A STUDY OF THE PROGNOSTIC VALUE OF THE MACQUARRIE TEST FOR MECHANICAL ABILITY IN FIRST-YEAR TYPEWRITING SPEED

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By

FLORENCE WOODARD LACKEY

Bachelor of Arts

University of Oklahoma

Norman, Oklahoma

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APPROVED:

Mayme Frisk
In Charge of Thesis

Mayme Frisk
Head, Department of Commercial Education

D. C. McIntosh
Dean of Graduate School

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CHAPTER I

INTRODUCTION

Increasing enrollment in commercial courses, especially typewriting, and the large number of failures in these courses, lead educators to wonder if the results are worth the cost in time, energy and money. Just what factors contribute to success in learning to typewrite are not definitely known, but some of the accepted ones are intelligence, interest, and particularly muscular control or motor ability.[1]

Efforts have been made to predict typewriting ability through measurement of mental traits,[2] school marks,[3] spelling,[4] vocabulary,[5] and in many other ways.[6]

Without doubt, motor ability is vital in learning to typewrite but no test has yet been discovered or devised which will accurately measure the essential elements of motor ability involved.

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1 August Dvorak, Nellie L. Merrick, William L. Dealey, Gertrude Catherine Ford, Typewriting Behavior, p. 300.

2 H. H. Davis, "Measurement in Commercial Education in the St. Louis Schools," Iowa Research Studies in Commercial Education, Vol. I, July, 1926.

3 Mary Lynch Gronert, "A Prognostic Test in Typewriting," Journal of Educational Psychology, Vol. 16, March, 1925, pp. 182-185.

4 Clara L. Johnson, "The Validity of Certain Tests to Prognosticate Typewriting Ability," Master's Thesis, University of Iowa, 1925.

5 Bruce White, "Prediction of Typewriting Success," Journal of Business Education, Vol.10, April, 1935, pp.15-16.

6 O. A. Ohmann, "The Possibility of Prognosis in Stenography," Iowa Research Studies in Commercial Education.

Book declares:

> .....if a learner lacks the characteristics needed to succeed in this type of work he should be definitely discouraged from taking up a course of study in school for two or four years that aims to fit him for a type of work in which he will have great difficulty to succeed. Much time and human effort would, for example be saved if a motor ability test were given to those who aim to become speed operators in typing, because the results of such a test would show before this intensive training was begun whether they possessed sufficient mental and motor control to learn to perform successfully the marvelous feats of a world-champion typist... All that can be done in our present state of knowledge and with the use of our present scientific technique is to make an analysis of an occupation or type of work to ascertain the things that are demanded for success in that field, and then to measure an individual's capacity for doing that specific kind of work.[7]

Dvorak expresses this opinion:

> Obviously you need distinct muscular ability, known as motor ability, to become a superior typist. It is not unlikely that motor-ability tests may help select very superior or very inferior typists from the very start.[8]

Motor ability has been partially measured by the use of serial-reaction tests,[9] tapping,[10] substitution,[11]

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7 Wm. F. Book, "How Progress in Learning to Type Should be Measured and Why," Iowa Research Studies in Commercial Education, Vol. I, 1926, p. 65.

8 August Dvorak, et al, op. cit., p. 463.

9 Hannah Elizabeth Brewington, "Prognostic Test in Typewriting," American Shorthand Teacher, Vol. 4, September and October, 1923.

10 Wm. F. Book, "Voluntary Motor Ability of the World's Champion Typists," Journal of Applied Psychology, Vol. 7, No. 3, September, 1924, pp. 283-308.

11 Minnie A. Vavra, "Success in Typewriting," Journal of Educational Psychology, Vol. 16, October, 1925, pp. 487-492.

and cancellation.[12] None of these has been accepted for definite prognosis. According to Hull the best tests which we now have never exceeded 30 per cent in efficiency.[13]

T. W. MacQuarrie devised a test for mechanical ability which requires some ability to recognize space relations, and to measure hand and eye coordination, speed of decision and of movement, muscular control, and visual acuity. He believes that these abilities are used by the barber, typist, motorman, waiter, telephone operator, tailor, plasterer, dentist, draftsman, baseball pitcher, and pianist as well as by the mechanic.[14]

Ackerson found that it is best to separate speed and accuracy in testing typewriting ability; that speed yields the highest correlations with psychological tests; that it is best to use tests which are most similar to the typing process.[15]

True, there are many other factors involved in the process of learning to typewrite and one test probably

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12 Luton Ackerson, "A Correlational Study of Proficiency in Typing," Iowa Research Studies in Commercial Education, Vol. I, July, 1926, pp. 88-95.

13 Clark L. Hull, "Psychological Tests and the Differentiation of Vocational Aptitudes," Iowa Research Studies in Commercial Education, Vol. I, July, 1926. pp. 24-35.

14 T. W. MacQuarrie, Instruction Sheet for Giving MacQuarrie Test for Mechanical Ability.

15 Luton Ackerson, op. cit., p. 89.

could not measure everything but should at least measure the most significant of such aptitudes. This study is concerned with typewriting speed. Dvorak states that suitable speed is of immediate importance.[16] Fast workers have been found to produce the greatest quantity of goods and to be the most accurate. O'Rourke found that 125 slow workers were 38 per cent accurate and 125 fast workers were 80 per cent accurate; the fast workers' production was five and one-half times greater than that of the slow workers.[17]

Book declares that speed in typewriting does not depend primarily upon the reaction time of the performer or upon the quickness with which a specific motor response can be made, but that effective speed in typewriting is conditioned by accuracy in details, because this makes the use of higher methods of control possible, and that the higher methods of control, in turn, aid in improving a learner's accuracy in details.[18] Dvorak says that the key to successful typewriting is in control and relaxation.[19]

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16 August Dvorak, et al, op. cit., Preface, p. xi.

17 L. J. O'Rourke, "Relation Between Speed and Accuracy," Handbook of Business Administration, pp. 802-806.

18 Wm. F. Book, Learning to Typewrite, p. 234.

19 August Dvorak, et al, op. cit., Preface p. xi.

PURPOSE

Since speed is so important in typewriting and since no reliable prognostic tests have as yet been found, this study seeks to determine what relationship, if any, exists between speed in typewriting and achievement in the MacQuarrie Test for Mechanical Ability or in any of its parts or combinations of parts.

MATERIALS AND METHOD

The materials for this study consist of J. N. Kimball typewriting tests, the MacQuarrie Test for Mechanical Ability, and Terman Group Test for Mental Ability, Form A. These tests were administered to 80 first-year typewriting students in the Cushing, Oklahoma, High School and to 156 first-year typewriting students in the Stillwater, Oklahoma, High School. Several students moved away from these schools and complete records were obtained for only 50 Cushing High School students and for 142 Stillwater High School students. The students tested were of the usual high school age, 14 to 20 years, and were in grades 10, 11, and 12. The tests were given in each high school under as nearly the same conditions as possible during the school year 1937-1938. Five typewriting tests, each ten minutes in length, were given to each group, and the average number of strokes for each student was obtained.

The data gathered from these tests were tabulated and correlations computed by the Pearson Product-moment

method between gross typewriting strokes and the MacQuarrie test totals, each part of the MacQuarrie test, various combinations of each part of the MacQuarrie test, and with the intelligence test scores.

The method used in this study is experimental which is defined by W. S. Monroe and M. D. Engelhart as follows:

> Experimentation is the name given to the type of educational research in which the investigator controls the educative factors to which a child or group of children is subjected during the period of inquiry and observes the resulting achievement.....In the simplest type of educational experiment the investigator seeks to evaluate the influence of some one educative or "experimental" factor on a single group of children. He must start the experiment with some measurement of the initial attainment of the children in the trait or ability to be influenced. He then subjects the group to the experimental factor, such as a particular type of drill material in arithmetic, for the duration of the experiment. At the end, the investigator applies a final test for the purpose of determining the gain in achievement that has resulted from the application of the experimental factor.[20]

This paragraph is completely in error

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[20] W. S. Monroe and M. D. Engelhart, Experimental Research in Education, pp. 15-16. A Quotation on page 325 in The Elements of Research by Frederick Lamson Whitney.

DESCRIPTION OF MACQUARRIE TEST

The following description of the MacQuarrie Test for Mechanical Ability is given by Bingham:[21]

> The MacQuarrie Test for Mechanical Ability is intended to furnish a first rough indication of aptitudes for acquiring manipulative skills. It requires some ability to recognize space relations, speed of decision and of movement, hand and eye coordination, muscular control, and visual acuity. It is a paper-and-pencil test which can be administered to an individual or to a group in about half an hour.
>
> There are seven sub-tests, each preceded by a fore-exercise to familiarize the candidate with the tasks expected of him. These tasks are: to draw a pencil line as fast as possible through a pattern of irregularly spaced openings without touching them (thirty seconds); to put three pencil dots in each of a number of circles as fast as possible (thirty seconds); to put a dot in each of many smaller circles (thirty seconds); to copy patterns each of which consists of four connected straight lines (two and a half minutes); to identify the locations of dots in squares by reference to the corresponding positions of letters in a larger square (two minutes); to count the blocks which touch certain blocks in each of several pictured piles (two and a half minutes); and to follow with the eye, one after another, each of several numbered lines drawn irregularly through a maze-like pattern, and to identify by means of the appropriate number the end of each line (two and a half minutes).
>
> These sub-tests, administered and scored as directed in the pamphlet of instructions which accompanies each packet of blanks, yield scores with maximum possible values as follows:
>
> Tracing.....80
> Tapping.....70
> Dotting.....33
> Copying.....80
> Location.....40
> Blocks.....30
> Pursuit.....40
>
> The "total score" is the sum of the sub-scores divided by three.....
>
> MacQuarrie aimed to prepare a test which would not measure intelligence.

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[21] Walter Van Dyke Bingham, Aptitudes and Aptitude Testing, p. 314.

Dr. T. W. MacQuarrie, the author of the test, describes the test as follows:[22]

> This test is an attempt to provide a standard performance for the measurement of mechanical ability.
>
> The term mechanical ability has never been carefully defined, in fact, a complete analysis would be very difficult. We assume that it takes mechanical ability to do the work of the mechanic, but we have a feeling that such ability is also used in greater or less degree by the barber, typist, motorman, waiter, telephone operator, tailor, plasterer, dentist, draftsman, baseball pitcher and pianist. These, and many others in addition to the mechanics, require manipulative skill, recognition of space relations, speed, muscular control, visual acuity, and all those accomplishments which we usually associate with the mechanical trades.
>
> No estimate of mechanical ability can be anything but rough. Nor is an accurate measurement necessary. There is no valid evidence at present to show that the carpenter requires more mechanical ability than the machinist, nor that the house painter must develop greater skill than the plumber. As a matter of fact, men with various degrees of mechanical ability do function in the same trade.....
>
> In view of the fact that there is no standard piece of work requiring mechanical ability, this test has been developed with the hope that it might meet such a need.....It has a very low correlation with intelligence test results, indicating that it measures something different.

The MacQuarrie test was primarily devised for testing mechanical ability but many of the factors necessary for success in mechanical work are also necessary for learning to typewrite. Gilbreth declared:

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[22] T. W. MacQuarrie, "MacQuarrie Test for Mechanical Ability," Instruction Sheet for Giving Test.

> I believe that what makes a champion is common to all fields. We have found extreme resemblances between the surgeon's motions and those of the bricklayer, the motions of the pianist and those of the typist. We have champion fencers, champion baseball players, champion typists. I have not found enough yet to know just why there is such similarity.[23]

Horning found that the MacQuarrie test correlated the highest with the time element showing that the fastest worker is the better worker and would produce a maximum in a minimum amount of time.[24] If this is true when used to measure ability for the trades and the same factors are essential both for mechanical ability in trades and in learning to typewrite, then the MacQuarrie test should be helpful in predicting typewriting speed. Both require manipulative skill, recognition of space relation, speed, muscular control, and visual acuity.[25]

REVIEW OF RELATED STUDIES

Walter Van Dyke Bingham reported Pond's scores for 83 of the Scovill toolmaker apprentices from correlations with the MacQuarrie test and the following: .291 with years of schooling, .293 with the Scovill Apprentice

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23 August Dvorak, et al, op. cit., p. 242.

24 S. D. Horning, "Testing Mechanical Ability by the MacQuarrie Test," Industrial Arts, October, 1926, pp. 348-350.

25 T. W. MacQuarrie, "MacQuarrie Test for Mechanical Ability," Instruction Sheet for Giving Test.

Scale, .336 with the o'Connor Wiggly Block, .381 with the Otis Higher Examination, .431 with the Kent-Shakow Form Board, and .507 with the Scovill F-Score.[26]

It seems that the MacQuarrie test gives a low indication of the degree to which a person has either manual or mechanical aptitudes.

S. D. Horning administered the MacQuarrie test to a number of first-year high school students and compared the results with scores from the Terman Group test of mental ability, teachers' grades, a project, and time. He found the lowest correlation between MacQuarrie test and I. Q. (.02). The correlation between the MacQuarrie test and accomplishment grade was .79; with test project, .66; with time, .72; between project and test time, .68. The high correlation between the MacQuarrie test and accomplishment shows that the MacQuarrie test measures those qualities necessary for trades. He also concluded that the correlation of .72 between the MacQuarrie test and time indicated that time was an important element; that the student would produce a maximum in a minimum amount of time; that the faster worker is the better worker.[27]

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[26] Walter Van Dyke Bingham, "MacQuarrie Test for Mechanical Ability," Occupations, December, 1935, p. 202.

[27] S. D. Horning, op. cit., pp. 348-350.

Overholtzer found the following correlations between typewriting copy test scores for 20 high school students and the following traits: following directions, .08; concentration and accuracy, .29; immediate memory, .30; tapping, .26; substitution test, .48. He found low correlation between intelligence and the following traits as measured by the MacQuarrie test: location, .81; substitution, .49; reaction time, .42; pursuit, .39; tapping, .39; completion, .37.[28]

Brewington gave rhythm, form substitution, color naming,and serial-reaction tests to 42 students and compared the results with teachers' marks in typewriting. The highest correlation between teachers' marks in typewriting and any of these tests was found with the serial-reaction tests, therefore, she concluded that it was possible to construct tests of high value for predicting success in typewriting.[29]

Vavra used the Lynch Substitution test and concluded that this test involves the qualities needed for successful typewriting. She declared that in 85 per cent of the cases tested the substitution test fulfilled its predictions and that the Intelligent Quotient seems a good

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[28] John Mathias Overholtzer, "A Study of the Possibilities of Predicting Typing Ability," Master's Thesis, University of Southern California, 1928.

[29] Hannah Elizabeth Brewington, "Prognostic Test in Typewriting," American Shorthand Teacher, September and October, 1923.

indication of ability to acquire typewriting skill and that taken together they form an almost perfect prognosis.[30]

Gronert used a substitution test (Lynch Prognostic Test) and found that wherever performance of the subject in the substitution test equalled or excelled the median for the class he was almost sure to do very good work in typewriting. Failures were reduced 17½ per cent from 50 per cent by the use of this test. Eighty-seven per cent of those failing in typewriting made below 50 on the substitution test.[31]

Ohmann gave a series of tests: Motility, language, vocabulary, spelling, following directions, memory span, handwriting, and Pyle's substitution test. He found the best combination of scores on these tests correlated .61 with the criterion. Correlation of typewriting with each of these tests was very low although the use of the tests would improve the guess 21 per cent.[32]

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30 Minnie A. Vavra, "Success in Typewriting," Journal of Educational Psychology, Vol. 16, October, 1925, pp. 487-492.

31 Mary Lynch Gronert, "A Prognostic Test in Typewriting," Journal of Educational Psychology, Vol. 16, March, 1925, pp. 182-85.

32 O. A. Ohmann, "The Possibility of Prognosis in Stenography," Iowa Research Studies in Commercial Education, Vol. I, July, 1926, pp. 36-41.

Davis found very low correlation between intelligence scores and copying tests for more than a thousand students in St. Louis.[33]

Bradford found low correlation between intelligence and typewriting grades and concluded that there are other factors than mental agility and motor ability in the process of learning to typewrite.[34]

Miller compared intelligence scores and copying-test scores of 93 students. She found a correlation of .26 between I. Q. and class grades and .33 between I. Q. and copying-test scores, which are too low to be useful.[35]

White gave a battery of tests. The correlations were as follows: general intelligence scores of 253 showed a correlation of .38 with gross typewriting strokes; Whipple Reading Test scores of 82 showed a correlation with typewriting scores of .41; no correlation between typewriting and vocational interest; serial response test and gross typewriting speed correlated .44;

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33 H. H. Davis, "A Survey of Typewriting in St. Louis," Iowa Research Studies in Commercial Education, Vol. I, July, 1926, pp. 42-52.

34 Lilah Bradford, "Does Typing Ability Depend Upon Mentality or Dexterity?" Journal of Business Education, December, 1930, pp. 23-24.

35 M. Alice Miller, "The Prognosis of Ability in Typewriting," Department of Curriculum Study and Educational Measurements and Research, Pittsburgh Public Schools, 1928.

a correlation of .58 was found between gross speed on single response combined with speed on multiple response. He concluded that intelligence, reading skill, age and performance on serial response motor tests are significant factors in typewriting achievement.[36]

Other studies were made by Stedman,[37] Robinson,[38] Johnson,[39] Bieneman,[40] Jones,[41] Wood,[42] and George.[43] These failed to predict typewriting ability from the use of motor tests or intelligence tests.

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36 Bruce White, "Prediction of Typewriting Success," Journal of Business Education, Vol. 10, April, 1935, pp. 15-16.

37 Melissa Stedman, "A Study of the Possibilities of Prognosis of School Success in Bookkeeping and Typewriting," Master's Thesis, University of Southern California, 1928.

38 Benjamin G. Robinson, "An Experimental Study of Certain Tests of Natural Capacity and Aptitudes for Typewriting," University of Iowa Studies in Psychology, Vol. 10, 1921.

39 Clara L. Johnson, "The Validity of Certain Tests to Prognosticate Typewriting Ability," Master's Thesis, University of Iowa, 1925.

40 Dora Bieneman, "Ability in Typewriting in Relation to Vocational Guidance," International Labor Office, Geneva, 1923.

41 Marian B. Jones, "Reading Rate and Comprehension as Determining Factors in the Selection of Pupils for Junior High School Typewriting Classes," Master's Thesis, University of Southern California, 1932.

42 Winifred Gantt Wood, "Relation Between Intelligence Quotient and the Rate of Attainment in Typewriting," Master's Thesis, University of Southern California, 1928.

43 Guy Gains George, "The Relationship Between Maze Learning and Typewriting Learning," Master's Thesis, Stanford University, 1930.

CHAPTER II

ANALYSIS AND INTERPRETATION OF DATA

As previously stated the purpose of this study is to determine what relationship, if any, exists between speed in typewriting and achievement in the MacQuarrie Test for Mechanical Ability or in any of its parts or combinations of parts.

The MacQuarrie test was used to measure the motor ability of 192 first-year high school typewriting students in the Cushing and Stillwater, Oklahoma, high schools. The J. N. Kimball typewriting tests were used to measure these students' speed in typewriting, and the Terman Group Test for Mental Ability was used to obtain intelligence quotients. The tests were administered during the school year 1937-1938, the MacQuarrie test being given at the beginning of the year, the Terman test at various times during the year, and the typewriting tests at the end of the year; the students were of the usual high school age, 14-20 years and were in grades 10, 11, and 12. The gross typewriting strokes were obtained by taking the average number of strokes from five 10-minute tests for each student.

Correlations were computed between the MacQuarrie total test scores and gross typewriting strokes; between each part of the MacQuarrie test and gross typewriting strokes; and between various combinations of parts of

the MacQuarrie test and gross typewriting strokes. A multiple correlation was computed between the MacQuarrie total test scores teamed with intelligence test scores and gross typewriting strokes. MacQuarrie total test scores were correlated with the intelligence quotients and also the gross typewriting strokes were correlated with the intelligence quotients. These correlations were found by the Pearson product-moment method.

The correlation between gross typewriting strokes and intelligence quotients was found to be .243 ± .046. This correlation indicates little prognostic value and is comparable to conclusions made in previous studies using intelligence quotients to predict typewriting ability. Sandy made a study of several pieces of research dealing with intelligence of secondary commercial students in which he found only three studies showing correlations between I. Q. and the criteria used high enough to have any significance in predicting success in commercial subjects. In the 17 typewriting studies, teachers' marks and net scores on typewriting tests were used for criteria.[1] The fact that marks given by teachers are frequently unreliable, invalid, and subjective will not be questioned. Net scores are not valid for measuring

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[1] Forrest M. Sandy, "A Critical Examination of Research Dealing with the Intelligence of Secondary School Commercial Students," Master's Thesis, University of Iowa, 1932.

either speed or accuracy in typewriting since they are a combination of speed and accuracy and are derived by the arbitrary method used in the International Typewriting Rules.

Few studies have been made using gross strokes as a criterion. White found a correlation of .38 ± .04 between I. Q. and gross speed.[2] Ackerson contended that psychological tests yielded the highest correlations with the speed element alone, although his correlations between speed and the Army Alpha Test were only in the .20's and .30's.[3] Sandy found the average correlation between typewriting and I. Q. to be .293[4] which is a little higher than the .243 found in the present study.

Lessenberry concludes:

> Apparently the use of the I. Q. as a reliable measure for predicting ability to learn typing is open to question. In general, those phases of typing that call for the organization of materials or work plans, rather than the simple straight-copy skill, may offer a more reliable measure of typing achievement with which to correlate I. Q. Intelligence may not be a necessary factor in learning to type, but it is a necessary factor in using the developed typing skill.[5]

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2 Bruce White, "Prediction of Typewriting Success," Journal of Business Education, Vol. 10, April, 1935, pp. 15-16.

3 Luton Ackerson, "A Correlational Study of Proficiency in Typing," Iowa Research Studies in Commercial Education, Vol. I, July, 1926, pp. 88-95.

4 Forrest M. Sandy, op. cit.

5 D. D. Lessenberry, Methods of Teaching Typewriting, p. 16.

A correlation of .186 ± .047 was found between the MacQuarrie total test scores and I. Q. This is lower than the .381 found between MacQuarrie and I. Q. by Pond.[6] However, it confirms MacQuarrie's statement that the MacQuarrie test has a low correlation with intelligence test results because it measures mechanical ability and not intelligence as measured by prevailing mental tests.[7]

These low correlations may have been due to the independence of the factors, therefore it was thought that the efficiency of the prediction might be increased by the method of multiple correlation. Proceeding on this supposition, a multiple correlation was computed between the team of MacQuarrie total test scores and intelligence quotients and gross typewriting strokes. This procedure resulted in a correlation of .112 ± .048. No value for prediction is found in this low correlation.

In addition to correlation between MacQuarrie total test scores and gross typewriting strokes, correlations between each part of the MacQuarrie test were computed with gross typewriting strokes because it was thought that perhaps each part of the MacQuarrie test might show more of the "individual differences in the more strictly visual

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[6] Reported in Aptitudes and Aptitude Testing by Walter Van Dyke Bingham, p. 314.

[7] T. W. MacQuarrie, "MacQuarrie Test for Mechanical Ability," Instruction Sheet for Giving Test.

and motor activities of the Tracing, Tapping, and Dotting tests, in the abilities required by the sub-tests in which visual perception of space relations is more obviously a factor, and in such verbal intelligence as is needed to grasp the instructions."[8]

Not only were correlations computed between each part of the MacQuarrie test, but various combinations of parts with gross typewriting strokes in an effort to determine whether there was more relationship here than in the previous correlations. Random combinations were taken because the correlations found between the total scores and each part were so low that it was thought unnecessary to use every combination, and the process would take too much time.

The coefficients of correlation between the MacQuarrie total test scores and gross typewriting strokes and between each part of the MacQuarrie test and gross typewriting strokes are given in Table I.

The correlations in Table I are low, the highest being .301 ± .044 between total MacQuarrie scores and gross typewriting strokes. Though too low for reliable prognosis, this correlation seems to indicate that there are common elements between the abilities measured by

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[8] Walter Van Dyke Bingham, op. cit., p. 314.

TABLE I

COEFFICIENTS OF CORRELATION BETWEEN MACQUARRIE TOTAL TEST SCORES AND GROSS TYPEWRITING STROKES AND BETWEEN EACH PART OF MACQUARRIE TEST AND GROSS TYPEWRITING STROKES

MacQuarrie Test:	Gross Typewriting Strokes	
	r	P. E.
Total Scores	.301	.044
Tracing	.186	.047
Tapping	.178	.047
Dotting	.245	.046
Copying	.161	.047
Location	.164	.047
Blocks	-.132	.048
Pursuit	.176	.047

the MacQuarrie test and those required in typewriting speed. Horning used the MacQuarrie test to predict success of boys taking shop work and found the high correlation of .79 between the MacQuarrie test and accomplishment, and .72 between the MacQuarrie test and speed in accomplishment, which would seem to indicate that the MacQuarrie test is of more value in predicting success for motor ability in the trades than in typewriting speed, and that the faster worker accomplishes more than the slow worker.[9]

[9] S. D. Horning, "Testing Mechanical Ability by the MacQuarrie Test," Industrial Arts, October, 1926, pp. 348-350.

For the group of 192 students tested in this study, the mean for the total MacQuarrie test scores is 68; for gross typewriting strokes, 2140, and for intelligence quotients, 104. The student with the highest intelligence quotient (142) had typewriting speed of 2303 strokes and a MacQuarrie test score of 76. Two students with the lowest intelligence quotients (70) had typewriting speeds of 2571 and 1711 with MacQuarrie test scores of 67 and 57, respectively. Seven students had typewriting speeds above 3000 strokes each, which is outstanding in speed for first-year high school typewriting students. The intelligence quotients for these seven students were 108, 114, 125, 88, 102, and 109 with MacQuarrie total test scores of 67, 70, 88, 77, 80, and 84, respectively. The student with the highest MacQuarrie test score (107) had typewriting speed of 1551 strokes and an intelligence quotient of 90. The student with the lowest MacQuarrie test score (36) had typewriting speed of 2158 strokes and an intelligence quotient of 96. Another student with a MacQuarrie test score of 45 had a typewriting speed score of 2111 strokes and an intelligence quotient of 126.

The correlations between each part of the MacQuarrie test and gross typewriting strokes as shown in Table I range from -.132 ± .048, Blocks and typewriting, to

.245 -1 .046, Dotting and typewriting. Apparently the ability measured in Blocks is not an essential factor in obtaining typewriting speed.

From Table I it will be observed that the highest correlation between any of the parts of the MacQuarrie test and gross typewriting strokes is .245 ± .046 between Dotting and gross typewriting strokes. There is little relationship indicated in this low correlation, although the factors measured by Dotting, such as visual acuity and steadiness of hand movement, are probably important in typewriting speed. A correlation of .20 has a predictive efficiency of about 2 per cent better than chance.

Tracing and Gross typewriting strokes correlate .186 ± .047. This is not high enough to be reliable, although the elements of visual and motor precision required seem to be essential factors in typewriting speed. It should be kept in mind that Dr. MacQuarrie intended only a rough measurement of motor ability even for skills such as mechanical trades.[10]

Tapping correlates .178 ± .047 with gross typewriting strokes. This device has been used in many studies in an effort to predict success in typewriting but no worthwhile prediction has been found, except by Book.[11]

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10 T. W. MacQuarrie, op. cit.

11 W. F. Book, "Voluntary Motor Ability of the World's Champion Typists," Journal of Applied Psychology, Vol. 7, No. 3, September, 1924, pp. 283-308.

White made the following statement:

> Most tests of simple tapping speed have shown a fairly high correlation with typewriting ability among the extremely expert typists, but indicate practically no relationship between tapping and typing speeds at lower levels of typewriting proficiency. One quite plausible explanation is that at the lower typewriting speeds each stroke is composed of a number of movement elements, and that typewriting speed is not achieved by the speeding up of each movement element, but by the elimination of some of the separate movements making up the stroke.[12]

Pursuit shows a very low correlation with gross typewriting strokes. George attempted to measure typewriting success with maze learning which is similar to Pursuit but found a minus correlation.[13]

Evidently no separate part of the MacQuarrie test is significant in predicting speed in typewriting.

The next step in the treatment of the data was to combine various parts of the MacQuarrie test and correlate these sums with gross typewriting strokes. No especial combinations were selected but a random sampling was taken since the previous correlations were so low and since it would take so long to use every possible combination.

It will be observed in Table II that the highest correlation, .313 ± .044, is between the combination of

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[12] Bruce White, Op. cit., pp. 15-16.

[13] Guy Gains George, "The Relationship Between Maze Learning and Typewriting Learning," Master's Thesis, Stanford University, 1930.

TABLE II

COEFFICIENTS OF CORRELATION BETWEEN RANDOM SAMPLING OF COMBINATIONS OF PARTS OF MACQUARRIE TEST SCORES AND GROSS TYPEWRITING STROKES

MacQuarrie Test:	Gross Typewriting Strokes	
	r	P. E.
Tracing and Tapping	.254	.045
Tracing and Dotting	.245	.046
Tracing and Copying	.215	.046
Tracing and Location	.228	.046
Tracing and Blocks	.095	.047
Tracing and Pursuit	.225	.046
Tapping and Location	.218	.046
Tapping and Pursuit	.218	.046
Dotting and Location	.228	.046
Dotting and Pursuit	.222	.046
Copying and Location	.192	.047
Copying and Pursuit	.200	.047
Location and Pursuit	.299	.044
Tracing, Tapping, and Dotting	.286	.045
Tracing, Tapping, Dotting, and Copying	.249	.046
Tracing, Tapping, Dotting, Copying, and Location	.313	.044
Tracing, Tapping, Dotting, Copying, Location, and Blocks	.258	.045

Tracing, Tapping, Dotting, Copying, and Location and gross typewriting strokes. This shows some relationship but not high enough to be valid for prediction purposes. The combination of Tracing and Blocks correlates with the criterion the lowest, .095 ± .048. This is not significant. The correlations between the other combinations and gross typewriting strokes range from .192 ± .047, Copying and Location, to .299 ± .044, Location and Pursuit. No high prognostic value can be claimed for these correlations.

Although the correlations continued to be very low, as shown in Table II, it was decided that other combinations might hold more promise as a basis for prognosis, and therefore further combinations of parts were made and correlated with gross typewriting strokes. The lowest correlation in Table II is between the combination of Tracing and Blocks and the highest between the combination of Tracing, Tapping, Dotting, Copying, and Location and gross typewriting strokes, therefore it was decided to leave out Blocks which seemed to lower the correlations and to use more combinations containing Dotting, Location, and Pursuit which seemed to raise the correlations.

Hence, Table III shows the coefficients of correlation obtained by further computations. Not all possible combinations of parts of the MacQuarrie test were used as it was thought the process would take too much time and since the correlations have proved to be so low thus far, it didn't seem essential.

TABLE III

COEFFICIENTS OF CORRELATION BETWEEN FURTHER COMBINATIONS OF PARTS OF THE MACQUARRIE TEST SCORES AND GROSS TYPEWRITING STROKES

MacQuarrie Test:	Gross Typewriting Strokes r	P. E.
Tapping and Dotting	.220	.046
Dotting, Location, and Pursuit	.293	.044
Tracing, Dotting, and Copying	.234	.046
Tracing, Dotting, and Location	.303	.044
Tracing, Dotting, and Pursuit	.269	.045
Tapping, Dotting, and Location	.267	.045
Tapping, Dotting, and Pursuit	.174	.047
Dotting, Copying, Location, and Pursuit	.261	.045
Tapping, Dotting, Location, and Pursuit	.264	.045
Tracing, Dotting, Location, and Pursuit	.269	.045
Tracing, Tapping, Dotting, and Pursuit	.307	.044
Tracing, Tapping, Dotting, Location, and Pursuit	.264	.045
Tracing, Dotting, Copying, Location, and Pursuit	.265	.045
Tapping, Dotting, Copying, Location, and Pursuit	.276	.045
Tracing, Tapping, Dotting, Copying, Location, and Pursuit	.289	.045

No higher correlations were found after making further computations between combinations of various parts of the MacQuarrie test with gross typewriting strokes. They are all low as shown in Table III. The highest correlation is .307 ± .044 between the combination of Tracing, Tapping, Dotting, and Pursuit and gross typewriting strokes. The next highest is .303 ± .044 between the combination of Tracing, Dotting, and Location and gross typewriting strokes. The others range from .203 ± .044, Dotting, Location, and Pursuit with gross typewriting strokes to .174 ± .047, Tapping, Dotting, and Pursuit with gross typewriting strokes. None of these correlations holds high value for prognosticating speed in typewriting.

It seems that there is as much significance between the total MacQuarrie test scores and gross typewriting strokes, which is .301 ± .044, as between any of the parts or combinations of parts of the MacQuarrie test and gross typewriting strokes.

The correlations between separate parts of the MacQuarrie test and gross typewriting strokes range from .245 ± .046 Dotting and gross typewriting strokes, to -.132 ± .048, Blocks and gross typewriting strokes. The highest correlation, .313 ± .044, is found between the combinations of the parts Tracing, Tapping, Dotting, Copying, and Location and gross typewriting strokes.

The lowest correlation is .095 ± .048 between the combination of the parts Tracing and Blocks and gross typewriting strokes.

The multiple correlation between intelligence quotients and total MacQuarrie scores on the one hand and gross typewriting strokes on the other is .112 ± .048.

These correlations show definite relationship between the MacQuarrie test and gross typewriting strokes but probably cannot be accepted as highly predictive of speed in typewriting.

CHAPTER III

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine what relationship, if any, exists between speed in typewriting and achievement in the MacQuarrie Test for Mechanical Ability or in any of its parts or combinations of parts.

The experimental method was used. The subjects were 50 Cushing, Oklahoma, first-year high school typewriting students and 142 Stillwater, Oklahoma, first-year high school typewriting students of the usual high school age, 14 to 20 years, and in grades 10, 11, and 12. The study was made during the school year 1937-1938.

J. N. Kimball straight copy typewriting tests were used to measure ability in speed in typewriting, the scores being obtained from an average for each student of five ten-minute tests. The MacQuarrie Test for Mechanical Ability was used to measure the motor ability of these students and the Terman Group Test for Mental Ability was used to obtain their intelligence quotients. The Pearson product-moment method was used to compute correlations between the MacQuarrie test scores and gross typewriting strokes and intelligence quotients.

From the examination of previous related studies on the problem of predicting success in learning to typewrite, few studies found correlations high enough to be of value for prognosis. In the attempts to predict

typewriting success by the use of intelligence quotients the correlations range from .38 in White's[1] study to as low as -.02 in Ohmann's[2] study. The majority of the writers concluded that the intelligence quotient could not be used to predict success in learning to typewrite.

Numerous other tests were used in an effort to find a valid test for predicting success in typewriting, among which the motor ability type of test was the most successful. Brewington found a high correlation of .85 between serial reaction tests and teachers' marks in typewriting.[3] George found a minus correlation between maze learning and typewriting grades.[4] Results of other studies range between these two extremes. Until more agreement is reached and better criteria found, success in prognosis will remain doubtful. According to Hull, even as high a correlation as Miss Brewington found is only about 45 per cent efficient for prediction.[5]

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1 Bruce White, "Prediction of Typewriting Success," Journal of Business Education, Vol. 10, April, 1935, pp. 15-16.

2 O. A. Ohmann, "The Possibility of Prognosis in Stenography," Iowa Research Studies in Commercial Education, 1926.

3 Hannah Elizabeth Brewington, "Prognostic Test in Typewriting," American Shorthand Teacher, September and October, 1923.

4 Guy Gains George, "The Relationship Between Maze Learning and Typewriting Learning," Master's Thesis, Stanford University, 1930.

5 Clark L. Hull, "Psychological Tests and the Differentiation of Vocational Aptitudes," Iowa Research Studies in Commercial Education, Vol. I, 1926, pp. 24-35.

The findings in the present study are similar to those of other studies on this problem. A correlation of .301 ± .044 was found between MacQuarrie total test scores and gross typewriting strokes. The highest correlation of separate parts of the MacQuarrie test with gross typewriting strokes was .245 ± .046 between Dotting and gross typewriting strokes; the lowest was -.132 ± .048 between Blocks and gross typewriting strokes. The highest correlation of combinations of parts was .313 ± .044 between Tracing, Tapping, Dotting, Copying, and Location and gross typewriting strokes. The lowest correlation of combinations of parts was .095 ± .047 between Tracing and Blocks and gross typewriting strokes. None of these coefficients can be accepted as valuable for prognosticating speed in typewriting.

The multiple correlation between MacQuarrie total test scores teamed with intelligence quotients and gross typewriting strokes yielded a coefficient of .112 ± .047. This low correlation is comparable to results found in the majority of studies made, using the intelligence quotient to predict success in typewriting, and concluding that the intelligence quotient cannot be used to predict success in learning typewriting. A correlation of .243 ± .046 was found between gross typewriting strokes and intelligence and a coefficient of .186 ± .047 between the MacQuarrie total test scores and intelligence quotients. These correlations are too low for prognosis.

When the MacQuarrie test was used by Horning to determine its value as a prognostic test for shop students, he found a correlation of .79 between accomplishment and the MacQuarrie test.[6] This would seem to indicate that the MacQuarrie test is more valuable as a prognostic test for the mechanical trades. In his description of his test Dr. MacQuarrie states that it is a test of mechanical ability but is intended to give only a rough indication of such mechanical ability.[7] The low correlations found in this study need not invalidate the test entirely for typewriting speed prognosis. Together with test scores on other psychological tests for students they might help form a basis for guidance purposes. Tests now available, according to Ohmann, do not correlate much above .55 or .60 with any criterion.[8] However, this should not cause predictive tests to be disregarded, for even with low forecasting precision, inexpensive tests will be useful. A small amount of information will be decidedly worth securing.[9]

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6 S. D. Horning, op. cit., p. 202.

7 T. W. MacQuarrie, Directions for Giving Test.

8 O. A. Ohmann, op. cit., pp. 36-41.

9 Clark L. Hull, op. cit., pp. 24-35.

Since the coefficients of correlation in this study were found to be no higher than .313 ± .044 on either the total test scores, on separate parts, or on combinations of parts, it must be concluded that the MacQuarrie Test for Mechanical Ability cannot be used as a valuable means for prognosticating speed in first-year typewriting.

In the light of previous studies reviewed here and the findings of this study, the following general conclusions are also justifiable:

No mental or motor ability test has yet been devised or discovered which will predict the ability to acquire speed in typewriting or success in learning to typewrite.

Motor ability seems to be fairly independent of speed in typewriting.

There are other factors in the process of acquiring speed in typewriting in addition to the abilities measured by current intelligence and motor tests. Until it is known just what the factors are in acquiring speed in typewriting, it will be difficult to find a measure for such an important trait.

Batteries of tests need to be constructed which will measure the various elements of ability required to achieve typewriting speed.

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APPENDIX

MACQUARRIE TEST for MECHANICAL ABILITY

A Simple Group Performance Test for the Use of School Counselors and Personnel Managers

By T. W. MacQuarrie, Ph. D.
President
San Jose State College
San Jose, California

FILL IN THE BLANKS BELOW, BUT DO NOT OPEN THE BOOKLET

City..... Date.....

School..... Grade.....

..... , ...
(Print your last name) (Print first name and initial)

Age, last birthday.....Date of birthday.....

RECORD

Tracing.....

Tapping.....

Dotting.....

Copying.....

Location.....

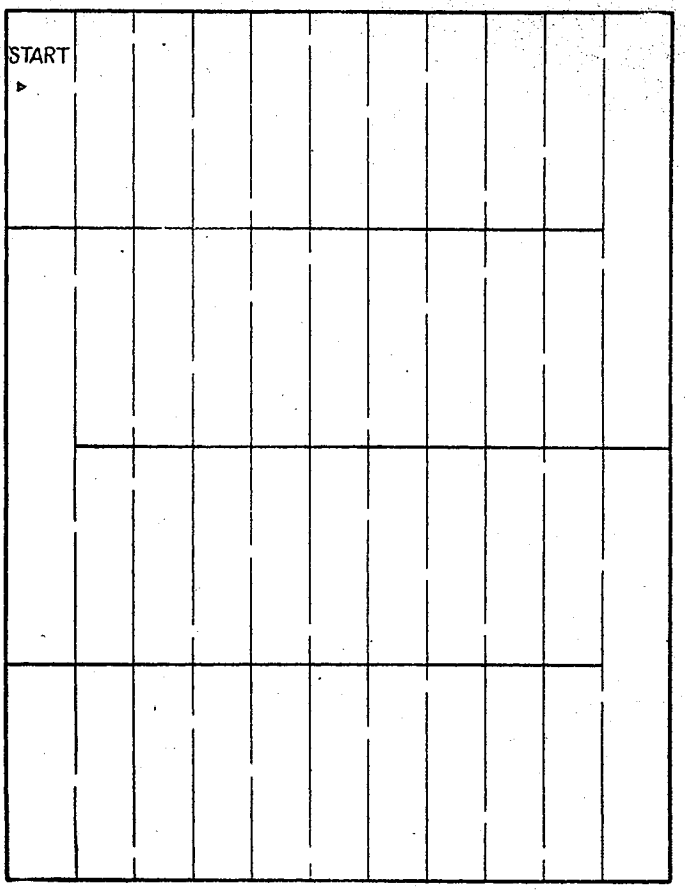
Blocks.....

Pursuit.....

Total 3).....

Score:

TRACING



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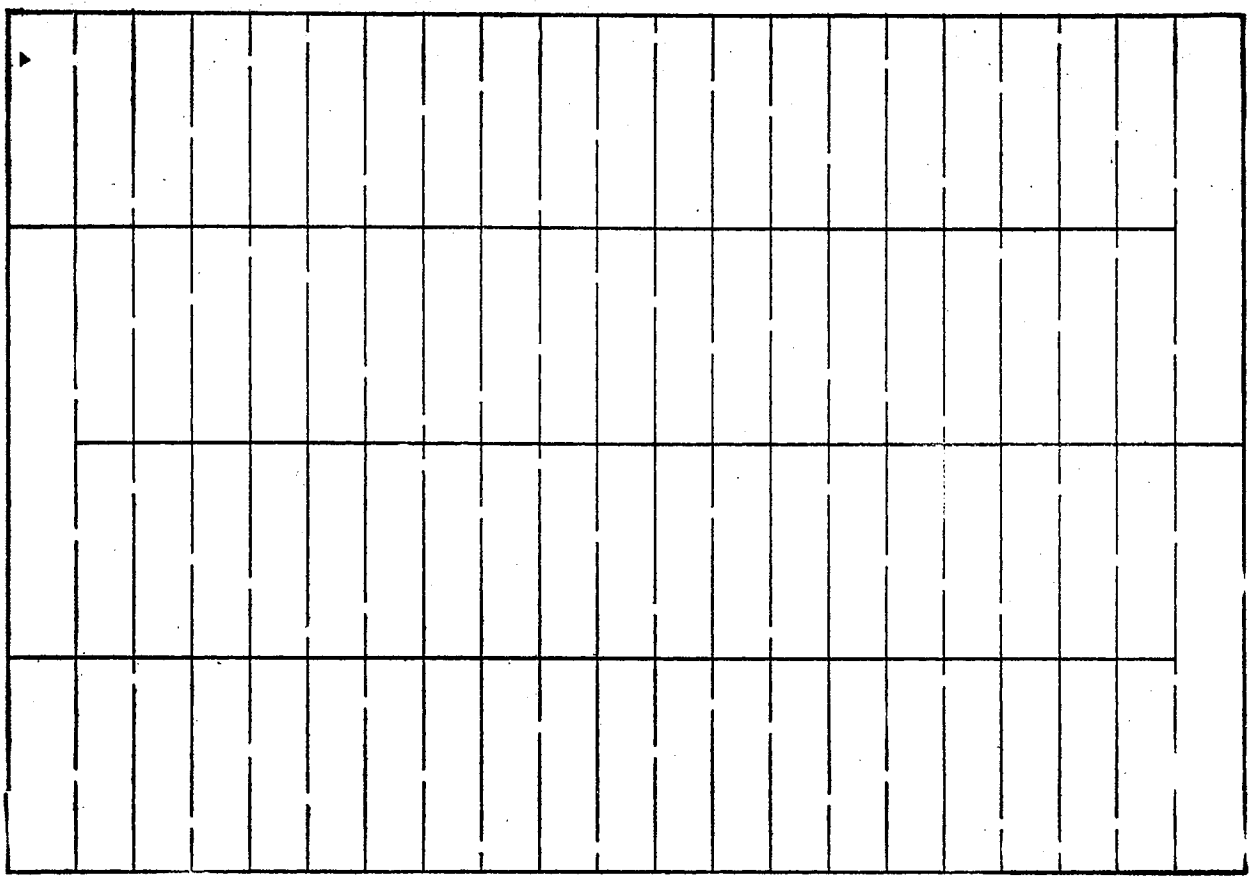

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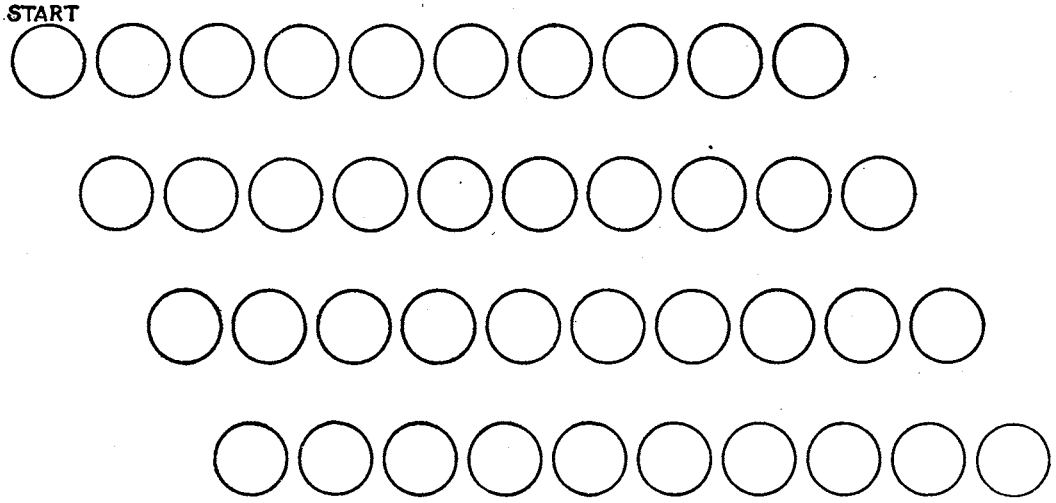
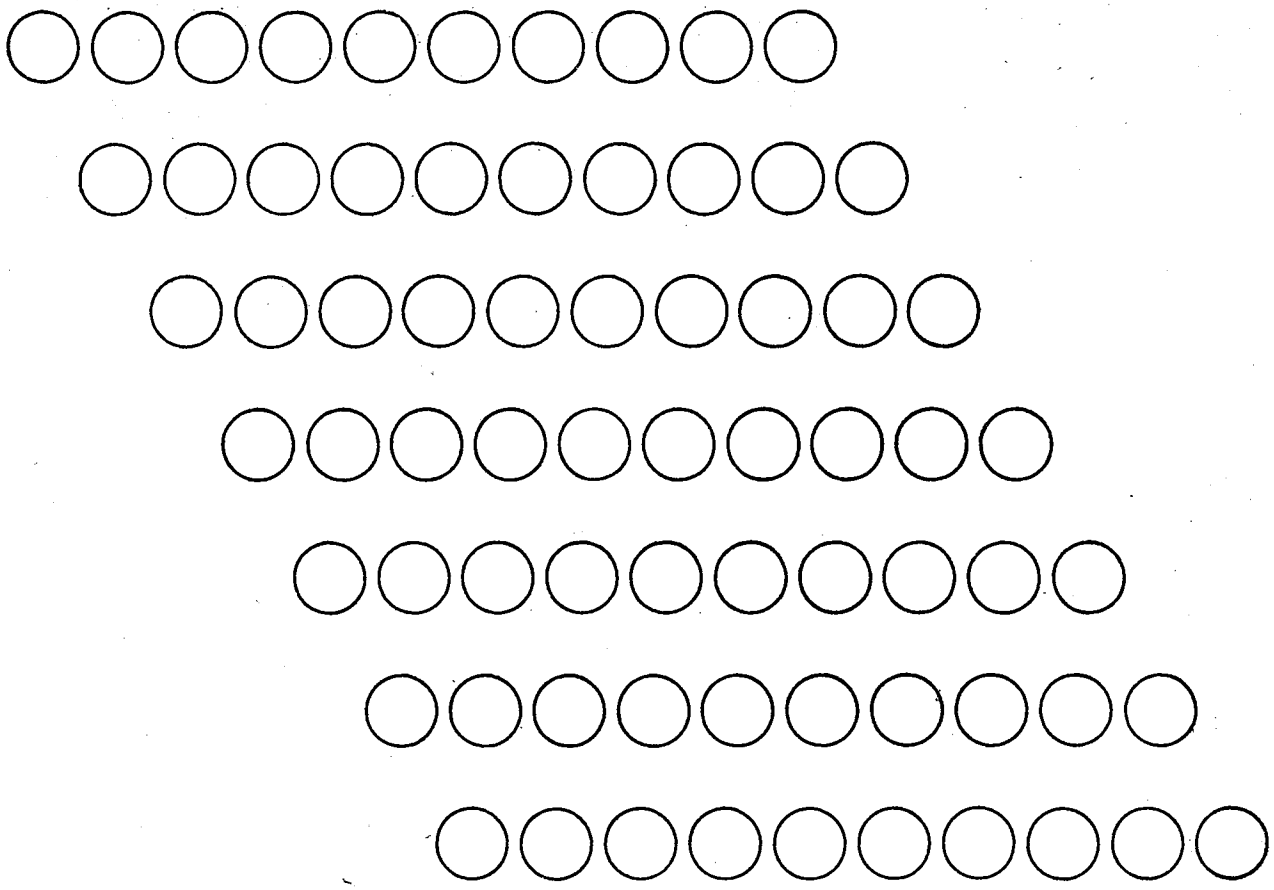
TAPPING

START





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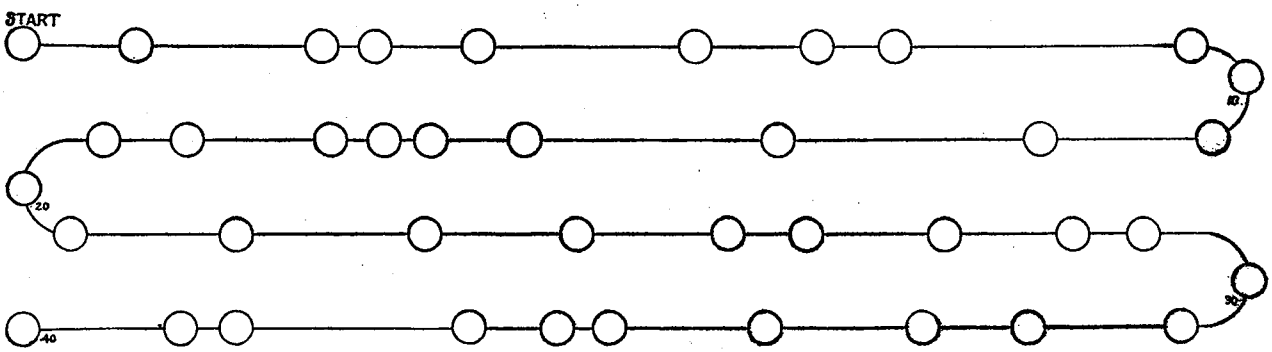

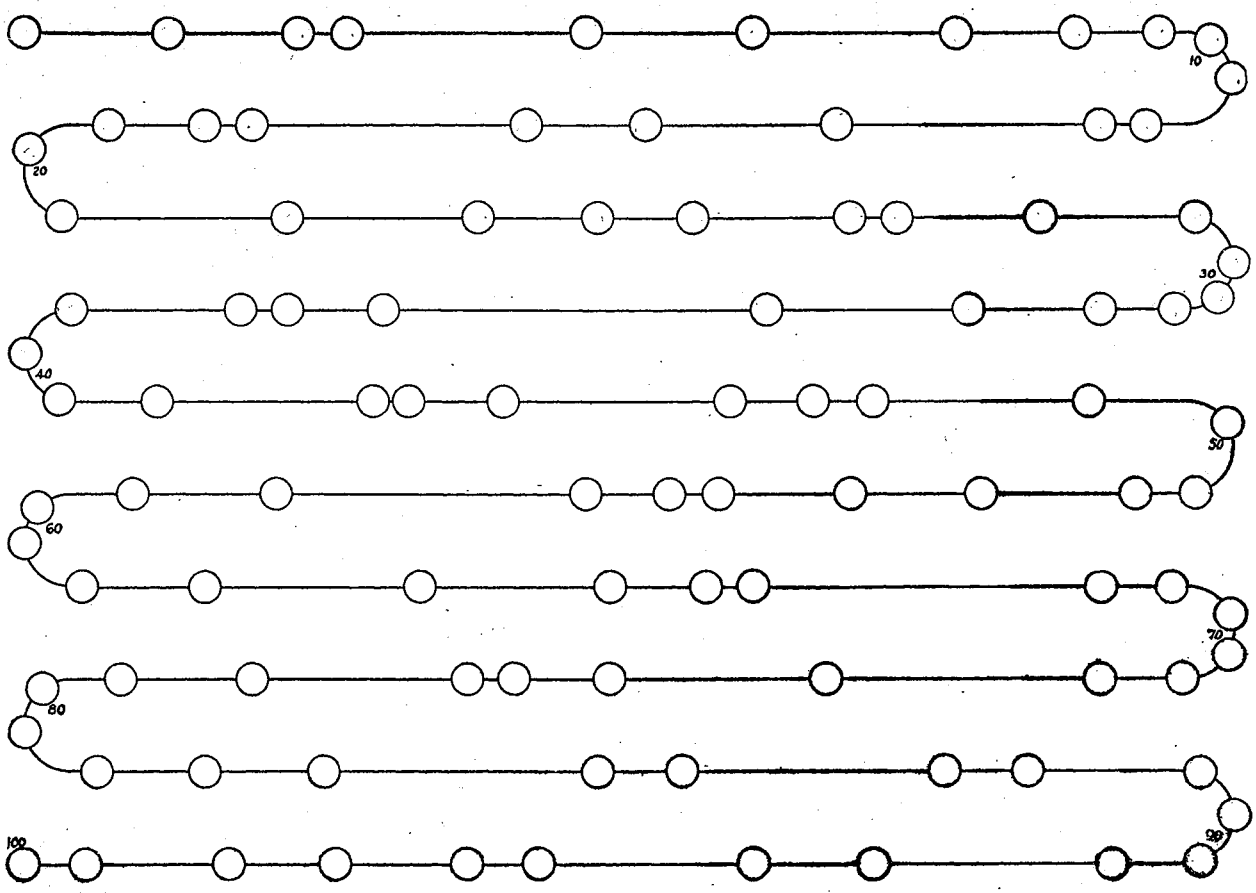

Dots.....÷3=Score.....

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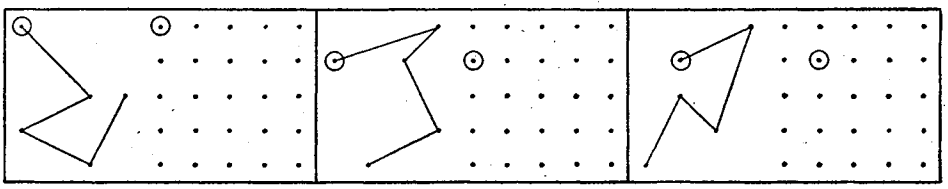

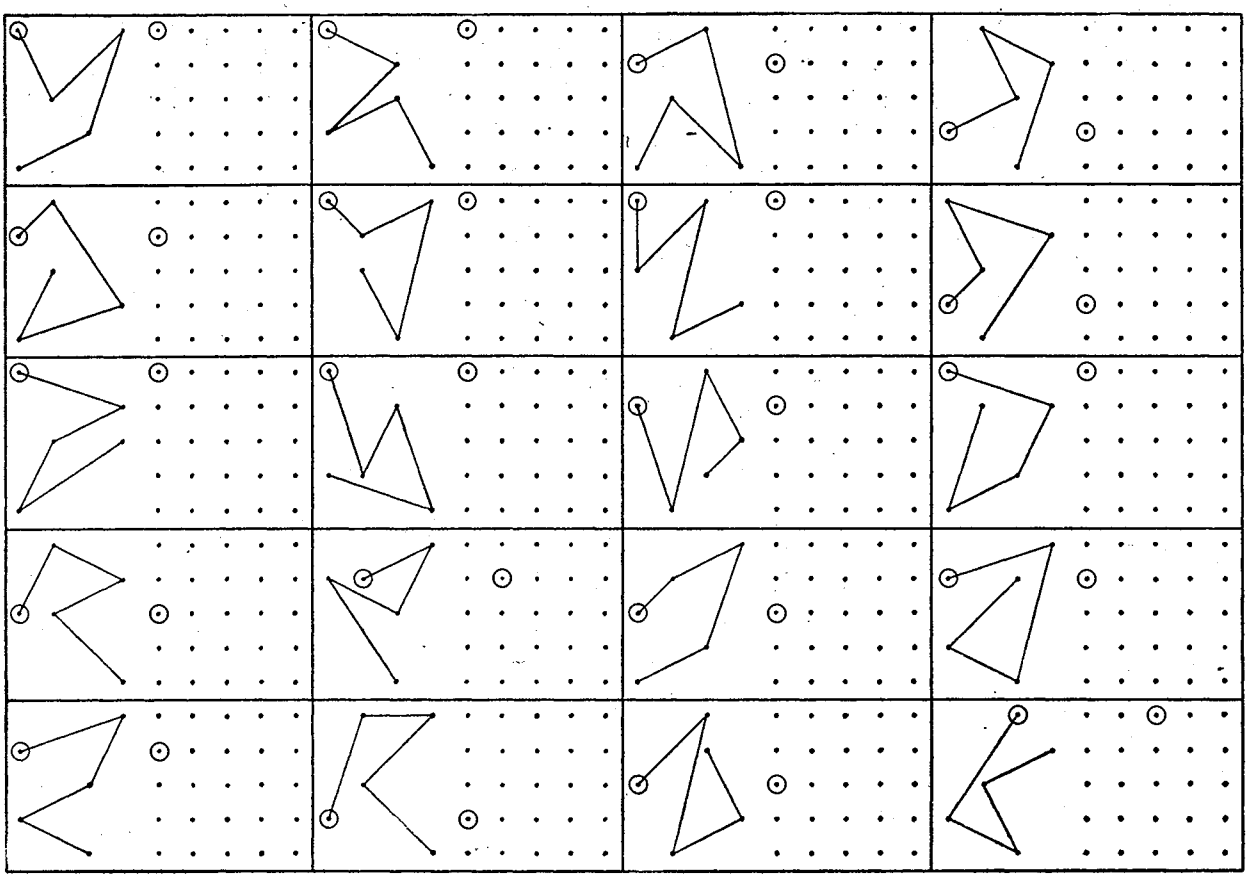

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G	H	J	K	L	M
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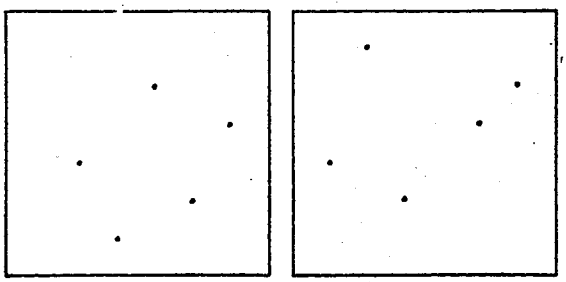

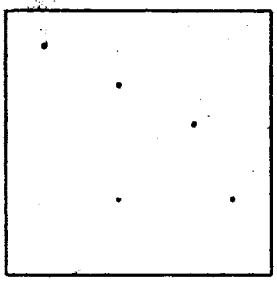

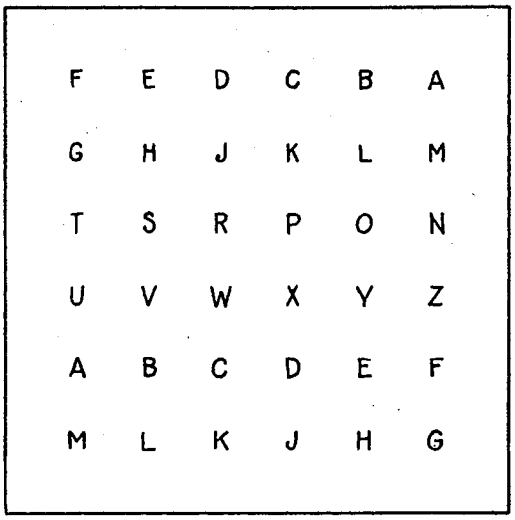

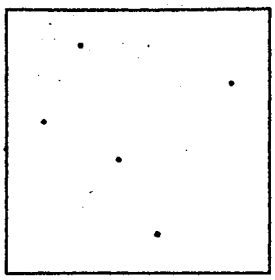

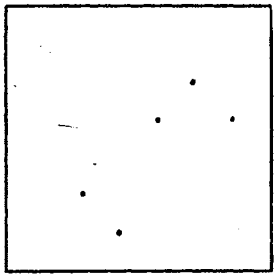

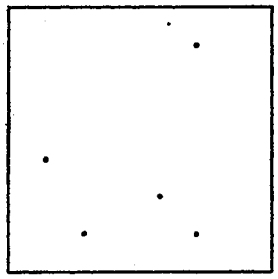

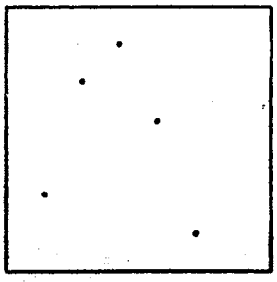

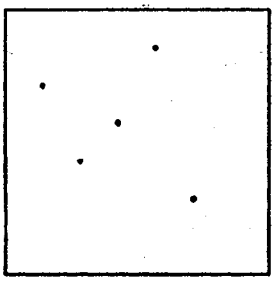

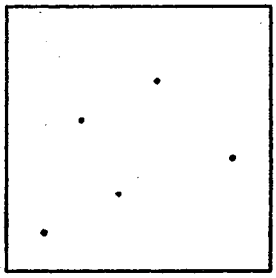

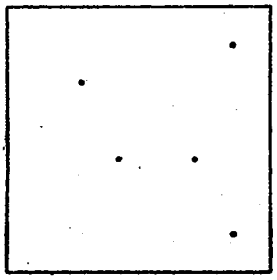

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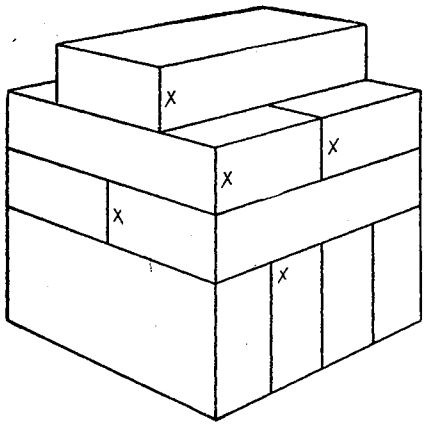

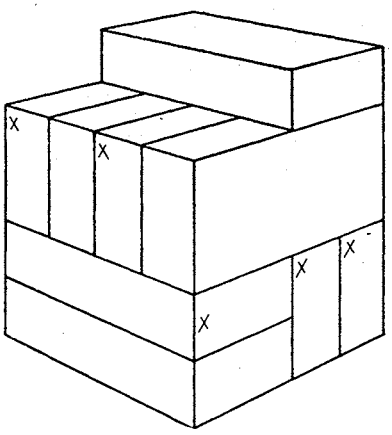

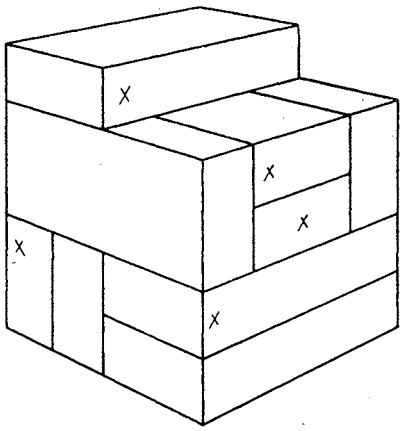

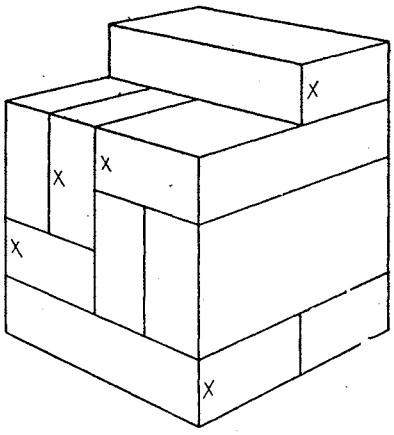

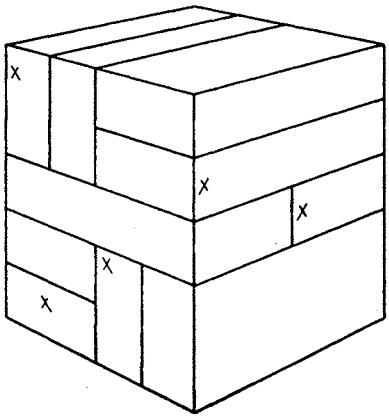

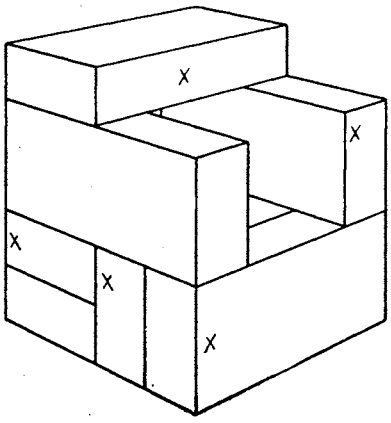

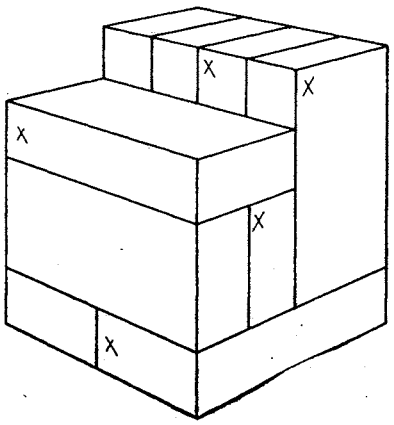

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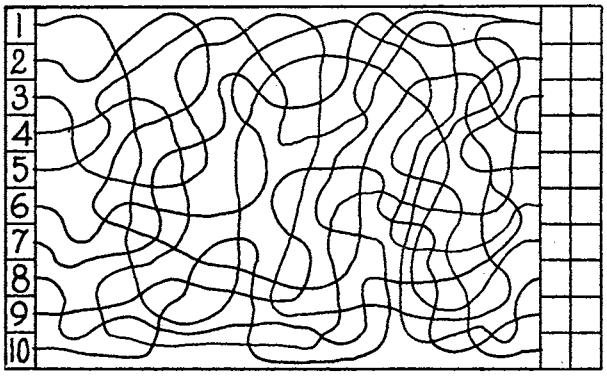

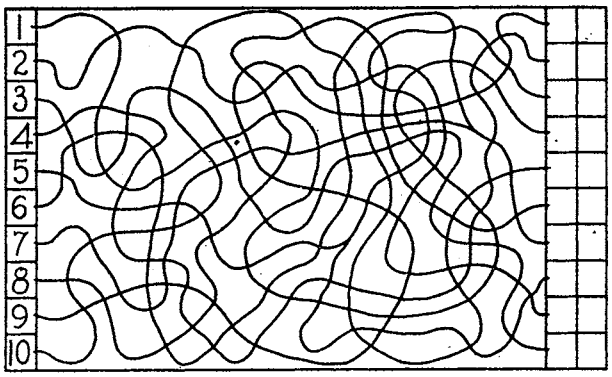

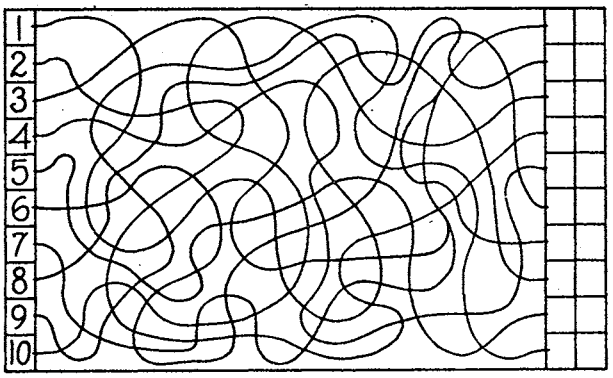

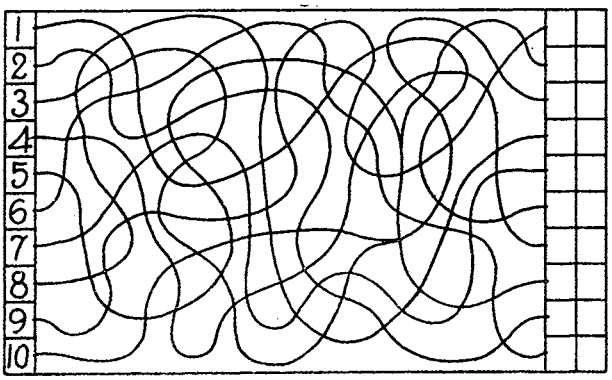

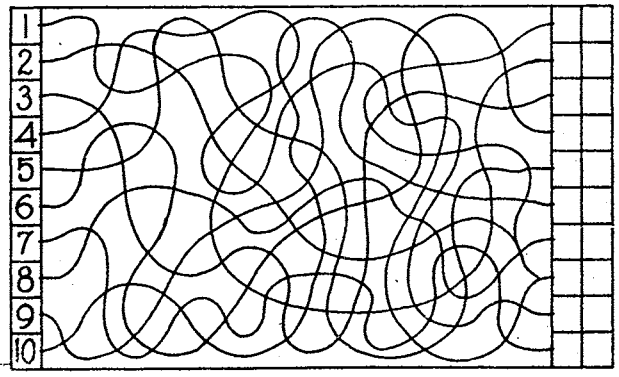

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MacQuarrie Test for Mechanical Ability

By T. W. MacQuarrie, Ph.D.

This test is an attempt to provide a standard performance for the measurement of mechanical ability.

The term **mechanical ability** has never been carefully defined, in fact, a complete analysis would be very difficult. We assume that it takes mechanical ability to do the work of the mechanic, but we have a feeling that such ability is also used in greater or less degree by the barber, typist, motorman, waiter, telephone operator, tailor, plasterer, dentist, draftsman, baseball pitcher and pianist. These, and many others in addition to the mechanics, require manipulative skill, recognition of space relations, speed, muscular control, visual acuity, and all those accomplishments which we usually associate with the mechanical trades.

No estimate of mechanical ability can be anything but rough. Nor is an accurate measurement necessary. There is no valid evidence at present to show that the carpenter requires more mechanical ability than the machinist, nor that the house painter must develop greater skill than the plumber. As a matter of fact, men with various degrees of mechanical ability do function in the same trade. If we had a definite minimum norm for entrance to each mechanical trade, then it would be important to have accurate measurements. Since there are no such norms, the best we can do is to say that a candidate for a mechanical vocation should show a high degree of mechanical ability before money is spent upon his training. There are not so many mechanics in the country that we need to take candidates haphazard. If we are to increase efficiency, we must train only those best fitted for the work.

If a shop foreman were asked to judge a strange mechanic, he would probably have the man do a piece of work in the trade. The skill he showed in handling his tools, the speed with which he worked, and the quality of his product would determine the man's rating in the mind of the foreman. Other competent foremen, however, would no doubt give the man different ratings, for it is a fact, here as elsewhere, that judges disagree.

In view of the fact that there is no standard piece of work requiring mechanical ability, this test has been developed with the hope that it might meet such a need. It is very simple. It requires for its material—paper, and for the single tool used—a lead pencil. It takes very little time to give and score. It has a high reliability and a satisfactory validity. Women and girls can take it as well as boys and men. It is well adapted to ages of ten years and up. Some eight and nine year olds even have made good scores. It has a very low correlation with inteligence test results, indicating that it measures something different. Those who take the test find it interesting, and teachers of shop work have approved of it as a mechanical job. They feel that it requires many of the abilities they use in making a table, or an elbow, or a piston ring. Considerable statistical evidence has been produced already to show that it is a satisfactory measure of general mechanical ability, and it is offered to those interested with the hope that it will be of service in selecting candidates for the mechanical trades.

At the present time, many counselors in junior and senior high schools, and a number in universities are placing scores on this test on the personnel cards of their students. In that way they have always on hand a standard measure of mechanical ability, and they may offer

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advice when the proper time comes which is something more than the usual off-hand guess. One dental college is already using the test to get an estimate of the aptitude of their candidates for training in manipulating dentistry. Dental training costs the student about ten thousand dollars, and the man who has little mechanical ability cannot possibly be a success.

A boy or girl should make a high score in mechanical ability before being approved by the counselor for a mechanical trade. Our estimates are bound to be rough, and we shall be more nearly right if we accept high scores only. A subject with an average score might be approved for a mechanical trade under specially favorable conditions, but it is very doubtful if a school is warranted in attempting to train anyone who makes a low score. In general it will be found that those who make low scores are not very much interested in mechanical trades, and respond readily to suggestions for other vocations.

Norms have been worked out for ages from ten to twenty. There is a wide range of scores for every age, and a great deal of overlapping. There is little increase from age to age, but it is rather steady. About a thousand cases, mostly school and college students were used to compute the norms. Later additions will change them somewhat, but not to any great extent.

For each age the mean is given, and also norms a standard deviation below and above the mean. A score which is near the highest norm for the age might well be considered high, one near the mean is average, and one near the lowest norm is certainly low. In the table given below, a few cases above the range were included with the twenties, and a few cases below were included with the tens.

AGE NORMS

Equalled or Exceeded by:	Very Low (93%)	Low (84%)	Low Average (69%)	Average (50%)	High Average (31%)	High (16%)	Very High (7%)
Age							
10 years	14	18	22	26	30	34	38
11 years	23	28	32	37	42	46	51
12 years	27	33	38	44	50	55	61
13 years	31	37	43	49	55	61	67
14 years	33	40	46	53	60	66	73
15 years	36	43	50	57	64	71	78
16 years	37	45	52	60	68	75	83
17 years	39	47	55	63	71	79	87
18 years	41	49	57	65	73	81	89
19 years	43	51	59	67	75	83	91
20 years	44	52	60	68	76	84	92

In interpreting the above norms it might be said that the subject who gets a score that is **high** would be about number sixteen from the top in a hundred unselected cases of that age arranged in the order of their mechanical ability. A **low** score would indicate that he would be about number sixteen from the bottom, and an **average** score would be in the middle.

A full description of this test will be found in the January, 1927, number of **The Journal of Personnel Research.**

DIRECTIONS

The usual rules for group test procedure, standard directions and standard conditions, apply in this case.

Ordinary school lead pencils, of medium hardness (No. 2) should be supplied. They should be sharpened on a pencil sharpener at both ends each time before using. (After the first sharpening they can be kept in proper condition very easily.) Other pencils should not be permitted.

A stop watch is desirable. The time can be taken from an ordinary watch which has a second hand, but a stop watch is easier to use, and more satisfactory.

Commands for starting and stopping should be given sharply and so all can hear. Where necessary, comments may be made at the end of practice tests for the benefit of those who start before the signal, or who do not stop promptly.

The examiner should pass quickly from each record test to the following practice test in order to interfere with attempts to add records after time is called. It is desirable, however, to take sufficient time on a practice test to be sure instructions are fully understood before going on to the record test.

Where large groups are being tested it is advisable to have one or more trained assistants in the room in order to assure standard procedure.

Where tests are given frequently, and to rather large groups, it is desirable for the examiner to have copies of the practice forms made on large sheets of cardboard to be hung up before the class. The instructor can then refer to them when giving directions.

GIVING THE TEST

(As soon as booklets and pencils are distributed.)

Fill in the blanks on the cover, but do not open the booklets.

(Allow about two minutes.)

This is a test to see what you can do with your hands and eyes. Use the pencils provided, as they are all the same. If a lead breaks, use the other end of your pencil, and go right on. You will have opportunity for practice before each test. Do your work as well as you can and as fast as you can. The signal will be READY, GO! and READY, STOP! Be sure to start and stop instantly.

Turn to Page 2. Fold your booklets back flat each time, like this. (Examiner illustrates.)

PAGE TWO

This is the practice test for TRACING.

Notice the little black triangle under the word START. You are to begin at the little triangle and draw a curved line through the small openings in the vertical lines without touching them. Draw first to the right and then back to the left in one continuous line. (Examiner should illustrate by holding up a test form, and showing how to do it.)

READY. Put pencils on the little triangles, GO!

(THIRTY SECONDS.)

READY, STOP. (Allow about two seconds between READY and STOP on all tests.)

Now look at your work to see if you have made any mistakes. You should be able to see clear space at every opening between your pencil line and the printed line.

Turn the booklet over to Page 3.

PAGE THREE

This is the real TRACING test. The instructions are the same.

READY, GO!

(FIFTY SECONDS.)

READY, STOP!

Turn to Page 4.

(The examiner should see that the booklets are folded back each time a page is turned.)

PAGE FOUR

This is the practice test for TAPPING. Here you are to put three pencil dots in each circle just as fast as you can. Start at the left of each line and work to the right, as you do in writing. Count to yourself as you tap, and very fast, 1, 2, 3 — 1, 2, 3, etc. Try to make just three dots each time, but do not stop to correct. Speed is of more importance than accuracy. You do not need to strike hard nor raise your pencils high. Be sure to start and stop instantly.

READY, GO!

(TEN SECONDS.)

READY, STOP!

Cross out any dots you made after the STOP signal.

(Do not permit further practice in tapping, as an element of fatigue will enter and spoil the test. In fact it is best to allow a moment for relaxation before going on.)

Turn to Page 5.

PAGE FIVE

This is the real test for TAPPING. The instructions are the same.

READY, GO!

(THIRTY SECONDS.)

READY, STOP!

Turn to Page 6.

PAGE SIX

This is the practice page for the DOTTING test.

Here you are to put one dot in each circle, as fast as you can. Follow the string. Dots must be clearly within the circles, and only one dot will be counted for any circle.

READY, GO!

(FIFTEEN SECONDS.)

READY, STOP!

Now see if you have made any mistakes. There should be just one dot in each circle, and it should not touch the circumference. (Be somewhat deliberate here.)

PAGE SEVEN

This is the real DOTTING test. Put one dot in each circle just as fast as you can.

READY, GO!

(THIRTY SECONDS.)

READY, STOP!

Turn to Page 8.

PAGE EIGHT

In this test you are to copy each of the figures in the dotted space to the right of it. The little circles show you where to begin. There is a dot for every corner. Your lines do not have to be straight, but they should begin and end on dots. Correct, if you wish, but do not waste time erasing.

(The examiner should illustrate, and may have to assist individuals with further explanations.)

READY, GO!

(TWENTY SECONDS.)

READY, STOP!

Check your work to see if you have copied the figures correctly.

(Some additional explanations may be necessary, but the examiner must guard against wasting time with the few who do not really understand.)

Turn to Page 9.

PAGE NINE

This is the real COPYING test. Work across the page in each row. (This is not vital, but helps somewhat in scoring.)

READY, GO!

(TWO AND ONE-HALF MINUTES.)

READY, STOP!

Turn to Page 10.

PAGE TEN

This is the LOCATION test. Notice the letters in the large square, and the five dots in each of the small squares below. For each dot in a small square, there is a letter in the same place in the large square. Put right on each dot the letter that stands in its place in the large square. For instance, the upper dot in the first small square is in the position of the letter K in the large square, so you will put a letter K on that dot.

READY, GO!

(THIRTY SECONDS.)

READY, STOP!

In the small square at the left you should have V. K, N, E, K. In the one at the right you should have U, E, M, O, C.

(Take a little time here for consideration of errors.)

Turn to Page 11.

PAGE ELEVEN

This is the real LOCATION test.

READY, GO!

(TWO MINUTES.)

READY, STOP!

Turn to Page 12.

PAGE TWELVE

Here is a pile of blocks, all the same size and shape. On five of the blocks, you will see X's. You are to find out how many blocks touch each block that has an X on it, and then mark the number right on the X. For example, the lowest block which has an X on it touches four other blocks. Please locate them now and place a 4 on the X. Put it there now, and you may have twenty seconds in which to number the other X's.

READY, GO!

(TWENTY SECONDS.)

READY, STOP!

You should have 2, 4, 4, 7, 4.

(Allow a moment for consideration.)

Turn to Page 13.

PAGE THIRTEEN

This is the record test for BLOCKS.

READY, GO!

(TWO AND ONE-HALF MINUTES.)

READY, STOP!

Turn to Page 14.

PAGE FOURTEEN

This is the PURSUIT test. Notice the numbers in the little squares at the left, where the curving lines begin. Follow each line by eye from the square where it begins at the left to the square where it ends at the right.

Remember the number at the beginning of the line, and put it in one of the small squares at the end. Do not be disturbed if two lines end in the same place, but just use both squares for your answers. Do not use your pencils to follow the lines if you can possibly help it. You will work much faster if you depend entirely upon your eyes.

READY, GO!

(FIFTY SECONDS.)

READY, STOP!

Your answers should read from top to bottom: 10, 3 and 8 together, 4, 2, 7, 5, 1, blank, 9, 6.

(Some further instructions may be necessary in individual cases.)

Turn to Page 15.

PAGE FIFTEEN

This is the real PURSUIT test.

Do not follow the lines with your pencils if you can help it.

READY, GO!

(TWO AND ON-HALF MINUTES.)

READY, STOP!

Close the booklets.

(Booklets and pencils should be collected promptly.)

SCORING THE TEST

Scoring for this test is very easy, and highly objective It is good practice to score at one time, the same page right through all of the pamphlets. When all of the forms have been checked, the results should be recorded in the blank spaces on the cover, and the final score determined

TRACING, PAGE THREE

This test has been placed first in the battery because the pencils are then in good condition.

Score is the number of openings through which the pencil line passes without touching. If to the scorer the line seems to touch as it passes through an opening, the attempt is counted an error. There is a total possible score of eighty, twenty openings in each row. One good method of scoring checks all the errors first, and then subtracts from the total attempted. If more than one attempt is made at an opening, credit is given for only one correct. Touching the printed line at a point other than an opening does not count an error. Short breaks in the pencil line are not noted, but if the total response is merely a series of dashes at the openings, no credit is given. Occasionally all of the tracing is done to the right. Full credit should be given in this case for openings properly passed.

TAPPING, PAGE FIVE

In such a test as this slight approximations may be made. The score is one-third of the number of dots, approximately the number of circles attempted. Since this test is an attempt to measure motility, all dots are counted even if they are not wholly within the circles, or even if some of them are entirely without the circles. The directions are merely for the purpose of spreading the dots so they can be counted. Occasionally more or less than three dots will be made in a circle, but usually they will contain just three. The scorer should glance over the page to see if most of the circles have the required three dots, and if that number appears to be in the great majority, the score is simply the number of circles attempted. If there is much variation the dots may be counted and divided by three, using the nearest whole number for the score.

DOTTING, PAGE SEVEN

The score in this test is one-third of the number of correct responses. This is not a test of motility, but rather of aiming, and no dot is counted unless it is clearly within the circle, and does not touch the circumference. If in doubt whether it touches or not, mark it wrong. It is best to check the errors first, and then subtract their number from the number attempted. Only one dot can be counted for any circle. Divide the total by three to get the score, using the nearest whole number.

COPYING, PAGE NINE

Score is the number of correct lines on the page. To be correct, a line must have proper length and direction

It is not penalized by previous incorrect lines, however. That is, it does not have to be in correct position with reference to the starting circle, but it should have proper length and direction and be intended evidently for a certain line in the figure. Lines should begin and end on dots, but slight discrepencies in this respect should be disregarded.

Scorer should take a general view of each figure, and if it is a correct copy, count 4 for it. Where some errors have been made, all correct lines should be counted and added to the total.

LOCATION, PAGE ELEVEN

Score is the number of dots correctly lettered. Beginning at the upper left, and following the string of small squares around to the upper right the answers are as follows, reading from the top down in each small square.
F J O C F, L P N B K, D H P A H, C G R V E,
K S Z C M, A H W Y G, B U D L H, E M T W J.

These letter answers may be written beside the proper squares on a used form, and then the squares may be cut out making a stencil that will aid much in scoring. Scores for each square may be marked right on the square and totaled later.

BLOCKS, PAGE THIRTEEN

Score is the number of blocks correctly marked. The strip printed below indicates the answers. Cut out the strip very close to the figures and paste it on a piece of cardboard, cutting the latter to fit. Then the strip may be placed between the upper and lower rows of blocks, and the answers will be in proper order for the X's to which they apply.

PURSUIT, PAGE FIFTEEN

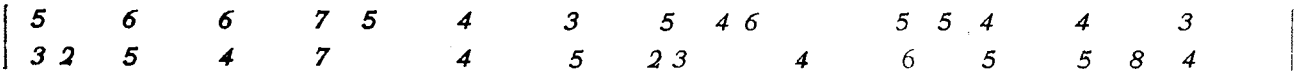
Score is number of squares correctly numbered. The answers are as follows:

Upper left: 9, 4, 5, 1, 10, 8, 6 & 7,—, 2, 3.
Lower left: 9, —, 3 & 10, 8, 7, 1, 4, 5, 2, 6.
Upper right: 3 & 7, 8, 10, 2, 4, 6, —, 1, 5, 9.
Lower right: —, 1, 3, 6, 5, 10. 8, 2 & 9, 4, 7.

Cut out a rectangle of cardboard or heavy paper three inches by four and a quarter. This card will fit in between the answer columns. Record the answers given above at the proper places, and scoring will be made easier. Answers may be recorded for each section and totaled later.

TOTAL SCORE

Record the form scores on the front cover of the booklet. The total score is the sum of the form scores divided by three, using the nearest whole number.



MACQUARRIE TEST FOR MECHANICAL ABILITY

Items: 1 - Tracing
2 - Tapping
3 - Dotting
4 - Copying
5 - Location
6 - Blocks
7 - Pursuit

Total: Sum of Items divided by 3.

Student	Total	Items							Strokes	I. Q.
		1	2	3	4	5	6	7		
1.	68	26	46	23	46	26	16	21	2027	101
2.	73	42	54	20	55	17	5	26	2511	102
3.	88	42	55	19	64	33	22	30	2620	104
4.	67	32	54	17	42	17	12	28	2393	118
5.	54	19	44	21	17	30	8	22	2410	100
6.	72	40	45	23	49	30	22	9	2011	100
7.	81	40	59	22	47	29	17	30	2042	102
8.	61	34	41	17	33	28	13	16	2100	107
9.	58	28	45	16	38	16	6	24	2603	106
10.	74	33	42	18	59	26	19	27	2125	103
11.	57	31	41	19	40	21	3	16	2150	100
12.	75	42	51	21	56	19	10	25	2215	108
13.	60	32	38	17	48	22	5	19	2031	89
14.	69	35	40	21	52	24	13	22	2055	122
15.	87	38	42	18	71	39	24	29	1746	109
16.	59	33	46	20	42	20	3	14	2209	77
17.	87	50	48	21	69	32	11	32	2347	94
18.	68	28	40	29	46	23	12	27	1965	110
19.	57	31	31	17	42	22	8	20	1714	106
20.	75	25	46	24	65	24	10	32	2260	105
21.	69	35	33	17	63	24	6	28	2088	101
22.	51	27	38	19	26	8	7	28	1969	91
23.	73	31	40	23	51	31	15	27	1943	102
24.	70	34	33	27	49	26	12	29	2030	86
25.	57	36	40	18	47	16	6	9	2275	84
26.	57	25	27	16	47	21	15	20	1927	94
27.	52	33	34	18	24	29	9	9	2092	95
28.	68	26	39	21	70	25	4	21	2128	77
29.	78	30	48	24	63	22	15	31	2316	109
30.	73	49	38	26	54	20	14	18	2284	115
31.	66	32	35	27	48	23	9	24	1877	91
32.	91	41	48	23	76	32	21	32	2164	115
33.	63	27	41	16	52	22	11	21	2022	111
34.	73	30	50	21	48	29	18	22	2107	111
35.	72	37	47	19	40	31	12	30	1825	98
36.	71	32	46	21	53	28	9	24	2543	104
37.	53	26	28	16	40	19	11	20	1606	123
38.	58	24	46	16	41	31	4	11	2139	105
39.	64	41	40	18	41	30	2	20	2140	109
40.	65	35	43	16	60	18	2	20	2137	101

Student	Total	Items							Strokes	I. Q.
		1	2	3	4	5	6	7		
41.	68	40	38	18	58	22	16	14	1927	93
42.	63	35	41	18	50	23	5	18	2292	125
43.	71	50	61	23	20	20	14	26	2040	110
44.	74	45	38	14	71	28	7	19	2054	121
45.	75	48	49	23	46	31	9	20	1970	101
46.	79	44	40	19	57	29	19	30	2052	100
47.	71	45	59	20	39	17	12	22	2151	101
48.	75	46	44	22	56	33	8	16	2972	110
49.	72	54	50	23	48	21	2	20	2590	106
50.	85	38	48	24	70	34	21	20	2906	117
51.	62	31	43	15	37	33	3	23	1795	101
52.	61	17	57	17	35	23	14	22	841	88
53.	61	20	64	17	38	14	12	20	2211	100
54.	62	24	70	16	28	17	16	16	1544	90
55.	66	36	70	21	36	18	10	9	2640	109
56.	66	67	11	27	24	26	9	35	2718	82
57.	68	27	60	19	47	17	15	19	2031	95
58.	73	31	69	16	59	12	12	22	2705	108
59.	71	23	60	18	65	26	4	18	2226	103
60.	71	33	70	21	30	21	9	29	2202	97
61.	76	30	70	19	54	23	14	18	2303	142
62.	78	32	63	20	47	24	19	29	2385	102
63.	81	44	70	29	42	25	7	28	2656	99
64.	86	43	70	20	53	30	10	33	2020	96
65.	91	44	70	21	73	26	9	31	2456	96
66.	93	35	66	23	72	39	16	30	2380	91
67.	70	38	40	19	56	18	15	24	1616	86
68.	77	46	47	22	72	7	10	29	3564	88
69.	74	33	57	23	37	26	14	33	1987	118
70.	76	61	49	23	52	14	9	20	2003	120
71.	54	35	38	17	26	16	10	21	2450	119
72.	73	48	45	22	40	35	5	23	2856	98
73.	81	46	46	25	56	35	8	26	2902	103
74.	71	50	35	14	59	19	16	20	1790	90
75.	75	54	34	20	54	31	10	23	2176	106
76.	94	64	52	25	64	33	17	28	2313	95
77.	65	36	40	22	52	23	4	18	2106	89
78.	55	37	41	15	32	16	3	21	2818	102
79.	79	49	37	20	65	22	13	30	1986	97
80.	71	40	53	24	36	24	16	20	1833	95
81.	54	27	31	18	42	13	12	19	1915	112
82.	62	34	37	19	40	18	13	27	2240	135
83.	85	38	50	23	60	40	17	28	2377	106
84.	63	37	39	18	40	19	14	22	1908	133
85.	68	45	38	21	54	16	14	16	1715	112
86.	90	45	39	23	68	35	23	37	1850	100
87.	87	49	41	23	62	38	16	32	1911	116
88.	79	43	46	21	66	21	16	24	2112	125

Student	Total	Items							Strokes	I. Q.
		1	2	3	4	5	6	7		
89.	61	29	36	19	35	28	14	22	1260	96
90.	88	80	47	24	53	18	11	30	2494	105
91.	78	33	43	21	57	34	16	30	2383	126
92.	84	43	48	19	59	29	23	32	1698	129
93.	63	21	55	21	28	20	21	23	2322	83
94.	77	55	37	21	64	13	19	22	2164	122
95.	64	31	39	14	46	25	12	26	2157	129
96.	74	41	43	26	60	10	9	32	2198	101
97.	71	52	41	11	55	29	8	18	2102	91
98.	75	41	60	23	47	6	23	25	2357	102
99.	80	48	48	29	45	23	18	31	1634	76
100.	65	39	47	14	33	23	16	22	2310	110
101.	88	48	53	17	62	40	13	32	3400	125
102.	84	68	70	19	38	28	5	25	1900	110
103.	58	39	39	11	37	21	9	18	1365	89
104.	61	36	42	15	28	27	18	18	1282	106
105.	64	46	40	18	33	27	13	15	1472	83
106.	91	69	59	20	52	39	11	24	2530	105
107.	67	43	40	14	53	27	2	24	2571	70
108.	64	50	34	14	49	22	11	13	1828	93
109.	101	49	60	21	75	37	26	37	1606	93
110.	82	56	60	17	68	25	5	17	1964	96
111.	61	44	35	15	36	7	18	28	1766	83
112.	72	33	40	18	66	29	11	18	1945	108
113.	69	53	38	22	43	26	11	15	1928	105
114.	55	34	38	19	34	19	8	12	3021	109
115.	46	12	35	18	28	18	10	19	2674	102
116.	73	42	39	21	53	28	14	22	2552	128
117.	89	70	55	26	44	40	15	18	2787	128
118.	84	62	50	27	39	32	12	29	3407	123
119.	77	41	53	24	45	30	7	30	1466	79
120.	57	33	42	18	26	25	6	21	1711	70
121.	42	7	43	15	21	15	11	13	1533	99
122.	58	31	29	17	60	10	15	13	1873	81
123.	69	34	30	19	48	31	15	30	2057	109
124.	43	30	28	17	24	11	11	8	1686	73
125.	62	34	30	19	40	26	17	21	2344	115
126.	47	28	25	14	32	18	11	14	2224	106
127.	83	57	62	23	31	39	11	25	2900	104
128.	67	39	46	19	36	22	14	26	2370	130
129.	49	22	55	13	18	24	1	13	2090	96
130.	75	47	62	21	22	27	21	26	2400	128
131.	70	22	59	22	30	27	21	29	2631	114
132.	45	27	42	k4	k2	k7	7	16	2111	126
133.	62	33	45	16	28	30	18	15	1200	96
134.	63	32	59	24	21	35	3	14	1968	109
135.	42	28	45	10	14	7	9	14	1919	107
136.	59	22	47	17	29	29	10	23	1719	95
137.	54	28	43	17	22	22	9	23	1702	100
138.	49	35	47	15	12	16	3	18	1902	106

Student	Total	Items							Strokes	I. Q.
		1	2	3	4	5	6	7		
139.	73	50	46	25	31	26	22	20	2591	80
140.	36	39	12	18	20	2	5	13	2158	96
141.	70	41	56	20	20	33	13	27	3154	114
142.	68	19	38	24	52	23	20	29	1892	103
143.	44	19	15	12	36	17	16	16	1283	92
144.	77	27	45	50	37	30	17	26	2401	101
145.	55	24	32	19	45	24	6	17	1944	91
146.	56	27	32	21	28	26	7	27	1827	112
147.	66	35	49	17	28	23	15	33	2416	137
148.	48	27	41	17	19	12	10	19	1786	80
149.	89	45	39	22	70	38	22	33	2207	134
150.	71	38	38	22	46	33	18	18	2002	113
151.	57	34	30	15	34	25	10	22	2077	110
153.	69	21	38	21	58	30	10	21	1998	109
153.	56	50	40	16	13	24	6	19	1892	86
154.	85	36	52	14	80	30	23	21	2448	98
155.	83	47	43	17	63	36	15	30	2414	126
156.	74	53	49	18	53	22	7	19	1867	107
157.	107	40	70	29	80	40	26	37	1551	90
158.	67	39	50	23	40	15	20	15	1900	120
159.	65	49	48	20	27	6	17	27	1560	100
160.	54	34	30	19	30	14	13	21	2537	119
161.	69	46	50	22	18	20	16	34	2089	100
162.	68	40	38	22	36	19	19	29	2245	127
163.	65	38	40	23	30	19	21	24	1732	102
164.	55	30	31	20	35	19	14	16	1964	130
165.	73	47	45	22	45	21	22	19	1174	98
166.	67	34	46	25	55	15	3	23	2859	102
167.	54	38	38	22	25	14	1	23	2520	103
168.	67	34	46	25	55	15	3	23	3335	108
169.	63	47	45	22	34	17	11	13	2056	122
170.	81	57	44	15	60	22	16	30	2458	120
171.	59	32	34	15	36	22	18	21	2176	123
172.	55	33	40	14	36	25	3	15	1814	82
173.	58	32	47	18	20	14	15	28	2901	108
174.	63	8	70	22	40	29	5	14	1933	104
175.	89	38	69	21	48	40	19	31	2880	115
176.	62	32	70	18	23	17	3	24	1376	86
177.	61	34	57	16	34	14	9	20	1982	96
178.	63	28	70	23	27	18	16	8	2041	75
179.	88	35	70	20	67	32	12	27	3283	128
180.	73	36	70	23	27	20	15	28	2284	93
181.	80	29	71	22	44	40	8	25	3713	102
182.	83	28	70	23	50	28	14	36	2147	91
183.	66	21	60	21	40	30	8	19	2840	89
184.	78	37	70	20	41	31	14	20	2814	100
185.	93	41	70	20	68	28	19	33	1749	97
186.	73	44	70	19	38	15	17	39	1713	116

Student	Total	Items							Strokes	I. Q.
		1	2	3	4	5	6	7		
187.	73	33	70	19	46	22	14	16	1672	113
188.	89	34	70	20	48	33	25	37	2004	122
189.	86	28	70	19	60	30	20	30	2196	110
190.	71	28	70	18	34	22	11	29	3002	105
191.	66	58	41	15	33	21	14	17	1977	111
192.	59	28	63	16	27	23	7	14	1604	128

Typist:

Florence Lackey

East of City