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PRINTING ERRORS AND THE PREDICTION OF ACADEMIC PERFORMANCE

MIDDLE TENNESSEE STATE UNIVERSITY M.A. 1984

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Printing Errors and the Prediction of Academic Performance

Robert L. Moore

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in partial fulfillment of the requirements
for the degree Master of Arts

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Printing Errors and the Prediction of Academic Performance

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Abstract

Printing Errors and the Prediction of

Academic Performance

by Robert L. Moore

The use of printing errors to predict academic achievement over a five-year period was investigated. The handwriting of 95 first graders was assessed. Ten measures of printing errors (form errors, added-letter errors, omission errors, boundary errors, letter-space errors, word-space errors, capitalization errors, total Simner, total Moore, and total errors) were correlated with academic achievement (Stanford Achievement Test scores) at the end of the sixth grade. Pearson product-moment correlations, stepwise regression, chi-square analysis, and multiple regression revealed that printing errors predicted academic achievement over a five year period ($p < .001$). Four of the seven specific measures of printing errors which were the best predictors of academic performance were also highly intercorrelated forming a "coordination" factor in the factor analysis. The total error score accounted for the most variability and is recognized as the most useful measure in predicting performance.

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Chapter I

Review of the Literature

Background of Handwriting Analysis

For many years psychologists and educators have attempted to identify children at risk of academic failure. Since the turn of the century handwriting has been used as a tool for locating those children at risk for academic failure. Many studies in the past 70 years have investigated the relationships that exist between the different types of handwriting errors and academic achievement. Empirical investigations started to appear in journals as early as 1917 with particular attention given to the relationship of handwriting to reading disabilities (Hinshelwood, 1917; Orton, 1925).

Hinshelwood (1917), an English ophthalmologist, studied a group of reading disabled children (number unspecified) intimately and compared them with cases of acquired word blindness, i.e., the loss of abilty to read which follows in certain cases of local brain destruction by hemorrhage, softening tumor, and other destructive organic processes. On the basis of this comparison, Hinshelwood hypothesized a congenital defect of development of the brain area for registration of visual memories of words, and concluded that this reading disability was a result of faulty development in part of the brain.

Orton (1925), a medical acquaintance of Hinshelwood, investigated the common characteristics of reading disabilities. Orton's sample from 1925 included 15 disabled readers representing the following grades: one first grader, three second graders, seven third graders, one seventh grader, one eighth grader, and two ninth graders. A test battery containing compositions, words, and letters was presented to the subjects. The subjects were asked to replicate the writing tasks presented. The common characteristics of the disabled readers were as follows: tendency to read from right to left; reversals such as "on-no" and "not-ton", and lower-case letter reversals such as "p-q" and "b-d." Although these children were labeled as learning disabled, Orton reported that he was extremely surprised to find that the children possessed normal communication skills and certain intellectual skills (mechanical ability, mathematical reasoning, etc.). Orton's final conclusion was that these were special children who were more closely comparable to those with true sensory deprivations than to the so-called feebleminded.

In a personal statement of position, Orton (1928) cites that the assumption of intellectual defect, as an explanation of reading disability, is easy to refute but difficult to eradicate. Orton states that many of these children are good in arithmetic, spelling, and listening comprehension.

He continues to state that the assumption that a local brain defect is the cause of reading disability is more difficult to refute; mainly because no necropsy reports (examination of body after death) of congenital word blindness have been made. Orton concludes by declaring that ordinary methods of school instruction do not provide remediation.

Use of Drawing Tests to Predict Achievement

The Bender Gestalt Test (Bender, 1938), a visual-motor test, has traditionally been one of the most widely used clinical tests for identifying those suffering from organic brain disease, schizophrenia, depressive psychosis, psychoneurosis, and mental retardation (Koppitz, 1963). The Bender Gestalt Test involves nine figures which are presented one at a time and which the subject is asked to copy on a blank piece of paper. A major advantage of the Bender Gestalt Test is that it can be interpreted psychoanalytically, educationally, and clinically (Koppitz, 1963). Although Bender discusses in some detail the process of maturation of visual-motor perception in young children, she does not provide an objective scoring system for the test (Koppitz, 1963). Koppitz (1963) constructed the Developmental Bender Scoring System for Young Children to differentiate what was normal and abnormal for Bender drawings at any given age. When Koppitz constructed the developmental scoring system, she compiled a list of 30 outstanding deviations and distortions. Such gross irregularities as distortion of shape, rotation, integration, and perserveration were identified and scored as either present or absent.

Bender (1938) stated that visual-motor perception is closely related to language ability and other functions associated with intelligence in young children. These included memory, visual perception, motor coordination, temporal, and spatial concepts, organization, and representation. Studies in the educational setting report that the Bender has been used to predict school achievement (Koppitz, 1962; Koppitz, Sullivan, Blyth, & Shelton, 1959; Norfleet, 1973) and to diagnose reading and arithmetic problems (Koppitz, 1963). The Koppitz et al. (1959) study was performed to determine the relationship between the Bender Test and the Metropolitan Achievement Test. The sample included 145 first-grade students from six different classrooms. The students were administered the Bender at the beginning of the school year. The Metropolitan Achievement Test was administered at the end of the school year by the classroom teachers. The same group of subjects was tested again with the Bender at the beginning of the second grade and with the Metropolitan Achievement Test at the end of the second and third grades. The correlation between the total average achievement on the Metropolitan Achievement Test and the first-grade Bender scores was maintained throughout the first three grades of elementary school (Grade 1, $r = -.68$; Grade 2, $r = -.49$; Grade 3, $r = -.54$; $p < .001$). The authors concluded by stating that the results of the study offer support for the hypothesis: Achievement in the first three grades of elementary school can be predicted from Bender scores.

Another study conducted by Koppitz (1962) dealt with the relationship of Bender scores to teacher judgment of students' achievement. The sample included 197 children drawn from 14 different classes with two classes from kindergarten and three from the remaining four grades (1-4). The Bender test was administered by Koppitz at the beginning of the school year to all children in these classes. Chi-squares were computed comparing the number of students with high and low teacher ratings whose Bender scores were above or below the normative mean score for their respective age levels. The results indicated that there is a considerable relationship between the Bender score and teacher ratings for first, second, and third grades ($p < .01$). Conversely, three out of four students with below average Bender scores will be rated as low achievers by their teachers at the end of the school year.

Koppitz (1963) conducted a study to discover whether any particular sign or deviation on the Bender Test is associated with problems in reading or arithmetic. The investigation was conducted using 174 first- and second-grade pupils with exceptionally high or very poor reading and number achievement on the Metropolitan Achievement Test. Chi-squares were computed comparing the high and low achievers in the group of subjects whose total Bender score was above or below the normative Bender score for their respective age level. Additional chi-squares were computed comparing the subjects on each of the 30 individual scoring items of the Developmental Bender Scoring System for Young Children. The total Bender score as well as 22 of the 30 individual Bender scoring items showed statistical relationships to achievement in reading and arithmetic on the first- and second-grade level. However, no single scoring item on the Bender test appeared to be exclusively related to the reading and number problems. The author concluded by stating that the total Bender score was consistently related to reading and number achievement as opposed to any one single Bender scoring item.

Norfleet (1973) administered the group Bender Gestalt Test to 311 beginning first graders (158 boys and 153 girls). The Gates-MacGinite Reading Tests were used as the criterion measure. Bender Gestalt test scores were used to predict good, average, and poor reading potential. The author reported that the scores on the Bender significantly correlated ($p < .001$) to year-end reading achievement. The author concludes by stating that the Bender Gestalt Test was especially accurate in predicting good reading performance.

However, recent findings lend support to a growing body of evidence showing that the Bender Gestalt test has little bearing on reading achievement (Buckley, 1978). Buckley (1978) reviewed the published investigations of the Bender Gestalt Test with school-age children. The review included all of the research results cited in Psychological Abstracts form 1966 to 1977. Buckley's report revealed that 17 out of 25 investigations reported no significant relationship between the Bender and reading achievement. However, he additionally stated that 18 out of the 25 investigations found the Bender to be a valid predictor of overall achievement.

Handwriting Analysis in Predicting School Success

It was not until recently that educators have closely examined the value of handwriting and shown interest in it as a potential source of predicting academic achievement (Barrett, 1965a, 1965b; Clark, 1970; Goins, 1958; Kaufman, 1980). Most attention has been focused on writing reversals, which have been used as a preliminary assessment of learning disabilities and academic achievement (Clark, 1970).

Clark's 1970 study involved 230 children who were having difficulty reading after the completion of second grade (persistent reversers). The group was studied further at the end of third grade, and an analysis was made of their level of intelligence. Spelling errors were also studied to determine whether reversals of letters or letter-order were common or rare occurrences in children who have difficulty with reading. An analysis was made of the reversal errors on the spelling test (Southgate Reading Test) within the total group of persistent reversers. Further analysis was made of the number of words where the letter order was reversed, for example, "geb" for "beg." Reversals were found to occur in 46.9% of the group tested. Clark concluded by stating that reversals were common among children experiencing reading difficulties.

In addition to reversals being utilized for purposes of identification of learning disabilities, reversals are used for predicting academic achievement (Barrett, 1965a; Kaufman, 1980). Research which has explored the relationships between a child's tendency to commit orientation ("b-d") or sequencing ("was-saw") reversal errors and subsequent success or failure in reading achievement includes several important studies (Barrett, 1965b; DeHirsch, Jansky, Langford, 1966; Goins, 1958; Jansky & DeHirsch, 1972).

Goins (1958), using 120 prereading first graders, attempted to determine the relationship between the level of competence in visual perception (figure, word, and letter tasks) and the level of competence in reading skills. Goins administered a battery of 14 selected tests of primary visual perceptual abilities including a measure called Reversals (matching nonverbal pictorial stimuli). Of the 14 visual perception measures administered, seven were statistically significant from zero at the .01 level. The best predictor was the Pattern Copying test which had a correlation of .52. The reversal measure was ranked the second best predictor with a correlation of .49 between reversals and scores on the Chicago Reading Test.

A few years later, Barrett (1965b) conducted a follow-up of Goins' study. The general purpose of his study was to determine the ability of the following reading readiness measures to predict first-grade reading achievement: Lorge-Thorndike Intelligence Test Level One-Form B, Gates Picture Directions Test, Gates Word Matching Test, Gates Word-Card Matching Test, Gates Reading Letters and Numbers Test, Goins' Pattern Copying Test, Picture Squares Test, and Goins' Reversals Test. Barrett stated that the visual discrimination tasks (all measures except the Lorge-Thorndike) were selected after a review of the literature revealed that they were representative of visual discrimination tasks as measures of reading readiness. Two types of reading achievement were employed as the dependent variables. These were the Gates Primary Word Recognition, Form One, and the Gates Primary Paragraph Reading Test, Form One. Results indicated that three of the visual discrimination tasks made relatively strong contributions to predicting first grade reading achievement ($p < .05$). The author stated that the reversal measure was a valuable predictor of reading achievement. Reversals also added significantly to the multiple regression coefficients for both Word Recognition and Paragraph Reading.

Jansky and DeHirsch (1972) undertook a cross-validation and expansion of earlier research (DeHirsch et al., 1966). The purpose of the 1966 investigation (DeHirsch et al., 1966) had been to establish a set of tests that would predict success of failure in reading. Their sample included 53 children from lower middle-class homes. They were tested on 37 measures in kindergarten, including a reversals test (a nine-item abbreviated version of the Horst Reversals Test), and were subsequently given reading achievement tests at the end of Grade 2. The reversals test correlated significantly with reading achievement ($r = .36$, $p < .01$). The 1972 investigation included data from the original sample ($N = 53$) as well as from a new sample of 347 subjects. The predictive test, a nine-item abbreviated version of the Horst Reversals Test, was administered in the spring of the kindergarten year, and reading and spelling achievement tests were given after two years of schooling. The reversals were again significantly correlated to the achievement test. The correlation of reversals and reading achievement was found to be $r = .43$ ($p < .01$) while the correlation of reversals with spelling achievement was $r = .42$ ($p < .01$).

In her 1980 studies, Kaufman set out to investigate the relationship of reversals to achievement. She administered the Horst Reversal Test to 401 beginning first graders reading achievement on most of the children at the end of first grade (interval = 7 months). The criteria were scores on the reading-related subtests of the Metropolitan Achievement Tests. Kaufman found the reversals measure to be quite reliable, as coefficient alphas of .96 and .94 were computed for blacks and whites, respectively. Predictive validity coefficients of -.62 to -.67 were obtained for the various criteria of reading achievement. When data were evaluated separately by race, coefficients of -.60 to -.67 were obtained for blacks and values of -.48 to -.56 were yielded for whites. The reversal measure was a significant predictor for both races ($p < .001$).

However, other researchers (Allington, 1976; Cohn & Stricker, 1979; Kaufman & Biren, 1976) report no particular utility for analyzing reversals as a means of detecting or predicting learning problems. Allington (1976) cites that Orton (1925) distinguished between reversals of sequence ("was-saw") and reversals of orientation ("b-d"), but the Jordan Left-Right Reversal Test (JLRRT) makes no such distinction, testing only orientation errors. Allington's work demonstrated that the visual-perceptual abilities, including sequence and orientation reversals, of poor and normal readers do not differ significantly, suggesting that a visual-perceptual deficit is an unlikely cause of reading disability. According to Allington, the JLRRT measures only the ability to detect optical orientation reversals while the following, more relevant tasks to reading are left unmeasured: reversals of sequence, verbal labeling, and associating either a name or phoneme with the grapheme. Allington additionally states that educators and clinicians should note that some directional confusion accompanied by reversal tendencies is so common among young children that it has to be considered normal up to and, for some children, beyond age seven. He concludes by stating that only if the errors persist after substantial remediation should one be concerned.

Kaufman and Biren (1976) stated that it is a common belief among teachers that children who make persistent reversal errors will be either poor readers or nonreaders. Kaufman and Biren's (1976) study was undertaken to test the following hypothesis: Children who make persistent spatial (reversal) errors after age seven will be poor readers, spellers and writers; and, conversely, children who are not spatially disorientated will not have learning problems. The study incorporated two groups of subjects:

11 younger children (six boys, five girls) between the ages of 7-0 and 8-9, and four older children (three boys, one girl) between the ages of 13-6 and 15-10. The researchers found that of the two younger children (7-0 to 8-9) who exhibited an excessive number of errors, one of the them was a normal reader and one a good reader. Conversely, it was found that older children (13-6 to 15-10) who had a history of spatial errors were poor readers: three of the poor reading students were extremely poor in reading skills and one almost two years below reading grade level. It also was found that a significant correlation (no correlation coefficeints given) existed among spatial errors and poor spelling and handwriting for both age groups.

Cohn and Stricker (1979), to determine the diagnostic value of reversals, systematically examined the incidence of reversal errors in a letter recognition task presented to first graders (N = 409; 201 boys, 208 girls). The entire first-grade population of four suburban schools was tested on responses to the letters b, d, p, and q. If a child was shown one of the letters (b, d, p, or q) and names any other letter in the grouping, it was considered a reversal error. Any other incorrect response was considered a nonreversal error. The number of reversal and nonreversal errors were compared among the three groups (strong, weak, and average in letter recognizing) by means of a 3 x 2 chi-square analysis. No analysis was performed for the letter p, since a total of only three reversals were made by the average and strong groups in naming it. Each of the analyses was significant. In each case when the number of errors for that group, the highest proportion of reversal errors was made by the strong group and the lowest proportion was made by the weak group. The researchers stated that reversals occur as frequently in strong as well as weak letter recognizers. They concluded by stating that letter reversals in the first grade are not necessarily indicators of a basic perceptual or cognitive deficit.

Categories of handwriting analysis that have been neglected include form, addition, and deletion (Simner, 1982). In an attempt to identify children at risk for academic failure, Simner investigated the value of using form, addition, and deletion errors as a means of preliminary assessment. Simner's study identified form errors as occurring when there is a marked change in the overall appearance of the original letter (poorly written). Examples of form errors are presented in Appendix A. Simner cites that form errors correlate reliably with academic performance measured at the end of kindergarten as well as throughout Grade 1 in reading, phonics, language, and math. He notes that this was not the case for the left-right reversal errors generated by these same letters (see Appendix A). Two groups of children totaling 125 nonrepeating kindergarteners were drawn from eight different classes. Sample 1 consisted of 67 children tested in the fall, while Sample 2 contained 58 children tested in the late spring. Simner measured form errors as well as additions and deletions, but did not provide any results for the additions and deletions.

The left-right mirror-image reversals were defined as when all of the parts in the original letter were reproduced correctly and rotated 180° about a vertical axis (b-d). The subjects were asked to print the letter shown. Form errors were identified according to the criterion provided in Appendix A. The teacher's end-of-year rank ordering of each child's readiness for Grade 1 was obtained as an index of academic performance in kindergarten. Product-moment correlations were obtained between the teacher's evaluations of academic performance and the number of reversals. The insignificant results were found to be as follows: Sample 1, $r = -.18$; Sample 2, $r = -.15$. Product-moment correlations were also obtained between teacher's evaluation of academic performance and form errors. The results of form errors were found to be as follows: Sample 1, $r = -.67$; Sample 2, $r = -.53$; $p < .01$. The results showed that form errors correlated reliably with academic performance measured at the end of kindergarten. This was not the case for the left-right reversal errors generated by these same letters.

Although Simner has made great progress in reliably correlating form errors with academic performance, his work has some limitations. His data are restricted to the kindergarten and first-grade level. Simner's research fails to give longitudinal predictive validity for more than one year. If the Simner study is to be used as a screening process to locate pupils "at risk," then there is a need to expand the predictive success through later grades.

Simner (1982) and Koppitz (1963) showed the importance of visual motor skills in making academic predictions. Although the criteria for the Bender test is based upon the ability to reproduce the designs, there are general applications that can be related to children's printing. Using the three areas of visual-motor maturity and the Developmental Bender Scoring System for Young Children (Koppitz, 1962), the present author (identified four types of printing errors (to be referred to later as the Moore predictor variables). The impetus for developing four additional printing error types was to expand the Simner study to better identify children at risk of academic failure. The first type of printing error is called a "boundary error" and is defined as being when a letter deviates more than one-eighth of an inch outside of the rule lines. This scoring principle was derived from the distortions and integration (deviation or overlap of more than one-eighth of an inch) categories on Koppitz' developmental scoring system.

The second and third types of printing errors are "letter-space" and "word-space" errors, respectively. These two errors are based on the integration (failure to join a part to a whole) of the Koppitz' developmental scoring system. Letter-space errors are defined as being when two letters within a word are the same distance apart as two words. The third type of printing error, word-space, is defined as being then the last letter of a word and the first letter of the following word are the same distance apart as two letters within a word.

The fourth type of printing error is called a "capitalization error" and is defined as being when a lower case letter is capitalized. This scoring principle was derived from the distortion (disportional) category of the Koppitz' developmental scoring system. Exampled of these four types of printing errors and the scoring criteria is presented in Appendixes B and C.

The present study proposed to expand on Simner's study by incorporating the four additional predictor variables and following a sample population through later elementary grades. This was accomplished by analyzing handwriting samples and correlating the form errors, added-letter errors, omission errors, boundary errors, word-space errors, letter-space errors, and capitalization errors to academic achievement over five years. The following hypothesis was tested:

Form errors, omission errors, added-letter errors, reversal errors, word-space errors, letter-space errors, boundary errors, and capitalization errors committed by first-grade pupils will be negatively correlated with their subsequent achievement in (a) Vocabulary, (b) Reading, (c) Word Skills, (d) Math Concepts, (e) Math Comprehension, (f) Math Applications, (g) Spelling, (h) Language, (i) Social Science, (j) Science, (k) Listening Comprehension, (l) Total Reading, (m) Total Auditory, (n) Total Math, and (o) Total Achievement. Achievement measures were from the subtests of the Stanford Achievement Test.

Chapter II

Method

Subjects

Subjects (N = 95) consisted of male and female elementary children enrolled in the Murfreesboro, Tennessee, City School system. Murfreesboro is a small city of 30,000 people and is located 30 miles southeast of Nashville, Tennessee. Subjects were nonrepeating sixth grade students from which a writing sample had been taken five years previously in the spring of grade 1. The subject sample was selected at random by the assistant superintendent.

Materials

The writing sample in Appendix D was used as the model for the children to replicate. The writing sample, developed by Dr. Rupert Klaus (assistant superintendent), included every letter of the alphabet (and capital "A") and seven additional vowels to form a complete sentence. In Appendix A are Simner's criteria (1982) that were used for assessing form errors. Simner provided criteria for 19 lower-case letters. The author of the present study provided the additional criteria (Moore's criteria) to use in assessing the remaining eight letters (seven lower-case and one capital letter) of the alphabet (see Appendix E). In Appendixes B, C, and E are Moore's criteria that were used for assessing boundary errors, letter-space errors, word-space errors, and capitalization errors. The author created the following: standardized written and oral (same content) instructions (see Appendix F), a "Samples and Criteria" sheet (see Appendix C), a "Sample Protocol" sheet (see Appendix B), a "Preliminary Protocol" sheet (see Appendix G), a "Preliminary Protocol Feedback Sheet" (see Appendix H), a "Error Assessment Score Sheet" (see Appendix I). Stanford Achievement Test (1979) scores were used as the criteria.

Procedures

The sample population was first tested in the spring of 1978 by another graduate student of psychology. Each child was given the instructions in Appendix J and was asked to print the 33-letter handwriting sample (see Appendix D). In Janaury, 1984, each handwriting sample was analyzed according to the criteria in Appendixes A, B, C, and E.

The entire sample of protocols was assessed by four psychology graduate students. Two raters were masters level students and the other two were doctoral level students. Each rater was given a standardized set of oral and written instructions (see Appendix F). The instructions were included to familiarize the rater and give a "hands-on" experience before the actual protocols were assessed. The instructions and the "Error Assessment Score Sheet" (see Appendix I) were given in a step-by-step manner to minimize confusion. Steps 1-5 on the instruction sheet were to explain and orient the rater to the types of errors. Step 6 stated that the rater was to take out the "Sample Protocol" (see Appendix B) sheet and examine the contents. At the bottom of the sample protocol, scores were provided to give feedback on how to score a protocol. Step 7 stated that the rater was to take out the "Preliminary Protocol" (see Appendix G) and assess it completely according to the rules provided in "Samples and Criteria" (see Appendix C). Step 8 instructed the rater to take out the "Preliminary Protocol Feedback Sheet" (see Appendix H). This step was included to provide the rater with information on how completely and reliably he/she performed. The mean time for the "learning process (steps 1-8 on the instructions sheet)" was 45 minutes each. The mean time for assessing the actual protocols was seven minutes each. After assessing the entire sample, each rater made similar statements about the assessment process. First, the raters stated that once they had assessed approximately ten protocols, they felt competent about their scoring skills. Second, the raters stated that about two-thirds of the protocols could be assessed in three to five minutes (few errors), whereas the protocols possessing many errors took up to ten minutes.

The numerical scores were derived from two categories, predictor variables and criterion variables. The predictor variables were organized into groups. The first group contained the following errors identified in Simner's (1982) study: added-letter errors, omission errors, form errors, and reversal errors. The scores of the present population tested on Dr. Klaus' (see Appendix D) standardized handwriting sample ranged from zero to ten on these variables. In the present study no reversals were identified in any of the protocols. Because reversals were not detected, statistical information was unobtainable. Simner's errors were summed and called the total Simner variable: The sum of added-letter errors, omission errors, and form errors. In summary, the first predictor variables were derived from Simner's study (added-letter errors, omission errors, form errors, and total Simner). The other group of predictor variables contained the errors originated by the present author: Boundary errors, letter-space errors, word-space errors, and capitalization errors. The scores of the population tested ranged from zero to 11 on these variables. Another variable was the sum of Moore's variables: Boundary errors, letter-space errors, word-space errors, and capitalization errors. In summary, the remaining predictor variables were created by Moore for the present study (boundary errors, letter-space errors, word-space errors, and capitalization errors). A final "total errors" variable was incorporated when the Simner and Moore totals were added together.

As an index of academic achievement in grade 6, the Stanford Achievement Test scores were obtained from each subject's academic record. In the present study the 15 achievement scores will be referred to as the criterion variables. The criterion variables were as follows: (a) Vocabulary, (b) Reading, (c) Word Skills, (d) Math Concepts, (e) Math Comprehension, (f) Math Applications, (g) Spelling, (h) Language, (i) Social Science, (j) Science, (k) Listening Comprehension, (l) Total Reading, (m) Total Auditory, (n) Total Math, and (o) Total Achievement. The scores of the population tested range from 141 to 228.

Interscorer reliability was calculated to determine agreement among the four raters. The reliability between the raters was derived by comparing the rating of all possible pairs of each letter of every protocol (95 protocols x 33 letters = 3,135 letters). Agreement between two raters occurred when both raters agreed on how the letter was assessed (form error, boundary error, etc). Conversely, a disagreement between two raters occurred when their assessment of a letter disagreed (word-space error vs. letter-space error). The reliability was then calculated by totaling the agreements (on all 95 protocols) and dividing them by the total number of letters (3,135). This number yielded a percentage of agreement, i.e., 97%. With four raters, six between-rater comparisons were made (Rater 1 to

Rater 2, Rater 1 to Rater 3, etc.). The six scores were then added together and divided by the number of scores ($\underline{N}$ = 6). This answer yielded a mean percentage of agreement or the interscorer reliability. The results indicated a 97.97% agreement.

Chapter III

Results

Means and standard deviations were computed for the sample population on the predictor and criterion variables (see Table 1). Data analysis included computing a chi-square, Pearson product-moment correlations, stepwise regression, multiple regression, factor analysis, and interscorer reliability.

The data presented in Table 1 were used to calculate a chi-square. The means of the total errors variables ($\overline{X}$ = 1.69) and the Total Achievement variable ($\overline{X}$ = 183.94) were used in the chi-square analysis. The chi-square test was used to test the significance of the differences between the expected frequencies falling in each category and the observed frequencies (number of subjects). The subjects were divided into four categories: (a) those subjects scoring below or equal to the mean on the total errors variable ($\overline{X}$ = 1.69, (b) those subjects scoring above the mean on the total errors variable, (c) those scoring below or equal to the mean on the Total Achievement variable ($\overline{X}$ = 183.94), and (d) those scoring above the mean on the Total Achievement variable. The expected frequency for each category was 23.75. The analysis revealed a chi-square of 19.36 (1, 95), which is significant beyond the .01 level.

Table 1

Means and Standard Deviations for Variables

Variable	Mean	Standard Dev.	Cases
Omissions	0.07	0.28	95
Form	0.46	0.87	95
Boundary	0.56	1.77	95
Word-Space	0.32	0.84	95
Letter-Space	0.23	0.69	95
Capitalize	0.07	0.33	95
Added-Letter	0.01	0.10	95
Total Simner	0.54	0.95	95
Total Moore	1.14	2.65	95
Total Errors	1.69	3.23	95
Vocabulary	182.83	18.08	95
Reading	181.82	20.11	95
Word Skills	180.24	17.87	95
Math Concepts	180.95	18.59	95
Math Computation	186.01	17.05	95
Math Applications	178.08	19.10	95
Spelling	187.87	19.05	95
Language	192.88	28.00	95
Social Science	183.33	20.12	95
Science	185.41	22.03	95
Listening Compre.	174.27	17.93	95
Total Reading	182.31	20.68	95
Total Auditory	175.02	15.21	95
Total Math	182.17	18.78	95
Total Achievement	183.97	19.13	95

Pearson product-moment correlations were computed to show the relationships among all of the variables (see Tables 2 and 3). A significant relationship existed between the total Simner variable and the Total Achievement variable (r = -.44, p < .001). There was a significant correlation between form errors (Simner) and Total Achievement (r = -.48, p < .001). Form errors correlated significantly with all of the criterion variables, with Science (r = -.55, p < .001) as the highest. The total Simner variable correlated significantly with all the criterion variables and Science (r = -.51, p < .001) was the strongest. All of the Moore variables, except capitalization errors, correlated significantly with the Total Achievement variable: boundary errors, r = -.37, p < .001; word-space errors, r - -.41, p < .001; letter-space errors, r = -.22, p < .05; and total Moore errors, r = -.43, p < .001. Boundary errors correlated significantly with all of the criterion variables, with word skills (r = -.42, p < .001) as the highest. Word-space errors also correlated significantly with all of the criterion variables, with math concepts (r = -.43, p < .001) as the highest. Letter-space errors correlated significantly with all of the criterion variables except three. Capitalization errors correlated significantly with math concepts (r = -.18, p < .05), math comprehension (r = -.19, p < .05), and total math (r = -.45, p < .001) as the strongest.

Table 2

Pearson Product Moment Correlations - Predictor Variables

Variable	Omissions	Form	Boundary	Word-Space	Letter-Space
Omissions	1.00	0.04	-0.04	-0.06	0.50***
Form	0.04	1.00	0.41***	0.49***	0.21*
Boundary	-0.04	0.41***	1.00	0.59***	0.13*
Word-Space	-0.60	0.49***	0.59***	1.00	0.38***
Letter-Space	0.50***	0.21*	0.13	0.38***	1.00
Capitalization	-0.04	0.20*	0.45***	0.49***	0.04
Added-Letter	-0.03	-0.05	-0.03	-0.04	0.04
Total Simner	0.33***	0.95***	0.39***	0.46***	0.35***
Total Moore	0.08	0.48***	0.89***	0.82***	0.47***
Total Errors	0.16	0.67***	0.84***	0.80***	0.49***
Vocabulary	-0.08	-0.41***	-0.31***	-0.36***	-0.27**
Reading	-0.06	-0.43***	-0.31***	-0.33***	-0.21*
Word Skills	0.02	-0.47***	-0.42***	-0.37***	-0.08
Math Concepts	0.04	-0.42***	-0.34***	-0.43***	-0.18*
Math Computation	0.02	-0.43***	-0.31***	-0.37***	-0.17*
Math Applications	0.09	-0.37***	-0.40***	-0.40***	-0.20*
Spelling	0.03	-0.46***	-0.26***	-0.30***	-0.02
Language	-0.01	-0.46***	-0.30***	-0.35***	-0.20*
Social Science	0.06	-0.35***	-0.32***	-0.38***	-0.15
Science	-0.02	-0.55***	-0.41***	-0.43***	-0.20*
Listening Comprehension	-0.05	-0.34***	-0.25***	-0.40***	-0.25**
Total Reading	-0.03	-0.43***	-0.35***	-0.34***	-0.17*
Total Auditory	-0.08	-0.44***	-0.33***	-0.44***	-0.30**
Total Math	0.05	-0.41***	-0.38***	-0.41***	-0.19*
Total Achievement	-0.01	-0.48***	-0.37***	-0.41***	-0.22*

* = $p < .05$ ** = $p < .01$ *** = $p < .001$

Table 2, cont.

Pearson Product Moment Correlations - Predictor Variables

Variable	Capitalization	Added-Letter	Total Simner	Total Moore	Total Errors
Omissions	-0.36	-0.03	0.33***	0.08	0.16
Form	0.20*	-0.05	0.95***	0.48***	0.67***
Boundary	0.45***	-0.03	0.39***	0.89***	0.84***
Word-Space	0.49***	-0.04	0.46***	0.82***	0.81***
Letter-Space	0.04	-0.04	0.35***	0.47***	0.49***
Capitalization	1.00	-0.02	0.22*	0.58***	0.54***
Added-Letter	-0.02	1.00	0.05	-0.23	-0.01
Total Simner	0.22*	0.05	1.00	0.51***	0.71***
Total Moore	0.58***	-0.02	0.51***	1.00	0.97***
Total Errors	0.54***	-0.01	0.71***	0.97***	1.00
Vocabulary	-0.11	-0.04	-0.41***	-0.40***	-0.45***
Reading	-0.07	0.01	-0.40***	-0.35***	-0.41***
Word Skills	-0.12	0.10	-0.42***	-0.40***	-0.45***
Math Concepts	-0.18*	-0.02	-0.38***	-0.41***	-0.45***
Math Computation	-0.19*	-0.01	-0.39***	-0.37***	-0.42***
Math Applications	-0.10	0.02	-0.32***	-0.43***	-0.45***
Spelling	-0.11	-0.02	-0.41***	-0.26**	-0.33***
Language	-0.10	-0.01	-0.42***	-0.36***	-0.42***
Social Science	-0.14	-0.02	-0.31***	-0.37***	-0.39***
Science	-0.10	0.03	-0.51***	-0.45***	-0.52***
Listening Comprehension	-0.12	0.10	-0.33***	-0.37***	-0.40***
Total Reading	-0.10	0.05	-0.40***	-0.37***	-0.42***
Total Auditory	-0.13	0.03	-0.43***	-0.44***	-0.49***
Total Math	-0.18*	-0.01	-0.37***	-0.43***	-0.46***
Total Achievement	-0.13	0.02	-0.44***	-0.43***	-0.48***

* = $p < .05$ ** = $p < .01$ *** = $p < .001$

Table 3

Pearson Product Moment Correlations - Criterion Variables

Variable	Vocabulary	Reading	Word Skills	Math Concepts	Math Computation
Vocabulary		0.83	0.65	0.72	0.66
Reading	0.83	1.00	0.73	0.71	0.69
Word Skills	0.65	0.73	1.00	0.68	0.66
Math Concepts	0.72	0.71	0.68	1.00	0.84
Math Computation	0.66	0.69	0.66	0.84	1.00
Math Application	0.70	0.72	0.63	0.81	0.75
Spelling	0.63	0.74	0.74	0.60	0.66
Language	0.73	0.80	0.73	0.71	0.75
Social Science	0.74	0.78	0.66	0.74	0.66
Science	0.82	0.85	0.74	0.80	0.72
Listening Comprehension	0.72	0.71	0.55	0.65	0.54
Total Reading	0.84	0.96	0.85	0.75	0.73
Total Auditory	0.92	0.83	0.69	0.74	0.66
Total Math	0.76	0.76	0.69	0.94	0.92
Total Achievement	0.89	0.92	0.81	0.85	0.83

All Significant ($p < .001$)

Table 3, cont.

Pearson Product Moment Correlations - Criterion Variables

Variable	Math Application	Spelling	Language	Social Science	Science
Vocabulary	0.70	0.63	0.73	0.74	0.82
Reading	0.72	0.74	0.80	0.78	0.85
Word Skills	0.63	0.74	0.73	0.66	0.74
Math Concepts	0.81	0.60	0.71	0.74	0.80
Math Computation	0.75	0.66	0.75	0.66	0.72
Math Application	1.00	0.54	0.71	0.75	0.83
Spelling	0.54	1.00	0.76	0.65	0.71
Language	0.71	0.76	1.00	0.76	0.79
Social Science	0.75	0.65	0.76	1.00	0.81
Science	0.83	0.71	0.79	0.81	1.00
Listening Comprehension	0.67	0.50	0.55	0.71	0.72
Total Reading	0.72	0.77	0.81	0.79	0.85
Total Auditory	0.74	0.62	0.71	0.77	0.83
Total Math	0.91	0.64	0.77	0.77	0.84
Total Achievement	0.84	0.79	0.89	0.87	0.93

All Significant ($p < .001$)

Table 3, cont.

Pearson Product Moment Correlations - Criterion Variables

Variable	Listening Comprehen.	Total Reading	Total Auditory	Total Math	Total Achievement
Vocabulary	0.72	0.84	0.92	0.76	0.89
Reading	0.71	0.96	0.83	0.76	0.92
Word Skills	0.55	0.85	0.69	0.69	0.81
Math Concepts	0.65	0.75	0.74	0.94	0.85
Math Computation	0.54	0.73	0.66	0.92	0.83
Math Application	0.67	0.72	0.74	0.91	0.84
Spelling	0.50	0.77	0.62	0.64	0.79
Language	0.55	0.81	0.71	0.77	0.89
Social Science	0.71	0.79	0.77	0.77	0.87
Science	0.72	0.85	0.83	0.84	0.93
Listening Comprehension	1.00	0.70	0.92	0.66	0.77
Total Reading	0.70	1.00	0.83	0.80	0.94
Total Auditory	0.92	0.83	1.00	0.76	0.89
Total Math	0.66	0.80	0.76	1.00	0.90
Total Achievement	0.77	0.94	0.89	0.90	1.00

All significant ($p < .001$)

Correlations were computed to determine the relationship between the total errors variable and the Total Achievement variable. The results indicated that there is a significant relationship (r = -.48, $p < .001$). The total errors variable correlated significantly with all of the Moore variables: Boundary errors (r = .84, $p < .001$, word-space errors (r = .81, $p < .001$), letter-space errors (r = .49, $p < .001$), and capitalization errors (r = .54, $p < .001$).

Stepwise regression equations were computed to determine which of the predictor variables, both alone and in connection with other predictors, were the best predictors of the criterion variables. Only those variables with significant "F to enter" ratios were included. The results indicated that the total errors variable was the most efficient predictor of Total Achievement, $F(1, 93) = 28.34$, $p < .001$. The remaining predictors did not have significant "F to enter" ratios. An additional multiple regression equation was computed in order to determine the level of the relationship betten the predictor variables and the criterion variables. The results were that the form error variable and the total error variables together had a significant multiple R when Total Achievement was the criteria (R = -.53, $p < .001$).

In order to examine the relationships among the various predictor variables, a standard principal components factor analysis was performed (see Table 4). The calculations identified four factors (see Table 4). Only the three factors possessing an eigenvalue of 1.00 or more were used. The three factors accounted for 91.9% of the item variance (factor I, 59.8%; factor II, 18.7%; and factor III, 13.4%). The factors seem to reflect the following relationships: factor I, coordination; factor II, visual-spatial; and factor III, perceptual-motor. Table 5 presents the communality of the three factors on each predictor variable.

Predictor variables that loaded heavily on factor I, coordination, included: word-space errors (-.82), boundary errors (-.79), and form errors (-.73). Variables with medium loadings included: capitalization errors (-.54) and letter-s-ace errors (-.48). The only variable that loaded heavily on factor II, visual-spatial, was omission errors (-.78). The only variable with a medium loading on factor II was letter-space errors (-.58). The only variable that loaded heavily on factor III. perceptual-motor, was form errors (-.64). The variable that had a medium loading was letter-space errors (-.44).

In order to obtain an estimate of the reliability and internal consistency of the Simner/Moore scoring system, a coefficient alpha (Nunnally, 1978) was computed. The results indicated a r_{kk} of -.74.

Table 4

Factor Matrix Using Principal Factor with Iterations

Variable	Factor 1	Factor 2	Factor 3	Factor 4
Omissions	-0.17	-0.78	-0.33	0.16
Form	-0.73	-0.21	0.64	0.04
Boundary	-0.79	0.37	-0.10	0.03
Word-Space	-0.82	0.21	-0.11	-0.03
Letter-Space	-0.48	-0.58	-0.44	-0.10
Capitalization	-0.54	0.37	-0.18	0.05
Added-Letter	-0.02	-0.05	-0.00	-0.78
Total Simner	-0.76	-0.42	0.49	-0.03
Total Moore	-0.95	0.19	-0.25	-0.01
Total Errors	-1.00	0.03	-0.06	-0.02
Total Variance				
Eigenvalue	4.83	1.51	1.08	.66
Pct. of variance	59.80	18.70	13.40	8.10
Cumulative Pct.	59.80	78.50	91.90	100.00

Table 5

Communality

Variable	Communality
Omissions	0.77
Form	0.98
Boundary	0.77
Word-Space	0.72
Letter-Space	0.77
Capitalization	0.47
Added-Letter	0.62

Chapter IV

Discussion

The major purpose of this study was to identify children at risk of academic failure by investigating the use of printing errors to predict academic achievement. The findings of this investigation underscore evidence reported by Simner (1982) that printing errors can be utilized for the purpose of identifying children with potential learning problems. The results of chi-square, stepwise regression, multiple regression, and product-moment correlations indicated that assessing printing errors could prove quite useful as an aid in an early screening program.

Numerous investigations have reported the utility of handwriting analysis as a valuable predictor of academic performance. Several researchers have found that reversal errors correlate significantly with academic achievement (Barrett, 1965B; Clark, 1970; DeHirsch et al., 1966; Goins, 1958; Kaufman, 1980). However, other studies have reported that reversal errors are not related to academic achievement (Allington, 1976; Cohn & Stricker, 1977; Kaufman & Biren, 1976). The present study does not support either contention because no reversals were found on any of the protocols.

Simner (1982) has stated that three categories of printing errors have been ignored: form errors, additions, and deletions. In an attempt to identify children at risk for failure, Simner found that form errors are valuable predictors of academic performance. The present study attempted to expand the work of Simner by (a) adding four additional predictor variables to the ones already studied by Simner and (b) correlating ten (seven measures and three totals) printing error variables to achievement over a five-year period. Other studies investigating printing analysis only provide one measure of handwriting (Barrett, 1965b; Clark, 1970; DeHirsch et al., 1966; Goins, 1958; Kaufman, 1980). Several studies have reported that handwriting and copying errors correlated significantly with academic achievement measured one year later (Barrett, 1965b; Kaufman, 1980; Simner, 1982), two years later (DeHirsch et al., 1966; Jansky & DeHirsch, 1972), and three years later (Koppitz, 1963; Koppitz et al., 1959). The present study revealed a significant correlation of printing errors to academic achievement over a five year period.

The chi-square analysis revealed that early printing errors are more common among children that later experience academic difficulty. Factor analysis provided additional information about the interrelationships of the seven measurements. All of the Moore variables had either a heavy or medium loading on factor I (coordination), as did form errors. Of the five variables loading on factor I, four (form errors, boundary errors, letter-space errors, and word-space errors) were highly intercorrelated (range = .59 to .21). The same four variables also were the best predictors of total academic achievement (in rank order): (a) form errors, (b) word-space errors, (c) boundary errors, and (d) letter-space errors.

Analyses were made to determine which of the variables were related to total achievement. Product-moment correlations revealed that the total scores were all highly related to the achievement measures. This finding suggests that all three measures predicted achievement equally well. Stepwise multiple regression was used to determine which variable was the most efficient predictor of total achievement. The results revealed that the total errors variable possessed a significant "F to enter" ratio. This finding indicated that the total errors variables was an efficient predictor of total achivement.

The findings of the present study were consistent with the findings of Simner (1982) and Koppitz (1963). The present study found that form errors correlated significantly with academic achievement (Simner, 1982) and that deviations in copying correlated significantly with academic achievement (Koppitz, 1963). However, the present investigation revealed some unique findings not included in the Simner (1982) study or the Koppitz (1963) study. The present study found that form errors correlated significantly with achievement over a five-year period. This finding strengthens the original study of Simner using form errors. In regard to the Koppitz' (1963) developmental scoring system, it was found that her scoring system can be applied to printing and not just to drawing.

The present author provides five reasons why the present study enhanced and expanded the area of printing errors. First, three of the four measures developed by Moore (boundary errors, letter-space errors, and word-space errors) predicted total academic achievement over a five-year period. Second, the present study contained seven measures of printing errors. The three other measures (total Simner, total Moore, and total errors) provided a total of ten measures. Third, the factor analysis revealed that all of the Moore measurements loaded on the same factor (factor I). This finding is of importance because it indicates that the Moore measurements are identifying the same type of problem. Fourth, the correlations revealed a significant relationship between total errors and academic achievement. Fifth, the present study provided a relatively quick and direct psychometric tool for the assessment of printing. It is suggested that a writing sample can be administered and scored by an experienced school psychologist in 15 minutes. This can be very helpful to the overloaded school psychologist who is in need of an estimate of the child's potential for academic failure. The test can be group administered or individually administered.

However, there are several limitations regarding the present study. First, the sample size is relatively small ($\underline{N}$ = 95). Second, the sample population represented a small, southern city, and may not be representative of large urban populations. Third, the present study was not able to provide information on the race, sex, or socioeconomic status of the subjects.

If educators were to use the findings of the present study to locate children at risk for failure, it is worth investigating why errors in printing related to later achievement. Simner (1982) offered two possibilities. First, Simner stated that printing errors (form, omission, and added-letter) might stem from the child's overall lack of familiarity with the letters of the alphabet. Second, Simner stated that the occurrence of form errors, omission errors, and added-letter errors may be due to momentary lapses in the child's attention to detail. He continued to state that if these lapses also occur through the school day, perhaps children who produce these errors do less well than their peers because they have more trouble attending to the material taught in class.

The author of the present study suggests that printing errors are the result of poor coordination. This suggestion is based on findings of Koppitz (1963). She stated that the ability to write within a limited boundary or the ability to perceive and copy correctly in regard to direction and form is significantly related to school achievement. This study supports her position even though recent research relating the Bender Gestalt to reading achievement indicates evidence to the contrary (Buckley, 1978).

The results of this investigation indicate that printing errors can be used to predict academic achievement. Of equal importance is the utility of these errors in identifying and locating children at risk for academic failure. If these errors are used as an aid in early screening, then the next step is for researchers to investigate the use of remedial strategies to assist the children who have been identified.

Appendix A

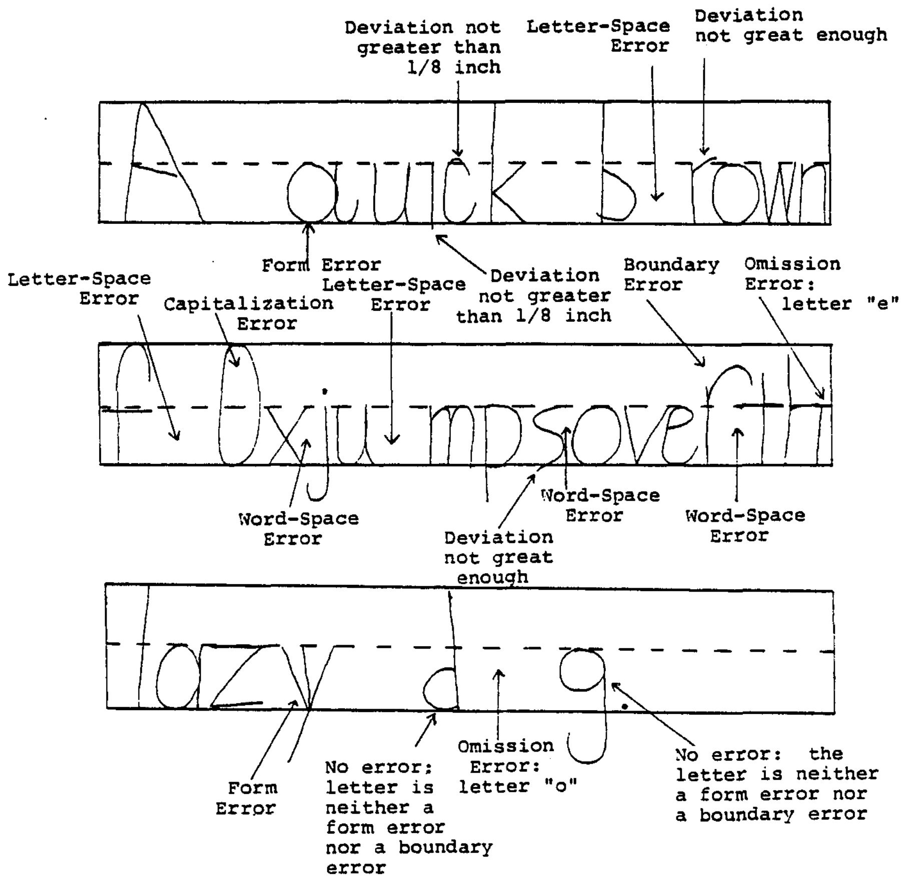
Simner Scoring Criteria

Letter	*Repro. Correct	Form Errors	Letter	*Repro. Correct	Form Errors	Letter	*Repro. Correct	Form Errors
a	a a a	d O d n d	g	g g g	> y g b g q	p	p p	p p ᵒ R
b	b b 6	F D b b d O o	h	h h h	∧ n b a n P r	q	q q	q q q Q R q
c	c	6 a E	j	j j	I J J J 3 U	r	r r r r	r + r r r b
d	d	d l 8 6 d	k	K K K K	K K K K K K	s	S S	S S 9 e 3
e	e e	O E O P E P	m	m m m	m m r r m	u	u u u u	y U 4 r u u
f		r E R	n	n n n	∧ r n n P h	z	z	3 2 J 4 L 2

*Reproductions judged correct

Appendix B

Sample Protocol



Totaling the Errors:

1. Omissions	2		
2. Form errors	2		
3. Boundary errors	1	Total 1, 2, 7	4
4. Word-space errors	3	Total 3-6	8
5. Letter-space errors	3	Total 1-7	12
6. Capitalization	1		
7. Added-letter errors	0		

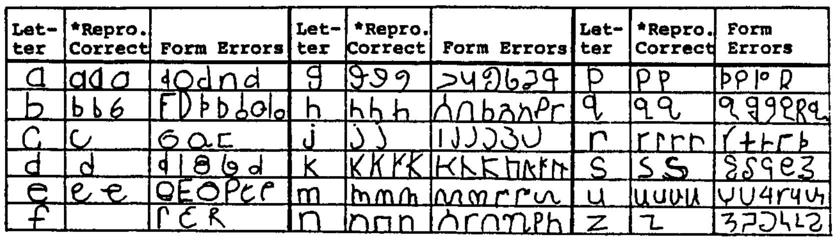
Appendix C

Samples and Criteria

I. Letter Assessment

A. Simner Scoring Criteria

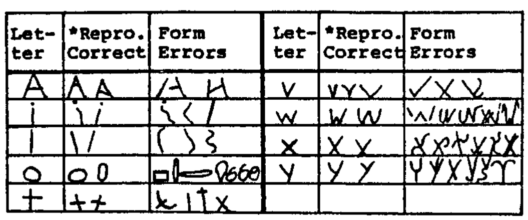
Simner Scoring Criteria



*Reproductions judged correct

B. Moore Scoring Criteria

Moore Scoring Criteria

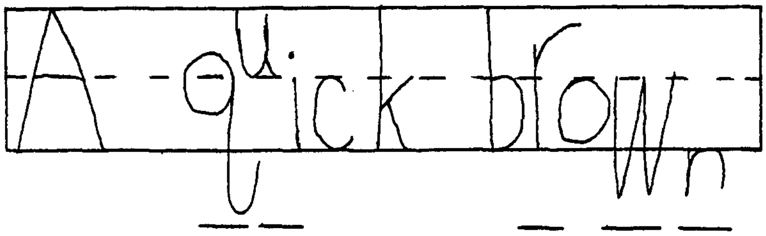


*Reproductions judged correct

II. Additional Assessment--"examples of additional criteria"

A. Boundary Error Criteria

NOTE: In order to be a boundary error, letter must deviant more than 1/8 of inch



= 5 errors

(5 is the maximum errors assessed only if the entire protocol is written out of boundary)

B. Word-Space Errors--no space between words

NOTE: If last letter of a word and the first letter of the following word are the same distance as 2 letters within a word, it is scored as a word space error.

A quickbrownfox jumps . . . = 2 errors (no maximum)

C. Letter-Space Errors--incorrect spacing between letters

NOTE: If 2 letters within a word are the same distance apart as 2 words, it is scored as a letter-space error.

A q-ui-ck br-ow-n . . . = 4 errors (no maximum)

D. Capitalization Errors:

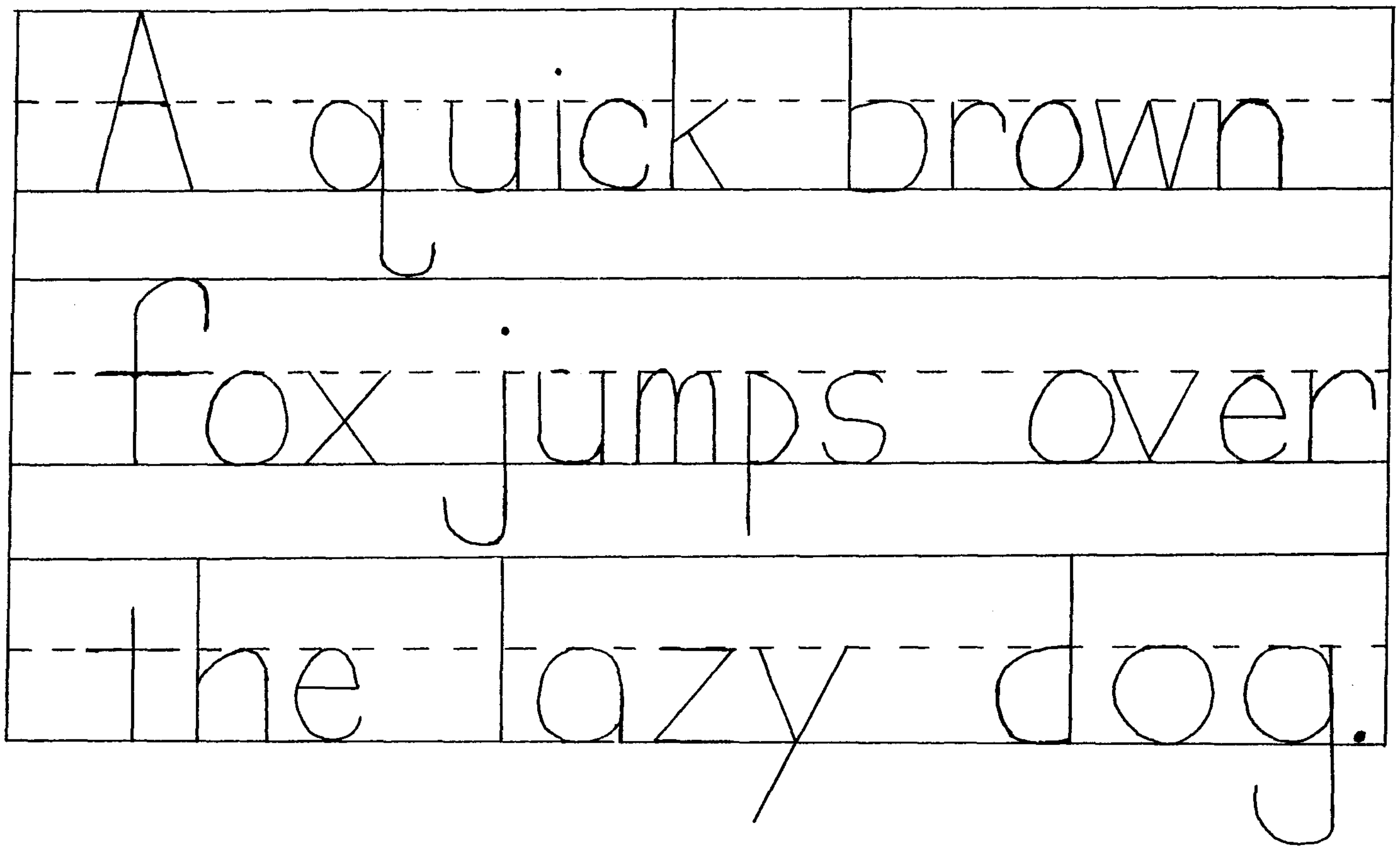
A quIck Brown fox . . . = 2 errors (no maximum)

E. Added-Letter Errors:

A quicke browne fox . . . = 3 errors (no maximum)

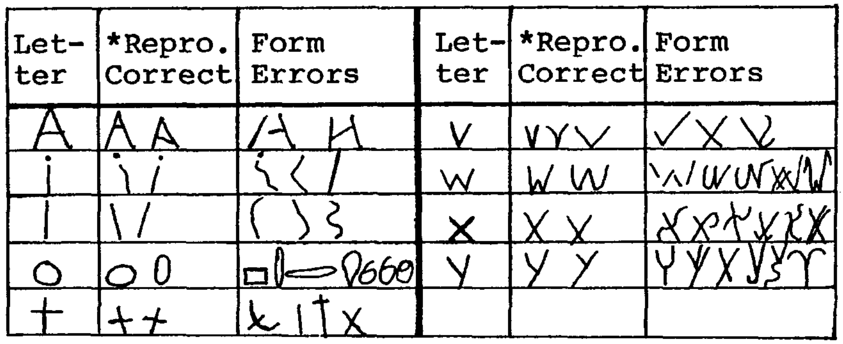
Appendix D

Model Writing Sample



Appendix E

Moore Scoring Criteria



*Reproductions judged correct

Appendix F

Instructions

1. Be sure to do the steps on the score sheet in order (1, 2, 3).
2. In step 1 count the number of letters.
3. In step 2 identify the errors.
   A. In step 2A draw a line through the letters which appear in the protocol. This is done to find if there are letters omitted.
   B. In step 2B the letters of the protocol are compared to Simner's and Moore's criteria to identify FORM ERRORS--circle the errors on the alphabet provided.
   C. In step 2C follow the same procedure as 2B, but compare the letters to the boundary error criteria. (Under "Examples of additional criteria")

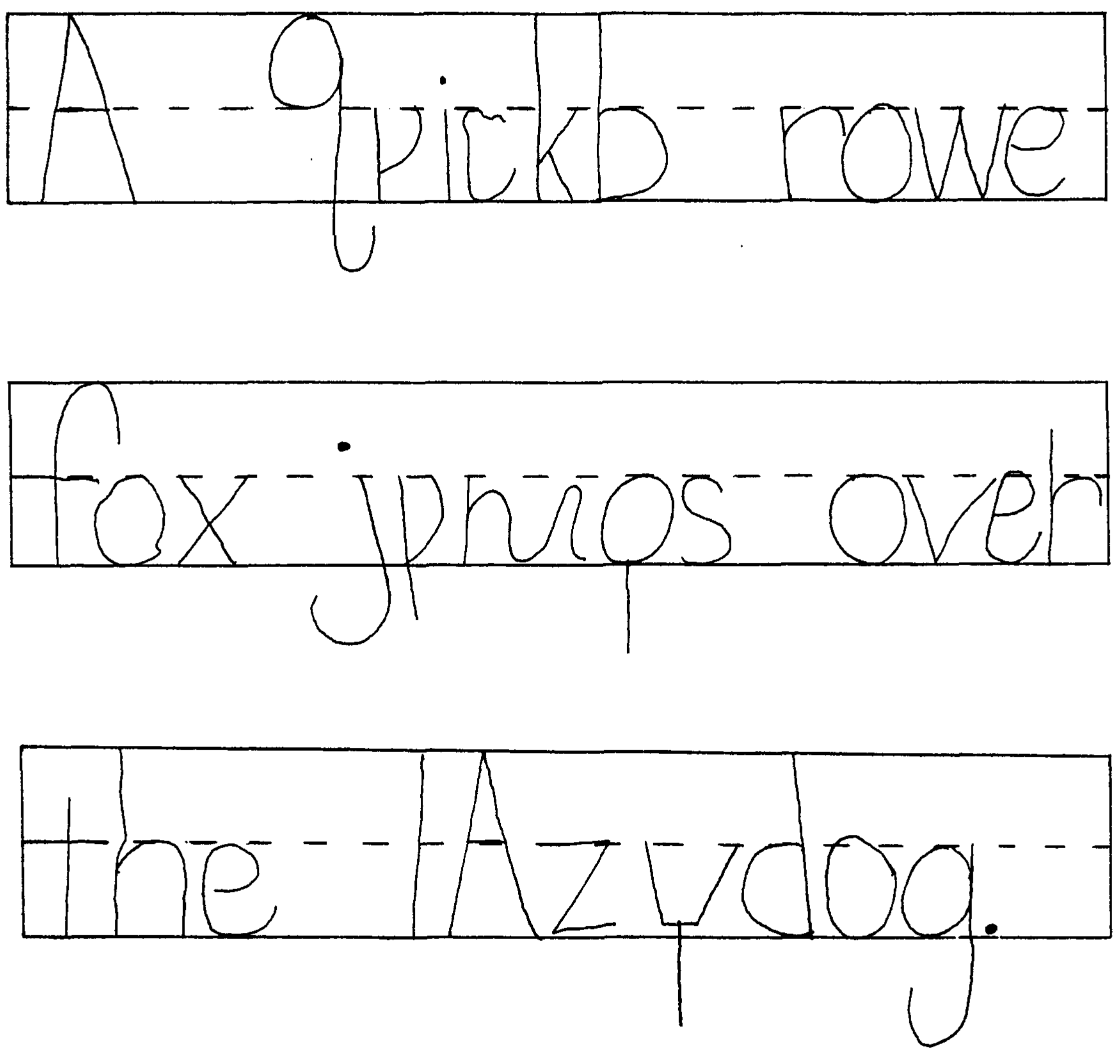
   Remember! If a letter contains both a form error and a boundary error, it is scored as two errors; circle the appropriate letter on 2B and 2C.
4. In step 3 compare the letters of the protocol to the criteria provided in "examples of additional cirteria."
   A. On step 3A, B, C, D list the error and where it was committed. Example: quickbrownfox = kb nf (see "examples of additional criteria).
5. In step 4 total the errors committed.
6. Take out the Sample Protocol sheet and examine the contents. Scores are provided at the bottom.

7. Take out the Preliminary Protocol and assess it completely according to the criteria provided in "Samples and Criteria."

8. After completing the Preliminary Protocol, take out the "Preliminary Protocol Feedback Sheet." The researcher will answer any additional questions.

Appendix G

Preliminary Protocol



Appendix H

Preliminary Protocol Feedback Sheet

____
Protocol Number

____
Rater Number

I. Letter Assessment

<u>step 1</u> Letter Count

Checklist: 1. Number of letters written <u>33</u> (33 maximum)

2. Number of o's written <u>4</u> (4 Maximum)

<u>step 2</u> Error Identification

A) On the alphabet below draw a line through the letters which appear on the protocol under consideration.

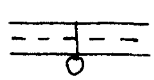
~~A a b c d e f g h i j k l m~~ (n) ~~o p q r s t u v w x y z~~ 1

*B) On the alphabet below circle the letter(s) which contain FORM ERRORS on the protocol (see Simner's and Moore's scoring criteria).

A a b c d e f g h i j k l (m) n o (p) q r s t (u)[2] v w x (y) z 5

*C) On the alphabet below circle the letter(s) which contain BOUNDARY ERRORS on the protocol (see boundary error criteria and the "sample protocol").

A a b c d e f g h i j k l m n o p q (r) s t (u) v w x y z 2

*If a letter contains both a form error and a boundary error it is scored as two errors; circle the appropriate letter on B) and C). Example: 

II. Additional Assessment (see "examples of additional criteria" and "sample Protocol").

step 3

A) List word-space errors ___k-b, y-d___ 2

____

B) List letter-space errors ___b-r___ 1

____

C) Capitalization errors (except the first "A") ______

___a(A)___ 1

D) Added-letter errors (list) ___e___ 1

____

III. Totaling The Errors

step 4

1. Number of omissions (step 2A) ___1___
2. Number of form errors (step 2B) ___5___
3. Number of boundary errors (step 2C) ___2___
4. Number of word-space errors (step 3A) ___2___
5. Number of letter-space errors (step 3B) ___1___
6. Number of capitalization errors (step 3C) ___1___
7. Added-letter errors (step 3D) ___1___

TOTAL 1, 2, 7 ___7___

TOTAL 3-6 ___6___

TOTAL 1-7 ___13___

Appendix I

Error Assessment Score Sheet

____
Protocol Number

____
Rater Number

I. Letter Assessment

<u>step 1</u> Letter Count

Checklist: 1. Number of letters written _____ (33 maximum)

2. Number of o's written _____ (4 maximum)

<u>step 2</u> Error Identification

A) On the alphabet below a draw a line through the letters which appear on the protocol under consideration.

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

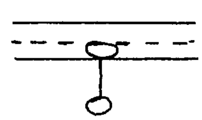
*B) On the alphabet below circle the letter(s) which contain FORM ERRORS on the protocol (see Simner's and Moore's scoring criteria).

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

*C) On the alphabet below circle the letter(s) which contain BOUNDARY ERRORS on the protocol (see boundary error criteria and the "sample protocol").

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

*If a letter contains both a form error and a boundary error it is scored as two errors; circle the appropriate letter on B) and C). Example:



II. Additional Assessment (see "examples of additional criteria" and "sample protocol").

step 3

A) List word-space errors ______________________________

____

B) List letter-space errors ____________________________

____

C) Capitalization errors (except the first "A") ______

____

D) Added-letter errors (list) __________________________

____

III. Totaling The Errors

step 4

1. Number of omissions (step 2A) _____
2. Number of form errors (step 2B) _____
3. Number of boundary errors (step 2C) _____
4. Number of word-space errors (step 3A) _____
5. Number of letter-space errors (step 3B) _____
6. Number of capitalization errors (step 3C) _____
7. Added-letter errors (step 3D) _____

TOTAL 1, 2, 7 _____

TOTAL 3-6 _____

TOTOL 1-7 _____

Appendix J

Instructions

1. In front of you are two pieces of paper. One is blank and the other one has a sentence written on it. The sentence contains every letter of the alphabet. It says, "A quick brown fox jumps over the lazy dog".
2. I want you to write this sentence on the other piece of paper (elementary ruled) the best you can. Make your sentence look just like the other one.
3. Remember, take your time so that you will not make any mistakes.
4. Bring your paper to your teacher as soon as you have finished.

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