

THE RELATION BETWEEN SYLLABIC STROKE
INTENSITY AND TYPEWRITABILITY

by

Mildred C. Lingerfelt

Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute
in candidacy for the degree of
MASTER OF SCIENCE
in
Business Education

APPROVED:

APPROVED:

Director of Graduate Studies

Head of Department

Dean of Applied Science and
Business Administration

Major Professor

May, 1952

Blacksburg, Virginia

ACKNOWLEDGMENTS

The writer wishes to express her grateful appreciation to Dr. Harry Huffman, her adviser, for his helpful guidance and constructive recommendations in the preparation and writing of this thesis; to Dr. M. E. Terry for his instruction in statistics and for his guidance in the statistical procedures so essential for the analysis of the data; to _____ for many hours spent in analysis of a great amount of data; and to _____, and _____, co-workers in typewritability studies, for their participation in the collection and tabulation of the data.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	2
CHAPTER	
I THE PROBLEM	5
Introduction	5
The Purpose of the Study	5
The Need for the Study	6
The Definition of Terms	7
II THE NATURE OF SYLLABIC STROKE INTENSITY	9
Related Studies	9
Selected Factor for this Study	11
III PROCEDURES	12
The Selection and Preparation of Tests	12
The Selection of Experimental Subjects	14
The Selection of the Experimental Design	15
IV ANALYSIS OF THE DATA	17
Tabulation of the Data	17
Analysis of the Experimental Design	18
V GENERAL SUMMARY AND CONCLUSIONS	20
Summary	20
Results of the Analyses	20
Results of Analysis of Variance on Errors Made	21
Results of Analysis of Variance on Strokes Typed	21
Correlations	22
Conclusions	23

TABLE OF CONTENTS (Concluded)

CHAPTER	Page
V GENERAL SUMMARY AND CONCLUSIONS (Continued)	
Recommendations	24
BIBLIOGRAPHY	31
VITA	32
APPENDIX A	33
APPENDIX B	52

LIST OF TABLES

Table

1 Analysis of Variance for Errors Made	25
2 Analysis of Variance for Strokes Typed	25
3 Analysis of Variance for Correlations	26

LIST OF FIGURES

Figure

1 Trend Effect of Errors Made in Order of Tests Given	27
2 Graph of Errors Made versus Syllabic Stroke Intensity	28
3 Graph of Strokes Typed versus Syllabic Stroke Intensity	29
4 Graph of Strokes Typed versus Errors Made	30

CHAPTER I
THE PROBLEM

Introduction

Business educators have for many years realized that some straight-copy materials are more difficult to typewrite than others. In the preparation of textbooks to be used in the teaching of reading, the factors which determine reading difficulty are considered. Likewise, the factors which determine the difficulty of typewriting material should be considered in the preparation of manuals of instruction in typewriting.

The Purpose of the Study

The production of typewriting copy depends upon the typewritability of the copy as well as upon the personal qualities of the typist, such as intelligence, manual dexterity, and coordination.

There are numerous factors which influence typewritability. Some of these factors are word stroke intensity, syllabic intensity, syllabic stroke intensity, number of frequently-used words, length of sentences, number of punctuation marks and capitals, ideas presented, and the like.

The specific purpose of this study is to isolate one of the factors of difficulty, syllabic stroke intensity, and to determine the influence of this factor on the typewritability of straight-copy material.

The Need for the Study

In the typewriting classroom the use of straight-copy material is important to the development of typewriting speed and power. If the factors that determine the difficulty of the copy are not recognized and controlled, the material does not serve a valid purpose in the skill building process. Straight-copy material of varying difficulty should be constructed to serve the needs of students on the progressive levels of development.

Straight-copy material is frequently used to measure copying ability in the classroom, in personnel selection for business and industry, and in typewriting contests. If straight-copy material varies in difficulty, then it is not an accurate measuring device unless the factors of difficulty are recognized and controlled. If word stroke intensity, syllabic intensity, and syllabic stroke intensity, as examples, influence the difficulty of straight-copy material, they may be regulated so that the results of different copying tests may be more accurately compared.

The advantages of a standard for measuring the difficulty of straight-copy material would be many. In reporting the results of this study to determine the effect that the length of the syllable has upon typewritability, valuable information is made available to persons who prepare typewriting copy to be used for instructional purposes and as measuring devices.

The Definition of Terms

The term typewritability refers to the difficulty of the material typed. In this study, the difficulty of the material was measured by the typist's performance in terms of the total number of strokes written within a limited period of time and in terms of the number of errors made by the typist.

Typewriting material is any material reproduced on the typewriter. That material may be business letters, tabulations of data, rough drafts, etc. The typewriting material used in this experiment was limited to straight-copy material typical of business correspondence. No attempt was made to construct copy with syllabic stroke intensity controlled. Copy was selected at random from instructional manuals in typewriting.

A factor may be any one of the various qualities of typewriting material that determine the difficulty of copying that material on the typewriter.

Word stroke intensity is the number of strokes in the average word. The total number of strokes in the copy, counted as if written on one continuous line, divided by the total number of words in the copy, yields word stroke intensity.

$$\text{Formula: } \text{WStI} = \frac{\text{Strokes}}{\text{Words}}$$

Syllabic intensity is the number of syllables in the average word. The total syllables in the copy divided by the total words yields syllabic intensity.

$$\text{Formula: } \text{SyI} = \frac{\text{Syllables}}{\text{Words}}$$

Syllabic stroke intensity is the number of strokes in the average syllable. The total strokes in the copy divided by the total syllables yields syllabic stroke intensity.

$$\text{Formula: SyStI} = \frac{\text{Strokes}}{\text{Syllables}}$$

Strokes in the copy mean all letters, numbers, symbols, punctuation marks and blank spaces required to reproduce that copy and are counted as if written on one continuous line. The terms blank spaces and white spaces may be used interchangeably.

The words test or form refer to the samples of typewriting material used in the experimentation. The samples were selected from five textbooks frequently used in the teaching of secondary school typewriting.

CHAPTER II

THE NATURE OF SYLLABIC STROKE INTENSITY

Related Studies

A few experiments have been conducted which support the hypothesis that certain factors influence the typewritability of straight-copy material.

In 1940 Shipley¹ conducted an experiment to determine the relative difficulty of each test in a series of typewriting tests and the reliability of the series as a whole. He found that fluctuation in a learner's typewriting speed is more likely to be caused by the variation in difficulty of different pieces of copy than by changes in his typewriting ability. When these findings became known, other research workers began to ask why the variation in typewritability exists.

In 1942 Vandegrift and McMillon² made a graphic motion study in typewriting classes of the WAVES using an original device for recording typewriting operations. They reported that all their subjects reached the greatest speed on two- and three-letter words. Thus it appears that typewriting

¹Shipley, Clifford B., "A Study to Determine the Relative Difficulty of a Series of Typewriting Tests and the Reliability of the Series" (Unpublished Master's thesis, Iowa City, University of Iowa, 1940).

²Vandegrift, J. R., and McMillon, Roy, "Recent Research in Graphic Time Studies in Typewriting," The National Business Education Quarterly, XII (Winter, 1943), 5-9.

copy which has an abundance of short words is easier to write than copy composed of many long words.

In 1947 a study was conducted at the University of Oklahoma by Taylor³ in which typewriting copy was graded according to its syllabic intensity. Results of the study indicated a highly significant negative correlation between production and syllabic intensity.

The need for syllabically graded straight-copy material was recognized by Lessenberry⁴ in 1933 when he graded the timed writings in his textbooks. Other authors of typewriting books have responded to this need.

In 1950 Bell⁵ conducted a study to measure the effect of word stroke intensity and per cent of frequently-used words upon typewriting performance in terms of gross strokes and errors, the effect of syllabic intensity upon performance, and to establish a formula to predict typewritability. The results of this study indicated a direct relationship between syllabic intensity and typewritability and a direct relationship between typewritability and word stroke intensity. Bell concluded her study with a formula for grading the difficulty

³Taylor, Ruth Pilgrim, "The Relation of Syllabic Intensity of Straight-Copy Typewriting Tests" (Unpublished Master's thesis, College of Education, University of Oklahoma, 1947).

⁴Lessenberry, D. D., 20th Century Typewriting (3rd ed; Cincinnati: South-Western Publishing Co., 1933).

⁵Bell, Mary LaVerne, "Some Factors of Difficulty in Typewriting Copy" (Unpublished Ed. D. dissertation, Graduate College, University of Oklahoma, 1950).

of straight-copy material. In the construction of the formula, consideration was given to the factors of word stroke intensity, syllabic intensity, and per cent of frequently-used words.

Selected Factor for this Study

The foregoing studies point to word stroke intensity and syllabic intensity as two factors which influence typewritability. If these factors affect the difficulty of typewriting material, syllabic stroke intensity may also be considered as a variable in typewritability.

Since typewriting skill above the letter-by-letter level may be assumed to proceed by pronounceable syllables, the following hypothesis is established: Variation in the number of strokes in the syllables of the copy results in differences in typewritability. For example, the one-syllable word straight which contains eight letters presumably presents a difficulty for the typist which is different from that of every which contains three short syllables.

So far as the author can determine, no study has been made dealing with syllabic stroke intensity. The specific purpose of this study is to isolate statistically the factor of syllabic stroke intensity and to determine its relationship to the difficulty of straight-copy typewriting material.

CHAPTER III

PROCEDURES

The Selection and Preparation of Tests

The purpose of the study was to determine the relation between syllabic stroke intensity and typewritability. Straight-copy material seemed best adapted to the study because that material is the most frequently-used device for measuring and testing typewriting performance.

After securing the sponsorship of the Business Education Service of the State Department of Education, Richmond, Virginia, permission was generously given by the publishers of five frequently-used typewriting texts^{6,7,8,9,10} to use the desired material in their books. A copy of the letter mailed to the publishers is given in Appendix A.

All straight-copy material in the texts was numbered consecutively. In order that all tests would be approximately

⁶Blanchard, Clyde I., and Smith, Harold H., Typing for Business, Two-Year Course, The Gregg Publishing Company, New York, 1946.

⁷DePew, Ollie, Complete Typewriting, Allyn and Bacon, Boston, 1948.

⁸Lessenberry, D. D., and Crawford, T. James, 20th Century Typewriting, Fifth Edition, South-Western Publishing Company, Cincinnati, 1947.

⁹Maxwell, W. C., Mursell, James L., and Fries, Albert C., Rhythmic Typewriting, The Ronald Press Company, New York, 1948.

¹⁰White, Walter T., and Reigner, Charles G., Rowe Typing, Second Edition, Baltimore, 1944.

the same in length, a minimum of 700 and a maximum of 1250 strokes was established. Straight-copy material was divided according to this specification when the number of strokes did not automatically fall within this range. Actually the shortest test contained 697 strokes while the longest test contained 1225 strokes.

The design of the experiment, which consisted of an 11 by 11 balanced lattice square replicated six times as shown in Experimental Designs by Cochran and Cox¹¹, required the use of 121 samples of test material. Using a method of random selection, 121 tests were drawn from the total 239 straight-copy tests available in the books. A random sampling of these tests is included in Appendix A. The source of the material, as stated at the bottom of the test, was omitted from the students' copies. Each test was coded according to the alphabetic assignment of the text. The texts were assigned a letter of the alphabet, A through E, to conceal the identity of the book. All tests were double-spaced and were duplicated on 8½ by 7-inch mimeograph paper.

The testing material was collated in booklets according to the random order determined by the lattice designs. Each line of 11 tests represented in the six 11 by 11 lattices was to be taken by ten different students making a total of 7260 tests to be used in the statistical analysis. This

¹¹Cochran, William G., and Cox, Gertrude M., Experimental Designs, John Wiley and Sons, New York, 1950, 364-365.

required the participation of 660 students. The use of the lattices facilitated the distribution of a large number of tests over a wide geographical area without placing an undue burden on students or on teachers administering the tests.

The Selection of Experimental Subjects

High school students were chosen for participation in the study because of their availability. A preliminary survey was conducted to determine the number of students enrolled in advanced typewriting classes in 52 public high schools throughout the state of Virginia. A random selection was made of those schools having as many as 30 second-year typewriting students. Schools with small enrollments were excluded from the experiment since the unit cost of administration for small groups was prohibitive. Letters were mailed to school principals and typewriting teachers securing their cooperation in the administering of tests. A copy of the letters is found in Appendix A.

Booklets of tests and instructions to teachers and students (Appendix A) were mailed to the participating schools. Teachers were instructed to time the students for exactly five minutes on each test. If the student completed the test before the end of the five-minute period, he was to repeat the material. Each student was required to take all of the tests in his booklet in the order in which they were arranged.

The tests were administered in April and May, 1951, by typewriting teachers in the Virginia schools listed below.

Blacksburg High School	Blacksburg
Christiansburg High School	Christiansburg
Crozet High School	Crozet
Culpeper High School	Culpeper
E. C. Glass High School	Lynchburg
Front Royal High School	Front Royal
George Washington High School	Alexandria
George Washington High School	Danville
John Marshall High School	Richmond
Lane High School	Charlottesville
Martinsville High School	Martinsville
McIntire High School	Charlottesville
Mount Vernon High School	Alexandria
Suffolk High School	Suffolk
Tazewell High School	Tazewell
Woodrow Wilson High School	Portsmouth

The Selection of the Experimental Design

It was desirable to set the experiment up on a relatively large number of tests, each test to be taken by a minimum of 60 students each. Furthermore, it was important that no one test be given in the same order throughout. It was obvious that not all of the large number of tests could be given to any one student and that there must be some systematic subdivision of the test groups presented to the several groups of students involved in the experiment.

The fundamental idea of the experiment was to obtain valid test measures of the number of strokes typed and the number of errors made in order to investigate relationships with syllabic stroke intensity. Hence, it became necessary to use a rather complicated statistical design belonging to the family of balanced incomplete block designs.

Incomplete block designs are designs wherein it is not necessary to present all of the tests to any one student.

The design becomes balanced when the test groups are presented to the several groups of students in such a manner that we can eliminate or average out effects due to the order in which the tests were given and the effect of the several groups into which the student body is divided.

A particularly useful form of design is the 11 by 11 lattice since it is composed of 121 elements, thus enabling us to use 121 different or distinct tests. These tests would be given in lines of 11 tests making 11 sub-groups in any one design. There are six distinct designs, which when used together, balance out the effects previously mentioned. The whole design consists of six large groups, each group consisting of 11 sub-groups of 10 students each. This design was practical to use and the analysis of the final results, although by no means simple, was feasible. It was felt that the 60 students taking any one test would be random with respect to age level, skill level, and intellect level.

CHAPTER IV
ANALYSIS OF THE DATA

Tabulation of the Data

When the test material was returned by the participating schools, the students' booklets of tests were arranged according to the design of the lattices. The pattern of the experiment required that the eleven tests in each line of the squares be taken by ten different students.

The returns from some schools were incomplete and some students' booklets were not usable because the instructions for taking the tests were not carefully observed. When all usable data was tabulated, it was found that tests for ten students for each line were not available. In order to use the balanced design, the number of students' booklets to be utilized in the analysis was reduced from ten to five.

The criterion for measuring performance was the total number of strokes typed and the total number of errors made by the students during five-minute testing periods. Tables 1 through 6 in Appendix B are a tabulation of errors made by 330 students on 3630 tests. The first row of numbers in each line indicates the test number. The second row of numbers represents the total errors made by five students on each test in that row.

Tables 7 through 12 in Appendix B are a tabulation of the strokes typed by five students on each of the 121 tests in the six replications.

In analyzing the data the purpose was to discover whether the students' performance was affected by variations in syllabic stroke intensity. To determine syllabic stroke intensity, the total strokes in each test were divided by the total syllables in that test. Table 13 in Appendix B is a summary of the strokes, syllables, and syllabic stroke intensity for the 121 samples of straight-copy material used in the experiment.

Analysis of the Experimental Design

The analysis of the lattice squares was made according to the instructions as given in Experimental Designs by Cochran and Cox.¹² This procedure utilizes the method of the Analysis of Variance and assesses the significance of the variation between the means of groups of observations. The Analysis of Variance for errors made and strokes produced, as shown in Table 1 and Table 2 on page 25 consists of five sources of variability each. The sources investigated were: between squares, or replications; between treatments, or test scores; between rows, or groups of five students; between columns, or effect of order; and experimental error. The calculations for the sums of squares and mean squares of these analyses of variance tables are shown in Appendix B.

¹²Ibid.

In order to test whether there was a meaningful and significant difference between the factors inherent in the design, the Null Hypothesis was first stated that there is no difference in the means between effects and the experimental error. This Null Hypothesis utilizes the Snedecor's F-test, which gives as a result the probability that the differences which do occur could have occurred by chance alone. This probability is known as significance level, and a significance level of less than 1% indicates that the chances are less than 1 in 100 that so large or larger a difference could have occurred by chance, given that the Null Hypothesis is true.

The significance levels for each effect are shown in the last columns of the Analysis of Variance tables.

The test scores were corrected for the variations inherent in the data; that is, the effects of variability were removed from the test scores to give a corrected group of test scores.

Studies were made in an attempt to correlate syllabic stroke intensity with errors made and syllabic stroke intensity with strokes produced.

CHAPTER V
GENERAL SUMMARY AND CONCLUSIONS

Summary

The purpose of the study was to determine the relationship between syllabic stroke intensity and difficulty in typewriting copy.

The design of the experiment required the use of 121 samples of material to be replicated in six 11 by 11 balanced lattices. One hundred twenty-one samples of straight-copy typewriting material were selected randomly from five frequently-used typewriting texts. The samples were duplicated and tests were administered by typewriting teachers in 16 Virginia high schools to students enrolled in advanced typewriting classes. All tests were timed for five minutes and were taken in the random order determined by the six 11 by 11 balanced squares.

Each of the 121 tests was taken by 30 different students making a total of 3630 tests which were used in the analysis. The criterion for measuring performance on these tests was the total strokes typed and total errors made by the students. Strokes and errors for each test in each replication were tabulated as shown in Appendix B. Syllabic stroke intensity was determined for the 121 samples of material.

Results of the Analyses

The inferences to be drawn from the data will be divided into four parts: Discussion of the results of the Analysis

of Variance on Errors Made, discussion of the results of the Analysis of Variance on strokes typed, discussion of correlation studies, and conclusions.

Results of Analysis of Variance on Errors Made

The results of the F-test applied to variability due to replications, or squares, show that there is a positive difference between replications at the 0.1% level. As this variability arose due to differences between groups of 55 students, the result is to be expected. Likewise, the effect of rows, or differences between groups of five students, is statistically significant at the 0.1% level.

As the tests were taken in the order in which they appear in the design, column by column, it is rather surprising that the effect of columns is significant at less than 0.1%. However, it is felt that this may be due to a fatigue factor and is shown graphically in Figure 1, page 27. In this figure, the total errors made for each column, as indicated in the design, is plotted against the column number in sequence. The resulting picture shows the trend of increasing errors with time.

The effect of treatments, while significant at the 5.0% level, could not be broken into discrete parts.

Results of the Analysis of Variance on Strokes Typed

An examination of the Analysis of Variance for strokes typed, Table 2, page 25, shows that all effects are

significantly different, with a probability of less than 0.1%. It is to be noted that the mean square terms in the Analysis of Variance for strokes typed are roughly proportional to the mean square terms in the Analysis of Variance for errors.

The main difference which exists between the terms occurs in the column factor, or factor for the order in which the tests were given. This factor for errors made shows a linear trend with order of tests taken. However, this effect in the strokes-typed analysis did not give this linear effect but only shows what seemed to be random or unexplained fluctuations.

Correlations

As stated in Chapter IV, attempts were made to find if any correlations existed between syllabic stroke intensity and errors, between syllabic stroke intensity and strokes typed, and between strokes typed and errors made.

As a first approximation to determine whether correlation studies might be justifiable, the data was plotted on coordinate paper and the resulting graphs studied. The graph of syllabic stroke intensity as plotted against errors produced is shown in Figure 2, page 28. A cursory examination of this figure will show the complete lack of correlation between these two factors, thus mathematical correlation attempts were not made.

The graph of syllabic stroke intensity versus strokes typed is shown in Figure 3, page 29. As it appears that there

is a definite correlation, mathematical studies were made which indicated that the correlation coefficient for these two factors is 0.362. The Analysis of Variance for this correlation is shown in Table 3, page 26. An F-test applied to the Analysis of Variance shows that the chances are less than 1 in 1000 that there is no correlation inherent in the data. From this result, it is safe to conclude that there is a correlation.

As an interesting sidelight on this problem, the results of the strokes typed was plotted against errors made. This is shown graphically in Figure 4, page 30. An examination of this figure would tend to indicate that no relationship existed between these two factors.

Conclusions

The results of this study indicate:

1. There is a definite correlation between syllabic stroke intensity and the amount of copy produced on the typewriter in a given time.

The correlation showed that an increase in syllabic stroke intensity produced a corresponding increase in the number of strokes typed, over the range investigated. This range was from 3.484 strokes per syllable to 4.285 strokes per syllable.

2. There appeared to be no correlation between syllabic stroke intensity and the errors made in a given time.

3. The study indicated that there is no relationship between the amount of copy typed and the number of errors made in typing that copy.

4. The errors made on the tests seemed to increase as the tests were progressively taken. Whether this is due to fatigue or some other factor is left for future research workers to determine.

Recommendations

If syllabic stroke intensity is a factor of difficulty in typewriting copy, as the results of this study indicate, then that factor should be considered in the preparation of manuals of instruction in typewriting.

In the use of materials for teaching and testing typewriting ability, teachers should recognize the length of the syllable as one of the measures of difficulty of that material.

Table 1

Analysis of Variance for Errors Made

Source	d/f	S. S.	M. S.	F-ratio	α
Replication	5	55,154.83	11,030.97	135	0.1%
Treatments	120	28,770.86	239.76	2.91	0.1%
Rows, Adjusted	60	60,026.82	1,000.45	12.20	0.1%
Columns, Adjusted	60	13,756.03	229.27	2.80	0.1%
Error	<u>480</u>	<u>39,273.48</u>	81.82	-----	-----
Total	725	193,982.03			

25

Table 2

Analysis of Variance for Strokes Typed

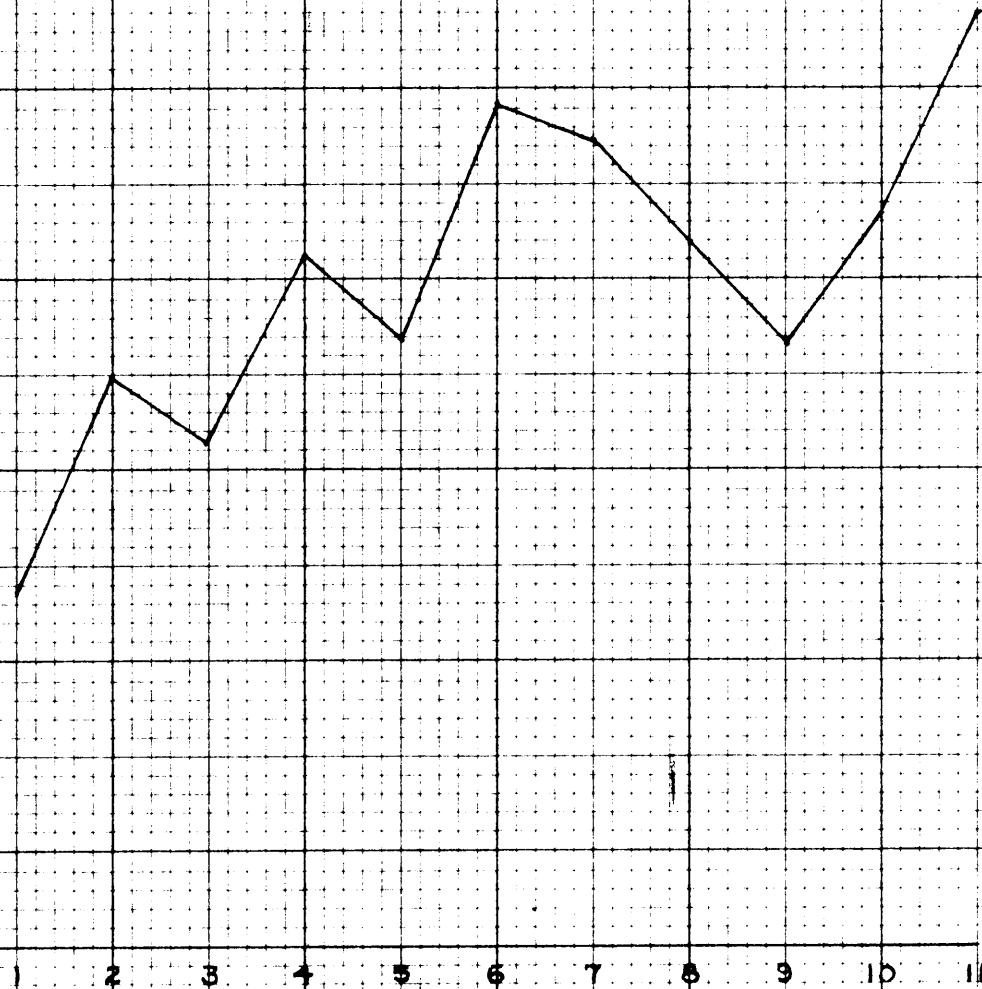
Source	d/f	S. S.	M. S.	F-ratio	α
Replication	5	73,764,723	14,752,945	227	0.1%
Treatments	120	58,509,345	487,578	7.49	0.1%
Rows, Adjusted	60	108,964,557	1,316,076	27.93	0.1%
Columns, Adjusted	60	8,881,249	148,021	2.274	0.1%
Error	<u>480</u>	<u>31,239,237</u>	65,081	-----	-----
Total	725	281,359,111			

Table 3

Analysis of Variance for Correlations

Source	d/f	S. S.	M. S.	F-ratio	α
Correlation	1	0.13118	0.13118	17.9698	0.1%
Residual	<u>119</u>	<u>0.86882</u>	0.00730		
Total	120	1.00000			

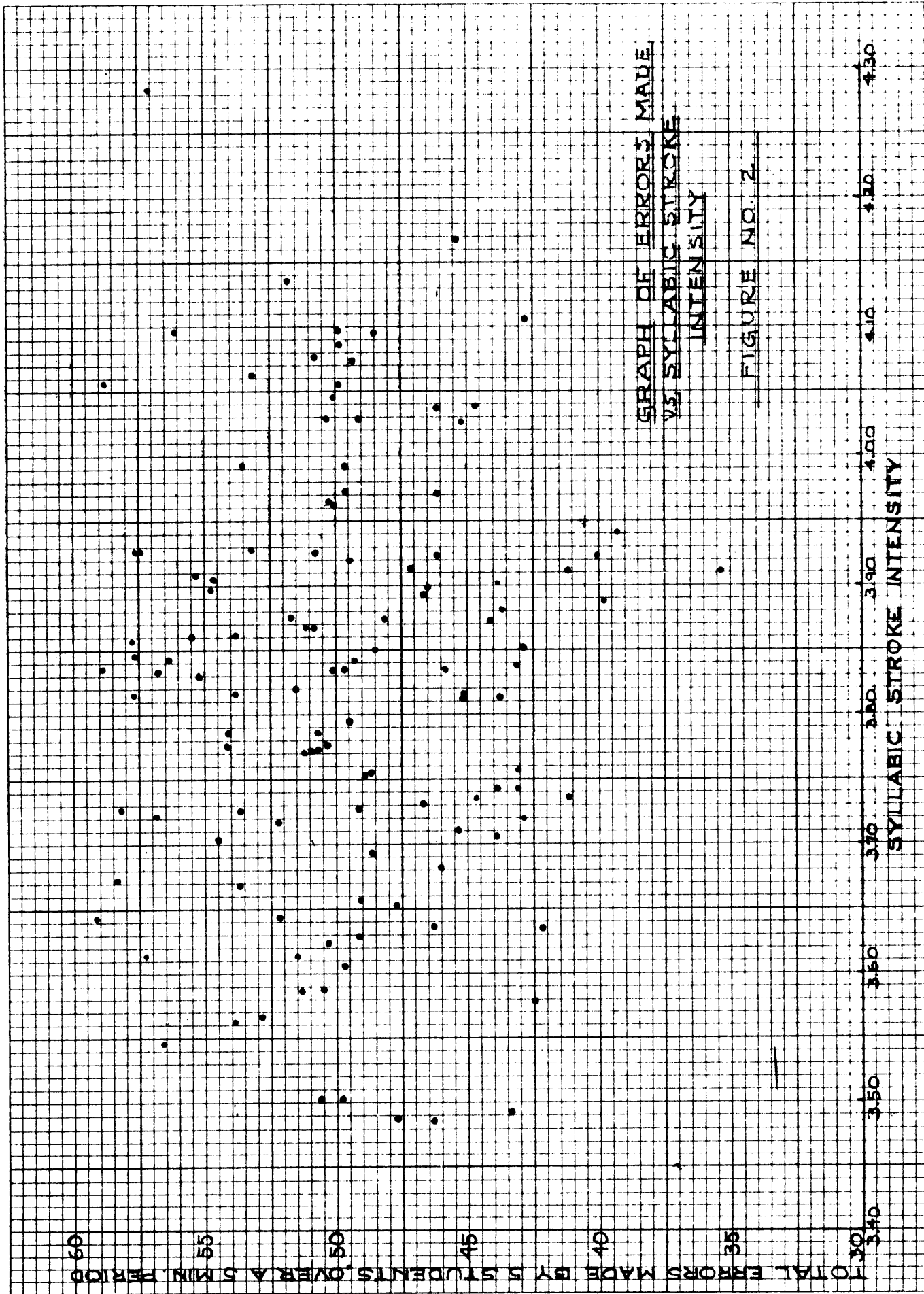
NO. OF ERRORS MADE ON EACH COLUMN

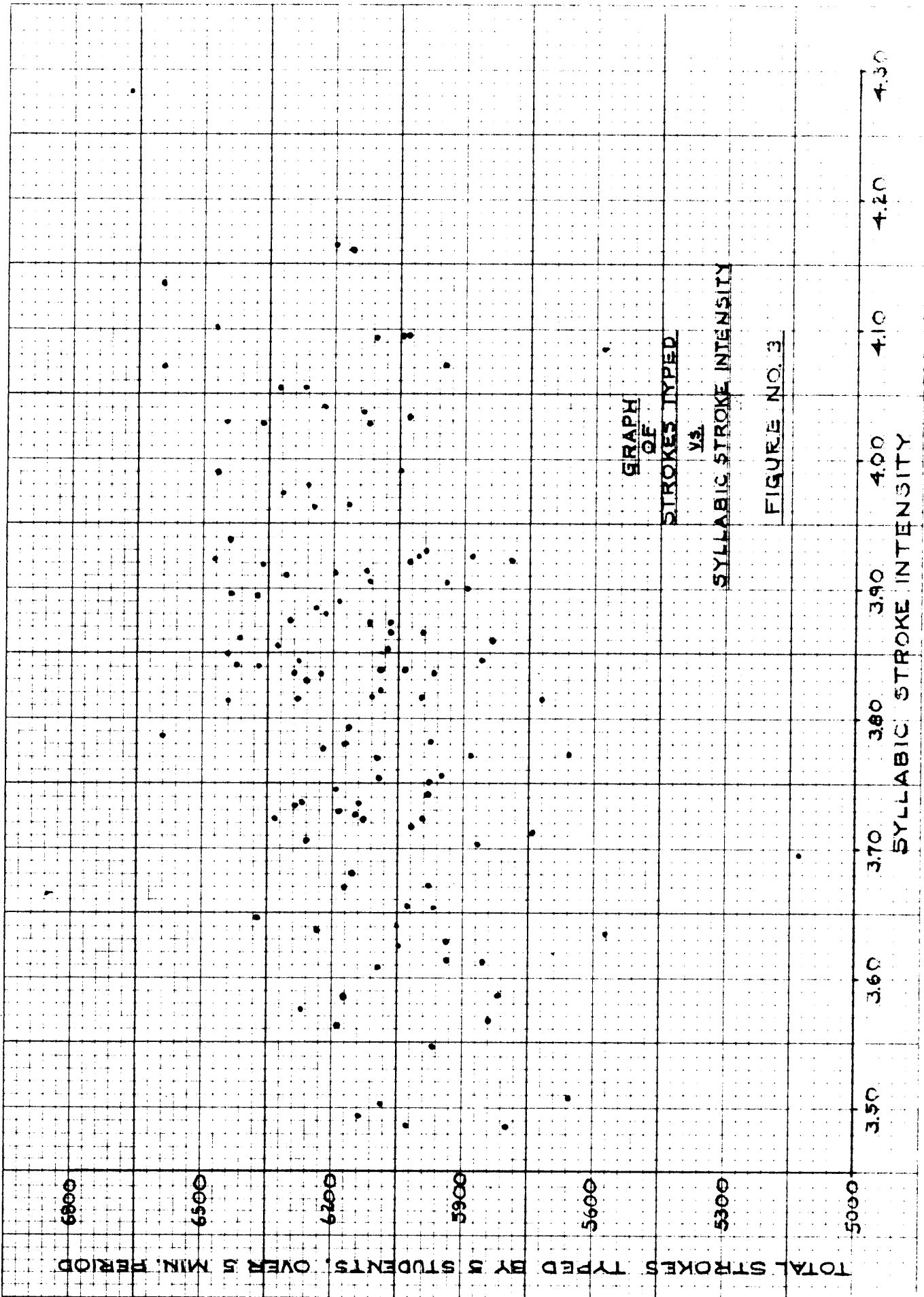


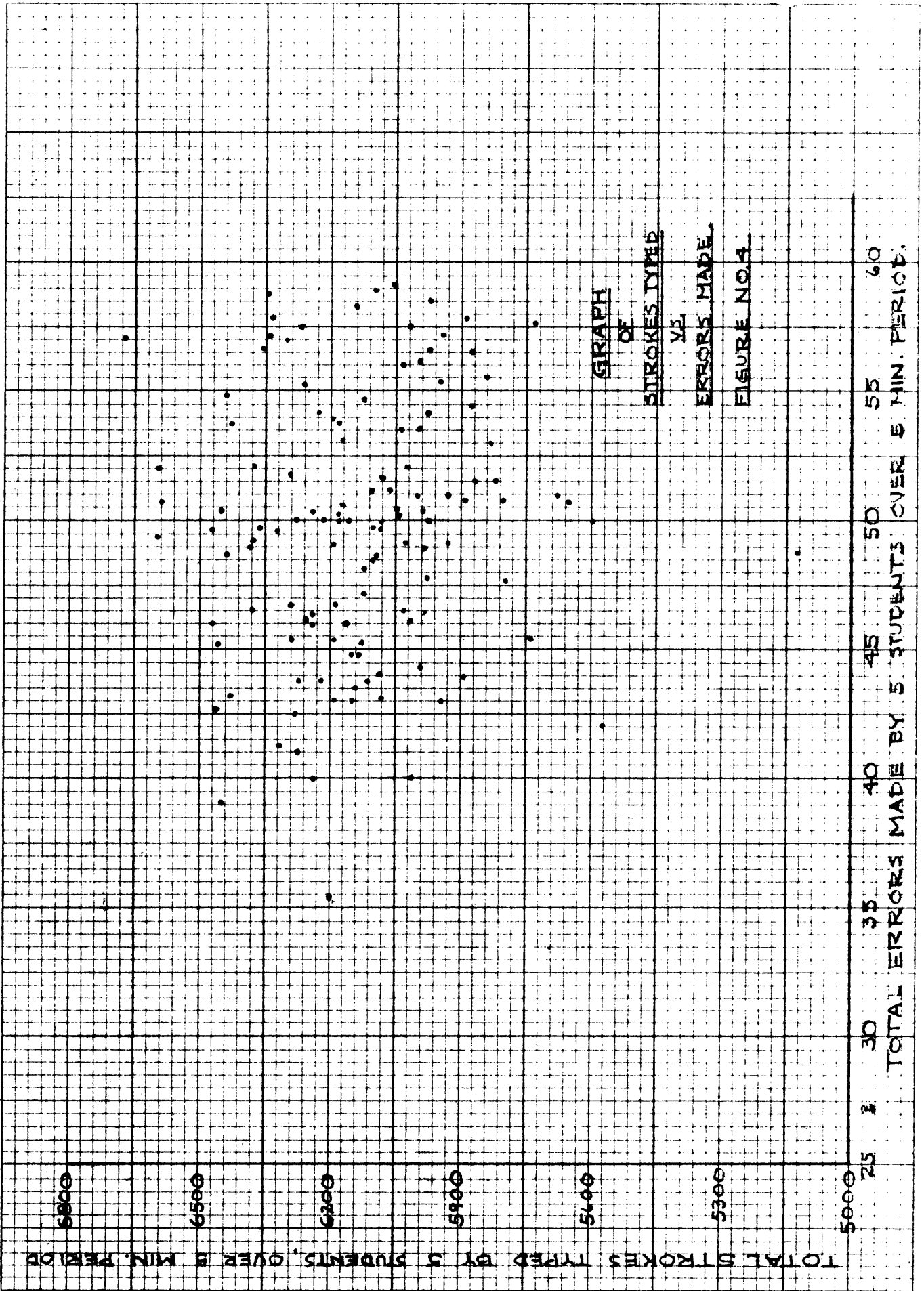
COLUMN NUMBER

FIGURE 1

TREND EFFECT OF ERRORS
MADE IN ORDER OF TESTS
GIVEN.







GRAPH
OF
STROKES TYPED
VS.
ERRORS MADE
FIGURE NO. 4

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Bell, Mary LaVerne, "Some Factors of Difficulty in Typewriting Copy" (Unpublished Ed. D. dissertation, Graduate College, University of Oklahoma, 1950).
2. Blanchard, Clyde I., and Smith, Harold H., Typing for Business, Two-Year Course, The Gregg Publishing Company, New York, 1946.
3. Cochran, William G., and Cox, Gertrude M., Experimental Designs, John Wiley and Sons, New York, 1950, 364-365.
4. DePew, Ollie, Complete Typewriting, Allyn and Bacon, Boston, 1948.
5. Lessenberry, D. D., 20th Century Typewriting (3rd ed; Cincinnati: South-Western Publishing Co., 1933).
6. Lessenberry, D. D., and Crawford, T. James, 20th Century Typewriting, Fifth Edition, South-Western Publishing Company, Cincinnati, 1947.
7. Maxwell, W. C., Mursell, James L., and Fries, Albert C., Rhythmic Typewriting, The Ronald Press Company, New York, 1948.
8. Shipley, Clifford B., "A Study to Determine the Relative Difficulty of a Series of Typewriting Tests and the Reliability of the Series" (Unpublished Master's thesis, Iowa City, University of Iowa, 1940).
9. Taylor, Ruth Pilgrim, "The Relation of Syllabic Intensity of Straight-Copy Typewriting Tests" (Unpublished Master's thesis, College of Education, University of Oklahoma, 1947).
10. Vandegrift, J. R., and McMillon, Roy, "Recent Research in Graphic Time Studies in Typewriting," The National Business Education Quarterly, XII (Winter, 1943), 5-9.
11. White, Walter T., and Reigner, Charles G., Rowe Typing, Second Edition, Baltimore, 1944.

VITA

**The vita has been removed from
the scanned document**

APPENDIX A

SAMPLE LETTER SENT TO TEXTBOOK PUBLISHERS

Gentlemen:

We are writing you at this time to request permission to use material from your textbook in a thesis study which we are planning to conduct.

Material is to be drawn at random from five typewriting texts to aid in conducting a testing program for a graduate study. This is a study concerning the effect of syllabic intensity, per cent of frequently-used words, stroke intensity, syllabic stroke intensity, and the like upon difficulty in typewriting copy.

This study is to be conducted under the guidance of Dr. Harry Huffman, Head, Department of Business Education, Virginia Polytechnic Institute, Blacksburg, Virginia.

We would like to reproduce from your textbook certain straight-copy matter for use in testing. In our study we are by no means endeavoring to make a comparison of typewriting texts.

It is our hope that the results of this study will prove useful in the business field.

Thank you in advance for your cooperation, and we shall sincerely appreciate it if you will grant us permission to use material from your book. Please let us hear from you in the near future.

Very truly yours,

SAMPLE OF LETTER SENT TO PRINCIPALS
OF PARTICIPATING SCHOOLS

Dear Sir:

Under the direction of Dr. Harry Huffman, Head, Department of Business Education, Virginia Polytechnic Institute, Blacksburg, Virginia, we are planning a thesis study in typewriting.

To date, we have selected five typewriting texts from which we shall draw at random samples of typewriting copy to be used in preparing tests for 660 advanced typewriting students in the State of Virginia. This testing program shall in no way try to prove that students of one school are more efficient in typewriting than students in another school. In fact, when the tests are returned to us from the various schools we shall mix them together before attempting to determine the results. Our sole aim shall be to determine the ease or difficulty in typewriting copy now in use.

At this time we are requesting that you grant us permission to use your advanced typewriting students in our testing program. If you will grant us this permission, we feel you will be participating in a study which we sincerely hope will contribute to the improvement of business education.

Please return the enclosed card at your earliest convenience indicating your pleasure relative to this matter. We are writing the Head of your Business Department at this time, but we shall not proceed with the study until we have received your authorization.

Thank you for your cooperation.

Very truly yours,

SAMPLE OF LETTER SENT TO BUSINESS TEACHERS
IN PARTICIPATING SCHOOLS

Dear Business Teacher:

Under the direction of Dr. Harry Huffman, Head, Department of Business Education, Virginia Polytechnic Institute, Blacksburg, Virginia, we are planning a thesis study in typewriting.

To date, we have selected five typewriting texts from which we shall draw at random samples of typewriting copy to be used in preparing tests for 660 advanced typewriting students in the State of Virginia. This testing program shall in no way try to prove that students of one school are more efficient in typewriting than students in another school. In fact, when the tests are returned to us from the various schools we shall mix them together before attempting to determine results. Our sole aim shall be to determine the ease or difficulty in typewriting copy now in use.

At this time we are requesting that you grant us permission to use your advanced typewriting students in our testing program. If you will grant us this permission, we feel that you will be participating in a study which we sincerely hope will contribute to the improvement of business education.

Please return the enclosed card at your earliest convenience indicating your pleasure relative to this matter. If you are willing for us to use your students, please include the number of advanced typewriting students you have available.

We have written your principal requesting permission to use your students in conducting this study, and we are sincerely hoping you and your principal will cooperate with us. A complete manual of instructions for administering the tests will be mailed you with the tests. This study shall in no way evaluate the efficiency of your teaching or the progress of your students.

Very truly yours,

INSTRUCTIONS TO TEACHERS ADMINISTERING THE TESTS

We are sending you, in booklet form, the timed writings which you so generously agreed to administer for us in our thesis study. In the preliminary request we sent you, we asked for the number of second-year typewriting students you have available. This was an attempt to place the tests at a level in typewriting speed of 40 words per minute. In a number of cases, we are not sending a test for each student because of the difficulty in mailing. Therefore, please administer the 11 timed writings to students in accordance with the number of booklets we are sending you.

It is extremely important that regulations be followed in administering these timed writings in order to have uniformity in all schools participating. Will you please consider the following in administering the timed writings.

1. Each booklet is designed for one student and that student must complete all of the timed writings in the booklet in the order in which they are arranged.
 - a. A student may make up a timed writing on another day if he should be absent and miss the writings given one day. Do not permit another student to complete the writings in that BOOKLET, however, every timed writing in the booklet must be completed.
 - b. Unless this regulation is followed, the timed writings typed from that booklet will not be valid.
2. Each timed writing is to be five minutes in length. If the material is completed before time is called have student repeat the material.
3. Upon completing the 11 timed writings (in each of the booklets we send you) have students staple their copies together in the order in which the timed writings have been taken.
4. Please destroy or return to us the booklets which we send you. This is extremely important in order that we may be protected from infringement of the copyright law.
5. You need not check these tests. You may utilize the results of these timed writings as you would any other timed writings you administer. We are interested only in the copy typed by the student

INSTRUCTIONS TO TEACHERS ADMINISTERING THE TESTS (Concluded)

and his output as evidenced by the errors and strokes. By this evidence we shall attempt to measure the difficulty of the material.

We would like for these timed writings to be completed and returned to us by May 22. You are at liberty to administer as many of these timed writings within one day as you wish.

You will be notified individually concerning return postage.

INSTRUCTIONS TO STUDENTS PARTICIPATING IN THE EXPERIMENT

This is not a test of your typewriting skill. You are participating in an experiment to determine the factors that contribute to the difficulty of the material you are copying. Therefore, you need not calculate net words per minute unless otherwise instructed by your teacher.

- a. Type in upper right-hand corner code number which is given in the upper right-hand corner of each test.
- b. Use a 70-space line and double spacing.
- c. Upon completion of timed writing, circle errors, write total strokes and number of errors at the top of your timed writing.

Business men and women have a keen interest in the work that 60
 students and teachers are doing in the classrooms of our schools, for 129
 they realize that out of the schools will come the men and women who 197
 will be the next leaders in business. Leadership is not now the ex- 265
 clusive privilege of men. There is quite a large number of women who 334
 lead the parade, so to speak, of those who achieve the unusual and worth 406
 while in business. There is just as much chance for success now as 473
 there has ever been, but the world of business requires more of its 540
 workers now than it did before. 571

As I talk with business men and women, I often ask them to tell me 637
 just what I shall say to young men and women who are now enrolled in the 709
 business education curriculum. For the most part, I get the same 774
 suggestion--in different words, of course, but the same in thought. 841
 They say business requires workers who can work without constant super- 912
 vision, who can prove their own work and know that it is right or 977
 wrong. They say, too, that employers expect students, while yet in 1044
 school, to learn to work up to capacity, to form the habit of holding 1113
 themselves to their best work at all times. There is no place in business 1187
 for the lazy man or woman. 1213

Reproduced from TWENTIETH CENTURY TYPEWRITING, by special arrangement with--
 and permission of--the publishers, South-Western Publishing Company, Cincinnati
 New York, Chicago, Dallas, San Francisco.

Carry into business the ideals of high thinking and noble achiev-	65
ing that have been held before you in the classroom. Do not lose your	135
sporting sense of fair play. You have work to do, a place of respon-	204
sibility waiting for you. This work requires the very best you have to	275
give. Work in harmony with others. Learn to respect the opinions of	344
your fellow-workers, but think your own problems through judiciously	412
for yourself. All this pays extra large dividends. Learning never	479
stops, whether you are in school or not. School is the place where you	550
can have organized direction for your study. If you discover that you	620
have made small use of your time in school, reinvest in yourself by in-	691
creasing the time you will give to your preparation. Fit yourself to	760
take your place in the work of the world, and the scope of your usefulness	834
will not be measured in dollars and cents but in more complete living.	904
It is an investment that will pay satisfactory dividends.	961

Reproduced from TWENTIETH CENTURY TYPEWRITING, by special arrangement with--
and permission of--the publishers, South-Western Publishing Company, Cincinnati,
New York, Chicago, Dallas, San Francisco.

There is another point which cannot be put in the form of a rule,	65
but which it is very necessary for you to understand if you wish to	132
learn effectively. Briefly it is this: Improvement is not regular,	200
but goes in waves. If you observe yourself while learning to type-	267
write, or indeed in doing anything else, you will notice this. There	336
will be periods, perhaps lasting considerable time, during which you will	409
not progress. Then all of a sudden, you will make a big advance. In	478
the language of technical psychology these periods of no progress are	547
called "plateaus" and the moments of swift advance are called "spurts."	618
Plateaus and spurts are found in every kind of learning, so you need not	690
be surprised or disturbed about them. You should know what to do to	758
make the plateaus as brief as possible, and to encourage the arrival	826
of spurts.	836

Reproduced from RHYTHMIC TYPEWRITING, by special arrangement with—and permission of—the publishers, The Ronald Press Company, New York.

D--40

From time to time you set yourself to the task of forming new habits	68
or of breaking yourself of bad habits into which you may have fallen.	137
To save time and to aid you to reach your goal, you ought to know the	206
best way to go about the job.	235
First of all, you must have clearly in your mind all the details of	302
the new habit you wish to form. If, for instance, you wish to form	369
habits that will make you a good pole vaulter, you need to study correct	441
form in all the aspects of that sport.	479
Next, you will want to make sure that you have clearly in your mind	546
the goal at which you are aiming. If you wish to learn to write a better	619
hand, you need to learn correct posture at the desk; but you also need	689
to have in your mind a picture of how well-written letters look.	753
Of course, you always want your typewritten notes and letters to look	822
neat and attractive. For that reason you will need to study the well-	892
written and properly arranged typewritten notes and letters which appear	964
in this book.	977

Reproduced from ROWE TYPING, Second Edition, by special arrangement with--and permission of--the publishers, The H. M. Rowe Company, Baltimore, Chicago, San Francisco.

When the secretary writes a letter, she has a plan by which she works. She may carry that plan in her mind, or she may make notes or an outline of the letter she is to write; then she sits down at her typewriter and writes the letter.	59 123 187 232
A business letter is a good letter when it achieves the result at which it is aimed. Unless it actually gets that result-- unless it collects the bill, answers the question, makes the adjustment, sells the goods or produces a mental attitude which leads to a sale--it is not a good letter, no matter how attractive its arrangement or how perfect its English may be. If you aspire to be a secretary, rest assured that one of the qualifications you will need to possess is the ability to write business letters--write them in a human, interesting, and forceful way. Letters are the shuttles which fly back and forth to weave the big web of commerce. The secretary is a secretary largely because she has the ability to sit down at her typewriter and compose letters which will favorably represent her employer to the outside world.	287 354 422 488 558 627 693 758 821 884 947 1014 1058

Reproduced from *ROME TYPING*, Second Edition, by special arrangement with-- and permission of--the publishers, The H. M. Rowe Company, Baltimore, Chicago, San Francisco.

How many residents of your town are not now buying power from	61
you but would gladly come on your line if they were sure that their	128
bills each month would not exceed a certain nominal figure, such as,	196
for instance, \$1 a month?	221
How many additional users of your power do you think you could get	287
if you could guarantee that the bills would never exceed \$1 a month?	355
In every town there are always a number of people who would like	419
to have electricity, but who feel that they cannot afford it. Yet, if	489
these same people were sure that their bills would never be more than a	560
certain amount, they would buy their power from you and would constitute	632
a very satisfactory increase in your load.	674
You can obtain this additional load by offering power to this class	741
of customers at a "flat rate" and limiting the maximum demand by the use	813
of an Excess Indicator, which, as you undoubtedly know, is a device that	885
causes all the lamps in the house to flicker if more lights than the	953
customer agrees to pay for in his flat-rate agreement with you are	1019
turned on at any one time.	1045

Reproduced from TYPING FOR BUSINESS, by special arrangement with--and permission of--the publishers, The Gregg Publishing Company, New York, Chicago, San Francisco, Dallas.

A week went by, as I have said, and the season of the line storm was near at hand. On the morning in question there were flags at the top of the pole by the south light telling of a gale that was slowly creeping up the coast. It was Monday, and during the night the barometer had gone down very rapidly and the sky showed such signs of coming bad weather that not one of the fishermen cared to venture out of the harbor; but all busied themselves with going aboard their boats and tying up the sails and rigging and making everything secure against what all knew was surely to come.

At the regular time, however, Mr. Nemo and the young woman came down from the cottage with the usual basket of luncheon and went aboard the "Maud." As the man was untying the sails a gray-haired old veteran of the sea walked to the edge of the wharf and said: "I say, Cap, there is bound to be a regular clewed topsail gale before night, and there is going to be a mighty nasty sea; I would stay on shore if I were you."

Reproduced from TYPING FOR BUSINESS, by special arrangement with--and permission of--the publishers, The Gregg Publishing Company, New York, Chicago San Francisco, Dallas.

Most pupils think they know how to read, but very few of them really	68
do. There are two methods of reading in the preparation of lessons.	136
The first of these is the general reading which you give your subject	205
matter to see what it is all about. In this preliminary reading, go as	276
fast as you can while still getting the main points and ideas. Read all	348
the words of a line at once, if you can. Practice making as few stops	418
with your eyes as possible, and you will save time, just as the limited	489
train saves time over the local. In all reading, read ideas, not words.	561
For your second reading, concentrate upon the difficult portions of	628
your work. You do not need to spend time upon easy things. Have a	695
dictionary close at your elbow, and look up the words which you do not	765
know and which are necessary for the understanding of the lesson. When	836
you have finished a paragraph or a section, stop and think about it. Sum	909
up the facts in your mind. Make good notes in outline form.	969

Reproduced from COMPLETE TYPEWRITING, by special arrangement with—and permission of—the publishers, Allyn and Bacon Company, Boston.

B--90

What are these "other factors" that all beginning workers must	62
have to make their skill worth while? It was the lack of these quali-	132
ties that had caused Ray to fail. Businessmen seemed to feel that	198
Ray was not alone in his failure because of the lack of these traits. In	271
finding for Ray the key to his own puzzling failures, I may give help	340
to some other beginner who needs to unlock the door to new oppor-	405
tunities. The starting point must be what the businessman wants--	470
and he says that he wants workers who are accurate and careful. Tact	539
and courtesy, too, must be ingrained traits. These four traits help	607
one to get along with others. They are just a few of the "other	671
factors" that make for success, but they offer an excellent beginning	740
for the student who would train for success in business.	796

Reproduced from TWENTIETH CENTURY TYPEWRITING, by special arrangement with--
and permission of--the publishers, South-Western Publishing Company, Cincinnati,
New York, Chicago, Dallas, San Francisco.

There is hardly an hour in the day when the secretary does not	62
exercise initiative in small things as well as in great things. She	130
makes sure that a sufficient supply of working materials is always	196
at hand. She thinks ahead and senses that her employer will need	261
certain papers in arriving at a conclusion on a business problem;	326
she uses her initiative and gets those papers together so that they	393
will be ready when they are needed. From time to time she brings to the	465
attention of her superior news items or other material which she knows	535
will be of interest to him. For that reason she scans trade papers	602
that come to her employer's desk. Often she is able to "boil down"	669
an article and then present it, in abstract form, to her employer.	735
In all these ways she makes herself useful--and indeed indispensable--	805
in activities which lie entirely beyond the plane of the mechanical	872
and the routine.	888

Reproduced from ROWE TYPING, Second Edition, by special arrangement with--and permission of--the publishers, The H. M. Rowe Company, Baltimore, Chicago, San Francisco.

That is just what happened to the system by which correspondence had	68
been conducted when the typewriter made its appearance. From that day	138
a new meaning was given to the word "amanuensis"; it had always been	206
translated as "one who writes for another," but it has meant ever	271
since "one who takes dictation in shorthand and transcribes that dictation	345
on a typewriter." It is not necessary to follow the history of the	412
machine for it is known to everybody: first the upper case only; then	482
the machine using capitals and small letters, now known as the invisible;	555
then the visible writing machine, and we have it in that form alone today.	629
Now then, having the machine in its most up-to-date form, let us	693
look at it a little and see what it is good for--wherein it is really of	765
worth and what service it renders to the world. There is one peculiar	835
thing about this combination of keys and levers; it has such a hold in	905
business life that, were it possible to wipe it out entirely in a single	977
day, on that day the wheels of commerce would be stopped as effectually	1048
as if they were overthrown by some convulsion of nature.	1104

Reproduced from TYPING FOR BUSINESS, by special arrangement with—and permission of—the publishers, The Gregg Publishing Company, New York, Chicago, San Francisco, Dallas.

D--120

A good stenographer is also distinguished by the fact that she	62
always uses apostrophes correctly. The confusion of words similarly	130
pronounced and the incorrect use or omission of the apostrophe are	196
two of the most glaring faults found in transcripts produced by	259
poor stenographers. Remember that secretaries come from the ranks	325
of good stenographers, not from the ranks of poor stenographers. The	394
rules for the use of the apostrophe are easily mastered. Keep in	459
mind, first of all, that the possessive forms of pronouns are written	528
without any apostrophes. Some people confuse contractions with the	595
possessive forms of pronouns. Keep your eyes open for a noun with	661
an s-ending followed immediately by another noun. In all probability	730
the first of the two nouns is in the possessive case and requires an	798
apostrophe.	809
The chief reason for the omission of apostrophes where they	868
are required does not at all lie in failure to understand how to	932
form the possessive case, but failure to understand that a particular	1001
noun is in the possessive case.	1032

Reproduced from ROWE TYPING, Second Edition, by special arrangement with--
and permission of--the publishers, The H. M. Rowe Company, Baltimore,
Chicago, San Francisco.

APPENDIX B

Table 1
Total Number of Errors Made per Five Students per Test

SQUARE I

1	2	3	4	5	6	7	8	9	10	11
16	56	29	41	43	38	36	40	26	48	46
12	13	14	15	16	17	18	19	20	21	22
33	45	41	51	72	56	57	67	50	58	75
23	24	25	26	27	28	29	30	31	32	33
12	16	24	28	20	16	27	18	35	34	41
34	35	36	37	38	39	40	41	42	43	44
34	15	34	43	39	27	30	42	25	34	50
45	46	47	48	49	50	51	52	53	54	55
40	44	53	42	51	37	45	45	41	70	56
56	57	58	59	60	61	62	63	64	65	66
32	40	43	37	33	30	41	38	46	37	30
67	68	69	70	71	72	73	74	75	76	77
47	40	50	59	46	59	44	37	64	58	55
78	79	80	81	82	83	84	85	86	87	88
24	25	28	39	35	35	25	28	39	31	41
89	90	91	92	93	94	95	96	97	98	99
32	42	42	48	52	56	46	49	51	46	51
100	101	102	103	104	105	106	107	108	109	110
44	40	41	45	33	39	35	47	44	37	38
111	112	113	114	115	116	117	118	119	120	121
35	32	47	28	51	45	39	31	51	47	43

Table 2
Total Number of Errors Made per Five Students per Test

SQUARE II

1	102	82	62	42	22	112	92	72	52	32
25	30	43	43	27	25	46	30	40	36	44
33	2	103	83	63	43	12	113	93	73	53
28	34	32	46	46	41	39	39	44	44	46
54	23	3	104	84	64	44	13	114	94	74
44	42	35	37	48	42	45	38	42	44	61
75	55	24	4	105	85	65	34	14	115	95
51	41	42	58	52	61	42	42	28	42	41
96	76	45	25	5	106	86	66	35	15	116
30	49	26	34	48	31	29	35	41	44	40
117	97	77	46	26	6	107	87	56	36	16
43	30	32	56	55	30	28	39	31	48	46
17	118	98	67	47	27	7	108	88	57	37
32	42	44	47	31	40	49	31	29	46	42
38	18	119	99	68	48	28	8	109	78	58
25	22	30	25	37	32	39	40	43	34	50
59	39	19	120	89	69	49	29	9	110	79
31	41	31	41	38	47	44	35	34	35	48
80	60	40	20	121	90	70	50	30	10	100
36	34	26	30	55	45	49	32	46	43	43
101	81	61	41	21	111	91	71	51	31	11
39	42	56	64	55	66	73	72	85	77	66

Table 3
Total Number of Errors Made per Five Students per Test

SQUARE III

1	115	108	90	83	76	58	51	44	26	19
29	37	30	33	39	47	26	33	43	38	50
20	2	116	109	91	84	77	59	52	34	27
74	74	83	74	84	64	76	80	79	69	80
28	21	3	117	110	92	85	67	60	53	35
32	41	48	48	47	38	48	48	47	54	56
36	29	22	4	118	100	93	86	68	61	54
45	34	34	49	36	38	50	32	60	32	56
55	37	30	12	5	119	101	94	87	69	62
54	51	45	60	53	54	44	46	60	52	48
63	45	38	31	13	6	120	102	95	88	70
42	36	33	48	37	40	50	44	39	32	56
71	64	46	39	32	14	7	121	103	96	78
37	58	53	51	35	50	60	34	43	59	66
79	72	65	47	40	33	15	8	111	104	97
52	58	42	52	29	31	37	34	51	50	59
98	80	73	66	48	41	23	16	9	112	105
36	19	31	32	41	32	30	23	33	35	41
106	99	81	74	56	49	42	24	17	10	113
38	44	32	44	44	31	43	20	50	43	50
114	107	89	82	75	57	50	43	25	18	11
47	65	38	44	35	59	75	67	58	54	57

Table 4
Total Number of Errors Made per Five Students per Test

SQUARE IV

1	40	68	107	14	53	81	120	27	66	94
46	66	48	87	64	80	63	95	81	67	88
95	2	41	69	108	15	54	82	121	28	56
63	89	66	85	76	85	90	68	95	75	62
57	96	3	42	70	109	16	55	83	111	29
69	70	70	67	70	54	73	64	59	70	99
30	58	97	4	43	71	110	17	45	84	112
48	45	72	96	82	83	66	75	93	78	94
113	31	59	98	5	44	72	100	18	46	85
69	67	50	56	96	68	94	81	64	74	60
86	114	32	60	99	6	34	73	101	19	47
77	70	70	58	88	53	63	59	52	81	68
48	87	115	33	61	89	7	35	74	102	20
56	45	52	79	42	54	75	47	53	60	56
21	49	88	116	23	62	90	8	36	75	103
40	46	35	46	34	41	37	96	58	70	76
104	22	50	78	117	24	63	91	9	37	76
52	43	45	45	52	35	52	46	40	51	62
77	105	12	51	79	118	25	64	92	10	38
104	75	57	65	64	83	61	84	53	63	95
39	67	106	13	52	80	119	26	65	93	11
28	66	50	56	63	48	62	61	53	63	62

Table 5
Total Number of Errors Made per Five Students per Test

SQUARE V										
1	119	105	91	88	74	60	46	43	29	15
56	73	60	64	70	93	67	79	85	73	81
16	2	120	106	92	78	75	61	47	44	30
37	47	51	52	49	51	55	41	45	75	69
31	17	3	121	107	93	79	76	62	48	34
65	44	40	50	40	52	46	45	53	49	56
35	32	18	4	111	108	94	80	77	63	49
50	42	48	58	64	75	49	67	36	68	73
50	36	33	19	5	112	109	95	81	67	64
35	35	39	60	43	64	52	44	52	69	79
65	51	37	23	20	6	113	110	96	82	68
35	43	46	33	49	59	51	54	49	68	66
69	66	52	38	24	21	7	114	100	97	83
53	59	49	40	50	64	56	55	57	45	80
84	70	56	53	39	25	22	8	115	101	98
93	89	69	88	64	79	83	84	86	97	102
99	85	71	57	54	40	26	12	9	116	102
42	41	45	45	49	46	57	36	34	39	48
103	89	86	72	58	55	41	27	13	10	117
67	57	60	42	48	63	51	52	52	60	75
118	104	90	87	73	59	45	42	28	14	11
49	49	43	50	49	53	67	58	39	42	48

Table 6
 Total Number of Errors Made per Five Students per Test
 SQUARE VI

1	110	87	64	41	18	116	93	70	47	24
35	38	63	50	59	45	64	73	52	55	55
25	2	100	88	65	42	19	117	94	71	48
30	33	45	56	25	40	48	50	42	35	44
49	26	3	101	78	66	43	20	118	95	72
50	44	46	49	37	49	50	48	53	48	69
73	50	27	4	102	79	56	44	21	119	96
38	65	68	64	63	76	60	72	68	67	91
97	74	51	28	5	103	80	57	34	22	120
21	17	45	45	46	48	39	40	59	51	63
121	98	75	52	29	6	104	81	58	35	12
66	46	36	42	31	44	33	35	39	44	59
13	111	99	76	53	30	7	105	82	59	36
21	18	24	31	23	25	39	31	23	42	35
37	14	112	89	77	54	31	8	106	83	60
37	34	56	35	52	40	38	52	46	30	44
61	38	15	113	90	67	55	32	9	107	84
31	46	37	41	38	44	39	49	29	58	38
85	62	39	16	114	91	68	45	33	10	108
50	42	44	49	31	47	58	41	45	57	54
109	86	63	40	17	115	92	69	46	23	11
38	53	44	62	51	65	59	64	67	75	97

Table 7

Total Number of Strokes Typed per Five Students per Test

SQUARE I

1	2	3	4	5	6	7	8	9	10	11
6198	6719	6117	5867	6127	6196	5755	6378	6807	6745	6000
12	13	14	15	16	17	18	19	20	21	22
7207	7395	6897	7399	7364	7780	7186	7185	7182	7226	7190
23	24	25	26	27	28	29	30	31	32	33
6130	6329	5995	6194	6401	6080	6530	5515	6779	6524	6733
34	35	36	37	38	39	40	41	42	43	44
5396	5655	5883	6031	5940	6055	6231	6200	6031	5864	6362
45	46	47	48	49	50	51	52	53	54	55
6637	6178	5969	6311	5972	6369	5623	6158	5968	5815	6108
56	57	58	59	60	61	62	63	64	65	66
5117	5798	5941	5936	6158	5972	5735	6156	6178	6603	6261
67	68	69	70	71	72	73	74	75	76	77
6144	6477	6555	6931	7516	6559	6490	6296	6619	6326	6255
78	79	80	81	82	83	84	85	86	87	88
6888	6582	7516	7143	6105	7229	6635	6738	6698	6683	7129
89	90	91	92	93	94	95	96	97	98	99
6717	6221	6670	6255	6787	6360	6698	5992	6375	6456	6471
100	101	102	103	104	105	106	107	108	109	110
5912	5603	5412	6267	6309	6088	6244	6038	5858	6043	6097
111	112	113	114	115	116	117	118	119	120	121
6111	6112	6113	6114	6115	6116	6117	6118	6119	6120	6121

Table 8

Total Number of Strokes Typed per Five Students per Test

SQUARE II

1	102	82	62	42	22	112	92	72	52	32
7034	7105	6796	7187	7068	8017	7569	6852	6706	6736	7314
33	2	103	83	63	43	12	113	93	73	53
6620	6180	6049	6144	6017	5529	6389	6084	6269	6363	5774
54	23	3	104	84	64	44	13	114	94	74
5233	5503	5946	5854	5291	5805	5041	5764	5916	5594	5885
75	55	24	4	105	85	65	34	14	115	95
6063	5699	6421	6392	6333	6706	6841	6337	7010	6228	6884
96	76	45	25	5	106	86	66	35	15	116
5068	5444	5613	5913	5607	5423	5636	5287	5670	6076	5549
117	97	77	46	26	6	107	87	56	36	16
5937	5006	5776	5567	5402	6210	5690	5767	5077	5358	5673
17	118	98	67	47	27	7	108	88	57	37
5772	5234	5634	6048	5659	5836	5692	5669	5909	5729	5198
38	18	119	99	68	48	28	8	109	78	58
6310	6598	6266	6383	6695	6872	6972	6667	6622	6632	6084
59	39	19	120	89	69	49	29	9	110	79
6186	5974	6097	6053	6592	6726	6382	5964	6379	6292	5805
80	60	40	20	121	90	70	50	30	10	100
5965	5669	6308	5899	5992	5955	5505	5860	6046	6112	6073
101	81	61	41	21	111	91	71	51	31	11
5848	5641	5339	5672	6194	5530	6211	6119	5549	5972	5864

Table 9

Total Number of Strokes Typed per Five Students per Test

SQUARE III

1	115	108	90	83	76	58	51	44	26	19
5574	5559	5339	5962	5945	5400	6413	5688	5765	5675	5981
20	2	116	109	91	84	77	59	52	34	27
6918	6652	6481	7572	7336	6456	8966	6407	7053	6327	6705
28	21	3	117	110	92	85	67	60	53	35
6731	6977	6823	6609	6600	7335	7295	7006	6579	6450	6680
36	29	22	118	100	100	93	86	68	61	54
5735	5829	6004	5361	5488	5930	6063	5678	5578	5948	5863
55	37	30	12	5	119	101	94	87	69	62
5974	5982	6412	6799	5952	6306	6313	6311	6053	6297	6087
62	45	38	31	13	6	120	102	95	88	70
6159	6687	6103	6477	6024	6942	6539	6567	6650	5979	6298
71	64	46	39	32	14	7	121	103	96	78
6396	4979	6335	6416	6342	6107	5590	6149	6221	5822	5903
79	72	65	47	40	33	15	8	111	104	97
5346	5074	5702	4971	5797	5629	5697	5453	5403	5325	5056
98	80	73	66	48	41	23	16	9	112	105
5842	5592	5519	5317	5415	5321	5538	5709	5648	5950	5568
106	99	81	74	56	49	42	24	17	10	113
5448	5289	5297	5272	4925	5296	5194	5502	5924	5717	5151
114	107	89	82	75	57	50	43	25	18	11
6121	5789	6344	5530	5742	5969	6684	5440	5946	6303	6476

Table 10
Total Number of Strokes Typed per Five Students per Test

SQUARE IV										
1	40	68	107	14	53	81	120	27	66	94
5514	5589	5641	5623	5608	5345	5880	5383	6050	5914	6019
95	2	41	69	108	15	54	82	121	28	56
5465	5752	5058	5264	5456	5715	5610	4942	5831	5694	5329
57	96	3	42	70	109	16	55	83	111	29
5423	5233	5456	5411	5110	5684	5554	5431	5560	5477	5634
30	58	97	4	43	71	110	17	45	84	112
6095	5939	5458	5852	5924	6313	6016	6229	6601	5803	6845
113	31	59	98	5	44	72	100	18	46	85
5644	5928	5943	6042	5858	5779	6174	5912	6172	6279	6456
86	114	32	60	99	6	34	73	101	19	47
5101	5219	5232	5232	5086	5512	4818	5264	5627	5676	5365
48	87	115	33	61	89	7	35	74	102	20
4959	5032	4975	5602	5322	5365	5036	4993	5281	5224	5449
21	49	88	116	23	62	90	8	36	75	103
5982	5321	5651	6345	5924	6142	5717	6236	5593	5978	6149
104	22	50	78	117	24	63	91	9	37	76
5740	5578	5732	5751	5288	5795	5579	5597	5910	5208	5396
77	105	12	51	79	118	25	64	92	10	38
4753	4490	4635	4904	4348	4532	4686	4758	4765	5228	5165
39	67	106	13	52	80	119	26	65	93	11
5180	4965	5003	5090	5264	5622	5046	5263	5410	5611	5766

Table 11

Total Number of Strokes Typed per Five Students per Test

SQUARE V

1	119	105	91	88	74	60	46	43	29	15
5852	5373	5259	5754	5439	5401	5489	5755	4904	5608	5688
16	2	120	106	92	78	75	61	47	44	30
6359	6478	6147	6183	6219	6266	6425	5893	6131	6032	6759
31	17	3	121	107	93	79	76	62	48	34
6776	6128	5703	5763	5641	6142	5868	5962	6163	5668	5596
35	32	18	4	111	108	94	80	77	63	49
7124	7515	7370	6922	7194	7317	7114	7376	7116	7392	7022
50	36	33	19	5	112	109	95	81	67	64
6121	6150	6178	6473	6200	6583	6260	6257	5662	6529	6271
65	51	37	23	20	6	113	110	96	82	68
5691	5471	5229	6080	5785	5631	8564	5731	5412	5491	6041
69	66	52	38	24	21	7	114	100	97	83
6194	6120	5861	6223	6369	6468	5917	6260	6127	5979	6360
84	70	56	53	39	25	22	8	115	101	98
7030	6547	5885	6657	7625	6982	7017	7160	6667	6953	7299
99	85	71	57	54	40	26	12	9	116	102
6169	6228	6272	6247	5884	6670	6184	6358	6602	6282	6941
103	89	86	72	58	55	41	27	13	10	117
6189	6220	5997	5980	6094	5794	5994	5900	6084	6085	5538
118	104	90	87	73	59	45	42	28	14	11
6117	6684	6631	6157	6181	6512	7331	6433	6414	6201	7124

Table 12

Total Number of Strokes Typed per Five Students per Test

SQUARE VI

1	110	87	64	41	18	116	93	70	47	24
6759	5960	6441	6640	6878	6972	6411	6314	6210	6378	6694
25	2	100	88	65	42	19	117	94	71	48
6866	6952	6958	7073	6903	6915	7100	6573	6846	7446	6889
49	26	3	101	78	66	43	20	118	95	72
5783	5814	5792	5806	6338	6019	5893	6299	6039	6518	6424
73	50	27	4	102	79	56	44	21	119	96
6024	5102	6019	5824	5889	5844	5817	5867	5304	5911	5870
97	74	51	28	5	103	80	57	34	22	120
5890	5962	5927	6640	6254	6318	6660	7100	5690	6690	6710
121	98	75	52	29	6	104	81	58	35	12
6434	6373	6199	6223	6601	6349	6244	6058	6291	5660	6305
13	111	99	76	53	30	7	105	82	59	36
6960	6716	6888	6546	6871	6874	7050	7044	6348	6757	6963
37	14	112	89	77	54	31	8	106	83	60
6552	6943	7389	7088	6821	6793	6162	6684	6480	6299	6273
61	38	15	113	90	67	55	32	9	107	84
6235	5950	6460	6035	6705	6488	6260	6284	6392	6152	5584
85	62	39	16	114	91	68	45	33	10	108
7678	7214	7385	7609	7666	8230	6445	7802	7439	7621	7329
109	86	65	40	17	115	92	69	46	23	11
6260	5987	6439	6851	6713	6564	6371	6398	6434	6542	6860

Table 13

Summary of Total Strokes, Total Syllables, and Syllabic Stroke Intensity for the 121 Samples of Test Material

Test	Strokes	Syllables	Syllabic Stroke Intensity
A-1	837	214	3.9112
A-2	947	243	3.8971
A-3	957	247	3.8744
A-4	1055	292	3.6130
A-5	1041	265	3.9283
B-6	1068	269	3.9702
B-7	1041	265	3.9283
B-8	1014	250	4.0560
B-9	871	221	3.9411
B-10	1213	301	4.0299
B-11	1012	262	3.8625
B-12	1065	279	3.8172
B-13	950	258	3.6821
B-14	1061	273	3.8864
B-15	1225	304	4.0296
B-16	1095	270	4.0555
B-17	720	187	3.8502
B-18	1185	304	3.8980
B-19	1061	275	3.8581
B-20	930	249	3.7349
B-21	767	211	3.6350

Table 13
(continued)

Test	Strokes	Syllables	Syllabic Stroke Intensity
B-22	859	219	3.9223
B-23	823	221	3.7239
B-24	1169	313	3.7348
B-25	1192	296	4.0270
B-26	1105	292	3.7842
B-27	1019	252	4.0436
B-28	819	211	3.8815
B-29	940	237	3.9662
B-30	961	238	4.0378
C-31	957	257	3.7237
C-32	880	229	3.8427
C-33	1082	271	3.9926
C-34	765	218	3.5091
C-35	1026	263	3.9011
C-36	963	251	3.8366
C-37	836	213	3.9248
C-38	1029	284	3.6232
C-39	1154	295	3.9118
D-40	977	238	4.1050
D-41	1106	286	3.8671
D-42	1145	284	4.0352

Table 13
(continued)

Test	Strokes	Syllables	Syllabic Stroke Intensity
D-43	1099	288	3.8159
D-44	1011	285	3.5473
D-45	1133	274	4.1350
D-46	1039	271	3.8339
D-47	1118	306	3.6535
D-48	1014	270	3.7555
D-49	1132	300	3.7733
D-50	1058	280	3.7785
D-51	1073	299	3.5886
D-52	948	263	3.6045
D-53	817	229	3.5676
E-54	889	242	3.6735
E-55	1027	283	3.6289
E-56	913	251	3.6374
E-57	1133	318	3.5628
E-58	981	262	3.7442
E-59	889	243	3.6584
E-60	1045	278	3.7589
E-61	902	230	3.9217
E-62	1017	271	3.7527
E-63	1089	287	3.7944

Table 13
(continued)

Test	Strokes	Syllables	Syllabic Stroke Intensity
E-64	1047	281	3.7259
E-65	1149	321	3.5794
E-66	1060	304	3.4868
E-67	823	214	3.8457
E-68	697	171	4.0760
E-69	955	235	4.0638
E-70	993	254	3.9094 <i>3.910</i>
E-71	888	218	4.0733
E-72	1121	292	3.8390
E-73	1100	315	3.4920
E-74	1171	317	3.6940
E-75	1206	316	3.8164
E-76	968	252	3.8412
E-77	976	250	3.9040
E-78	1195	307	3.8925
E-79	864	229	3.7729
A-80	969	247	3.9230 <i>3.923</i>
A-81	1036	269	3.8513
B-82	1103	270	4.0851
B-83	769	194	3.9639
B-84	928	266	3.4887

Table 13
(continued)

Test	Strokes	Syllables	Syllabic Stroke Intensity
B-85	850	214	3.9719
B-86	1060	274	3.8686
B-87	1139	290	3.9275
B-88	1076	275	3.9127
B-89	736	193	3.8134
B-90	796	191	4.1675 ²⁷⁰⁵
B-91	984	260	3.7846
C-92	1091	286	3.8146
C-93	835	218	3.8302
C-94	1022	271	3.7712
D-95	910	237	3.8396
D-96	1116	289	3.8615
D-97	954	257	3.7120
D-98	1054	272	3.8750
D-99	974	254	3.8346
D-100	888	242	3.6694 ²⁷⁰⁵
E-101	972	251	3.8725
E-102	1070	287	3.7282
E-103	1065	282	3.7765
E-104	1000	268	3.7313
E-105	952	272	3.5000

Table 13
(continued)

Test	Strokes	Syllables	Syllabic Stroke Intensity
E-106	848	207	4.0966
E-107	942	230	4.0956
E-108	959	234	4.0982
E-109	942	254	3.7086
E-110	1104	295	3.7423 <i>3730</i>
E-111	1150	301	3.8205
B-112	797	186	4.2849
D-113	944	259	3.6447
E-114	970	253	3.8339
D-115	1119	301	3.7176
E-116	1145	319	3.5893
D-117	1022	276	3.7028
B-118	1001	277	3.6137
A-119	1046	262	3.9923
D-120	1032	277	3.7256
D-121	998	274	3.6423 <i>4154</i>

CALCULATION SHEET FOR ANALYSIS OF VARIANCE
OF ERRORS MADE

I. Sum of Squares, Total:	
Raw Sum of Squares	1,986,373.00
Correction Term	-1,789,390.97
Corrected Sum of Squares	196,982.03
II. Sum of Squares, Treatments:	
Raw Sum of Squares	1,818,161.83
Correction Term	-1,789,390.97
Corrected Sum of Squares	28,770.86
Divisor	120
Mean Square	239.76
III. Sum of Squares, Replicates:	
Raw Sum of Squares	1,844,545.80
Correction Term	-1,789,390.97
Corrected Sum of Squares	55,154.83
Divisor	5
Mean Square	11,030.97
IV. Sum of Squares, Rows (Adj.):	
Raw Sum of Squares	126,213.22
Correction Term	-66,186.40
Corrected Sum of Squares	60,026.82
Divisor	60
Mean Square	1,000.45
V. Sum of Squares, Columns (Adj.):	
Raw Sum of Squares	79,942.43
Correction Term	-66,186.40
Corrected Sum of Squares	13,756.03
Divisor	60
Mean Square	229.27
VI. Correction to Rows, λ'	
Correction to Columns, μ'	.01669
	.01169

CALCULATION SHEET FOR ANALYSIS OF VARIANCE
OF STROKES TYPED

I. Sum of Squares, Total:	
Raw Sum of Squares	27,546,130,264
Correction Term	<u>-27,264,771,153</u>
Corrected Sum of Squares	281,359,111
II. Sum of Squares, Treatments:	
Raw Sum of Squares	163,939,682,988
Divisor	6
Raw Sum of Squares, Divided	27,323,280,498
Correction Term	<u>-27,264,771,153</u>
Corrected Sum of Squares	58,509,345
Divisor	120
Mean Square	487,578
III. Sum of Squares, Replicates:	
Raw Sum of Squares	3,307,962,841,040
Divisor	121
Raw Sum of Squares, Divided	27,338,535,876
Correction Term	<u>-27,264,771,153</u>
Corrected Sum of Squares	73,764,723
Divisor	5
Mean Square	14,752,945
IV. Sum of Squares, Rows (Adj.):	
Raw Sum of Squares	197,482,212
Correction Term	<u>-88,517,655</u>
Corrected Sum of Squares	108,964,557
Divisor	60
Mean Square	1,816,076
V. Sum of Squares, Columns (Adj.):	
Raw Sum of Squares	97,398,904
Correction Term	<u>-88,517,655</u>
Corrected Sum of Squares	8,881,249
Divisor	60
Mean Square	148,021
VI. Correction to Rows, λ'	
	0.01753
Correction to Columns, μ'	0.0101877
Adjusted Mean Square of Treatments	38,896,170
Effective Error Mean Square	243,826

CALCULATIONS FOR CORRELATIONS

I.	Raw Sum of Squares, Syllabic Stroke Intensity	1773.9586
	Correction Term	<u>-1770.6935</u>
	Corrected Sum of Squares	3.2651
II.	Raw Sum of Squares, Test Score	4,533,552.066
	Correction Term	<u>-4,527,087.720</u>
	Corrected Sum of Squares	6,464.346
III.	Raw Sum of Cross Products	2,833,265
	Correction Term	<u>-2,831,601</u>
	Corrected Sum of Cross Products	1,664
IV.	(Correlation coefficient) ² =	$\frac{2,768,896}{21,106,736} = 0.13118$
V.	Correlation Coefficient	0.362