training to the task incorporating what is known about perceptual and motor development.

The devices to assess the level of development of visual-motor integration abilities and the development of programs to train or remediate this ability have been numerous. The tasks involved and the theories supporting the "training programs" have been varied. For this reason, a brief history
of their development precedes a review of the assessment devices.

The epitomy of integration is probably expressed in this summary by Jansky and deHirsch (1972):

A child's body image, as reflected in his human figure drawing, results from the integration of his proprioceptive, sensorimotor, emotional, and interpersonal experiences. Ability to cope with spatial relationships (and printed words are patterns laid out in space) originally derives from the child's awareness of his own body, its parts, and the relationship of these parts to one another.

Therefore, the Draw-a-Person Test is used as a predictor for school success and reading success.

One of the earliest theorists dealing with visual perception, motor coordination, and academic success or lack of it, was probably Orton. Orton (1937, 1939) proposed the theory that children who do not establish hemispheric dominance in particular areas of the brain experience specific disabilities in the area of developmental language, such as reading disability. Mixtures of left- and right-sidedness in handedness, eyedness, and footedness were termed "motor intergrading." He reasoned that if the symptoms of mixed or confused dominance were seen in the motor areas, then a comparable mixing may occur also in the language areas of the brain.

Orton's theory of the dominant hemisphere of the brain being opposite the preferred hand, seems to be generally opposed today. Studies (Eisenson, Auer, & Irwin, 1963;
Penfield & Roberts, 1959) indicate that language and handedness are independent. Orton's theory, however, is still the basis for much training in motor tasks. The complex program prescribed by Delacato (1963) which "retrains eye, hand, and foot dominance," is one example.

One of the well-known names in the motor training area is Kephart (1960). He contends that, since perceptual skills provide continuous feedback for coordinating movements, perceptual-motor abilities should be considered a combined activity. He has developed a testing instrument and planned a program for remediation. Kephart begins with sensory-motor abilities which he sees as basic to visual-perceptual abilities. Barsch (1967) and Getman (1968) have similar programs with slightly varying theoretical bases. This interest in sensory-motor training might be said to have begun as early as 1846 when Seguin (1907) directed his methods toward severely mentally deficient children. Although several assumptions have been made as a basis for these and similar programs, concerning the interrelationship of visual perception and motor ability and its influence on academic success, there is little empirical evidence (as previously discussed) supporting the hypothesis that basic perceptual motor training leads to improvement in perceptual motor abilities or to better academic performance (Chalfant & Scheffelin, 1969; Balow, 1971).
Form reproduction is a basic method employed for assessing visual-motor integration. Gesell (1940) and Bender (1938) are the primary contributors in this field. They have made developmental analyses of form reproductions. Their investigations have determined the ages at which a child (average) can correctly reproduce the various forms, as well as providing information concerning the developmental stages of achievement on the various forms. Gesell's data (1951) were based on observations of bright children in the lower age ranges:

- Scribble - 18 to 24 months of age
- Circle - 24 to 36 months
- Cross (+) - 3 years
- Square with rounded corners - 3-1/2 to 4 years
- Square - 5 years
- Triangle - 5 to 6 years
- Diamond - 7 to 8 years

While Gesell's aim was merely to be descriptive of typical developmental stages, Bender's research (1938) had a different purpose. Efforts to determine what is perceived by another often had been determined by having the individuals describe their experiences. Guided by the expedient that the individual draws what he perceives, Bender developed a method for determining what the individual perceives by using some of the Wertheimer forms and having the subjects copy them. However, the designs contain many oblique lines and acute angles which are too difficult for young children, particularly below five years of age.
According to Bender (1938), the drawings demonstrate the process of maturation of visual-motor perception in young children. Bender mainly devoted her time to the clinical application of the test to various types of adult patients suffering from various handicaps or illnesses, and there was no objective scoring system developed.

Koppitz (1963) extended the use of the Bender designs by establishing norms for children. The Koppitz scoring system provides only gross differentiations for use with ages five through nine. The number of errors is counted for a total score but no developmental data is provided. This is the visual-motor assessment device most widely used in the state of Ohio by trained psychologists in the schools.

Starr (1952) developed the Rutgers drawing tests which are appropriate for ages four through nine, and use the basic Gesell forms and some elaborations. No developmental data are given on the forms other than those which are reflected in the total score norms. Although the forms are common in appearance, Starr discounted the importance of practice on the forms, saying that practice and familiarity with a pencil seemed to have some effect upon the ease and speed of drawing, but not on the finished product.

Other tests have been developed which are variations using the Gesell forms (The Perceptual Forms Test, 1969) and the Bender forms (The Minnesota Percepto-Diagnostic Test, 1963), or downward extensions of the Bender (The
Primary Visual Motor Test, 1970). These visual-motor integration assessment devices are summarized in Appendix B.

School Readiness in General

Much is being done recently (Austin & Morrison, 1963; Wilson & Robeck, 1966; Jansky & deHirsch, 1972) in the area of "readiness assessment" of preschool, kindergarten, and early-first grade children to determine those who are not candidates for success in later school endeavors unless intervention is planned. In most instances, the emphasis is on prediction for reading success alone. A few of the most well known of these devices are reviewed as possible pre-writing assessment devices.

Among the various "readiness tests," there is much repetition in the types of tasks required of the students. The tasks were examined for relevance to writing "readiness." The Anton Brenner Developmental Gestalt Test (1964) requires the student to copy a ten-dot pattern, copy a simple sentence, and draw a man. The Contemporary School Readiness Test (Sauer, 1970) includes one subtest, out of a total of nine, which deals with handwriting. The child receives one point for each word or letter reproduced, providing that it is "reproduced in a reasonably legible manner." However, no standard of legibility is provided.

The only other example of writing readiness assessment is evident in the Kindergarten Evaluation of Learning
Potential (KELP, 1969), which evaluates students' performance continually throughout the school year as the items are presented as regular instructional tasks. The evaluation is based on a three-level scale (described in Appendix B) which indicates that readiness for learning to write is evident when the child demonstrates that he can write.

Most notable in this group of instruments is the lack of validity for prediction of first grade success, and often reliability is not reported. These factors are detailed (Appendix B) for each assessment device reviewed.

**Summary**

Although the three subskills, visual perception, motor coordination, and visual-motor integration, have been delineated in the research (Freeman, 1954; Hildreth, 1936c; Myers, 1963) as critical in the acquisition of handwriting skills, no research could be found which involved assessment of these subskills for prediction of handwriting success or failure. There is research which investigates these abilities in order to predict academic success in general (deHirsch et al., 1966; Ilg & Ames, 1964; Koppitz, 1973; Lessler, Schoeninger, & Bridges, 1970), reading success (Cohen, 1969; Goins, 1958; Harriman & Harriman, 1950; Leibert & Sherk, 1970), and even arithmetic and spelling, in particular (Bannatyne & Wichiara-jote, 1969; Keogh & Smith, 1967). Little could be found in the research which related to handwriting predictions.
Some of the assessment devices available for determining the level of development of handwriting skills, visual perception, motor coordination, and visual-motor integration have been reviewed and task- and process-oriented tests were selected for this investigation. The Slingerland Tests for Identifying Children with Specific Language Disability (Slingerland, 1970) is the one task assessment device. It was devised as a screening instrument to detect visual and kinesthetic-motor (writing) disorders. It was selected for its five subtests sampling handwriting under various specified conditions.

The Word Discrimination Test (Huelsman, 1949) was selected for an assessment of visual perception because it does not require that the student copy a stimulus. Only minimal motor involvement is required as the student circles the chosen responses, determined through visual perception.

The devices reviewed for fine-motor coordination assessment were eliminated because of the preponderance of gross-motor tasks required by the students or because of unsuitable age ranges for use with first graders in this investigation. No test of fine-motor coordination was selected.

For evaluation of visual-motor integration development, the Bender Gestalt Test for Young Children (Koppitz, 1963) was selected. In addition, the Developmental Test of Visual-Motor Integration (Beery, 1967a) was selected. Devised as a
"downward and upward" extension of the Bender, it requires the copying of geometric forms arranged in order of increasing difficulty. The value of these eight tests and sub-tests when administered as a predictive battery was to be determined in this investigation.
CHAPTER III

METHODOLOGY

This chapter describes the methodology of this investigation. First, is the explanation for the selection of the population and the subjects; and next, the procedure for the determination of assessment instruments is described with a review of the reliability and validity data available for the instruments selected. The procedures used to secure and evaluate the classroom handwriting samples are described, and the steps involved in the administration of the tests are detailed. Last, the design and statistical procedure are discussed.

Selection of the Population

First grade students were the subjects in this study because they have had almost one year's instruction in manuscript writing, but have not been introduced to cursive writing. Also, since first grade pupils were approximately seven years of age, they were still growing developmentally in visual-motor-perception skills under consideration and the process instruments were expected to differentiate among their abilities.
The first grade pupils of the Clear Fork Valley Local School District were the source for subject selection because of the accessibility of the school district to this examiner and several other factors. Each of the eight local school districts serviced through the County Office in this area was accessible to this examiner for research purposes. However, the school district chosen was of moderate size, that is, not the largest nor the smallest, in area and population, of the school districts in this county. It was however, of sufficient size to provide enough subjects of the age necessary for this investigation. The socioeconomic components of the communities serviced by this school district, and the proportions of businesses, industries, and rural areas, indicated it could be considered representative of the county school districts. In addition, group achievement tests administered yearly during the past five years indicated the school district chosen to have the mean or average achievement among the eight districts in the county.

The district was composed of two small towns, with populations of approximately 1700 and 1100, plus the residents of the surrounding farm lands. The communities were similar in their economic bases and population composition. They were dependent upon the farming community and summer and winter recreational facilities for their economic bases. The communities were just 12 and 18 miles from a moderate-sized metropolitan community where some residents were employed.
The children attended kindergarten through grade eight in their local community school and entered a combined high school for grades nine through twelve. The total school population kindergarten through twelve was approximately 2750 pupils.

**Selection of the Subjects**

There were three classrooms of first graders in each of the two elementary buildings in this school district. All of these students were included in the study. This was a total of 124 students. However, for some of the individual assessments, three of the students were absent, so some of the data included 121 students.

The classrooms were self-contained and ranged in size from 19 to 25 pupils (Table 15). In addition, one of the classrooms with sixteen first graders, also contained eight second graders who were not included in the study.

The classrooms were heterogeneous in composition. That is, no attempt was made to group or place the students into a particular first grade room when the classes were assembled. Although the school provides special education programs for both Learning Disabilities students and those requiring Intensive Education (below 80 I.Q.), only one student had already been removed from these classes at the time of the study, for placement in the Learning Disability classroom. Five of the students included in the study and
regular members of the first grade classrooms, had been identified as Learning Disabilities students and were receiving tutoring help one hour per day.

Although no intelligence tests' scores were available for all of the students, twenty-nine did receive individual psychological assessments by the school psychologist and their scores from the Stanford-Binet Intelligence Scale are available (Table 16). These twenty-nine received scores ranging from 69 to 113. This is another example of the heterogeneity of the population.

The only group test data available for the students were the Readiness Percentile Scores from the Gates-MacGinitie Reading Tests—Readiness Skills (1966) administered May, 1975, when the students were in kindergarten (Figure 4).

The chronological ages ranged from 6-6 to 8-7. This included eight children who had been retained one year in school. Of the 124 students, 62 were boys and 62 were girls. However, three boys were absent for some of the individual testing, so some data are from 121 students.

**Determination of Instruments**

**Task Assessment**

An instrument was needed which would provide an assessment of the actual task of handwriting. A review of the handwriting task assessment devices available indicated that the majority were scales for judging quality of the finished
product (Zaner Bloser, 1975; Thorndike, 1910). Some scales measured both speed and quality of the writing (Ayres, 1912). The estimate of the quality of the writing was based on a rough scale which allowed for wide variations, and although reliable (West, 1950), little information could be gained from them other than determining the need for improvement or remediation of the handwriting.

The Screening Tests for Identifying Children with Specific Language Disability (Slingerland, 1970), hereinafter referred to as the "Slingerland," was selected as an instrument which provided valuable instructional information regarding handwriting (Wallace & Kauffman, 1973). Form A of the Slingerland (Revised edition, 1970) was prepared for grade one and beginning grade two students. The various subtests of the Slingerland were designed "to test various aspects of sensory-motor functioning through varying the tasks" (Slingerland, 1970). The tasks included the writing of letters, words, phrases, numerals, and geometric forms, and the conditions varied from near-copying to writing-from-memory and matching-from-memory.

The purposes of the tests, as stated in the Slingerland Manual (1970), were as follows:

To identify in individual children, the probable perceptual-motor difficulty--visual, auditory or kinesthetic (motor)--that is the underlying cause of dysfunction with language.

To identify children, within a grade or group, who manifest specific perceptual-motor behavior that
is indicative of probable or potential interference with adequate development in reading, writing, and spelling.

To identify children with slow or uneven perceptual-motor maturation so that the curriculum may be modified to accommodate their developmental patterns.

To show classroom teachers the strengths and weaknesses in the learning modalities of their pupils, so that informed decisions may be made in the selection of teaching methods and materials to be employed.

Because this investigation was limited to handwriting and its visual and motor aspects, those subtests of the Slingerland tapping auditory involvement were omitted. The following subtests were selected from the Slingerland, Form A, for administration:

Slingerland Test 1, Copying Chart: The subjects copied a paragraph written in manuscript from a wall chart (placed not more than twenty feet away) onto their lined test paper. (Appendix C, Slingerland Test 1)

Slingerland Test 2, Copying Page: The subjects copied from the printed test page, onto the bottom section of that page, a selection of words, numerals, and phrases in manuscript. (Appendix C, Slingerland Test 2)

Slingerland Test 3, Visual Perception-Memory: Cards on which a word, series of letters, or numerals were printed, were exposed one at a time for just ten seconds. After each presentation, there was a short distraction and delay involving picking the pencil up from the floor and turning the
test booklet over. Then the student attempted to select the previously exposed symbols from a series of four printed on the test page. (Appendix C, Slingerland Test 3)

Slingerland Test 4, Visual Discrimination: The subjects were presented with a page of lists of words. At the top of each list there was a word with a line under it. The subject was required to look at the underlined word, and the four "words" under it, and draw a line under the one exactly like the underlined word. (Appendix C, Test 4)

Slingerland Test 5, Visual Perception-Memory-Copying: Cards on which a word, series of letters, a phrase, some numerals, or a geometric form is printed, were exposed one at a time for just ten seconds. After each presentation, there was a short distraction and delay (previously described) and the student was required to write or draw on the paper in front of him, exactly what he remembered of what he saw on the card. (Appendix C, Test 5)

According to the Manual (Slingerland, 1970), each test was designed to assess various aspects of sensory-motor functioning:

Slingerland Test 1, Copying Chart: This test was intended to assess visual perception, in association with a kinaesthetic-motor ability (writing or drawing), through copying from a far-point model. This presumed to include limited memory involvement.
Slingerland Test 2, Copying Page: This test was intended to assess visual perception, in association with a kinesthetic-motor ability (writing or drawing), through the use of a near-point model. This is presumed to exclude memory involvement.

Slingerland Test 3, Visual Perception-Memory: In this test a visual perception and memory was matched to an item that was visually discriminated from among several choices. The motor task involved merely circling a response.

Slingerland Test 4, Visual Discrimination: This test involved visual perception and discrimination of symbols and sequence within words and the ability to perceive similarities and differences. However, memory was not involved, since the model was always in view.

Slingerland Test 5, Visual Perception-Memory-Copying: This subtest was described as requiring "a higher degree of receptive-expressive integration . . . than in the previous tests. A visual perception must be stored in memory and then retrieved to be matched to a kinesthetic memory of the sequence of movements (writing or drawing) that will produce the desired forms in correct relationships."

This testing device was chosen to assess individual skills relative to the task demands imposed within the educational system, thus it was task-oriented, but devised so that process abilities might be identified. For this reason, it was chosen for correlation with the process-oriented
tests, to establish more than an empirical basis for the assumption that various perceptual-motor abilities are necessary for good handwriting.

Validity. There are no data from the test manual or author comments to indicate any research relative to the validity of this instrument. It must be remembered, however, that this instrument was unequaled in its approach and content, and so had no predecessors for correlational studies.

Studies reported to date (Slingerland, 1973), involved children identified with the instrument as potential candidates for reading and school difficulties, who were then included in the remedial program advocated by Slingerland (Gillingham & Stillman, 1960). There was no control group in any of the studies reported. All pre-test and post-test data reported are on reading achievement assessed on various standardized tests. Slingerland (1973) stated that the Slingerland tests "may be used for comparative purposes to measure gains after remediation, but this is not primarily their purpose."

Current literature in the learning disabilities field (Wallace & Kauffman, 1973) indicated that the Slingerland has been recognized as a diagnostic instrument to provide instructional information for handwriting. Also, Wepman (1972) stated:

The tests were designed and have been used to provide early identification of potential learning difficulties through tasks involving auditory,
kinesthetic, and visual modalities. Much emphasis is placed on perceptual processes within the three modalities.

The various tasks within these subtests . . .

. . . lead to a rather neat multi-sensory integration of input to output and might well provide excellent information on the process of perceptual integration. In fact, that emphasis—a very necessary one in understanding children—makes the test worthwhile, especially in its Form A for grades 1 and 2.

Communication from the author (Beth H. Slingerland, personal letter, August 12, 1974) indicated no knowledge of any previous studies involving the Slingerland and handwriting assessment as proposed in this investigation.

Reliability. No data on the reliability of the instrument were available, evidently none having been accumulated. The emphasis of past research (Slingerland, 1973) had been, not on the testing instrument, but on the success of the remedial training offered to those identified by the testing instrument. Evidently little post-testing on the instrument had been undertaken.

Process Assessment: Visual Perception and Discrimination

Tests reviewed as primarily visual perception and discrimination assessment devices required considerable motor production through the copying of a stimulus (Dennis & Dennis, 1969; Frostig et al., 1966) and some even involved a memory factor (Benton, 1955; Graham & Kendall, 1960). The only tests not requiring a motor production (Raven, 1956, 1963) were those
designed to aid in assessing mental ability through solving problems presented in abstract figures and designs. None of these assessment devices appeared adequate for evaluating visual perception and discrimination as a subskill for handwriting success.

One assessment device of visual perception which had minimal motor involvement was the Word Discrimination Test (Huelsman, 1949). Designed to test the child's visual perception of word form, it required a reading knowledge on the part of the child and that he circle the one word in each line. The other four groups of letters presented in each line were similar to the word, but were not words, and so incorrect choices.

**Validity.** Item analysis indicated that the items selected for this device showed discriminatory power, decreasing difficulty with increased grade level, and that they were sufficiently difficult to be useful in the test. Correlation coefficients were computed between the Word Discrimination Test and three reading test scores; Vocabulary, Total Comprehension, and Rate of Reading. The data indicated "a positive, and in most instances, a highly significant relationship between the skill in word form perception as measured by the Word Discrimination Test and reading ability." (Huelsman, 1947)

**Reliability.** The two forms of the Word Discrimination Test were administered to 1213 children in grades one through eight. The reliability coefficients varied from .74 to .92.
Process Assessment: Muscular Control or Fine-motor Coordination

Tests reviewed as primarily muscular control or fine-motor coordination assessment devices included some that emphasized gross motor movements (Ayres, 1969; Roach & Kephart, 1966; Orpet, 1973). Only two, therefore, might be considered adequate for evaluation of fine-motor coordination as a sub-skill for handwriting success. The Southern California Motor Accuracy Test (Ayres, 1964) consists of an irregular printed black line approximately 51 inches long. The line is to be centered before the child so that he is required to cross the midline of his body during the task. He is to try to trace over the line with a pencil without getting off the line. Each hand is to be used and scored with separate norms for the most accurate and least accurate hand. Since this device was designed for children ages four to 7-11, it was believed that its use with first graders might be unfeasible because too many of the students would perform near or beyond the "ceiling" of the instrument.

The Oseretsky Tests of Motor Proficiency (Doll, 1946) designed for individual administration to children from four to sixteen years, provides a year-by-year scale of the fine- and gross-motor development of children. An analysis of the specific tasks on this device at the lower age limits (up to eight years) indicates predominantly gross-motor tasks. Therefore, none of these assessment devices appeared adequate for evaluating fine-motor coordination and no test of fine-motor coordination was selected.

Selection of a testing device for visual-motor integration was considered most crucial, since handwriting is most often described as a visual-motor integration task, rather than either a perception task or a motor task. Use of the Bender Gestalt Test for Young Children (Koppitz, 1963) in this investigation was based on two premises. One, the Bender was one of the oldest and most used and researched testing devices available in this area of investigation. Two, the Bender was an integral part of the repertoire of Ohio school psychologists and used, for various reasons and purposes, in their daily work with children.

Validity. The use of this test was based on Bender's (1938) and Koppitz' (1963) findings which indicated that immaturity or malfunctioning of visual-motor-perception could be detected in children. Also relevant were deHirsch, Jansky, and Langford's (1966) correlational results between kindergarten Bender Gestalt performance and second grade writing achievement, .33, statistically significant at the .01 level.

Reliability. The Koppitz' (1963) developmental scoring system was used. Scorer reliability had been determined to be from .88 to .96 (statistically highly significant). Test-retest reliability had been determined to be significant at the .001 level.
Process Assessment: Selection of a Second Visual-Motor Assessment

Most of the visual-motor integration tests reviewed were variations of the Bender (Fuller & Laird, 1963) or presented much-simplified geometric forms for use with younger children (Haworth, 1970; Curry, 1969; McQuarrie, 1968; Starr, 1969). Only the Developmental Test of Visual-Motor Integration, hereinafter referred to as the Visual-Motor Integration test, provided for assessing children from below three years of age through thirteen years of age. The Visual-Motor Integration test was devised as a "measure of the degree to which visual perception and motor behavior are integrated in young children" (Beery, 1967b). Beginning with simpler geometric forms (vertical straight line, visual-motor integration age 2-10) than the Bender, the Visual-Motor Integration test was designed as both a downward and upward (three dimensional star, visual-motor integration age 13-7) extension of the Bender. Further, this device included developmental comments for each of the twenty-four geometric forms arranged in order of increasing difficulty.

Validity. The manual (Beery, 1967b) reported a correlation of .89 between Visual-Motor Integration test scores and chronological age. This was considered a verification of the developmental sequence of the items.

The manual further reports "Visual-Motor Integration correlations with reading, achievement are higher than those
between IQ and reading achievement." Also, Visual-Motor Integration correlations with mental age (.59 in first grade) were higher than with chronological age.

Many studies were reported "in progress" using mentally retarded children, but these were considered of little relevance to this investigation. No extensive prediction studies using an outside criterion were reported in the manual or technical report available.

**Reliability.** Some studies using small samples were reported (Beery, 1967a). Internal consistency reliability (K-R 20) of .93 was reported. Test-retest reliability over a two-week period yielded a coefficient of .83 for boys and .87 for girls.

**Summary**

The subtests and tests which were administered as a battery of tests were selected for their assessment of visual and motor components theorized to be necessary for successful handwriting. The tests are listed in Table 1 with an empirical analysis of the tasks required by each test. The value of these tests for use as a predictive battery, for identifying individuals who might require individualized instruction or some other intervention in order to gain good handwriting, was to be determined in this study.
Table 1: Analysis of subtests' tasks and modalities

<table>
<thead>
<tr>
<th>Tests and Subtests</th>
<th>Tasks and Modalities</th>
<th>Visual Perception*</th>
<th>Visual Memory**</th>
<th>Kinesthetic-Motor Act</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Near Model</td>
<td>Far Model</td>
<td>Circling/ Writing/ Underlining</td>
</tr>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Discrimination Test</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 1, Copying-Chart</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 2, Copying-Page</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 3, Visual-Perception Memory</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 4, Visual Discrimination</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 5, Visual-Perception-Memory-Copying</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

*Although all tests require visual perception, this column refers specifically to the method of presentation of the model to be matched or copied.

**Visual memory refers to a specified delay between the viewing and the task.
Procedure for Obtaining Data

Evaluation of Classroom Handwriting

To provide a valid and reliable method of evaluating the children's handwriting performance in the classroom, the following procedures were implemented:

1. Two daily work papers were obtained on consecutive days from each of the students in the first grade classrooms. The samples of writing from each classroom varied both in content and conditions under which they were written since the selection of the papers was left to the classroom teacher. The only requirement placed upon the selection of the papers was that the papers not have been part of a writing lesson. The students' names were removed from the papers and they were coded for later identification.

2. Two judges were necessary to rate each sample. The examiner elected to participate as one judge because (a) of her previous experience as a classroom teacher at this level, and (b) of a need to experience the advantages and disadvantages involved in evaluating the handwriting samples by the process determined.

The other judge selected was one of the first grade teachers involved in the study. She was chosen because (a) of her extensive experience as a classroom teacher in the primary grades, (b) of her philosophy regarding the importance of handwriting, exhibited both in her instructional methods and daily usage standards, and (c) her interest in children
as individuals, as reflected in her individualized instruction methods as observed by the examiner.

3. Each classroom submitted the two sets of papers to be judged separately. Each set was sorted into seven groups of writing legibility by a judge. The seven groups were labeled from "seven" to "one", with seven points for the best papers and one point for the poorer writing samples. Each child's writing was compared with that of his peers. As the sorting of a classroom's papers proceeded, the classification for any paper might be shifted as other papers in that set were determined to be relatively better or worse. The number of papers with each rating could vary. In other words, there could be as many papers in each group as were judged to be of equal quality, but there had to be at least one paper in each group.

4. After the number of points was noted on a tally sheet next to the coded number for the student, the papers were mixed and given to another judge to be sorted. Thus, each set of papers was sorted and scored by two judges. Each paper then had two scores which were later totaled for a composite score for each paper. Since each student had two writing samples, each with two scores, each student's handwriting achievement was rated as the total number of points from the four scores.

5. Eighty per cent agreement between the two judges was considered necessary and an indication of a high
correlation between the judge's evaluations. Agreement was defined as:

- a) the two judges agreed exactly on the number of points assigned to a particular writing sample; or
- b) the second judge scored a particular writing sample one point higher than judge one; or
- c) the second judge scored a particular writing sample one point lower than judge one.

**Administration of Group Tests**

The group administered tests were completed first. Each class was tested by the examiner in two separate sessions so that only ten to twelve students were in each session. The grouping was done by the classroom teacher so that she would have students to work with in the room. Sometimes this left the teacher with a reading group intact; in other instances the division was done alphabetically.

An empty classroom and library were used for the group testing. In each case, the children were assigned to desks or seats at tables so that they could not copy from each other. Since the Slingerland Test 3, Visual Perception-Memory, required the left-handed children to be seated at the ends of rows on the left-hand side of the room, facing the examiner, this was done at the beginning of the testing session so that no moves would be necessary once the testing began.
Many No. 2 pencils were sharpened ahead of time, with plenty of extras in case of broken points. The erasers were removed from all of the pencils to assure that no erasing could be done by the students. Pencils were provided to the students so that all used the same soft lead and so that no erasers were available to them.

**Word Discrimination Test.** This test was administered first with each group of students. The test, which was several pages in length, was passed out to each student. The first page of the test included the directions, which were read to the students, and a few samples, which the students did under the direction of the examiner. Since the pencils had no erasers, the students were told to draw a line through any answer they wanted to change. The students were allowed to proceed through the test pages, stopping when they were "sure that they could do no more of the exercise," as stated in the directions. The students were encouraged by the examiner to "try a few more," when they stopped working. If it was evident to the examiner, by glancing at their answers, that they were not being successful and were probably just guessing, they were allowed to stop. If it was evident to the examiner that they could "figure out" a few more answers, this was encouraged. The slower workers needed about fifteen minutes of time to complete this test. Then, this test was collected.
Slingerland Test 1, Copying Chart. The lined papers used for this test were passed out, one to each student. The charts used were those printed in manuscript as specified in the Slingerland manual (1970b) and were placed in two locations in the room so that the children were facing the chart to be copied. Also, the chart was not more than 20 feet away from any student.

The children were told not to erase and used the pencils without erasers, as recommended in the manual (Slingerland, 1970b). Directions from the manual were modified slightly to avoid the use of the word "brackets" and the following paragraph of directions was used:

"But if you do make a mistake, or want to change something, just put a circle or box around it, and then do what you think is right."

A sample correction was done on the board to show the students how to "circle or box-in" whatever they wanted to erase.

It took approximately eight to ten minutes for the children to complete the copying of the chart onto the paper provided for Slingerland Test 1. A few children needed more room than the one page allowed, and were told to use the back side of the paper to complete copying the paragraph. This page was then collected from the students. About five minutes were taken to allow the students to go to the washroom and to get a drink of water before returning to the testing.
Slingerland Test 2, Copying Page. The page with Test 2 on it was distributed to each child, and the directions from the manual (Slingerland, 1970b) were read to the students. The students then copied the words and phrases, which were printed on the top portion of that page, onto the lines provided on the bottom portion of that page. This test required no more than four minutes for the group to complete. Then, those pages were collected.

Slingerland Test 3, Visual Perception-Memory. The page with Test 3 on it was passed out to each child. The directions from the manual (Slingerland, 1970b) were read to the students. The students then were shown the cards with the words, series of letters, or numerals printed on them, for an exposure of ten seconds each. Each time, after the exposure, the students picked their pencils up from the floor, turned the page over, and proceeded to select the appropriate selection from the choices printed on the page. As each student marked his selection, he turned his paper over, returned the pencil to the floor, and waited for the next stimulus card to be displayed. When a student objected that he could not remember, he was reassured with the words, "I know some of these may be hard to remember, but just do the best you can." When all the items were completed, the papers were collected. This test required no more than eight minutes to complete.
Slingerland Test 4, Visual Discrimination. Page four was distributed to each student and the directions from the manual (Slingerland, 1970b) were read to the group. The students then proceeded to look at the underlined word on the page and the four "words" under it, and selected the one which looked exactly like the underlined word. The examiner monitored the students as they worked to point out items which had been "skipped over," so that all items were attempted by each student. The papers were then collected. It took no more than three minutes to complete this test.

Slingerland Test 5, Visual Perception-Memory Copying. Page five was distributed to each child and the directions from the manual (Slingerland, 1970b) were read to the group. The students turned their papers over to the blank side and placed their pencils on the floor next to their chairs as the directions stated. They were then shown the cards with the words, letters, series of numerals, or geometric designs and pictures printed on them, for an exposure of ten seconds each. After each card, the students picked up their pencils from the floor, turned their papers over, and wrote or drew the appropriate symbols, as they remembered them, on to the paper. When the student completed that item, he returned the pencil to the floor and turned the paper over so the blank side was up. This test required no more than ten minutes to complete the twelve items.
Summary of the Group Testing. The administration of the Word Discrimination Test and the five Slingerland tests completed the portion of the evaluations which were group-administered. The total time used by each group varied slightly, but the approximate times are given for general information purposes (Table 2).

Administration of Individual Tests

The two remaining assessment devices were administered individually to each child. The students were taken from the classrooms, in no particular order, and seated with the examiner at a small desk in a room separate from the regular classroom.

Developmental Test of Visual-Motor Integration. This test was administered first to each child because it begins with simple lines to be copied by the student and then progresses to more complex angles and geometric shapes and designs. Thus, each child would have the same type of "practice" and experiences before attempting the more difficult designs of the Developmental Test of Visual-Motor Integration and the Bender Gestalt Test for Young Children.

The test was administered according to the directions in the manual (Beery, 1972b). The stimulus shapes and designs printed on separate cards were presented to the student one at a time to be copied on plain white paper, presented
Table 2: Approximate time allocations for the group-administered tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Time used for giving directions and student working time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Discrimination Test</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Slingerland Test 1, Copying Chart</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Slingerland Test 2, Copying Page</td>
<td>4 minutes</td>
</tr>
<tr>
<td>Slingerland Test 3, Visual Perception-Memory</td>
<td>8 minutes</td>
</tr>
<tr>
<td>Slingerland Test 4, Visual Discrimination</td>
<td>3 minutes</td>
</tr>
<tr>
<td>Slingerland Test 5, Visual Perception-Memory-Copying</td>
<td>10 minutes</td>
</tr>
<tr>
<td>TOTAL</td>
<td>50 minutes*</td>
</tr>
</tbody>
</table>

*Five to seven minutes additional were used for a washroom visit and getting a drink of water after completion of Slingerland Test 1.
Every student began with design number one and continued copying each design through each of the progressively more difficult design cards until it was evident to the examiner that three in succession were not completed correctly. Some students were able to complete all of their designs on one piece of paper, while others were offered a second sheet to use before the first sheet of paper became crowded.

Bender Gestalt Test for Young Children. A new piece of paper was given to the student, presented vertically, and he placed his name at the top of the paper. The set of cards on which the Bender designs were printed were presented one at a time, according to the directions in the manual (Koppitz, 1963). All of the nine designs were copied by each student as required by this test.

Completion of the administration of these two assessment devices required approximately fifteen minutes per child. However, no time limit was placed upon any student.

Scoring.

The same examiner administered all of the tests and scored each according to the directions in the manuals accompanying the tests. Raw scores from each test were recorded for each student. As indicated in Table 3, some tests yielded a count of correct responses while others yielded a count of errors.
Table 3: Interpretation of raw scores achieved on tests administered and handwriting samples evaluated

<table>
<thead>
<tr>
<th>Test</th>
<th>Range of Points Achieved</th>
<th>Points Indicate Errors/Successes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Discrimination Test</td>
<td>6 to 56</td>
<td>X</td>
</tr>
<tr>
<td>Slingerland Test 1, Copying Chart</td>
<td>13 to 0</td>
<td>X</td>
</tr>
<tr>
<td>Slingerland Test 2, Copying Page</td>
<td>9 to 0</td>
<td>X</td>
</tr>
<tr>
<td>Slingerland Test 3, Visual Perception-Memory</td>
<td>4 to 0</td>
<td>X</td>
</tr>
<tr>
<td>Slingerland Test 4, Visual Discrimination</td>
<td>6 to 0</td>
<td>X</td>
</tr>
<tr>
<td>Slingerland Test 5, Visual Perception-Memory-Copying</td>
<td>9 to 0</td>
<td>X</td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>8 to 19</td>
<td>X</td>
</tr>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>14 to 0</td>
<td>X</td>
</tr>
<tr>
<td>Handwriting Evaluations</td>
<td>4 to 28</td>
<td>X</td>
</tr>
<tr>
<td>(Total of four scores)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design

This investigation was descriptive research which sought to determine the relationship between performances on various tests of visual and motor subskills and various levels of success and failure in gaining handwriting skills.

Simply determining multiple correlation coefficients which reflected the relationship between performance on the various subtests and achievement in writing gave some of the information desired in this investigation. But, variation in the dependent variable (handwriting achievement) was believed to be a function of concomitant variation in many independent variables (visual perception, motor coordination, and visual-motor-integration) acting simultaneously. The aim of this investigation was to determine if the tests selected measured the same thing and so showed some overlap in the contribution they made toward predicting handwriting performance, or if each made some separate and significant contribution toward predicting handwriting performance.

Therefore, a multiple regression analysis was used in order to select from the entire battery of potential predictors, a subset of variables which, in combination, yielded the best possible equation for predicting success at handwriting. Thus, the scores from the following,

Word Discrimination Test
Bender Gestalt Test for Young Children
Developmental Test of Visual-Motor Integration
Slingerland Test 1, Copying Chart
Slingerland Test 2, Copying Page
Slingerland Test 3, Visual Perception-Memory
Slingerland Test 4, Visual Discrimination
Slingerland Test 5, Visual Perception-Memory-Copying

were correlated with the handwriting evaluations and
multiple regression analysis applied to determine the efficacy
of using these tests for predicting handwriting performance.
CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The primary concern of this investigation consisted of examining relationships among measures of visual perception, motor coordination, visual-motor integration, and handwriting achievement of first grade children in a small-town and rural setting. For the present study, a total of 124 students, those enrolled in the first grade of the two elementary schools in the Clear Fork Valley Local School District, were administered a battery of visual-perception and visual-motor integration tests during April and May, 1976. This battery of tests, identified as the predictor variables, included the Bender Gestalt Test for Young Children (1963), the Developmental Test of Visual-Motor Integration (1967), the Word Discrimination Test (1949), and five subtests of the Slingerland Screening Tests for Identifying Children with Specific Language Disability (1970). In addition to the above, two samples of writing papers from each student were collected by the classroom teachers and scored by two judges. These writing samples are identified as the criterion variable.

Statistical analysis of the data and presentation of the results are presented in several sections. First, there
is the description of the sample population; second, handwriting achievement evaluations are considered; third, determining a predictive battery for handwriting achievement; fourth, examination of alternative scoring methods for the Slingerland tests; and fifth, examination of a secondary battery for predicting handwriting achievement. The review of data concludes with an analysis of specific inter-test correlations of concern in this investigation.

**Description of Sample Population**

**Dominance and grasp.** While the students were working on the various tests administered individually, notice was made of the preferred hand used by each student (dominance), as well as the manner in which each held the pencil as he wrote (grasp). Fifteen per cent of the students were left-handed, and 85 per cent were right-handed (Table 4). This is a typical dominance distribution. Pearson correlation coefficients were calculated between dominance and achievement, \( r = 0.00268 \) (Table 5). As expected, this correlation was low and was calculated merely for descriptive purposes.

The pencil grasp used by the students tended to be easily distinguished as one of three types:

**Grasp #3** - Regarded as desirable. A three-finger hold with movement at the finger joints for fine-motor control, and the hand resting on the paper for large movements across the page.

**Grasp #2** - Regarded as appropriate, but not efficient. A three- or four-finger pinch,
Table 4: Distribution of right- and left-handed writers using various qualities of pencil grasp, in the sample of first graders

<table>
<thead>
<tr>
<th>Grasp #1</th>
<th>Grasp #2</th>
<th>Grasp #3</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Right-handed Writers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>71%</td>
<td>10</td>
<td>71%</td>
</tr>
<tr>
<td>Left-handed Writers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>29%</td>
<td>4</td>
<td>29%</td>
</tr>
<tr>
<td>Totals</td>
<td>7</td>
<td>100%</td>
<td>14</td>
</tr>
</tbody>
</table>

N = 124
Table 5: Correlation matrix for Dominance, Grasp, and Handwriting Achievement of first grade students

<table>
<thead>
<tr>
<th></th>
<th>Dominance</th>
<th>Grasp</th>
<th>Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>1.00000</td>
<td>-0.16437</td>
<td>0.00268</td>
</tr>
<tr>
<td>Grasp</td>
<td>-0.16437</td>
<td>1.00000</td>
<td>0.03981</td>
</tr>
<tr>
<td>Achievement</td>
<td>0.00268</td>
<td>0.03981</td>
<td>1.00000</td>
</tr>
</tbody>
</table>

N = 121
usually tight, with no rest of the remainder of the hand for movement across the page. Usually excessive tension is exhibited by a tight pinch of the pencil and pressure on the paper.

Grasp #1 - Regarded as undesirable. Usually indicated by the thumb being wrapped around the other two fingers, or inside the other fingers with no direct control being exerted on the pencil's movement by the thumb.

Pearson correlation coefficients computed between grasp and achievement, $r = 0.03981$ (Table 5), indicated a slight correlation. This negligible correlation between grasp and achievement indicated that children develop quality handwriting despite various finger grasps, and that correct positioning alone does not insure good writing results.

However, of some note is the distribution of quality of finger grasp among the left-handed and right-handed writers. The correlation between grasp and dominance, $r = 0.16437$ (Table 5), was slightly skewed toward the preferred pencil grasp being evidenced by the right-handed students in a greater proportion than by the left-handed students (Table 4).

Bender Gestalt Test for Young Children. Examination of the means and standard deviations achieved by the sample on the standardized tests administered (Table 6), indicated that this sample of first graders performed within the average range on the tests for which norms were available for comparison. For example, this sample of first graders achieved a mean of 6.05 errors on the Bender Gestalt Test,
Table 6: Mean scores and standard deviations of scores on the Bender Gestalt Test for Young Children, Developmental Test of Visual-Motor Integration, Word Discrimination Test, and Handwriting Achievement scores achieved by first graders in Clear Fork Valley Schools, 1976

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>6.0496</td>
<td>2.8747</td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>11.6860</td>
<td>1.7797</td>
</tr>
<tr>
<td>Word Discrimination Test</td>
<td>26.4711</td>
<td>11.4550</td>
</tr>
<tr>
<td>Handwriting Achievement</td>
<td>15.9587</td>
<td>6.4800</td>
</tr>
<tr>
<td>Handwriting Achievement (single sample score)</td>
<td>3.99</td>
<td></td>
</tr>
</tbody>
</table>

N = 121
with a standard deviation of 2.87 (Table 6). The norms published for the Bender Gestalt Test (Koppitz, 1963; Appendix C) indicated a mean score of 6.4 with a standard deviation of 3.76 for the 6-6 to 6-11 age group. This sample population, with a mean age of 7 years, 2 months, would be compared with the norms for the 7-0 to 7-5 age group which indicated a mean score of 4.8 errors, with a standard deviation of 3.61.

**Developmental Test of Visual-Motor Integration.** On the Developmental Test of Visual-Motor Integration, this sample scored a mean of 11.69 points for correct responses, with a standard deviation of 1.78 (Table 6). The norms (Beery, 1967; Appendix C) indicate this performance is more typical of a child one year younger than this sample's mean age of 7-2.

The age norm estimate for each form and the total score age equivalents (Figure 1) were not used in the statistical analyses but were of value in describing the sample population and their performance on this assessment device. Raw scores were used in the statistical computations.

**Word Discrimination Test.** The last test administered for which standardized norms are available is the Word Discrimination Test. These norms (Huelsman, 1949; Appendix C) also indicated that this sample performed within the range of norms for average first graders. This sample population scored a mean of 26.47 correct items, with a standard deviation of
Figure 1: Scattergram of first graders' scores on Developmental Test of Visual-Motor Integration, May, 1976
11.46, while in Grade 1.8 (Table 6). The Word Discrimination Test norms indicate Grade 1.8 for the scores of 25-29.

**Slingerland Tests.** The other tests administered were five subtests of the Slingerland Screening Tests for Identifying Children with Specific Language Disability. These tests have no established norms. The manual (Slingerland, 1970b) specifically recommends that the child's performance be judged and compared with his peers' rather than with national norms. The mean scores achieved by this sample, then, have been computed for informational purposes (Table 19) in future uses of this assessment device.

**Handwriting Achievement Evaluations**

Two different sets of writing papers were evaluated from each classroom. Two judges, one first-grade teacher and the examiner, evaluated each of the sets of papers on a scale of one through seven. With some papers in each classification, it was originally intended that "four" be used as the mid-point, meaning "average" or "satisfactory" performance. However, it was evident when the papers were first sorted by the examiner that there needed to be more levels of "unsatisfactory" papers than three, and it was difficult to fill the three classifications of "above satisfactory." Therefore, it was decided that, although a seven-point scale was to be used, the mid-point would be considered to be "five," thereby making allowances for finer discriminations.
Table 7: Coding as determined by judges and used in evaluating writing samples to assign handwriting achievement scores.

<table>
<thead>
<tr>
<th>Score</th>
<th>Qualitative Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unreadable, messy</td>
</tr>
<tr>
<td>2</td>
<td>Very poor</td>
</tr>
<tr>
<td>3</td>
<td>Poor</td>
</tr>
<tr>
<td>4</td>
<td>Fair</td>
</tr>
<tr>
<td>5</td>
<td>Average, good</td>
</tr>
<tr>
<td>6</td>
<td>Very good</td>
</tr>
<tr>
<td>7</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
of less-than-satisfactory papers (Table 7). Thus, the scale was established with the papers from each classroom being compared against the rest of the papers from that room.

The judges independently evaluated each of the writing samples on a scale of one through seven, with a midpoint of "five" for "satisfactory" or "average" handwriting. Since each student had two papers, evaluated by two judges, there were four scores to be totaled for each student. The mean total for the 124 students was 15.96, for an average score of 3.99 per writing sample (Table 8). Since 5.0 was considered "satisfactory" or "average" in the scoring, it is evident that first graders at the end of their first year in school, in general, have not mastered the manuscript writing skills.

The determination had been made that 80 per cent agreement between the judges was necessary. The agreement between the two judges was 89.1 per cent (Table 25) using the definition of "agreement" as identical scores or scores just one point different.

Each judge's scoring reliability (intrajudge consistency) is evident in the means for each group of writing samples (Table 9) which vary only 0.0242 points for Judge #1 and not at all for Judge #2. Since the types of writing samples produced by each classroom of children were not
<table>
<thead>
<tr>
<th>Class</th>
<th>Number of Subjects</th>
<th>Mean Age</th>
<th>Total Mean Score</th>
<th>Single Sample Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25</td>
<td>7-1</td>
<td>14.72</td>
<td>3.68</td>
</tr>
<tr>
<td>B</td>
<td>16</td>
<td>7-4</td>
<td>16.50</td>
<td>4.13</td>
</tr>
<tr>
<td>C</td>
<td>19</td>
<td>7-1</td>
<td>18.06</td>
<td>4.52</td>
</tr>
<tr>
<td>D</td>
<td>20</td>
<td>7-1</td>
<td>18.45</td>
<td>4.61</td>
</tr>
<tr>
<td>E</td>
<td>20</td>
<td>7-1</td>
<td>14.35</td>
<td>3.59</td>
</tr>
<tr>
<td>F</td>
<td>24</td>
<td>7-3</td>
<td>16.21</td>
<td>4.05</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>7-2</td>
<td>15.96</td>
<td>3.99</td>
</tr>
</tbody>
</table>

N = 124
Table 9: Mean scores and standard deviations of scores on two writing samples, each evaluated by two judges, done by first graders in Clear Fork Valley Schools, 1976

<table>
<thead>
<tr>
<th></th>
<th>Judge #1</th>
<th>Judge #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing Sample #1</td>
<td>M 3.7903</td>
<td>M 4.1452</td>
</tr>
<tr>
<td>S.D.</td>
<td>1.8136</td>
<td>1.7655</td>
</tr>
<tr>
<td>Writing Sample #2</td>
<td>M 3.7661</td>
<td>M 4.1452</td>
</tr>
<tr>
<td>S.D.</td>
<td>1.7628</td>
<td>1.7609</td>
</tr>
<tr>
<td>Difference</td>
<td>M .0242</td>
<td>M .0000</td>
</tr>
</tbody>
</table>

N = 124
controlled or specified, there was much variation in subject area and format of the samples received. Since the rating of handwriting quality was done comparatively, and established relatively within each set of papers, the problem caused by the variation was held to a minimum.

It is evident, also, that the judges' evaluations were able to be consistent despite these variations. Pearson correlation coefficients (Table 10) were computed to compare for each judge the evaluations performed on the two writing samples from each child (intrajudge consistency). Correlations between the two writing samples, when evaluated by the same judge, were high, \( r = 0.7093; r = 0.7333 \) (\( p > .001 \)).

The highest correlations were evident between the two judges when the same writing samples were evaluated, \( r = 0.8754; r = 0.8701 \) (\( p > .001 \)). This indicates that there is more variation in the student's performances than in the judges' evaluations or scores. These interjudge correlation coefficients (Table 11) for each group of writing samples are an index of the concomitant variation of the judges' evaluations.

A further indication of both intrajudge and interjudge reliability are the standard deviations (Table 9) which indicate similar dispersion of the scores on the different samples, by the two judges. In fact, the standard deviations for three of the four combinations were the same (1.76) to the hundredths of a point.
Table 10: Intrajudge reliability—Pearson correlation coefficients between two handwriting achievement scores earned on two writing samples by each student

<table>
<thead>
<tr>
<th>Variable</th>
<th>Judge #1</th>
<th>Judge #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing Samples</td>
<td>0.7093*</td>
<td>0.7333*</td>
</tr>
</tbody>
</table>

* = significant at the .001 level
Table 11: Interjudge reliability—Pearson correlation coefficients between two handwriting achievement scores assigned by two judges on the same writing sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Writing Sample #1</th>
<th>Writing Sample #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judges</td>
<td>0.8754*</td>
<td>0.8701*</td>
</tr>
</tbody>
</table>

* = significant at the .001 level
It is evident (Table 9) that Judge #2 used lower standards and evaluated the writing samples with consistently higher scores than Judge #1; the mean scores by the two judges are noticeably variant. However, the similarities in the standard deviations indicate similar dispersions of the scores. Despite the difference in the standards, the difference in scoring was consistent and the scores of the two judges evidenced concomitant variation.

Determining a Predictive Battery for Handwriting Achievement

Hypothesis: A battery of tests can be determined which may be administered early in first grade to predict and identify handwriting difficulties.

Conclusion: A review of available task- and process-oriented tests provided a selection of tests for investigation:

- Word Discrimination Test
- Bender Gestalt Test for Young Children
- Developmental Test of Visual-Motor Integration
- Slingerland Test 1, Copying Chart
- Slingerland Test 2, Copying Page
- Slingerland Test 3, Visual Perception-Memory
- Slingerland Test 4, Visual Discrimination
- Slingerland Test 5, Visual Perception-Memory-Copying

The fundamental question of concern in this study now is:
What is the most effective combination among the eight variables employed in the study, for predicting performance in handwriting achievement as adjudged on written papers from first grade classrooms?
Variable 1, Bender Gestalt Test for Young Children. Analysis of the correlation of the selected predictor variables with the criterion, Achievement, as determined through stepwise multiple regression procedures is summarized in Table 12. The first variable selected was the error score of the Bender Gestalt Test for Young Children which showed a correlation of -0.43471 with the criterion. This correlation is both significant and substantial. The correlation attained significance at the 0.01 level. Performance on the Bender Gestalt alone accounts for approximately 19 per cent of the criterion variance in the present sample as indicated by the square of the above correlation.

The selection of the Bender Gestalt as the first predictor of the criterion shows the importance of visual-perception-integration performance in handwriting. The higher the visual-perception-integration level of the child, as indicated by a lower number of errors in the copying of the Bender Gestalt designs, the better are his chances for writing success as measured by the criterion, the teachers' evaluations of the writing samples.

Variable 2, Word Discrimination Test. The next variable selected, the Word Discrimination Test, measures visual discrimination. Inclusion of the Word Discrimination Test results in increments in $r^2$ which attains significance beyond
the 0.01 level. The obtained multiple $r$ of 0.55103 indicates that the Bender Gestalt and the Word Discrimination Test might be expected to account for approximately 30 per cent of the criterion variance in a cross-validation study employing a similar sample.

Examination of the regression procedure indicates that both variables were selected because of a high correlation with the criterion (Table 12) and relative independence from each other (Table 20). That is, the Word Discrimination Test functions to subtract variance unrelated to visual-motor integration, thus improving prediction by approximately 11 per cent. Further, performance on the Word Discrimination Test alone accounts for approximately 14.7 per cent of the criterion variance, 11 per cent of which is unrelated to visual-motor integration as accounted for by the Bender Gestalt performance.

**Variable 3, Slingerland Test 2, Copying Page, Error Score.** The third variable selected is the test score of the Slingerland which required the subjects to copy a selection of words, numerals, and phrases, directly from the printed page onto the bottom of that same page. Inclusion of the Slingerland Test 2 error score results in increments in $r^2$ which amounts to approximately 4.5 per cent. In other words, the three variables might be expected to account for approximately 35 per cent of the criterion variance, as indicated by the multiple $r$ of 0.59073.
Table 12: Correlation matrix for eight predictor variables* and handwriting achievement, N=121.

* Primary Battery

<table>
<thead>
<tr>
<th>Variables</th>
<th>#1 Bender Gestalt Test for Young Children</th>
<th>#2 Word Discrimination Test</th>
<th>#3 Slingerlan Test 2 Error score</th>
<th>#4 Slingerlan Test 5 Error score</th>
<th>#5 Slingerlan Test 1 Error score</th>
<th>#6 Slingerlan Test 4 Error score</th>
<th>#7 Developmental Test of Visual-Motor Integration</th>
<th>#8 Slingerlan Test 3 Error score</th>
<th>Handwriting Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Bender Gestalt Test for Young Children</td>
<td>1.00000</td>
<td>-0.10902</td>
<td>0.27150</td>
<td>0.48277</td>
<td>0.38584</td>
<td>0.12972</td>
<td>-0.52305</td>
<td>0.27450</td>
<td>-0.43471</td>
</tr>
<tr>
<td>#2 Word Discrimination Test</td>
<td>-0.10902</td>
<td>1.00000</td>
<td>-0.17803</td>
<td>-0.24322</td>
<td>-0.05722</td>
<td>-0.29245</td>
<td>0.21457</td>
<td>-0.45716</td>
<td>0.38399</td>
</tr>
<tr>
<td>#3 Slingerlan Test 2 Error score</td>
<td>0.27150</td>
<td>-0.17803</td>
<td>1.00000</td>
<td>0.23821</td>
<td>0.15577</td>
<td>0.38038</td>
<td>-0.16739</td>
<td>0.13387</td>
<td>-0.37101</td>
</tr>
<tr>
<td>#4 Slingerlan Test 5 Error score</td>
<td>0.49277</td>
<td>-0.24322</td>
<td>0.23821</td>
<td>1.00000</td>
<td>0.20787</td>
<td>0.14376</td>
<td>-0.48993</td>
<td>0.37837</td>
<td>-0.41499</td>
</tr>
<tr>
<td>#5 Slingerlan Test 1 Error score</td>
<td>0.38584</td>
<td>-0.05722</td>
<td>0.15577</td>
<td>0.20787</td>
<td>1.00000</td>
<td>-0.07613</td>
<td>-0.36755</td>
<td>0.20854</td>
<td>-0.27050</td>
</tr>
<tr>
<td>#6 Slingerlan Test 4 Error score</td>
<td>0.12972</td>
<td>-0.29245</td>
<td>0.38038</td>
<td>0.14376</td>
<td>-0.07613</td>
<td>1.00000</td>
<td>-0.04675</td>
<td>0.29416</td>
<td>-0.16740</td>
</tr>
<tr>
<td>#7 Developmental Test of Visual-Motor Integration</td>
<td>-0.52305</td>
<td>0.21457</td>
<td>-0.16739</td>
<td>-0.48993</td>
<td>-0.36755</td>
<td>-0.04675</td>
<td>1.00000</td>
<td>-0.20320</td>
<td>0.34283</td>
</tr>
<tr>
<td>#8 Slingerlan Test 3 Error score</td>
<td>0.27450</td>
<td>-0.45716</td>
<td>0.13387</td>
<td>0.37837</td>
<td>0.20854</td>
<td>0.29416</td>
<td>-0.20320</td>
<td>1.00000</td>
<td>-0.29133</td>
</tr>
<tr>
<td>Handwriting Achievement</td>
<td>-0.43471</td>
<td>0.38399</td>
<td>-0.37101</td>
<td>-0.41499</td>
<td>-0.27050</td>
<td>-0.16740</td>
<td>0.34283</td>
<td>-0.29133</td>
<td>1.00000</td>
</tr>
</tbody>
</table>
The Slingerland Test 2, Copying Page, was selected to assess the subjects' performance on a "task" device; that is, it requires the subjects to do actual handwriting, but under controlled conditions which can easily be replicated in the typical evaluation setting. The error score of the Slingerland Test 2 showed a correlation of -0.37101 with the criterion. This correlation is both significant and substantial and attained significance at the 0.01 level. It is interesting to note that of the three variables discussed thus far, Slingerland Test 2 is empirically most similar to the criterion, since both could be described as handwriting tasks. The other two variables copying geometric designs (Bender Gestalt) and selecting the one word in each set of five groups of letters (Word Discrimination Test). Yet, the correlation of Slingerland Test 2, error score, and Handwriting Achievement was the lowest of the three (Table 20) and the Bender Gestalt showed the highest correlation with Handwriting Achievement.

Variable 4, Slingerland Test 5, Visual Perception-Memory-Copying, Error Score. The fourth variable selected is the test score of the Slingerland Test 5, which required the subjects to copy from memory the series of letters, the word, phrase, numerals, or geometric form which had been exposed to them for just ten seconds. The error score of the Slingerland Test 5 showed a correlation of -0.41499 with the criterion. While performance on the Slingerland Test 5
alone accounts for approximately 17 per cent of the criterion variance, inclusion of the Slingerland Test 5 error score with the scores of the first three variables results in a multiple r of 0.60807. This is only an increase of two percentage points. The fourth variable (Slingerland Test 5 error score) is similar to the third variable (Slingerland Test 2 error score) in many ways, but sufficiently different to account for some of the variance (2 per cent) in the criterion that is not previously accounted for by the first three variables. Both Slingerland Test 5 and Slingerland Test 2 assess the subjects' performance on a "task" device. They require actual handwriting, but under controlled conditions. Slingerland Test 2 requires the subjects copy letters and numerals from a "near model," words and symbols printed on the same page. Slingerland Test 5, however, requires the subjects to "copy from memory" letters and numerals presented on cards as "far models." Combined then with the other two variables which assess visual-motor-integration (Bender Gestalt) and visual discrimination (Word Discrimination Test), a total of 37 per cent of the criterion variance is accounted for by the four variables.

**Variable 5, Slingerland Test 1, Copying Chart, Error Score.** Three additional variables were also included in the final regression equation. Addition of these variables resulted in slight but significant (p > .01) increments in prediction. The fifth variable selected, the Slingerland
Test 1 error score, required the subjects to copy a paragraph from a wall chart. The error score of the Slingerland Test 1 showed a correlation of -0.27050 with the criterion, Handwriting Achievement. Alone, performance on the Slingerland Test 1 accounts for approximately 7 per cent of the criterion variance. Inclusion of the Slingerland Test 1 error score with the scores of the first four variables results in a multiple r of 0.61491. The five variables, then, account for approximately 37.8 per cent of the criterion variance. Inclusion of the Slingerland Test 1 error score adds less than 1 per cent (0.00837) to the prediction equation. This amount, however, is significant at the 0.01 level.

Variable 6, Slingerland Test 4, Visual Discrimination, Error Score. The sixth variable selected is the error score of the Slingerland Test 4 which is a word discrimination task. Model words are presented on the page, and below each word are four similar choices, only one of which is exactly like the model word. Understandably, this variable showed the lowest correlation with the criterion (Table 12), -0.16740. Alone, performance on the Slingerland Test 4 accounts for approximately 2.8 per cent of the criterion variance. Inclusion of the Slingerland Test 4 error score with the scores of the first five variables results in an increase of less than 1 per cent (0.00197) in the prediction equation. Approximately 38 per cent of the criterion variance is accounted for by the six variables.
Variable 7, Developmental Test of Visual-Motor Integration. The seventh, and last, variable selected is the score of the Developmental Test of Visual-Motor Integration (VMI). This "measure of the degree to which visual perception and motor behavior are integrated in young children" (Beery, 1967) requires the subject to copy geometric forms which are presented on cards and which become progressively more difficult. The score on this test of visual-motor integration shows a correlation of 0.34283 with the criterion, Handwriting Achievement. Performance on the VMI alone accounts for approximately 12 per cent of the criterion variance. The seven variables, with the inclusion of the VMI score, result in a multiple r of 0.61661. These variables represent 38 per cent of the variance of the criterion. Analysis of variance for this multiple correlation coefficient yields 9.90 (significant beyond .01) as seen in Table 21. However, the increase in percent of variance accounted for, is a negligible amount (0.012 per cent).

Variable 8, Slingerland Test 3, Visual-Perception-Memory, Error Score. Further computation through stepwise multiple regression procedures indicates that the inclusion of the last variable does not yield an f-level or tolerance-level sufficient to justify the use of eight variables. This last variable is the error score from the Slingerland Test 3 which requires the subject to make a visual discrimination with memory as a factor. A word, series of letters,
or numerals printed on a card is exposed one at a time for just seconds. A short distraction and delay intervene, and then the subject must—select the previously exposed symbols from a series of four similar ones printed on the test page. Although the error score of the Slingerland Test 3 shows a correlation of -0.29133 with the criterion, and alone accounts for 8 per cent of the criterion variance, when included with the other seven variables in the prediction equation, it does not significantly improve the predictability.

Including the last three variables, Slingerland Test 4 error score, Developmental Test of Visual-Motor Integration, and Slingerland Test 3 error score, results in only a slight improvement in predictive efficiency. Consequently, including them in a predictive battery would be of questionable value.

**Summary.** The regression equation, initially investigated with eight variables (Bender Gestalt Test for Young Children, Word Discrimination Test, Slingerland Test 2, 5, 1, 4, Developmental Test of Visual-Motor Integration, and Slingerland Test 3), can be readily interpreted. A test of visual-motor integration (Bender Gestalt) is the most effective single predictor of Handwriting Achievement. When combined with the test of visual discrimination (Word Discrimination Test), over 30 per cent of the variance of the criterion can be accounted for. Use of three of the Slingerland tests (Slingerland Test 1, 2, and 5 error
scores) increases the amount of variance accounted for by 7.4 per cent. Generally described as "task devices," these three which require actual handwriting are of sufficient value to be included in the prediction equation. Because each Slingerland test contributes different predictability to the equation, it is important to recognize the conditions under which the writing occurs: a) direct copying from a "near" model, b) direct copying from a "far" model, and c) copying from a model which has been removed, so that memory is a factor. The last three variables, Slingerland Test 4, Developmental Test of Visual-Motor Integration, and Slingerland Test 3, are similar enough to the previous variables that little new variance could be accounted for by their inclusion in the equation. Thus, though seven of the eight variables prove to be of sufficient discriminatory value to be included in the prediction equation, accounting for 38 per cent of the variance, the first five variables are sufficient to account for 37.8 per cent.

**Examination of Alternate Scoring Methods**

Of the tests administered, the five tests of the Slingerland Screening Tests for Identifying Children with Specific Language Disability (1970) were selected as the task-oriented assessment devices. The tests were scored initially by the primary scoring method described in the Slingerland manual (1970), the counting of errors. However,
two additional scoring bases were suggested in the Slingerland manual, letter scores and space scores. In order to determine the full value of the Slingerland as a test which directly samples writing, the tests were rescored to determine letter scores and space scores, and these additional variables were correlated with Handwriting Achievement.

Error scores were defined in the manual and were computed on each of the five Slingerland tests administered. The types of errors counted vary slightly from test to test depending upon the demands of the test, but were essentially "wrong" letters, words, or numerals. The error scores may contain both a count of incorrect responses as well as critical letter formation errors such as reversals, inversions, and transpositions. The error scores were the basic or primary scores used in the analysis of the subjects' performance.

The other types of scoring, letter scores and space scores, were more subjective in nature and also varied with the type of test and its demands. Letter scores are essentially determined by counting letters or numerals which are not "perfectly" formed. In other words, letter formation errors are counted in the three tests which require writing, Slingerland Test 1, Copying Chart; Slingerland Test 2, Copying Page; and Slingerland Test 5, Visual Perception-Memory-Copying.
Space scores were only able to be counted on Slingerland Test 1, Copying Chart; and Slingerland Test 2, Copying Page. When sufficient space was not left between words in copying sentences and phrases, an error was counted for each "insufficient space."

**Letter scores.** Understandably, the highest correlations resulted when the handwriting achievement scores were compared with the letter scores of Slingerland Test 1, \( r = 0.6396 \), and Slingerland Test 2, \( r = 0.6076 \) (Table 14). These are the two tests which result in actual writing samples by having the students copy material. The third highest correlation resulted when handwriting achievement scores were compared with letter scores of Slingerland Test 5, \( r = 0.5238 \), which required the students write words and phrases from short-term memory. This would indicate that handwriting samples in a testing situation can be indicative of classroom writing, particularly when the letter scores are obtained.

Slingerland Test 1 sampled the children's ability to copy from a "far point," a paragraph which had been printed on a card. That this task most highly correlated with the classroom samples of handwriting is probably indicative of the tasks being most similar. This was the only test resulting in an entire page of writing and which necessitated the duration of effort inherent in classroom writing.
Slingerland Test 2, conversely, required the children to copy single words and phrases and series of numerals directly from the top of the paper on which they were working—"near-point" copying. Slingerland Test 5 required the students to write from memory the words, phrases, series of numerals, or geometric shapes shown them on a "far-point" card for ten seconds. This required memory, and although probably most similar to day-to-day writing required of adults and older children, this was not true for first graders. They do most of their writing by copying from the board, books or worksheets.

Space scores. The importance of correct spacing of words is less critical to "good handwriting" than is correct letter formation (Table 22). Space scoring contributed significantly, however, in predicting handwriting achievement (Table 23). Slingerland Test space score more highly correlated with handwriting achievement ($r = 0.2993$) than the recommended method of scoring, Slingerland Test 1 error score ($r = 0.2705$). Slingerland Test 2 space score showed a similar correlation ($r = 0.2709$) with handwriting achievement, while Slingerland Test 2 error score correlation ($r = 0.3710$) was slightly higher.

Summary. It is understandable that the portions of the task device which directly samples writing (Slingerland Tests 1, 2, and 5), very highly correlate with handwriting achievement. It is also evident that the scoring
method which counts poor letter formation (letter scores) involves similar variables as are looked at in judging handwriting achievement; thus, the letter scores are most valuable in attaining an objective picture of a student's handwriting. Also indicated by the data is that the copying of a paragraph in a testing situation \( r = 0.6396 \) can provide an accurate picture of a student's classroom writing achievement.

It would appear, then, that the scoring recommended in the Slingerland manual (1970), a counting of error scores, is not as valuable as the letter scores and space scores, the alternative scoring methods described in the manual. Thus, a secondary battery was computed using the letter scores and space scores in addition to the error scores used in the primary battery.

**Examination of the Secondary Battery for Predicting Handwriting Achievement**

With realization of the value of alternative scoring methods for the Slingerland tests, the fundamental question of concern for this study was changed by the addition of five variables. The question now reads: What is the most effective combination among the thirteen variables employed in this study, for predicting performance in handwriting achievement as adjudged on first graders' classroom papers?

Analysis of the correlation of the thirteen selected prediction variables with the criterion, Handwriting Achievement, as determined through stepwise multiple
regression procedures is summarized in Table 13. By the addition of these five alternative scoring variables (Slingerland Test 1 letter score and space score; Slingerland Test 2 letter score and space score; Slingerland Test 5 letter score) to the standard scoring of the Slingerland tests (error scores), the secondary battery of test scores was compiled for analysis and a more detailed evaluation of writing, done under the various conditions imposed by the tests, was secured. In addition, it is important to note the total variability accounted for by the secondary battery as compared with the variability accounted for by the primary battery. The primary battery, using the standard scoring on the Slingerland tests, obtained a cumulative correlation of 0.61661 and accounted for 38 per cent of the variance in handwriting achievement. The secondary battery, using alternative scoring methods on the Slingerland tests, obtained a cumulative correlation of 0.75755 and accounted for approximately 57.4 per cent of the variance in handwriting achievement. This means that by using the alternative scoring methods on the tests already administered, 19.4 per cent more variance can be accounted for by the secondary predictive battery. Thus, the secondary battery is examined here in detail.

Variable 1, Slingerland Test 1, Copying Chart, Letter Score. Analysis of the correlation of the selected predictor variables with the criterion, Handwriting Achievement,
Table 13: Comparison of the amount of variability in Handwriting Achievement scores which can be accounted for by a Primary Battery of tests and a Secondary Battery using alternative scoring methods

<table>
<thead>
<tr>
<th></th>
<th>Handwriting Achievement Cumulative r</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Battery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bender Gestalt Test,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Discrimination Test,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Tests 1, 2,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4, and 5 (error scores),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>0.61661</td>
<td>0.38020</td>
</tr>
<tr>
<td><strong>Secondary Battery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Tests 1, 2,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and 5 (letter scores),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Discrimination Test,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Tests 1 and 2 (space scores),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bender Gestalt Test,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Tests 2, 3, and 4 (error scores),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>0.75755</td>
<td>0.57388</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.14094</td>
<td>0.19368</td>
</tr>
<tr>
<td></td>
<td>(19.4% more)</td>
<td></td>
</tr>
</tbody>
</table>
as determined through stepwise multiple regression procedures is summarized in Table 14. The first variable selected was the letter score of the Slingerland Test 1 which showed a correlation of -0.63964 with the criterion. This correlation is both significant and substantial. The correlation attained significance at the 0.01 level. Performance on the Slingerland Test 1 as scored by the letter score method, alone accounts for approximately 41 per cent of the criterion variance in the present sample as indicated by the square of the above correlation.

The selection of the Slingerland Test 1 letter score as the first predictor variable of the criterion is indicative of the similarity in tasks. Slingerland Test 1 required the students to copy a paragraph from "far point," necessitated prolonged writing, and was scored for actual letter formation accuracy. The high correlation of Slingerland Test 1 letter score with Handwriting Achievement (r = 0.63964) indicates that having the students copy a paragraph in a testing situation can provide an accurate picture of a student's classroom writing achievement, even when scored by this one scoring method, letter scores.

Variable 2, Slingerland Test 5, Visual Perception-Memory-Copying, Letter Score. The next variable selected, Slingerland Test 5, again involved the letter scoring method for the words, phrases, series of numerals, and geometric shapes written by the students, after being shown
Table 14: Correlation matrix for thirteen predictor variables and handwriting achievement, N=121

<table>
<thead>
<tr>
<th>Variables</th>
<th>#1 Slingerland Test 1 Letter score</th>
<th>#2 Slingerland Test 3 Letter score</th>
<th>#1 Word Discrimination Test</th>
<th>#4 Slingerland Test 1 Space score</th>
<th>#5 Bender Gestalt Test for Young Children</th>
<th>#7 Slingerland Test 4 Error score</th>
<th>#8 Slingerland Test 2 Space score</th>
<th>#9 Slingerland Test 3 Error score</th>
<th>#10 Slingerland Test 1 Error score</th>
<th>#11 Developmental Test of Visual-Motor Integration</th>
<th>#12 Slingerland Test 5 Error score</th>
<th>#13 Slingerland Handwriting Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Slingerland Test 1 Letter score</td>
<td>1.00000</td>
<td>0.40593</td>
<td>-0.25375</td>
<td>0.27531</td>
<td>0.70658</td>
<td>0.32636</td>
<td>0.23547</td>
<td>0.15534</td>
<td>0.44295</td>
<td>-0.25069</td>
<td>0.28346</td>
<td>0.32816</td>
</tr>
<tr>
<td>#2 Slingerland Test 3 Letter score</td>
<td>0.40593</td>
<td>1.00000</td>
<td>-0.21559</td>
<td>-0.01532</td>
<td>0.44304</td>
<td>0.47777</td>
<td>0.06430</td>
<td>0.12564</td>
<td>0.31764</td>
<td>0.42169</td>
<td>-0.33272</td>
<td>0.30599</td>
</tr>
<tr>
<td>#7 Word Discrimination Test</td>
<td>-0.25375</td>
<td>-0.21559</td>
<td>1.00000</td>
<td>-0.14033</td>
<td>-0.31111</td>
<td>-0.15952</td>
<td>-0.29245</td>
<td>-0.10566</td>
<td>-0.41716</td>
<td>-0.17503</td>
<td>0.21477</td>
<td>-0.03722</td>
</tr>
<tr>
<td>#4 Slingerland Test 1 Space score</td>
<td>0.27531</td>
<td>-0.01532</td>
<td>-0.14033</td>
<td>1.00000</td>
<td>0.20673</td>
<td>0.20900</td>
<td>0.13232</td>
<td>0.41563</td>
<td>0.06598</td>
<td>-0.01927</td>
<td>-0.14413</td>
<td>0.00946</td>
</tr>
<tr>
<td>#5 Slingerland Test 2 Letter score</td>
<td>0.70658</td>
<td>0.44304</td>
<td>-0.31111</td>
<td>0.20673</td>
<td>1.00000</td>
<td>0.40748</td>
<td>0.23413</td>
<td>0.10873</td>
<td>0.25741</td>
<td>0.55732</td>
<td>-0.33152</td>
<td>0.32832</td>
</tr>
<tr>
<td>#6 Bender Gestalt Test for Young Children</td>
<td>0.32636</td>
<td>0.47777</td>
<td>-0.10902</td>
<td>0.20900</td>
<td>0.40748</td>
<td>1.00000</td>
<td>0.12972</td>
<td>0.27200</td>
<td>0.27450</td>
<td>0.27150</td>
<td>-0.52035</td>
<td>0.38584</td>
</tr>
<tr>
<td>#7 Slingerland Test 4 Error score</td>
<td>0.23407</td>
<td>0.08420</td>
<td>-0.29125</td>
<td>0.13232</td>
<td>0.23433</td>
<td>0.12972</td>
<td>1.00000</td>
<td>0.09669</td>
<td>0.29416</td>
<td>0.26838</td>
<td>-0.04673</td>
<td>-0.07613</td>
</tr>
<tr>
<td>#8 Slingerland Test 2 Space score</td>
<td>0.21559</td>
<td>0.12541</td>
<td>-0.10667</td>
<td>0.43163</td>
<td>0.10873</td>
<td>0.27200</td>
<td>0.09669</td>
<td>1.00000</td>
<td>0.06246</td>
<td>0.02698</td>
<td>-0.26912</td>
<td>0.02650</td>
</tr>
<tr>
<td>#9 Slingerland Test 3 Error score</td>
<td>0.15534</td>
<td>0.31764</td>
<td>-0.05716</td>
<td>0.06598</td>
<td>0.23741</td>
<td>0.27450</td>
<td>0.29416</td>
<td>0.06246</td>
<td>1.00000</td>
<td>0.13387</td>
<td>-0.20320</td>
<td>0.2084</td>
</tr>
<tr>
<td>#10 Slingerland Test 2 Error score</td>
<td>0.44295</td>
<td>0.42769</td>
<td>-0.17803</td>
<td>-0.01927</td>
<td>0.55332</td>
<td>0.27150</td>
<td>0.38838</td>
<td>0.02848</td>
<td>0.13387</td>
<td>1.00000</td>
<td>-0.16739</td>
<td>0.15577</td>
</tr>
<tr>
<td>#11 Developmental Test of Visual-Motor Integration</td>
<td>-0.25069</td>
<td>-0.35272</td>
<td>0.21657</td>
<td>-0.16613</td>
<td>-0.33192</td>
<td>-0.52305</td>
<td>-0.06675</td>
<td>-0.26922</td>
<td>-0.23220</td>
<td>-0.16739</td>
<td>1.00000</td>
<td>-0.36755</td>
</tr>
<tr>
<td>#12 Slingerland Test 1 Error score</td>
<td>0.28346</td>
<td>0.30599</td>
<td>-0.05722</td>
<td>0.00946</td>
<td>0.32832</td>
<td>0.38584</td>
<td>-0.07613</td>
<td>0.02650</td>
<td>0.2084</td>
<td>0.15577</td>
<td>-0.36755</td>
<td>1.00000</td>
</tr>
<tr>
<td>#13 Slingerland Test 5 Error score</td>
<td>0.32816</td>
<td>0.57573</td>
<td>-0.24222</td>
<td>0.16409</td>
<td>0.37522</td>
<td>0.48777</td>
<td>0.12794</td>
<td>0.37837</td>
<td>0.23251</td>
<td>-0.40993</td>
<td>0.20787</td>
<td>1.00000</td>
</tr>
<tr>
<td>Handwriting Achievement</td>
<td>-0.63964</td>
<td>-0.52383</td>
<td>0.38999</td>
<td>-0.79927</td>
<td>-0.60755</td>
<td>-0.43671</td>
<td>-0.15749</td>
<td>-0.27087</td>
<td>-0.29123</td>
<td>-0.37101</td>
<td>0.32832</td>
<td>-0.27050</td>
</tr>
</tbody>
</table>
on "far-point" cards for only a short time. Thus, the added subskill of memory became a factor. Inclusion of the Slingerland Test 5 resulted in increments in $r^2$ which attained significance beyond the 0.01 level. The obtained multiple $r$ of 0.69295 indicates that Slingerland Tests 1 and 5 letter scores might be expected to account for approximately 48 percent of the criterion variance in a cross-validation study employing a similar sample.

Examination of the regression procedure indicates that both variables were selected because of a high correlation with the criterion (Table 14) and relative independence from each other (Table 23). That is, the Slingerland Test 5 letters score functions to subtract variance unrelated to writing skills involved in copying a paragraph (Slingerland Test 1 letter score), thus improving prediction by approximately 7 per cent. Further, performance on the Slingerland Test 5 letter score alone accounts for approximately 27 per cent of the criterion variance, 7 per cent of which is unrelated to writing skills as accounted for by the Slingerland Test 1 performance.

Variable 3, Word Discrimination Test. The third variable selected, the Word Discrimination Test, measures visual discrimination. Inclusion of the Word Discrimination Test resulted in increments in $r^2$ which attained significance beyond the 0.01 level. The obtained multiple $r$ of 0.72076
indicates that the three variables might be expected to account for approximately 52 per cent of the criterion variance. Of the variables thus far discussed, Word Discrimination Test is the only test administered which does not require actual writing. In lines containing five groups of letters, the student must use "long-term" memory to select the one group of letters which is a word, from among the others which are close visual approximations. The skills necessary to make these visual discriminations and word choices appear undefinable, but important in handwriting achievement. The Word Discrimination Test performance alone accounts for over 27 per cent of the criterion variance, almost 4 per cent of which is unrelated to writing skills as accounted for by the previous two variables, Slingerland Tests 1 and 5.

Variable 4, Slingerland Test 1, Copying Chart, Space Score. The fourth variable selected is the Slingerland Test 1 space score. The space score showed a correlation of -0.29927 with the criterion. While this performance alone accounts for approximately 9 per cent of the criterion variance, inclusion of the Slingerland Test 1 space score with the scores of the first three variables results in a multiple r of 0.73625. This is only an increase of 2 percentage points, but the four variables account for a total of 54 per cent of the criterion variance.
Variable 5, Slingerland Test 2, Copying-Page, Letter Score. This fifth variable is the last of the letter scores. Test 2 of the Slingerland requires the subjects copy letters and numerals from a "near" model, symbols printed on the same page. The fact that all three letter scores are included in the first five variables selected indicates that each has a high correlation with the criterion and relative independence from each other. Inclusion of the Slingerland Test 2 letter score results in increments in $r^2$ which attains significance beyond the 0.01 level. The obtained multiple $r$ of 0.74783 indicates that the five variables might be expected to account for a total of almost 56 per cent of the criterion variance. Although performance on Slingerland Test 2 (letter score) alone accounts for approximately 37 per cent of the criterion variance, only a little over 1.7 per cent is unrelated to the other four variables and unaccounted for by them.

Variable 6, Bender Gestalt Test for Young Children. Six additional variables were also included in the final regression equation. Addition of these variables resulted in slight but significant ($p > .01$) increments in prediction. Only the first of these, however, adds close to one per cent (0.00913) to the prediction equation. This variable, added on step six, is the error score of the Bender Gestalt Test for Young Children which showed a correlation of -0.43471 with the criterion. Performance on the Bender
Gestalt alone accounted for approximately 19 per cent of the criterion variance, and inclusion of the Bender Gestalt score with the scores of the first five variables results in a multiple $r$ of 0.75391, and account for a total of 56.8 per cent of the criterion variance.

Selected as a test of visual-motor integration as indicated by the child's ability to copy the Bender Gestalt designs, the Bender was selected as the first predictor in the primary battery and accounts alone for 19 per cent of the criterion variance. It should be noted that with the inclusion of the letter scores and space scores in the secondary battery equation, the results of the Bender Gestalt become less critical. Now, added to the secondary battery prediction equation on step six, the Bender Gestalt score increases the $r^2$ by .9 per cent. Evidently, the Bender Gestalt has value for predicting handwriting achievement, but a sampling of actual writing provides more information when properly scored.

Variable 7, Slingerland Test 4, Visual Discrimination Error Score. Added on step seven is the variable Slingerland Test 4 error score. The seven variables now attain a multiple $r$ of 0.75551, and account for a total of 57 per cent of the criterion variance. This test is a visual discrimination task which requires no writing. The correct response is merely circled. Model words are presented on the page and below each word are four similar choices, only one of which is exactly like the model word. It is not surprising
that this variable shows the lowest correlation with the criterion, handwriting achievement, (-0.16740) and contributes only .24 per cent to the total of 57 per cent of the criterion variance accounted for by the seven variables.

Variable 8, Slingerland Test 2, Copying Page, Space Score. Slingerland Test 2 space score is added to the equation on step eight. This score increases the total variance accounted for by only .23 per cent. The eight variables attain a multiple r of 0.75706 and account for a total of 57.3 per cent of the criterion variance. Slingerland Test 2 space score is a count of the "spacing errors" on the test. The Test 2 letter score already entered the equation on step five, and the error score for this test is considered on step ten. The importance of the alternative scores is apparent (Table 23) in their relative contribution to the prediction equation.

Variable 9, Slingerland Test 3, Visual Perception-Memory, Error Score. The last subtest of the Slingerland battery is introduced on step nine with the addition of the error score of Test 3. This test requires the subject to make a visual discrimination with memory as a factor. Although this task is similar to that of the Word Discrimination Test and Slingerland Test 4, Visual Discrimination error score, which have already been included in the equation, and the amount of additional variance which can be accounted for by its inclusion is minimal, an analysis of variance at
this point indicates an f-value significant beyond the 0.01 level. Alone, the Slingerland Test 3 error score correlates highly with handwriting achievement (r = 0.29133) and accounts for almost 8.5 per cent of the criterion variance. However, when included in the equation with the other eight variables, it adds only .05 per cent to the amount of variance accounted for by the equation. The nine variables account for 57.35 per cent of the criterion variance.

**Variable 10, Slingerland Test 2, Copying Page, Error Score.** On step ten, the variable Slingerland Test 2 error score is added to the equation and increases the total variance accounted for by only .011 per cent. The ten variables attain a multiple r of 0.75750 and account for a total of 57.381 per cent of the criterion variance.

**Variable 11, Developmental Test of Visual-Motor Integration.** The last variable which is added to the prediction equation is entered for the first time on step eleven, the Developmental Test of Visual-Motor Integration. Similar to the Bender Gestalt which entered the equation on step six, this test requires the subject to copy geometric forms. Alone, the VMI correlates highly with achievement in handwriting (r = .34283) and accounts for approximately 11.7 per cent of the criterion variance. However, when included with the other ten variables, the VMI increases the total variance accounted for by only .007 per cent, and brings the
total variance accounted for to 57.388 per cent. Analysis of variance for this multiple correlation coefficient (0.75755) yields 13.35 (significant beyond .01) as seen in Table 24.

**Variable 12, Slingerland Test 1, Copying Chart, Error Score; and Variable 13, Slingerland Test 5, Visual Perception-Memory-Copying, Error Score.** Further computation through stepwise multiple regression procedures indicates that the inclusion of these last two variables, error scores of Slingerland Tests 1 and 5, does not yield an f-level or tolerance-level sufficient to justify the use of twelve or thirteen variables. Although the error score of Slingerland Test 1 shows a correlation of -0.27050 with the criterion and alone accounts for 7 per cent of the criterion variance, and the error score of Slingerland Test 5 shows a correlation of -0.41499 with the criterion and alone accounts for 17 per cent of the criterion variance, when included with the other eleven variables in the prediction they do not significantly improve the predictability.

Including the last five variables of the equation, Developmental Test of Visual-Motor Integration, error scores of Slingerland Tests 2, 3, and 4, and space score of Slingerland Test 2, results in only a little more than half-a-percent (0.0055) increase in predictability. Consequently, including them in a predictive battery would be of questionable value.
Summary. The regression equation, for the secondary battery of thirteen variables, can be readily interpreted. The alternate method of scoring, using letter scores and space scores, provides five of the first eight variables entered in the equation. The letter score of the Slingerland Test 1 is the most effective single predictor of Handwriting Achievement. This score alone accounts for over 40 per cent of the criterion variance. When combined with the letter score of Slingerland Test 5, over 48 per cent of the variance of the criterion can be accounted for. The addition of the Word Discrimination Test increases by four per cent the amount of variance accounted for by the equation. Using the space score of Slingerland Test 1 provides a little over 2 per cent more variance accountability without administering an additional test. The letter score of Slingerland Test 2 increases the amount of variance accounted for by almost two per cent. Use of the Bender Gestalt Test for Young Children score adds a little less than one per cent. These six variables, provided for by the Slingerland Tests 1, 2, 5 and the Word Discrimination Test and the Bender Gestalt Test for Young Children, account for over 56.8 per cent of the criterion variance.

The additional administration of Tests 3 and 4 of the Slingerland and the Developmental Test of Visual-Motor Integration would provide five more variables (error score of Slingerland Tests 2, 3, 4; space score of Test 2; and
VMI score), but add only .55 per cent to the variance accounted for by the equation. These last five variables are similar enough to the previous variables that little new variance could be accounted for by their inclusion in the equation. Thus, though eleven of the thirteen variables prove to be of sufficient discriminatory value to be included in the secondary battery prediction equation, accounting for over 57.3 per cent of the variance, the first six variables are sufficient to account for 56.8 per cent of the variance.

Hypothesis: A battery of tests can be determined which may be administered early in first grade to predict and identify handwriting difficulties.

Conclusion: When the information from the Slingerland tests is not maximized through the alternate method of scoring, the primary battery accounts for only 38 per cent of the variance. However, there would be no advantage to administer the tests and not maximize the scoring. Therefore, the secondary battery, which accounts for about 57 per cent of the variance, qualifies for serious consideration.

Administration of the Slingerland Test 1 provides a score which alone accounts for over 40 per cent of the variance. For a child who has attained "some" handwriting skill, this short and easily administered test is valuable as a valid indication of his classroom handwriting achievement, and would provide a standardized sample to identify specific difficulties and errors in his handwriting.
Analysis of Specific Inter-Test Correlations

Hypothesis: Handwriting evaluated in a testing situation through the use of a task-oriented test correlates with evaluations of handwriting done by first graders in the classroom.

Conclusion: When the handwriting done on a task test (Slingerland tests) is scored for letter formation accuracy (letter scores), the highest correlations with classroom handwriting are achieved (Table 26). When the testing requires the student to copy a paragraph of about four sentences from a far-model, such as a chart on the wall, the writing sampled is most similar to classroom handwriting.

Hypothesis: First graders' performances on tests developed as process-oriented assessments to evaluate visual perception, motor coordination, and visual-motor integration, correlate with evaluations of handwriting done by first graders in the classroom.

Conclusion: Since no test of motor coordination was administered, the two tests of visual-motor integration (Bender Gestalt Test for Young Children and the Developmental Test of Visual-Motor Integration) and the visual perception test (Word Discrimination Test) are considered here. The Bender correlation with handwriting was the highest of the three, $r = -0.43471$, but the correlation of the visual perception test was higher than the other test of visual-motor integration (Table 27).
Hypothesis: First graders' performances on various tests of visual perception are significantly correlated.

Conclusion: Examination of correlations among the Word Discrimination Test; Slingerland Test 3, Visual Perception-Memory; and Slingerland Test 4, Visual Discrimination, reveals that only the Word Discrimination Test and Slingerland Test 3 correlate highly. This indicates that visual perception tasks required on both these tests are similar. Evidently the memory factor required in both makes a significant difference in this correlation ($r = -0.45716$) (Table 28).

Hypothesis: First graders' performances on two tests of visual-motor integration are significantly correlated.

Conclusion: The Bender Gestalt Test for Young Children and the Developmental Test of Visual-Motor Integration achieved a high correlation ($r = -0.52305$). As expected, this correlation of the two visual-motor integration tests is higher either of the two correlated with handwriting achievement (Table 29).

Hypothesis: First graders' performances on the process tests and the task tests administered are significantly correlated.

Conclusions: The Word Discrimination Test, the first of the process tests to be considered here, was most highly correlated with the visual perception test of the Slingerland Tests (Test 3, Visual Perception-Memory) as expected.
This correlation of -0.45716 was followed by the correlation of -0.31111 (Slingerland Test 2, Copying Page, letter score). These two correlations suggest that visual perception development has relevance for handwriting achievement. The visual discrimination subtest of the Slingerland (Test 4, error score) correlated next most highly, although it only required circling of like words after fine discrimination of similar words in a list. (Table 30)

When comparing the Bender performance with other tests, higher correlations are evident than when other process tests are compared. As previously noted, the Bender is most highly correlated ($r = -0.52305$) with the Developmental Test of Visual-Motor Integration. (Table 31) Slingerland Test 5, Visual Perception-Memory-Copying, both letter score and error score correlate next most highly with the Bender. Evidently the requirements for successful completion of the Bender designs are similar to those for successful copying, from memory, words, phrases, and designs from cards presented for ten seconds viewing. The next level of correlations result with the Slingerland Test 2 and Test 1 which require copying a paragraph from a wall chart and words or phrases from the top of a page.

The tests which rank the highest in correlation with the Developmental Test of Visual-Motor Integration are the same tests which correlate highest with the Bender. This
confirmation of similarity of visual-motor integration tests was expected. The Bender correlated more highly with Handwriting Achievement \(r = -0.43471\) than did the Developmental Test of Visual-Motor Integration \(r = 0.34283\) and this tendency of Bender superiority over the VMI test is noticeable in the other correlations also (Table 32).
CHAPTER V

DISCUSSION, LIMITATIONS, IMPLICATIONS, AND SUMMARY

The importance of a procedure for reliable early identification of children with potential learning difficulties has been recognized in the field of education. Early identification can result in preventive strategies to reduce the large number of children who later manifest learning disabilities and concomitant behavioral-emotional reactions (Goldberg & Shiffman, 1972). Learning disabilities may be evident in one or more areas of deficiency, evidenced in speech, language, perception, behavior, reading, spelling, writing, or arithmetic (Strauss & Lehtinen, 1947; Strauss & Kephart, 1955; Bannatyne, 1968).

Many of the more commonly noted behavioral correlates of children labeled learning disabled are those involved in writing. Examples of these writing correlates include reversal of letters or words in writing, lack of hand preference, illegible handwriting, confused spatial orientation, problems of laterality and directionality, memory disorders, and impaired visual perception (Myklebust & Johnson, 1962). Yet, comparatively little research and development of remediation techniques and materials have been done in the area of
writing as compared with the other stated areas of deficiency (Chalfant & Scheffelin, 1969; Johnson & Myklebust, 1967).

Early preventive assessment and preventive teaching strategies are critical in the field of learning disabilities (Koppitz, 1973). Diagnostic teaching requires a continuous, evaluative process (Stephens, 1970; Telford & Sawrey, 1972). Assessment devices must be chosen for their efficacy and specificity. The educator is probably most ill-equipped with respect to the availability of standardized diagnostic tests for writing disorders (Chalfant & Scheffelin, 1969).

**Statement of the Problem**

The identification of children most likely to experience difficulty in learning correct letter formation and correct writing techniques is important early in the instructional process. Early identification could obviate the necessity for remedial instruction which is so often difficult, inefficient, or neglected. Individualized, preventive teaching could be initiated for the few "high risk" students.

The major thrust of this investigation was (a) to review available assessment instruments of handwriting skills and writing subskills such as visual perception, motor coordination, and visual-motor integration; and (b) to administer a selected few of these instruments to determine their contribution to a battery to predict handwriting achievement.
Determination of Instruments

Task Assessment

Of the several instruments reviewed, the Slingerland subtests (Screening Tests for Identifying Children with Specific Language Disability, 1970) alone met the need for an instrument which provided instructional information regarding handwriting (Wallace & Kauffman, 1973). It alone is designed to assess "various aspects of sensory-motor functioning through varying the tasks" (Slingerland, 1970). The five subtests selected from the Slingerland for administration in this investigation required writing under various conditions and so elicited various aspects of sensory-motor functioning, commonly known as handwriting.

Process Assessment

Handwriting has been established to be a perceptual-motor skill involving perceptual and muscular control (Hildreth, 1936; Myers, 1963). Thus, the process-oriented tests desired were those which assessed, as isolated as possible, (a) visual perception and discrimination, (b) muscular control or fine-motor coordination, and (c) visual-perceptual-motor integration.

Visual perception and discrimination. Of the several instruments reviewed which assess visual perception, the one chosen because of minimal motor involvement was the Word Discrimination Test (Huelsman, 1949). It is designed
to test the child's visual perception of word form and requires only that the subject circle the one word in a line composed of groups of letters.

Muscular control or fine-motor coordination. Of the several assessment devices reviewed in this area, most emphasized gross motor coordination. The one assessment device which tested fine motor coordination (Ayres, 1964) was not included in the battery because its limited age range made it inappropriate for this investigation. Therefore, no assessment device of fine-motor coordination alone was included in this battery.

Visual-motor development and visual-motor integration. The Bender Gestalt Test for Young Children (Koppitz, 1963) was included as one of the assessment devices in this investigation because it has stood the tests of time, wide usage, and extensive research. Among the testing devices available in the area of visual-motor assessment, the Bender Gestalt is a classic.

Most of the tests for visual-motor development were variations of the Bender or used simplified geometric forms to assess visual-motor skills. The Developmental Test of Visual-Motor Integration (VMI) (Beery, 1967) was chosen from the group using geometric forms because of its construction and emphasis. It continues the age expansion downward from the Bender and so can be easily used with young children. It has a developmental basis not apparent in the Bender
construction. These characteristics were desired in this investigation.

**Procedure**

**Collection of Data**

First grade students attending the two elementary schools in a small, mid-Ohio local school district were administered the battery of tests and subtests in the spring of 1976. In addition, two samples of written papers from each student (N=124) were collected by the classroom teachers and scored by two judges.

**Statistical Methodology**

1. To provide a statistical description of the sample population, Pearson correlation coefficients were computed among the variables of Grasp, Dominance, and Achievement. Means and standard deviations from the standardized tests administered were examined.

2. To analyze the judges' evaluations of the handwriting samples, Pearson correlation coefficients were computed for interjudge and intrajudge reliability.

3. To determine a predictive battery of handwriting achievement, stepwise multiple regression analysis was employed. The eight independent variables (the error scores from the five Slingerland subtests, the Bender, and the scores from the Developmental Test of Visual-Motor-Integration
and the Word Discrimination Test) were regressed upon the dependent variable (the handwriting achievement scores) to determine the Primary Battery.

4. To determine the value of alternative scoring methods of the Slingerland subtests, Pearson correlation coefficients were computed for the letter scores and space scores. These two alternative scoring methods were compared with the primary scoring method which yielded error scores.

5. To determine a secondary predictive battery for handwriting achievement, stepwise multiple regression analysis was employed. The five alternative scoring variables (letter scores on Slingerland subtests, 1, 2 and 5, and space scores on Slingerland subtests 1 and 2) were included with the primary scoring of the five Slingerland subtests (error scores), the Bender error scores, and the scores from the Developmental Test of Visual-Motor Integration and the Word Discrimination Test for a total of thirteen independent variables. These independent variables were regressed upon the dependent variable (the handwriting achievement scores) to determine the Secondary Battery.

Discussion of Results

Description of Sample Population

The 124 students in the sample evidenced a typical dominance distribution; fifteen per cent were left-handed, and 85 per cent were right-handed. However, the correlation
between dominance and achievement was very low. Although the pencil grasp used by the students was easily distinguished in qualitative terms, the very slight correlation between grasp and achievement indicated that children develop quality handwriting despite various finger grasps, and that correct positioning does not insure good writing results. The "preferred" grasp was evidenced, however, by the right-handed students in a greater proportion than by the left-handed students. Examination of the means and standard deviations achieved by the sample on the standardized tests administered indicated that this sample of first graders fell within the average range (i.e., ± 1.0 S.D.).

Handwriting Achievement Evaluations

For use in rating the classroom samples of the students' writing, a scale of seven points was devised. With seven representing the best samples, five was considered to be midpoint or "average" performance. The need to allow for fewer gradients of above-average performance and more gradients of below-average performance is an indication of the lack of proficiency in manuscript writing apparent in these first graders. It is a still-developing skill for most of the students. So, it would appear that assessments near the end of first grade are not too late to identify students needing individualized instruction.

The 124 students achieved a mean score of 3.99 per writing sample. This low average is another indication of the
lack of mastery of manuscript writing skills by the end of first grade. This is particularly significant when one considers the amount of written work produced daily by first grade students.

Both intrajudge and interjudge reliability were evident in the means, standard deviations, and correlations computed. The highest correlations resulted when the two judges' scorings were compared for the same writing samples (interjudge reliability). This indicated that there was more variation in students' performances than in judges' evaluations or scores. The sorting method used for judging handwriting achievement was considered reliable.

It was evident also in the samples of writing received from the various first grade classrooms, that many different levels of handwriting demands are placed on first graders. The samples varied from filling in blanks with single letters or words copied from elsewhere on the page, to creative writing of several sentences in length. Some students maintained good letter formation and quality handwriting through all levels of writing, while others' writing seemed to deteriorate on the longer tasks. These observations were not investigated as a concern of this research, but could provide a basis for further investigation.

Determining a Predictive Battery for Handwriting Achievement

The primary battery investigated revealed that some of the process tests (Bender Gestalt Test for Children and the
Developmental Test of Visual-Motor Integration) correlated more highly with handwriting achievement than the task tests (Slingerland subtests). The correlations received with the Bender Test may be due to the complexity of the angles and the spatial relationships which must be maintained in copying the Bender designs. The simpler geometric shapes of the Developmental Test of Visual-Motor Integration are apparently less appropriate for children of about seven years of age when one is interested in sampling fine-motor control in order to make judgments relative to writing capability.

Visual-motor integration as indicated by performance on the Bender, visual discrimination as measured by the Word Discrimination Test, and writing tasks which vary conditions and demands as evident in the Slingerland Tests 1, 2, and 5, can be used as a predictive battery for handwriting achievement when administered in mid- to late-first grade. The importance of the visual discrimination measure (Word Discrimination Test) to supplement the information received from the Bender was glaring. Both tests correlated highly with handwriting achievement and yet contributed unique information to a prediction equation.

The next three scores which appeared in the regression equation were from the task tests, the Slingerland Tests 1, 2, and 5 error scores. These tasks included copying from a model which has been removed, so that memory is a factor. Each of these writing tasks is enough different
from each other to provide unique information about handwriting achievement. Again, it can be seen that varied conditions of the writing task need to be considered when requiring writing from first graders.

Examination of Alternate Scoring Methods

The value of the Slingerland as a task-oriented assessment device was explored by the examination of various methods of scoring the subtests. The error scores were the basic or primary scores used in the analysis of the subjects' performance as described in the Slingerland manual (1970), and used in the Primary Battery. However, letter scores and space scores, despite their more subjective nature, proved to be of significant value. The high correlations of letter scores (Slingerland Tests 1, 2, and 5) with the handwriting achievement scores indicated that handwriting samples in a testing situation were indicative of classroom writing. The writing task which most highly correlated with the classroom samples of writing was the one (Slingerland Test 1) which required the student copy from a far-model, a paragraph which had been printed on a card. This subtest resulted in an entire page of writing, which necessitated the duration of effort inherent in much classroom writing.

The recognition of correct spacing of words was less critical to "good handwriting" than was correct letter formation. However, space scoring did correlate highly with writing achievement and represented a different aspect of writing
than was represented by letter scores or error scores. This became more evident when the secondary battery was examined.

Examination of the Secondary Battery for Predicting Writing Achievement

The secondary battery is a result of using the alternative scoring methods on the Slingerland Tests, which yields letter scores and space scores. More variance (19.4 per cent more) could be accounted for by the secondary predictive battery than by the primary battery. Accounting for 57.4 per cent of the variance of handwriting achievement indicates a high level of correlation and predictability in comparison with that obtained for most readiness batteries (Dykstra, in Buros, 1972).

In the secondary battery, the task instrument (Slingerland tests) proved to be of more value in determining handwriting deficiencies than the process instruments (Word Discrimination Test, Bender Test). However, the type of scoring employed on the Slingerland was critical to the value received by its administration. Slingerland Test 1, copying a paragraph from a far chart, which is then scored by counting the letters or numerals which are not "perfectly formed" (letter score), alone accounts for approximately 41 per cent of the variance in handwriting achievement. The recommended seven variables of the primary battery accounted for only 38 per cent of the criterion variance.
Now, by making the task test more similar to the actual classroom writing demands (a whole page, copied from a distance) and scoring for accuracy of letter formation rather than only omissions or gross distortions, the best predictor of handwriting achievement is achieved. The child must only do some actual writing under simulated classroom demands and the resultant product, when evaluated critically, is highly indicative of classroom performance.

With these results it might appear that there would be no need to examine other tests. However, the next task test (Slingerland Test 5) does provide a different task for the student by the addition of a memory factor. Words, phrases, numerals, and geometric shapes are written by the student (from memory) after having been shown them on far-point cards for only a short time. Evidently, memory is a critical factor in handwriting which is not sufficiently assessed by the copying from a far-model (Slingerland Test 1).

The Word Discrimination Test, which does not require any writing, (only drawing circles around words), appears next in the multiple regression procedures. The visual discrimination skills or the long-term memory abilities which appear to be critical to this test apparently are also important in handwriting achievement. What the visual discrimination skill might be that makes a unique contribution to predicting handwriting achievement, even after two task tests have been included, is a dilemma for future investigations.
Examination of Specific Inter-Test Correlations

The Slingerland Test 1, Copying Chart, provides a valid sample of a child's classroom handwriting. However, the scoring must be that method (letter scores) which looks at letter formation accuracy. Having the child copy a paragraph of four or five lines from a wall chart provides the examiner with a writing sample which can be compared periodically through the school years for improvement or regression of the handwriting skill. In addition, with the young child of first grade age, much observational data can be obtained from viewing the writing habits and attention to task involved in the completion of this task.

The value of the administration of the Bender Gestalt Test for Young Children to children of first grade age has been supported by this investigation. Although it does not provide as much information relative to handwriting abilities as is obtained when one has the child do writing under standardized conditions possible through the administration of the Slingerland Test 1, the high correlations of the Bender with the various Slingerland subtests (Table 31) do indicate that the skills involved in the completion of the Bender designs are quite similar to skills involved in the handwriting process. Administration of the Bender to kindergarten children with correlations computed for handwriting achievement attained in later years is a suggestion for future research.
The value of the Bender, as compared to that of the Developmental Test of Visual-Motor Integration, has been verified in this investigation. For children of late-first grade age, the Bender is efficient and more discriminating for evaluating that "visual-motor integration" ability than is the Developmental Test.

Tests of visual perception examined in this investigation were of value when a memory factor was involved. The factor of memory which is a part of handwriting is important even when copying from a far-model or a near-model. The investigation of other tests of visual perception and a test of visual memory might provide a more suitable battery for predicting handwriting achievement.

Applicability of the Predictive Battery

Hypothesis: A battery of tests can be determined which may be administered early in first grade to predict and identify handwriting difficulties.

Conclusion: The Secondary Battery for predicting handwriting achievement and identifying handwriting difficulties has significant value when administered near the middle or end of first grade to determine those who need intensive instruction in handwriting. It is important to note that:

1. Both process- and task-instruments contributed significantly to a predictive battery of handwriting achievement.
   a) The Bender Gestalt Test for Young Children (test of visual-motor integration) and the Word Discrimination Test.
(test of visual discrimination) provided data relevant to handwriting achievement. They contribute most when actual writing is not available, or when the scoring of the task device is not maximized, as was the case in the Primary Battery investigated.

b) The Slingerland Tests (the task devices) provided the highest correlations with classroom handwriting performance when scored with letter and space scores (Secondary Battery).

c) The task assessment device, Slingerland Test 1, Copying Chart, when scored for letter formation accuracy provides a score which accounts for more of the variance in handwriting achievement than the complete primary battery.

2. It is possible to adequately sample handwriting in a testing situation.

a) The value of the handwriting assessment depends on the variation in the writing tasks. That is, the writing sample provides the most information when sampled under varying conditions. The Slingerland Tests 1, 2, and 5 have proven quite adequate in this regard.

However, certain limitations should be noted in considering the Secondary Battery of tests for predicting handwriting achievement:

1. The scoring which is of most value in the battery, letter scores and space scores of the Slingerland Tests are the most subjective in the entire battery.
2. Because the greater component in this equation is the performance on the tests which require handwriting, its administration must wait until some writing skills have been acquired. In order to best predict the students who will have difficulty gaining good handwriting skills, it is necessary to wait until it can be shown how well they are learning to write.

3. It is apparent that handwriting is a complex visual-motor skill which involves the integration of many subskills not yet identifiable for assessment in isolation. This battery of process tests did not adequately isolate or identify these subskills.

Implications for Improved Handwriting

The Slingerland Test 1, Copying Chart; Test 2, Copying Page; and Test 5, Visual Perception-Memory-Copying, could be administered near the middle of first grade and repeated at the end of first grade to provide an indication of progress in handwriting development of individual children. Administered in mid-first grade, it would provide specific skill needs information for individual students which could provide the basis for individual or small group instruction.

Used with successive groups of first graders, the tests could provide a focus of attention on handwriting and suggest a basis for possible revisions in the techniques of teaching handwriting.
The regular collection of writing samples (several times during a school year) using the Slingerland Tests for students at all levels of schooling would provide a basis for peer comparison of progress, evaluation of individual improvement, and establishment of grade level standards. The value of samples under varying conditions--copying far, copying near, and copying with memory--is evident and available through the administration of the Slingerland Tests.

The wide range of handwriting samples, with the majority evidencing a lack of writing proficiency, indicates that first graders vary considerably in the amount of instruction, as well as type of instruction, required to continue growth in handwriting. Individualized instruction and/or a revised approach in techniques for teaching handwriting appear warranted.

**Limitations of the Study**

As a preliminary step toward the assembly of a predictive battery of handwriting achievement, this investigation had some limitations:

1. The writing samples evaluated to determine handwriting achievement varied from classroom to classroom, both in content and conditions under which they were written. Judging would have been simplified and perhaps more reliable if two specific samples, each copied under different, designated conditions, had been required from each class.

2. The visual discrimination test selected, Word Discrimination Test, required some ability to read. It may be that
the correlation between the Word Discrimination Test and handwriting was in fact a correlation between ability to learn to read and ability to learn to write rather than a correlation of visual discrimination or visual perception and handwriting achievement. A multiple-choice or matching test of designs or letters might have provided a "purer" test of visual perception. Since none was available at the time, such a test might have been developed for this investigation. One is now available for future research.

3. The letter and space scoring methods used on the Slingerland tests were not objectively described in the Slingerland manual (1970b). Establishment of a standard for determining satisfactory letter formations and spacing (such as through the use of overlays) would greatly enhance the value of the tests from examiner to examiner.

4. The selection of process instruments might have been strengthened by the inclusion of a gross-motor test. The additional time and personnel needed for administration of such a test might have made its inclusion in a regularly administered battery impractical. However, it might have provided more information relative to the relationship between motor development, both physiologically and on-task, when handwriting.

5. There was variability among the teachers of the various classes assessed which was evident in the methods,
techniques, time, and even emphasis placed upon the instruction of writing skills. Because the investigation included all of the first grade classes, and no comparisons were made among them, these differences were not considered in this investigation. Future research of these dimensions might provide specific recommendations for classroom instruction of writing skills.

6. The selection of kindergarten or pre-kindergarten children as subjects for the administration of the various process tests would be more meaningful for predictive considerations. The followup of actual handwriting evaluations a year or two later would make the correlations between the handwriting and the process tests more meaningful. This is a possibility for future research regarding prediction of writing difficulties prior to the beginning of instruction.

7. The investigation was limited to a correlational study of the students' performance on the predictive tests and the present writing skills evidenced by the students. To appropriately determine the validity of a predictive battery, the investigation should be continued so that the students' handwriting can be evaluated at mid- or late-second grade to determine if the predictability improves or lessens. A correlation with the cursive writing skills gained in late-third grade and assessed then and in fourth grade would be of even more value.
APPENDIX A

Tables and Figures
TABLES
Table 15: Subject distribution in the various first grade classes assessed, number and mean age

<table>
<thead>
<tr>
<th>Class</th>
<th>Number of Subjects</th>
<th>Mean Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25</td>
<td>7-1</td>
</tr>
<tr>
<td>B</td>
<td>16</td>
<td>7-4</td>
</tr>
<tr>
<td>C</td>
<td>19</td>
<td>7-1</td>
</tr>
<tr>
<td>D</td>
<td>20</td>
<td>7-1</td>
</tr>
<tr>
<td>E</td>
<td>20</td>
<td>7-1</td>
</tr>
<tr>
<td>F</td>
<td>24</td>
<td>7-3</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>7-2</td>
</tr>
</tbody>
</table>

N = 124
Table 16: Results of individually administered assessments using the Stanford-Binet Intelligence Scale with twenty-nine of the students who were first graders in May, 1976

<table>
<thead>
<tr>
<th>Identification Number</th>
<th>Assessment Date</th>
<th>Stanford-Binet Intelligence Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5/14/76</td>
<td>113</td>
</tr>
<tr>
<td>2</td>
<td>10/13/75</td>
<td>113</td>
</tr>
<tr>
<td>3</td>
<td>12/2/76</td>
<td>112</td>
</tr>
<tr>
<td>4</td>
<td>2/25/76</td>
<td>109</td>
</tr>
<tr>
<td>5</td>
<td>5/21/76</td>
<td>108</td>
</tr>
<tr>
<td>6</td>
<td>1/16/76</td>
<td>106</td>
</tr>
<tr>
<td>7</td>
<td>1/7/76</td>
<td>106</td>
</tr>
<tr>
<td>8</td>
<td>5/7/76</td>
<td>105</td>
</tr>
<tr>
<td>9</td>
<td>2/10/76</td>
<td>101</td>
</tr>
<tr>
<td>10</td>
<td>5/14/76</td>
<td>101</td>
</tr>
<tr>
<td>11</td>
<td>2/25/76</td>
<td>100</td>
</tr>
<tr>
<td>12</td>
<td>4/15/75</td>
<td>99</td>
</tr>
<tr>
<td>13</td>
<td>1/23/76</td>
<td>98</td>
</tr>
<tr>
<td>14</td>
<td>3/6/76</td>
<td>92</td>
</tr>
<tr>
<td>15</td>
<td>11/6/75</td>
<td>90</td>
</tr>
<tr>
<td>16</td>
<td>4/10/75</td>
<td>90</td>
</tr>
<tr>
<td>17</td>
<td>12/4/75</td>
<td>90</td>
</tr>
<tr>
<td>18</td>
<td>4/16/75</td>
<td>90</td>
</tr>
<tr>
<td>19</td>
<td>2/15/76</td>
<td>88</td>
</tr>
<tr>
<td>20</td>
<td>4/16/75</td>
<td>87</td>
</tr>
<tr>
<td>21</td>
<td>3/5/75</td>
<td>87</td>
</tr>
<tr>
<td>22</td>
<td>1/17/76</td>
<td>83</td>
</tr>
<tr>
<td>23</td>
<td>4/10/75</td>
<td>83</td>
</tr>
<tr>
<td>24</td>
<td>5/24/76</td>
<td>83</td>
</tr>
<tr>
<td>25</td>
<td>11/6/75</td>
<td>82</td>
</tr>
<tr>
<td>26</td>
<td>5/7/76</td>
<td>82</td>
</tr>
<tr>
<td>27</td>
<td>5/7/76</td>
<td>79</td>
</tr>
<tr>
<td>28</td>
<td>6/3/76</td>
<td>76</td>
</tr>
<tr>
<td>29</td>
<td>12/3/75</td>
<td>69</td>
</tr>
</tbody>
</table>
Table 17: Coding and scoring key for variables examined in the investigation of handwriting achievement and visual-motor-perception abilities of first grade students

<table>
<thead>
<tr>
<th>Variable</th>
<th>Scoring Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td><strong>D</strong></td>
</tr>
<tr>
<td>Grasp</td>
<td><strong>G</strong></td>
</tr>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td><strong>BG</strong></td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td><strong>VMI</strong></td>
</tr>
<tr>
<td>Word Discrimination Test</td>
<td><strong>WDT</strong></td>
</tr>
<tr>
<td>Handwriting Achievement</td>
<td><strong>1</strong> = Unreadable, messy</td>
</tr>
<tr>
<td></td>
<td><strong>2</strong> = Very poor</td>
</tr>
<tr>
<td></td>
<td><strong>3</strong> = Poor</td>
</tr>
<tr>
<td></td>
<td><strong>4</strong> = Fair</td>
</tr>
<tr>
<td></td>
<td><strong>5</strong> = AVERAGE, Good</td>
</tr>
<tr>
<td></td>
<td><strong>6</strong> = Very good</td>
</tr>
<tr>
<td></td>
<td><strong>7</strong> = Excellent</td>
</tr>
</tbody>
</table>
Table 18: Means and standard deviations of Slingerland subtests' error scores, letter scores, and space scores of first grade children in Clear Fork Valley Schools, 1976

<table>
<thead>
<tr>
<th>Slingerland Tests</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1 Error Scores</td>
<td>3.3306</td>
<td>2.4644</td>
</tr>
<tr>
<td>Test 2 Error Scores</td>
<td>1.2975</td>
<td>1.9776</td>
</tr>
<tr>
<td>Test 3 Error Scores</td>
<td>0.8760</td>
<td>1.0533</td>
</tr>
<tr>
<td>Test 4 Error Scores</td>
<td>0.6777</td>
<td>1.0264</td>
</tr>
<tr>
<td>Test 5 Error Scores</td>
<td>3.0826</td>
<td>2.1587</td>
</tr>
<tr>
<td>Test 1 Letter Scores</td>
<td>13.2562</td>
<td>11.6043</td>
</tr>
<tr>
<td>Test 2 Letter Scores</td>
<td>4.5536</td>
<td>5.9104</td>
</tr>
<tr>
<td>Test 5 Letter Scores</td>
<td>3.5537</td>
<td>2.9466</td>
</tr>
<tr>
<td>Test 1 Space Scores</td>
<td>3.0000</td>
<td>3.7171</td>
</tr>
<tr>
<td>Test 2 Space Scores</td>
<td>1.5289</td>
<td>1.5115</td>
</tr>
</tbody>
</table>

N = 121
Table 19: Using the three scoring methods described by the author*, means and standard deviation scores on the Slingerland Tests for first graders in Clear Fork Valley Schools, 1976

<table>
<thead>
<tr>
<th>Slingerland Tests</th>
<th>Error Score</th>
<th>Letter Score</th>
<th>Space Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean/</td>
<td>Mean/</td>
<td>Mean/</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>S.D.</td>
<td>S.D.</td>
</tr>
<tr>
<td>Test 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copying-Chart</td>
<td>3.33</td>
<td>13.26</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>2.46</td>
<td>11.60</td>
<td>3.72</td>
</tr>
<tr>
<td>Test 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copying-Page</td>
<td>1.30</td>
<td>4.55</td>
<td>1.53</td>
</tr>
<tr>
<td></td>
<td>1.98</td>
<td>5.91</td>
<td>1.51</td>
</tr>
<tr>
<td>Test 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual-Perception-Kemory</td>
<td>.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Discrimination</td>
<td>.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual-Perception-Memory-Copying</td>
<td>3.08</td>
<td>3.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.16</td>
<td>2.95</td>
<td></td>
</tr>
</tbody>
</table>

*Slingerland, 1970

N = 121
Table 20: Stepwise addition analysis of visual and motor subskills tests' scores regressed upon handwriting achievement scores of first grade children

**STEPWISE MULTIPLE REGRESSION SUMMARY TABLE PRIMARY BATTERY**

<table>
<thead>
<tr>
<th>Variable</th>
<th>r</th>
<th>Multiple r</th>
<th>r²</th>
<th>r² Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>-0.43471*</td>
<td>0.43471</td>
<td>0.18897</td>
<td>0.18897</td>
</tr>
<tr>
<td>Word Discrimination Test</td>
<td>0.38399*</td>
<td>0.55103</td>
<td>0.30363</td>
<td>0.11466</td>
</tr>
<tr>
<td>Slingerland Test 2 Error score</td>
<td>-0.37101*</td>
<td>0.59073</td>
<td>0.34896</td>
<td>0.04533</td>
</tr>
<tr>
<td>Slingerland Test 5 Error score</td>
<td>-0.41499*</td>
<td>0.60807</td>
<td>0.36975</td>
<td>0.02079</td>
</tr>
<tr>
<td>Slingerland Test 1 Error score</td>
<td>-0.27050*</td>
<td>0.61491</td>
<td>0.37812</td>
<td>0.00837</td>
</tr>
<tr>
<td>Slingerland Test 4 Error score</td>
<td>-0.16740*</td>
<td>0.61651</td>
<td>0.38008</td>
<td>0.00197</td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>0.34283*</td>
<td>0.61661</td>
<td>0.38020</td>
<td>0.00012</td>
</tr>
<tr>
<td>Slingerland Test 3 Error score**</td>
<td>-0.29133</td>
<td><strong>f-level or tolerance-level insufficient for further computation.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = significant at the .01 level
Table 21: Analysis of variance for the multiple regression of seven variables* upon handwriting achievement

PRIMAR Y BATTERY*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due to Regression</td>
<td>7</td>
<td>1915.762</td>
<td>273.680</td>
<td>9.90**</td>
</tr>
<tr>
<td>Deviation about</td>
<td>113</td>
<td>3123.031</td>
<td>27.637</td>
<td></td>
</tr>
<tr>
<td>Regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>5038.793</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Bender Gestalt Test for Young Children
Word Discrimination Test
Slingerland Test 2, Error score
Slingerland Test 5, Error score
Slingerland Test 1, Error score
Slingerland Test 4, Error score
Developmental Test of Visual-Motor Integration

** Significant at .01 level
\[ F_{7, 125}^{*} = 2.08 \]
\[ F_{7, 125}^{*} = 2.79 \]
Table 22: Pearson correlation coefficients for thirteen predictor variables and handwriting achievement

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Handwriting Achievement</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r$</td>
<td>$r^2$</td>
</tr>
<tr>
<td>Slingerland Test 1 Letter score</td>
<td>-0.63964</td>
<td>0.40914</td>
</tr>
<tr>
<td>Slingerland Test 2 Letter score</td>
<td>-0.60755</td>
<td>0.36911</td>
</tr>
<tr>
<td>Slingerland Test 5 Letter score</td>
<td>-0.52383</td>
<td>0.27440</td>
</tr>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>-0.43471</td>
<td>0.18897</td>
</tr>
<tr>
<td>Slingerland Test 5 Error score</td>
<td>-0.41499</td>
<td>0.17222</td>
</tr>
<tr>
<td>Word Discrimination Test</td>
<td>0.38399</td>
<td>0.14745</td>
</tr>
<tr>
<td>Slingerland Test 2 Error score</td>
<td>-0.37101</td>
<td>0.13765</td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>0.34283</td>
<td>0.11753</td>
</tr>
<tr>
<td>Slingerland Test 1 Space score</td>
<td>-0.29927</td>
<td>0.08956</td>
</tr>
<tr>
<td>Slingerland Test 3 Error score</td>
<td>-0.29133</td>
<td>0.08487</td>
</tr>
<tr>
<td>Slingerland Test 2 Space score</td>
<td>-0.27087</td>
<td>0.07337</td>
</tr>
<tr>
<td>Slingerland Test 1 Error score</td>
<td>-0.27050</td>
<td>0.07317</td>
</tr>
<tr>
<td>Slingerland Test 4 Error score</td>
<td>-0.16740</td>
<td>0.02802</td>
</tr>
</tbody>
</table>
Table 23: Stepwise addition analysis of visual and motor subskills tests' scores regressed upon handwriting achievement scores of first grade children, using alternative scoring methods on the Slingerland subtests

<table>
<thead>
<tr>
<th>Variable</th>
<th>r</th>
<th>Multiple r</th>
<th>r²</th>
<th>r² Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slingerland Test 1 Letter score</td>
<td>-0.63964</td>
<td>0.63964</td>
<td>0.40914</td>
<td>0.40914</td>
</tr>
<tr>
<td>Slingerland Test 5 Letter score</td>
<td>-0.52383</td>
<td>0.69295</td>
<td>0.48019</td>
<td>0.07105</td>
</tr>
<tr>
<td>Word Discrimination Test</td>
<td>0.38399</td>
<td>0.72076</td>
<td>0.51949</td>
<td>0.03931</td>
</tr>
<tr>
<td>Slingerland Test 1 Space score</td>
<td>-0.29927</td>
<td>0.73625</td>
<td>0.54206</td>
<td>0.02257</td>
</tr>
<tr>
<td>Slingerland Test 2 Letter score</td>
<td>-0.60755</td>
<td>0.74783</td>
<td>0.55925</td>
<td>0.01719</td>
</tr>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>-0.43471</td>
<td>0.75391</td>
<td>0.56838</td>
<td>0.00913</td>
</tr>
<tr>
<td>Slingerland Test 4 Error score</td>
<td>-0.16740</td>
<td>0.75551</td>
<td>0.57080</td>
<td>0.00242</td>
</tr>
<tr>
<td>Slingerland Test 2 Space score</td>
<td>-0.27087</td>
<td>0.75706</td>
<td>0.57314</td>
<td>0.00234</td>
</tr>
<tr>
<td>Slingerland Test 3 Error score</td>
<td>-0.29133</td>
<td>0.75743</td>
<td>0.57370</td>
<td>0.00056</td>
</tr>
<tr>
<td>Slingerland Test 2 Error score</td>
<td>-0.37101</td>
<td>0.75750</td>
<td>0.57381</td>
<td>0.00011</td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>0.34283</td>
<td>0.75755</td>
<td>0.57388</td>
<td>0.00007</td>
</tr>
<tr>
<td>Slingerland Test 1 Error score*</td>
<td>-0.27050</td>
<td>* f-level or tolerance-level insufficient for further computation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 5 Error score*</td>
<td>-0.41499</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 24: Analysis of variance for the multiple regression of eleven variables* upon handwriting achievement

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due to Regression</td>
<td>11</td>
<td>2891.667</td>
<td>262.879</td>
<td>13.35**</td>
</tr>
<tr>
<td>Deviation about Regression</td>
<td>109</td>
<td>2147.126</td>
<td>19.698</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>5038.793</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Slingerland Test 1, Letter score
Slingerland Test 5, Letter score
Word Discrimination Test
Slingerland Test 1, Space score
Slingerland Test 2, Letter score
Bender Gestalt Test for Young Children
Slingerland Test 4, Error score
Slingerland Test 2, Space score
Slingerland Test 3, Error score
Slingerland Test 2, Error score
Developmental Test of Visual-Motor Integration

** Significant at .01 level  \( F_{11, 125 @ .05} = 1.86 \)
\( F_{11, 125 @ .01} = 2.40 \)
Table 25: Percentages of agreement between Judge #1 and Judge #2 in their evaluations of handwriting samples

<table>
<thead>
<tr>
<th>Class</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAME</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N %</td>
<td>N %</td>
<td>N %</td>
</tr>
<tr>
<td>Class A</td>
<td>12</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>40%</td>
<td>44%</td>
<td>10%</td>
</tr>
<tr>
<td>Class B</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>34.3%</td>
<td>34.3%</td>
<td>22%</td>
</tr>
<tr>
<td>Class C</td>
<td>4</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>37%</td>
<td>47%</td>
<td>8%</td>
</tr>
<tr>
<td>Class D</td>
<td>10</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>47.5%</td>
<td>25%</td>
<td>22.5%</td>
</tr>
<tr>
<td>Class E</td>
<td>9</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>27.5%</td>
<td>10%</td>
</tr>
<tr>
<td>Class F</td>
<td>7</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>29%</td>
<td>40%</td>
<td>8%</td>
</tr>
<tr>
<td>Totals</td>
<td>98</td>
<td>91</td>
<td>32</td>
</tr>
</tbody>
</table>

N = 124 students; 248 writing samples
Table 26: Correlations of handwriting from classroom samples* and writing on the Slingerland Tests 1, 2, and 5

<table>
<thead>
<tr>
<th>Slingerland Tests</th>
<th>Error score</th>
<th>Letter score</th>
<th>Space score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1: Copying Chart</td>
<td>-0.27050</td>
<td>-0.63964</td>
<td>-0.29927</td>
</tr>
<tr>
<td>Test 2: Copying Page</td>
<td>-0.37101</td>
<td>-0.60755</td>
<td>-0.27087</td>
</tr>
<tr>
<td>Test 5: Visual Perception-Memory-Copying</td>
<td>-0.41499</td>
<td>-0.52383</td>
<td></td>
</tr>
</tbody>
</table>

* = Handwriting Achievement
Table 27: Correlation of handwriting from classroom samples* and the process-oriented assessments

<table>
<thead>
<tr>
<th>Test</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>-0.43471</td>
</tr>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>0.34283</td>
</tr>
<tr>
<td>Word Discrimination Test</td>
<td>0.38399</td>
</tr>
</tbody>
</table>
Table 28: Correlation matrix for the various tests of visual perception—Word Discrimination Test, and Slingerland Tests 3 and 4

<table>
<thead>
<tr>
<th></th>
<th>Word Discrimination Test</th>
<th>Slingerland Test 3</th>
<th>Slingerland Test 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Discrimination</td>
<td>. 1.00000</td>
<td>-0.45716</td>
<td>-0.29245</td>
</tr>
<tr>
<td>Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 3</td>
<td>-0.45716</td>
<td>1.00000</td>
<td>0.29416</td>
</tr>
<tr>
<td>Visual Perception-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 4</td>
<td>-0.29245</td>
<td>0.29416</td>
<td>1.00000</td>
</tr>
<tr>
<td>Visual Discrimination</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 29: Correlations between two tests of visual-motor integration, Bender Gestalt and Developmental Test of Visual-Motor Integration, and handwriting achievement

| Correlation                        |  
|------------------------------------|-----------------|
| **Bender Gestalt Test for Young Children** | Developmental Test of Visual-Motor Integration | -0.52305 |
| **Bender Gestalt Test for Young Children** | Handwriting Achievement | -0.43471 |
| **Developmental Test of Visual-Motor Integration** | Handwriting Achievement | 0.34283 |
Table 30: Tests which attained the highest correlations with the Word Discrimination Test

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slingerland Test 3 Visual Perception-Memory, error score</td>
<td>-0.45716</td>
</tr>
<tr>
<td>Slingerland Test 2 Copying Page Letter score</td>
<td>-0.31111</td>
</tr>
<tr>
<td>Slingerland Test 4 Visual Discrimination Error score</td>
<td>-0.29245</td>
</tr>
<tr>
<td>Slingerland Test 1 Copying Chart Letter score</td>
<td>-0.25375</td>
</tr>
</tbody>
</table>
Table 31: Tests which attained the highest correlations with the Bender Gestalt Test for Young Children

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Correlation (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developmental Test of Visual-Motor Integration</td>
<td>-0.52305</td>
</tr>
<tr>
<td>Slingerland Test 5 Visual Perception-Memory-Copying Error score</td>
<td>0.48277</td>
</tr>
<tr>
<td>Slingerland Test 5 Visual Perception-Memory-Copying Letter score</td>
<td>0.47977</td>
</tr>
<tr>
<td>Slingerland Test 2 Copying Page Letter score</td>
<td>0.40741</td>
</tr>
<tr>
<td>Slingerland Test 1 Copying Chart Error score</td>
<td>0.38584</td>
</tr>
<tr>
<td>Slingerland Test 1 Copying Chart Letter score</td>
<td>0.32636</td>
</tr>
</tbody>
</table>
Table 32: Tests which attained the highest correlations with the Developmental Test of Visual-Motor Integration

<table>
<thead>
<tr>
<th>Test Description</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bender Gestalt Test for Young Children</td>
<td>-0.52305</td>
</tr>
<tr>
<td>Slingerland Test 5 Visual Perception-Memory-Copying</td>
<td>-0.48993</td>
</tr>
<tr>
<td>Error score</td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 1 Copying Chart Error score</td>
<td>-0.36755</td>
</tr>
<tr>
<td>Slingerland Test 5 Visual Perception-Memory-Copying</td>
<td>-0.35272</td>
</tr>
<tr>
<td>Letter score</td>
<td></td>
</tr>
<tr>
<td>Slingerland Test 2 Copying Page Letter score</td>
<td>-0.33192</td>
</tr>
</tbody>
</table>
FIGURES
Figure 2. Scattergram of first graders' scores on Bender Gestalt Test for Children, May, 1976
Figure 3: Distribution of first graders' scores on Word Discrimination Test, May, 1976
Figure 4. Readiness percentile scores from Gates-MacGinitie Reading Tests—Readiness Skills, administered May 8, 1975 when present first grade children were in kindergarten
APPENDIX B

Annotated Bibliography of Assessment Devices
I. AVAILABLE DEVICES FOR ASSESSMENT OF THE HANDWRITING TASK.


Ages: Grades 2 through 8
Purpose: Rate quality of writing and speed.
Task: Write first three sentences of Lincoln's Gettysburg Address as many times as possible in two minutes.
Scoring: One set of eight samples of various qualities of cursive writing is matched with the students' writing, irregardless of grade level.
A rating score is given for speed.


Ages: Primary grades.
Purpose: Screening device for locating student with poor quality writing.
Task: Writing is sampled from the spelling test.
Scoring: A seven-point scale designates a legibility rating.


Ages: Grade 2 and above.
Purpose: Rate speed of writing.
Rate difficulties in handwriting on a checklist.
Task: Copy a paragraph from the reading selections on the test.
Scoring: Speed is scored according to grade level expectations and the number of letters per minute which are copied.
A subjective check list of handwriting difficulties noted by the examiner is completed noting: hand use, speed too slow, poor letter formation, poor position: hand, pencil, paper, eye; and irregular height, spacing, slant.


Ages: Manuscript - Gr. 1, 2, 3.
Cursive - Gr. 2 through 9.

Purpose: Rate quality of writing.

Task: Sentence or paragraph of material appropriate to grade level is copied by student.

Scoring: A separate set of five samples of writing is available for each grade.

In each set, the five samples of graduated quality of writing are grossly different.


Ages: Kindergarten students.

Purpose: Identify kindergarteners who would most likely be reading failures by end of grade two.

Task: Five tasks make up the screening component.
Ten tasks are added for the diagnostic component.

Of the fifteen tasks, three deal with visual discrimination, eight with oral language or auditory input, and four deal with writing and/or use of pencil and paper:
1) pencil use
2) Bender designs
3) name writing
4) spelling two words

Scoring: Performance on each task is rated, "poor," "fair," or "good," and the entire battery is scored for predicting reading failure, NOT handwriting failure.

Ages: One battery of tests for use in Kindergarten. Three batteries of tests for use in grade 1 through 4.

Purpose: Designed to detect symptoms of possible language disability (as revealed in written work and oral responses) in children in the primary grades.

Task: Each battery contains a series of subtests requiring the child to:

1) copy a paragraph from a wall chart;
2) copy words, phrases, and numerals from a printed page;
3) match a word on the page with one shown on a wall chart;
4) match a word on the page with one at the top of the page;
5) copy letters, words, numbers, and geometric forms onto a page, from memory as seen on exposed cards;
6) write letters, numbers and phrases from memory as dictated;
7) write initial and final sounds of dictated words; and
8) match words, numbers, and letter combinations on a printed page, with dictated items.

There is a supplementary Auditory Memory Test which requires the child to:

9) repeat multisyllable words and short phrases presented verbally.

Scoring: Errors are counted on each subtest. No norms are available. Each student's performance must be judged in comparison with his peers'.
II. AVAILABLE DEVICES FOR ASSESSMENT OF VISUAL PERCEPTION.


Ages: Eight to adult.

Purpose: Designed to assess memory perception or visual memory, and visual-motor functions. Has been used to attempt to diagnose brain injury. When administered to learning disabled children, it is used to describe the nature or extent of their difficulties in visual perception (Myers and Hammill, 1969).

Task: An individually-administered test. A number of designs are shown to the subject for a specified period of time and reproduced by him from memory.

Scoring: Objective standards are provided for scoring.


Ages: Grades one through six.

Purpose: Designed to identify perceptually handicapped children.

Task: Designs are embedded in a field of reference points in the upper half of a page in a small booklet. The student must reproduce the designs in an equivalent field in the lower half of the page. A total of 20 designs is provided.

Scoring: Rosen (in Buros, 1972) notes that this instrument is handicapped by imprecise scoring.


Ages: Three to eight.

Purpose: Designed specifically to separately test various perception skills of young children, and identify both strengths and handicaps.
Marianne Frostig (cont'd)

Task: Five "different" perceptual areas:
I. Eye-Motor Coordination,
II. Figure-Ground Discrimination,
III. Constancy of Shape (Form Constancy),
IV. Position in Space, and
V. Spatial Relationships, require a different
type of performance by the student on each
subtest.

Scoring: Present research (Silverstein, 1965; Ward, 1970)
indicates only one perception factor is being assessed.

Memory-for-Designs Test. Missoula, Montana: Psychological

Ages: 8.5 and over.

Purpose: One of the most popular tests for the assessment
of brain damage in both children and adults.
When administered to children with learning disa­
bilities, it is used to assess and describe the
nature and extent of the difficulties in visual
perception.

Task: Test material consists of fifteen cards of simple
straight line designs. The subject is shown the
cards one at a time for five seconds, after each
of which he is required to reproduce the design
from memory.

Scoring: An objective scoring system has been developed.

Standard Progressive Matrices. New York: Psychological Cor­
poration. Revised 1956. (J. C. Raven)

Ages: Six to fourteen, and mentally retarded adults.

Purpose: Described as a perception assessment device, this
is a nonverbal test series designed to aid in
assessing mental ability in solving problems
presented in abstract figures and designs.

Task: The test consists of a series of items, each ar­
ranged in matrix form, usually two by two. In
each item, some progressive feature can be dis­
tinguished, and one cell is missing. It is the
subject's task to indicate which one of four pos­
sible cell-fillers offered to him is appropriate.
Scoring: Scoring key provides an objective scoring system.


Ages: Five to fourteen, and mentally retarded adults.

Purpose: Designed to be administered individually to children five and six years of age, and in groups with older subjects. Purpose is the same as above.

Task: Same as above, with the addition of color to the matrices.

Scoring: Scoring key provides objective standards.


Ages: Grades one through eight.

Purpose: Designed to show how well students use length, internal design, and external configuration in perceiving words; that is, to test the child's visual perception of word form.

Task: In each row there is printed one word and four groups of letters that are similar but not words. The child is to circle the one word in each row.

Scoring: Correct responses are merely counted and that score matched with the norms provided to yield a grade equivalency.
II. AVAILABLE DEVICES FOR ASSESSMENT OF MOTOR SKILLS (with possible relevance for handwriting).


Ages: Six to twelve years.

Purpose: Designed to pinpoint "any areas of sensory-motor development requiring special attention" (Orpet, 1972) and can be followed with the Move-Grow-Learn Program to improve these skills.

Task: Twelve tests are performed by each student. The tests are designed to assess five factors:
   a) hand-eye coordination;
   b) strength;
   c) balance;
   d) visually guided movement; and
   e) flexibility.

Scoring: Standards for scoring provided in manual.


Ages: Four through sixteen years.

Purpose: Designed to provide a year-by-year scale of the fine- and gross-motor development of children. Conceived and executed for measurement of motor skills in the same manner as the Stanford-Binet Scale.

Tasks: Administered on an individual basis, the student is required to perform various physical acts requiring:
   a) general static coordination;
   b) dynamic coordination of the hands;
   c) general dynamic coordination;
   d) motor speed;
   e) simultaneous voluntary movements; and
   e) performance with extraneous movements.

Scoring: Adequate performances are scored and basal age and ceiling age are computed similar to the Binet, and a Developmental Age of motor proficiency is attained.

Ages: Six to ten years.

Purpose: Designed to identify those children lacking perceptual-motor abilities necessary for acquiring academic success, according to Kephart (1966).

Tasks: Administered on an individual basis, the student must perform eleven subtests, of which six are motor, two are cognitive in emphasis, and three of which are writing or drawing tasks:

a) Walking Board;
b) Jumping;
c) Obstacle Course;
d) Kraus-Weber;
e) Angels-in-the-Snow;
f) Ocular Pursuits;
g) Imitation of Movements;
h) Identification of Body Parts;
i) Chalkboard;
j) Developmental Drawings; and
k) Rhythmic Writing.

Scoring: Ratings for each task are described in varying degrees of "success" and given 4, 3, 2, or 1 points.


Ages: Four to 7-11.

Purpose: Designed to assist in making diagnosis of perceptual-motor dysfunction.

Task: The test consists of an irregular printed black line approximately 51 inches long. The line is centered before the child so that he must cross the midline of his body during the task. He is to try to trace over the line with a pencil without getting off the line.

Scoring: Each hand is used and scores are developed separately for the more accurate hand and the less accurate hand.

Ages: Four to eight years.

Purpose: Designed to assess gross-motor performance of young children.

Task: The student performs six separate tasks involving

a) imitation of postures;
b) crossing of midline of body;
c) bilateral motor coordination;
d) right/left discrimination;
e) standing balance-eyes closed; and
f) standing balance-eyes open.

Scoring: Student's performance on each task is compared with the norms for his age group and deficiencies and strengths are noted.
IV. AVAILABLE DEVICES FOR ASSESSMENT OF VISUAL-MOTOR INTEGRATION.

The Bender Gestalt Test for Young Children. New York: Grune & Stratton, Inc., 1963. (Elizabeth Munsterberg Koppitz)

Ages: Five through ten years.

Purpose: Evaluate perceptual-motor functioning.

Task: Nine figures are presented one at a time and the subject is asked to copy the figures on a blank piece of paper.

Scoring: Koppitz (1963) provided the norms for scoring this test for children when she saw the need to determine "the significance of the different distortions and deviations on the Bender Test for children of different age levels" and to "clarify objectively what level of performance can be expected from children at various ages." Specific errors are counted.


Ages: Two to fifteen years.

Purpose: Determine the visual-motor-integration age as demonstrated by the number of geometric forms correctly copied.

Task: Twenty-four geometric forms are presented in order of increasing difficulty and are to be copied by the subject. May be administered either individually or in groups.

Scoring: The number of correctly copied forms, prior to three consecutive failures, is compared with the age-equivalent norms for each sex.


Ages: Three to fifteen years.
Purpose: Devised to detect brain damage and emotional disturbances.

Task: Six stimulus figures are copied by the subject. The designs are just two of the Bender figures (A and 3) each presented three ways: conventionally; on a diamond-shaped card with the figure rotated 90° from the usual presentation; and conventionally on a diamond-shaped card.

Scoring: Reproductions are scored for amount of rotation.

Edition for First Grade. 1968. (Charles McQuarrie)
Kindergarten Edition. 1969. (Genevieve I. Curry)

Ages: Five to six; six to eight.

Purpose: Designed to test perceptual development using the Gesell forms of seven figures: circle, cross, square, triangle, divided rectangle, horizontal diamond, and vertical diamond.

Task: Can be individually or group administered. It requires both the copying of the geometric forms and completing incomplete forms of the same figures.

Scoring: Much personal judgment is required in the scoring. The scoring is not objective and is very confusing.

Robinson (in Buros, 1972) notes that this is a disorganized perceptual testing approach with different versions of testing and training handbooks which confuse the usage.


Ages: Between four and eight years.

Purpose: Devised as a downward extension of the Bender-Gestalt concepts and method to measure visual-motor development in young children.

Task: Sixteen outline figures or designs are to be copied by the subject.
Scoring: Designs are scored for errors in reproduction according to standards described in the test manual and fall into 14 scoring categories. Scoring reliability good.


Ages: Form A - four to six years. Form B - six to nine years.

Purpose: May be administered individually or in group situations to determine visual-motor ability as determined by success in copying forms.

Task: Form A contains 14, and Form B contains 16, two-dimensional geometric and bilaterally symmetrical designs of increasing complexity and difficulty, to be copied by the student.

Scoring: Correctness of reproduction is scored with key. Norms of Form A provide "drawing ages" in months. Form B gives only drawing scores.
V. AVAILABLE DEVICES FOR ASSESSING SCHOOL READINESS.


Ages: Five and six years.

Purpose: In order to determine kindergarten and first grade readiness through numeric-perceptual tasks.

Task: a) number producing - placing specified number of blocks in examiner's hand;
    b) number recognition - counting dots arranged in various patterns;
    c) ten dot Gestalt - copying a ten dot pattern;
    d) sentence Gestalt - copying a simple sentence;
    e) draw-a-man - drawing a man.

Scoring: Two scores for an Achievement-Ability rating and a Social-Emotional Behavior rating.

ABC Inventory to Determine Kindergarten and School Readiness. Muskegon, Mich.: Research Concepts. 1965. (Normand Adair and George Blesch)

Ages: Five years.

Purpose: Designed primarily as a reading readiness test and to predict first grade success.

Task: Draw a man; answer questions about characteristics of objects; answer questions about general topics; complete some simple tasks involving numbers and shapes.

Scoring: Objective scoring guide with norms to indicate Mental Age. No data on validity for predicting first grade success nor on reliability.


Ages: End of Kindergarten or beginning of first grade.

Purpose: To predict the success of children in first grade.
Task: Nine subtests, only one of which deals with handwriting.

Scoring: The child receives one point for each word or letter reproduced, providing that it is "reproduced in a reasonably legible manner." (Duffy in Buros, 1972) No standard of legibility is provided.


Ages: Kindergarten and beginning first grade children.

Purpose: Designed to sample "three major kinds of handicaps which impede school success: 1) intellectual deficiency, 2) central nervous system dysfunction, and 3) emotional disturbance." (American Guidance Service, 1975)

Task: In a group administration of the test items, the students respond to items sampling:

a) child's fund of knowledge,
b) development of his body image,
c) perception of his own emotional motivation,
d) accuracy of his perception of maternal figures,
e) perception of appropriate play,
f) visual-motor coordination,
g) ability to follow directions, and
h) memory.

Scoring: Objective scoring standards are simple and identical for boys' and girls' booklets.


Ages: Kindergarten students.

Purpose: This is not a once-administered test. The students are evaluated continually throughout the school year as the items are presented as regular instructional tasks. Based upon the students' learning during the course of that year, a prediction of school success can be made.
Task: Many typical kindergarten tasks are included in this battery. The only writing or writing readiness test results in a three-level scale.

Scoring: Readiness for learning to write is evident when the child is able to write! Level 1 - copies name; Level 2 - prints name without sample; Level 3 - writes or labels on own initiative.


Age: Kindergarten or grade one children.

Purpose: Devised to detect children who might have learning difficulties.

Task: Administered individually, the test involves
a) motor patterning,
b) visual-perceptual-motor tasks,
c) language performance, and
d) a total score.

Scoring: Some "rating" is involved in the scoring, which indicates some subjectivity of scoring.
APPENDIX C

Samples of Tests Administered

and Conversion Tables
Bender Gestalt Test for Young Children

Raw Score Conversion Table

Bender Mean Scores by Age and Sex for Normative Population

<table>
<thead>
<tr>
<th>Age</th>
<th>Boys</th>
<th>Girls</th>
<th>All Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>14.8</td>
<td>13.0</td>
<td>13.6</td>
</tr>
<tr>
<td>5½</td>
<td>10.0</td>
<td>9.8</td>
<td>9.8</td>
</tr>
<tr>
<td>6</td>
<td>8.8</td>
<td>8.6</td>
<td>8.4</td>
</tr>
<tr>
<td>6½</td>
<td>6.2</td>
<td>6.6</td>
<td>6.4</td>
</tr>
<tr>
<td>7</td>
<td>5.3</td>
<td>4.2</td>
<td>4.8</td>
</tr>
<tr>
<td>7½</td>
<td>4.0</td>
<td>4.4</td>
<td>4.7</td>
</tr>
<tr>
<td>8</td>
<td>3.0</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>8½</td>
<td>2.6</td>
<td>2.4</td>
<td>2.5</td>
</tr>
<tr>
<td>9</td>
<td>1.5</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>9½</td>
<td>1.0</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>10</td>
<td>1.5</td>
<td>1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>10½</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Bender Gestalt Test for Young Children.
Developmental Test of Visual-Motor Integration

Raw Score Conversion Table

**VMI Age Equivalents**

Raw score is based on the total number of forms passed up to three consecutive failures. Imitated forms are not to be counted in deriving the total score.

<table>
<thead>
<tr>
<th>Raw Score</th>
<th>Male</th>
<th>Female</th>
<th>Raw Score</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2-10</td>
<td>2-10</td>
<td>13</td>
<td>6-10</td>
<td>6-7</td>
</tr>
<tr>
<td>2</td>
<td>3-0</td>
<td>3-0</td>
<td>14</td>
<td>7-4</td>
<td>7-2</td>
</tr>
<tr>
<td>3</td>
<td>3-2</td>
<td>3-2</td>
<td>15</td>
<td>7-10</td>
<td>7-11</td>
</tr>
<tr>
<td>4</td>
<td>4-1</td>
<td>3-10</td>
<td>16</td>
<td>8-7</td>
<td>8-8</td>
</tr>
<tr>
<td>5</td>
<td>4-4</td>
<td>4-1</td>
<td>17</td>
<td>9-4</td>
<td>9-6</td>
</tr>
<tr>
<td>6</td>
<td>4-6</td>
<td>4-4</td>
<td>18</td>
<td>10-2</td>
<td>10-3</td>
</tr>
<tr>
<td>7</td>
<td>4-9</td>
<td>4-8</td>
<td>19</td>
<td>10-11</td>
<td>11-1</td>
</tr>
<tr>
<td>8</td>
<td>5-0</td>
<td>4-11</td>
<td>20</td>
<td>11-9</td>
<td>12-0</td>
</tr>
<tr>
<td>9</td>
<td>5-3</td>
<td>5-3</td>
<td>21</td>
<td>12-8</td>
<td>13-0</td>
</tr>
<tr>
<td>10</td>
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Developmental Test of Visual-Motor Integration.
### Word Discrimination Test

#### Raw Score Conversion Table

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Word Discrimination Test, page 1.

1. g a / g o
2. I w o / f w o
3. d n a / o n d
4. b o a l / b o a h
5. k o m / c e m o
6. m a s e / m e l s e
7. b a l h / b a f l
8. p t a y / p l a v
9. n o u s e / h o u s e
10. b o w n / d o m n
11. w n e r e / w h e r e
12. f u n n y / f u n u y
13. f i n d / f i n d
14. b o k c / b l a x
15. n u f / f u n
16. a m e / c a m
17. u o u n / e u r
18. s o o n / s o o n
19. k o m / h o u m
20. g o o d / d o o g
21. t h e r e / t e r e
22. r a b b i l / r a b b i t
23. a n k h / t h a n k
24. h o n / h e n
25. g l e a s e / p l e a s e
26. w e n t / w e n t

Number Right...............................Wrong.................................Omitted.................................
Word Discrimination Test, page 2.

27. pretty  pretty  yuelp  typret  pretty
28. white  white  while  white  white
29. haggy  happy  pyhap  happy  yppah
30. new  wen  new  new  new
31. guess  guess  guess  guess  guess
32. arm  armf  armf  arm  arm
33. under  derun  under  under  under
34. friends  frieeds  frieends  friens  friends
35. lady  ladi  ladv  dyla
36. deep  deep  beed  beeq  deep
37. queer  queer  queer  queeq  queer
38. done  done  done  done  duhe
39. flour  flour  flour  flour  oufl
40. wonder  wonder  wonder  wonder  wondere
41. older  older  older  older  olde
42. roar  roar  nor  nor  roar
43. biggest  biggess  biggest  biggest  biggess
44. obey  obay  obey  obey  oday
45. twinkle  twinkle  twinkle  twinkle  eltwink
46. trouble  trouble  trouble  trouble  trouble
47. puppet  puppet  puppet  teppup  puppet
48. dekebp  dekekp  peeked  pekeb  peked
49. center  center  center  center  center
50. cousin  cousin  cousin  cousin  cousin
51. basement  basement  basmnt  basinent  basement
52. slipping  slpping  slpping  slpping  slpping
53. certainly  cerltain  cerltainly  cerltainly  cerltainly
54. sweater  sweer  sweeter  sweeter  sweeter
55. customers  customers  customers  customers  customers
56. solving  solying  solving  solving  gnvilos
57. outfits  outfit  outis  outis  fitous
58. soup  souq  seup  suop  soup
59. lump  ymud  hnwp  hump  nump
60. magician  magian  magician  magician  majitian
61. type  tyqe  type  type  tyve

Number Right................................. Wrong................................. Omitted.................................
Bobby had two big fat balloons.

The lady gave some to little Donny and to me. They went up high in the air.
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### Slingerland Test 3, Visual-Perception-Memory

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<td>onr</td>
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<td>3</td>
<td>mith</td>
<td>with</td>
<td>thim</td>
<td>thiw</td>
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Test 3

174

em

New SC 0
Slingerland Test 4, Visual Discrimination.

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<td>lats</td>
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<tr>
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<td>want</td>
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Slingerland Test 5, Visual-Perception-Memory-Copying.

- CRJ
- CRJ 8. 25.48
- hgd 9.  
- net 10.  
- bud 11.  
- on us 12.  
- 357  
- 69  
- NW 1 SC 0 PP L
APPENDIX D

Letter to Parents
Dear Parents:

During the next two months all of the first graders in the Clear Fork Valley Local School District will be taking part in some writing lessons and doing some drawing and writing which will give us more information about how we can help children learn to write better.

I will be working with each of the first grade classes in groups, and with each of the children individually, on a one-to-one basis. The children's names will not be a part of the records, so all data will be anonymous. No information will become a part of your child's school records.

The results regarding child development in visual-motor perception skills and progress in handwriting ability are expected to be of value in our future work with children in the schools. Should you have any questions concerning this procedure, please call me at 524-4004. Thank you for your cooperation.

Sincerely,

Mary Ann Engleman
Child Study Consultant
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