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Mental Tests of School Children

MENTAL TESTS OF
SCHOOL CHILDREN

by

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Introduction

The gradation and classification of pupils, the nature of the curriculum and methods of teaching, have long been vital questions for educators. The mental measuring rods for classification and promotion which have been universally applied are: (1) the amount assimilated of the knowledge specified in the school curriculum, and (2) the teacher's judgment of the child's ability. The need of a more scientific procedure has for some time been felt by those who are busy with these practical problems. The appalling number of repeaters in the grades, year after year, demands that these questions cease to be mere matters of opinion but be based upon accurate knowledge of mental abilities.

The desire to render some service to the great body of workers in the field of education and to prevent what is probably avoidable waste of the time of our boys and girls has led me to attempt furnishing some information upon this subject.

I am indebted (1) to the subjects to whom the tests were given and who thus made the data possible, (2) to the Superintendents and Principals, elsewhere mentioned, who assisted in giving the tests and grading the papers, and (3) to Dr. Wm. H. Pyle for guidance, inspiration and kindness.

Section I.

Studies in Mental Tests.

Historically, the idea of mental tests originated in the psychological laboratory, either in the developing of experimental psychology as a science or as a consequence of special attempts to study the correlations between mental and physical capacities.

As might be expected with such an origin, mental tests were first elaborated for the adult who had reached a stage of comparative mental equilibrium. The earliest investigations in this field were: (1) in Germany, ~~Bergström~~, Jost, Kraepelin and Ebbinghaus, (2) in France, Flourney and Binet, and (3) in America, Jastrow, Nevers and Calkins. As early as 1892 Kraepelin attempted to measure the mental capacities of a number of Heidelberg students. In 1894 Jastrow conducted a series of mental tests in association with more than a hundred Wisconsin University men and women. Miss Nevers in 1894 and Miss Calkins in 1896 conducted a similar series of tests with Wellesley women.

The desirability of a satisfactory mental scale for the grades has long been granted. Kirkpatrick, in 1900, in his "Individual Tests of School Children," calls attention to the great need of mental tests adapted to the grades. The first attempts to establish such age norms for the entire elementary school period were: (1) the very meager De Sancti tests, (2) the Binet-Simon series of 1905, and (3) the revised Binet-Simon series of 1908. That they have awakened wide interest in this country is manifest in their extensive use by men of renown and by the experimental work that has been based upon them. Dr. H. H. Goddard has used

them extensively in testing his patients in ^{the} ~~his~~ Training School for the Feeble Minded, at Vineland, New Jersey. J. E. W. Wallin, Clinical Psychologist to the New Jersey State Village for Epileptics, at Skillman, has found them valuable. Huey at the Illinois State Institution for Feeble Minded has likewise made wide use of them. We owe their use in our own country to Goddard, and we are indebted to Terman and Childs for their 1911 revision and adaptation to American conditions. Wallin and Huey are largely responsible for their dissemination through the publication of their experiences with them.*

These tests were, however, revised and disseminated in the interest of the subnormal child. The difficulty of the problem is greatly increased when one attempts to measure the capacity of the normal child at each stage of his development, chiefly because of the greater number of measurements that must be made in order to establish reliable norms. Wallin in his article "Mental Efficiency" states his belief that it is possible, however, to establish age norms of mental capacity with a fair degree of precision. "Just as native capacity differs with individuals," he says, "so will the capacity to acquire differ with individuals, but there is probably a certain rate of acquisition which is fairly normal in a given order of civilization, so that it is possible to establish norms which hold for the great mass of average or typical individuals." The establishment of such norms involves three correlated problems: (1) what tests to give, (2) their standardization, (3) the practical value of the norms thus established.

*"Backward and Feeble Minded Children." --Huey.

--Wallin. "The New Clinical Psychology and the Psycho-Clinicist."

A good mental test must satisfy the following conditions:

1. It must be simple and easily given, in order that it may not take too much time and trouble.
2. It must be readily understood by the pupil.
3. It must be easily graded--to be accurate.
4. It must be brief enough to be completed without causing undue fatigue.
5. It must require a minimum of apparatus, so as to render it practical in schools having no laboratory equipment for conducting mental tests.
6. Each test must, in a modified form, be applicable to all stages of development.
7. Each must test those aspects of mind which count most in mental efficiency.
8. Each must have a positive correlation with general intelligence, as measured by school standing.

The British investigators: Brown, Cyril Burt, Hart and Spearman have given valuable information as to which tests best satisfy these conditions. Cyril Burt of the University of Liverpool conducted an extensive series of "Experimental Tests of General Intelligence," which he reports in the British Journal of Psychology, 1909-10.

Subjects.--His subjects consisted of forty-three boys between the age limits of twelve years six months and thirteen years six months. Thirty of these were chosen from a superior elementary Oxford school and were of the lower middle class, sons of local tradesmen. Thirteen were chosen from a high class

Oxford preparatory school and were in nearly every case sons of men of eminence.

Tests.--The tests given these subjects were psycho-physical tasks. They might be classified into five groups: (1) Sensory tests, (2) Motor tests, (3) Association tests, (4) Sensori-Motor tests, (5) Voluntary Attention tests.

Results.--Of the twelve strictly mental tests given, six furnish coefficients above +.50. The most promising of these six were: (1) the Dotting test, devised specifically to test concentration of attention, (2) the Mirror test, intended to measure adaptability to acquire new coordinations or, in other words, learning power, (3) the Spot Pattern test, devised as a test of scope of apprehension, and (4) the Alphabet Sorting test of attention. Burt concludes that if called upon to recommend any one of these he would select the last, because of its high correlation and simplicity.

The following table shows the mental tests Burt used and their correlations with intelligence, as measured by school standing:

Test	Elementary School	Preparatory School
Alphabet Sorting	.68	.91
Dotting	.65	.84
Spot Pattern	.76	.75
Memory Concrete	.58	.84
" Abstract	.48	.78
Mirror	.67	.54
Nonsense Syllables	.43	.75
Card Sorting	.52	.56

Brown reports in the same Journal "Some Experimental

Results in the Correlation of Mental Abilities."

Subjects.--His subjects were as follows:

Group I. Sixty-six boys, between the ages of eleven and twelve years, of a London elementary school.

Group II. Thirty-nine girls of the same age and school.

Group III. Forty boys of the same age, from a London higher grade school.

Group IV. Fifty-six Training College or Normal School students. These were women of the same year and approximately the same age.

Group V. (1) Thirty-five University students (men).
(2) Twenty-three University students (women).

Tests.--The tests given these subjects were:

(1) Crossing out the letters "e" and "r" in a page of print.

(2) Crossing out the letters "a, n, o, s" in a page of print.

(3) Crossing out every letter in a page of print.

(4) Adding up single digits in groups of ten.

(5) Bisecting ten printed lines (80 mm. long) and putting in points of trisection in each of ten other lines (90 mm. long).

(6) Measurement of Müller-Lyer Illusion.

(7) Mechanical memory by means of nonsense syllables.

(8) Memory for poetry.

(9) The Vertical-Horizontal Illusion.

(10) The Ebbinghaus Combination Test.

Results.--The most reliable coefficients with children were obtained with tests 2, 3, 4 and 10 of the above list. Ebbinghaus himself found test 10 to improve very noticeably with age.

Bernard Hart and C. Spearman in their study of "General Ability, its Existence and Nature," found the tests giving the highest correlations between pairs of columns to be the following:

(1)	Mathematical Judgment vs. Controlled Association	+1
(2)	" " " Literary Interpretation	+1
(3)	" " " Selective Judgment	+ .98
(4)	Controlled Association with Literary interpretation	+.99
(5)	" " " Selective Judgment	+1
(6)	Literary Interpretation with " "	+1

The above data substantiate Spearman's theory of "General Ability." "All performances depend to a certain degree upon one and the same General Common Factor. Correlations are produced between all sorts of performances to the extent that the performances connected involve the use of this General Common Factor and such correlations between columns will be positive and very high." It is also seen from these data that the tests which give the highest correlations are:

(1)	Tests of attention.	(4)	Tests of memory.
(2)	" " learning	(5)	" " invention.
(3)	" " association.		

Most of the tests in the form given above are objectionable in that (1) they cannot be given to groups, and (2) they require too much apparatus. We therefore have chosen for the

purposes of this experiment, simpler group tests which measure the same aspects of mind. The following list, judging from the experiments that have been conducted, seems ~~to~~ most nearly ^{to} satisfy the conditions of good tests.

Logical Memory.

The most elaborate investigation of memory for connected trains of thought is that of Henderson, who administered a series of tests to over two hundred subjects, ranging from ten-year-old fifth-grade children to adults in the University. Binet, Henri, and Miss Sharp conducted tests of memory for sentences. Shaw made a study of the memory of school children. Wissler made memory tests with a number of Columbia freshmen. Terman made a study of the memory of bright and dull boys. Pyle has made quite extensive logical memory tests, both with school children and adults.

Results and Conclusions.--The Logical Memory test, Whipple's Marble Statue, is one of the best tests, as is indicated by (1) its high correlation with permanent retention, (2) its high correlation with other tests, and (3) its high correlation with school standing. Wissler found a correlation of $+0.19$ in eighty-six cases out of one hundred, with school standing in the lower grades, and a much closer correlation in higher grades. Pyle found a correlation of $+0.79$ with permanent retention and one of $+0.29$ with other tests.

Substitution.

Another valuable test is that of learning capacity.

Whipple's Substitution test. Whipple gave this test to a group of forty college students, and to a group of six dull and five bright, grammar school boys. Pyle gave it to one hundred forty-four children ranging in age from eight to eighteen years.

Results and Conclusions.--Whipple in comparing the dull and the bright group found a tendency toward correlation with intelligence. Pyle found a positive correlation with logical memory of $+.68$ and an average correlation with the sum total of all the other mental tests of $+.45$.

Association.

Association tests are another valuable group. The most extensive work with this group of tests has been done by Miss Norsworthy, in controlled association. Pyle also gave this test to the same group of one hundred forty-four public school children previously mentioned.

Results.-- Pyle found the highest correlation to be with attention, ^{*}i. e. $+.57$. The correlation with the sum total of all the other tests was $+.49$. Miss Norsworthy's results are summarized below.

Part-Wholes Test.										Number of persons 504.
Age	8	9	10	11	12	13	14	15	16	Adults
Norm	6.5	7.8	7.8	8.7	8.7	9.0	9.0	9.0	9.0	10.0
Genus-Species Test.										Number of persons 511.
Norm	5	5	7	9.2	9.2	9.3	9.3	9.5	9.5	10.0
Opposites Test.										Number of persons 605.
Norm	7.4	9.0	9.9	12.5	13.5	14	14.5	15	15.5	20.0

* The cancellation test

In every case the feeble minded children proved to be distinctly inferior to normal children. Only nine per cent of the feeble minded children reached the degree of efficiency attained by fifty per cent of the normal children.

Miss Squire found a correlation between the Opposites test and age as follows:

Age	6	7	8	9	10	11	12	13
Average No. words	8.5	13.1	16.1	17.6	17.1	19.3	19.5	19.4

Rote Memory Test.

This is one of the oldest and most used tests. It has, however, been used with little standardization of method.

Correlation and Mental Ability.--Conclusions as to the relation between memory capacity and general intelligence range from a flat denial of such relationship by Bolton and Ebbinghaus, to assertions of notable positive correlations. A considerable number of investigators, among whom are Binet, Bourdon, Burt, Pohlman, Smedley and Pyle, have found at least a fairly good degree of correlation.

The use of the Jastrow exposure apparatus or disc Tachistoscope is neither essential nor advisable in giving this test to school children, the better form being the list of concrete and abstract words.

Invention Test.

Miss Sharp used (1) the method of assigning three certain words to be incorporated into a sentence, and (2) the development of a theme, as tests of linguistic invention. Binet gave his

subjects partially written sentences to be completed, for linguistic invention, and puzzle problems for constructive invention. Whipple had the word building test suggested to him by the game of anagrams and by the advertisements in magazines in which a prize is offered to the person who can make the most words from a given word or series of letters. He gave the invention test in the form of building the largest number of words from the letters e, a, i, r, l, p, to a group of college students, thirty-two men, ninety-five women, and to fifty boys from the seventh and eighth grades.

Pyle gave the Whipple test to more than a hundred public school children. Still another form of invention test has been used, i.e., the Ebbinghaus Completion Method, devised by Ebbinghaus to measure the fatigue effects of a continuous five-hour session.

Conclusions.--The development of a theme proved unsatisfactory as a test of invention. Whipple found no correlation with his grammar school pupils between word building and class standing, but with his college students a correlation of $+0.13$. He found a correlation between word building and ink blots. Pyle found the correlation with all other tests to be $+0.43$. Terman found stupid boys generally inferior to bright ones in this test. Burt and Ebbinghaus both found the highest correlation with intelligence in the lower grades, in case of the completion test.

Imagination Test.

Ink blots were suggested as a test of visual imagination by Binet and Henri in 1895. Dearborn, in 1897, described results of the use of one hundred twenty blots in case of sixteen Harvard

students and professors and published suggestions for making a series of blots. Kirkpatrick tried the ink blot test with public school children of the eight elementary grades. Miss Sharp used them in a study of individual psychology upon graduate students in Cornell. These all gave the test from the qualitative method of procedure, the average number of names given to each blot being the grade. Dearborn estimated the average time for making a single association to a blot to be 10.3 seconds. Pyle, using this method, found a correlation of $+ .40$ with logical memory and of $+ .22$ with all the other tests.

The Cancellation Test.

This test originated with Bourdon, who used it with ten adults to measure discrimination. Many other investigators have used it to measure degree of attention. The various forms that have been used are: (1) cancellation, on a regulated pied page, of one letter and of four letters, (2) word cancelling, and (3) cancelling misspelled words.

Results and Conclusions.--Whipple found an inverse relation $-.40$ between speed and class standing. He found a direct correlation of $+ .39$ when four letters were cancelled between accuracy and class standing. When speed and accuracy are combined there is no correlation between cancellation of letters and class standing. Wissler found no correlation between the "A" test and school standing.

The second of the correlated problems, the standardization of the tests, is yet to be perfected. The most

valuable work that has been done toward their standardization is Whipple's "Manual of Mental and Physical Tests" and Pyle's manual, "Mental Examination of School Children." These manuals give detailed, definite information as to method of procedure in giving the tests, grading the material, and figuring the data.

The third of these related problems--the practical value of norms of mental efficiency, has recently received careful investigation by (1) Miss Clara Schmidt and Miss Carrie Ransom Squire of the Chicago Department of Child Study, and (2) Miss Martha Alder, Assistant Principal of Public Schools, New York City.

In these cases mental tests have been used as a factor in the grading and classification of pupils, determining methods of teaching, and to a considerable extent the nature of the curriculum. Miss Schmidt from her study, "Retardation Statistics of Three Chicago Schools," concludes that what teachers have been calling retardation is not retardation, properly speaking, but the result of a course of study unsuited to the powers of the children who pursue it. Miss Squire made a study of eight groups of ten children each, ages six to thirteen. These children were so selected that the chronological, physiological, pedagogical and psychological ages should correspond as closely as possible.

Results.--She found a decided parallelism between the experimental results and the mental development and school performances of the pupils. Since that time her plan of

classification has been to give the mental tests and group the pupils according to the results.

Miss Alder's experiment consisted in giving Dr. Goddard's 1911 revision of the Binet-Simon tests to, (a) seventy first-grade boys ready to begin second half year of school, and (b) the Binet group for ten-year-olds and three class tests to eighty-nine boys of grade four. The class tests used were: (1) Logical memory, (2) Terman's generalization from fables, and (3) the Courtis arithmetic tests. The thirty-five who passed the highest tests were placed in Class A, the remainder in Class B. The thirty-six of the eighty-nine boys who ranked highest were assigned to Class A and the others to the regular fourth-grade section.

Results.--Of the thirty-five first-grade children in Class A, five removed and of the remainder, eighteen completed the first half of the second year's work during their first school year. They gained six months during their first school year. In Class B regular first-grade work was carried on, with the result that there was much less necessity for group work in the class than is usual in first grade, while the approximate uniformity in the abilities of the pupils made the instruction better fitted to the individual needs. In Class A of the fourth-grade children, thirty-two of the thirty-five gained a half year. Class B advanced at a much more uniform rate than is customary.

General Conclusions.--1. The Binet tests form an excellent basis for the classification of young pupils.

2. Mental tests, combining both individual and

group tests, form an excellent basis for the classification of middle grade pupils.

3. The pupil is distinctly individualized.

4. The teacher is better able to interpret her work because she more thoroughly understands her material, and consequently the proper mode of procedure therewith.

5. School organization will have a more intelligent basis when Mental Tests are more generally used by those who classify pupils. The bright pupils will be grouped together, and in this way held up to maximum efficiency. A better adaptation of method will be possible and scientific teaching will be facilitated.

Upon my main problem, "The Establishment of Norms of Mental Efficiency for all Grades," little work has been done up to the present time. Goddard gave the Binet-Simon tests to two thousand children in a normal school. Miss Squire gave the work just reported.

Conclusions.--The Binet scale of tests up to and including the twelfth year of age are satisfactory but they are vulnerable at various points.

Some of the individual tests are out of place, either too high or too low in the scale.

The scale lacks in the establishment and employment of controlled and standardized conditions of testing so that the experimental procedure can be exactly repeated.

It needs to be extended so as to include more of the teens.

It does not measure the aspects of mind that are most vital in school success, i.e., memory, learning, attention, association, etc.

My problem, therefore, is to establish norms of mental efficiency for the different ages of school children using for the scale, tests, (1) that have been found to measure the things that are vital in school success, (2) that will, in a modified form, be usable in all grades and with all ages, and (3) that have a scientific, standardized method of procedure, such that the tests can at any time and in any school be repeated. I have, therefore, selected for the scale in this experiment the following tests:

Logical Memory -- "Whipple's Marble Statue."

Rote Memory -- The list of words on page 22.

Learning -- The Digit-symbol and Symbol-digit substitution test sheets, pages 29 and 30.

Association

(a) Controlled

(1) Genus-species, page 39.

(2) Part-wholes, page 39.

(3) Opposites, page 39.

(b) Uncontrolled or Free, page 37.

Attention -- The Cancellation test, page 45.

Imagination -- The Whipple Ink Blot test, page 44.

Invention -- The Word Building, page 34.

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Section II.

The historical review given in the preceding section indicates the nature, extent and results of experimental work in mental tests up to the present. The tests conducted in connection with the writing of this thesis were given in the following schools:

Three St. Louis ward schools:

- (1) Delmar, by Principal, Luther.

- (2) Ferguson, by Principal, Luther.
(3) Harrison, " " , Miller.

One Kansas City ward school, Mount Washington, by Principal, Ritter.

Rolf, Oklahoma, public schools, by Superintendent, Steed.

Shelbina, Mo., " " , by Dr. W. H. Pyle.

Albany, Mo., " " , by High School Principal, Thornton.

Bottineau, N. D., " " , by Superintendent, Cole.

University of Missouri, students in School of Education.

The individuals tested include both boys and girls in the above mentioned schools. The ages range from eight to eighteen years and the grades range from third grade through high school. The adults tested consisted of a class of summer school students in the School of Education, University of Missouri; sixty-five men and eighty-six women. The total number of school children included in the data is 2731, of which 1365 are girls and 1215 are boys. The tests given were those listed on page 16. The grading of the material, the figuring of the tables of norms and correlations, were done either by or under the supervision of the writer.

Logical Memory.

Object.--The object of the logical memory test is to determine the child's immediate memory for ideas. A pupil's standing in this test may be used to indicate his ability to remember the subject matter of school studies which deal with logical material.

Method.--The following instructions were given: "I shall read to you a story entitled, 'The Marble Statue.' I wish you to listen while I read. When I have finished reading, you may write down what you remember of the story. You need not use the exact words that I read unless you wish, but you may write it down in your own words; try to remember as much as possible and write down all you remember."

Grading the results.--There are sixty-seven ideas in the story. One credit was allowed for each idea adequately reproduced.

The Material. The Marble Statue. --Whipple.

A young / man / worked / years / , to carve / a white / marble / statue / of a beautiful / girl. / She grew prettier / day by day / . He began to love the statue / so well that / one day, / he said to it: / "I would give / everything / in the world / if you would be alive / and be my wife." / Just then / the clock struck / twelve, / and the cold / stone began to grow warm, / the cheeks red, / the hair brown, / the lips to move. / She stepped down, / and he had his wish. / They lived happily / together / for years, / and three / beautiful / children were born. / One day / he was very tired, / and grew / so angry, / without cause, / that he struck her. / She wept, / kissed / each child / and her husband, / stepped back / upon the pedestal, / and slowly / grew cold, / pale / and stiff, / closed her eyes, / and when the clock / struck / midnight, / she was a statue / of pure / white / marble / as she had been / years before, / and could not hear / the sobs / of her husband / and children.

Table I.

Norms.*

Boys.												
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.*
Number	102	148	142	149	156	163	129	89	60	45	32	65
Norm	24.3	28.7	30.0	32.9	35.1	36.8	36.1	36.5	34.4	34.6	36.9	38.3
Av.dev- iation	6.7	9.1	6.7	5.6	7.4	6.3	7.0	6.7	5.6	8.7	6.0	7.0
Girls.												
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.
Number	89	158	138	156	191	164	146	99	94	81	48	86
Norm	28.5	31.0	33.5	36.4	38.1	38.5	39.0	39.1	37.3	36.6	37.8	40.1
Av.Dev.	11.3	9.4	6.8	7.7	7.2	7.1	7.5	6.3	5.1	6.9	4.4	5.9

*In this and all the tables of mental norms that follow, "age" means the age at the last birthday. The averages would, therefore, be 8 1/2, 9 1/2, 10 1/2, etc.

Logical Memory Graph. In the graph of Logical Memory on the following page, and in all the graphs that follow, age is represented on the horizontal and standing in the tests on the vertical axis. The solid line indicates the standing of the boys, and the broken line that of the girls.

* Ad = adults

Logical Memory

Age

Adults.

Rote Memory.

Object.--The object of the rote memory test is to determine the immediate memory of the pupil for unrelated impressions. This is a test in verbal memory. A high relative standing in this test probably indicates ability in studies which demand simply verbal memory; i.e., spelling, dates, tables and similar material.

Material.--Two lists of words, concrete and abstract, with six groups in each list.

Concrete.

1. Street, ink, lamp.
2. Spoon, horse, chair, stone.
3. Ground, clock, boy, chalk, book.
4. Desk, milk, hand, card, floor, cat.
5. Ball, cup, glass, hat, fork, pole, cloud.
6. Coat, girl, house, salt, glove, watch, box, mat.

Abstract.

1. Time, game, scheme.
2. Grade, fact, work, thing.
3. Pluck, love, blame, fear, proof.
4. Space, force, pride, fright, joy, size.
5. Length, light, style, rate, cause, youth, hate.
6. Law, thought, plot, glee, life, call, price, strength.

Method.--The following instructions were given to the pupils: "I shall pronounce to you a number of words, one group at a time. There are three in the first group, but more in the others. As soon as I have pronounced a group of words, you may write them down. Try to write them in the same order in which they are given. If you cannot remember some words, leave their places vacant and write in the proper places the words you do remember."

The concrete words were given first. The first group

was pronounced and the children given time to write the words. Then the second group was pronounced, and so on till the six groups of concrete words were all pronounced. Then the abstract words were similarly given. The children were asked to prepare blanks as follows:

Concrete.	Abstract.
1	1
2	2
3	3
4	4
5	5
6	6

Grading.--The work was graded on both memory for the words and their positions. A word remembered counts one point, and its correct position one point. The word correctly remembered and in its correct position, therefore, counts two points. A perfect score is sixty-six points for the concrete list, and sixty-six points for the abstract list.

Table II.
Concrete Norms.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	34	58	64	55	60	35	35	25	14	7	5	64	
Norm	31.2	32.4	35.8	37.7	37.7	38.3	40.0	40.2	43.4	45.7	49.0	44.3	39.64
Av.Dev.	6.7	7.4	6.3	6.4	5.0	5.6	6.4	4.9	6.3	5.1	7.6	6.6	6.19
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	37	68	69	52	70	51	34	13	17	8	2	88	
Norm	32.9	32.7	39.6	37.7	38.7	40.4	44.2	42.0	42.5	40.5	52.0	47.6	40.9
Av.Dev.	7.1	6.2	5.2	5.2	6.1	5.4	7.0	7.0	4.8	4.6	2.0	7.7	5.69

Abstract Norms.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	34	58	63	55	60	60	35	25	14	7	5	62	
Norm	22.9	26.3	26.8	31.7	31.0	32.4	37.3	34.1	40.0	41.1	40.8	42.3	33.89
Av.Dev.	7.8	7.5	7.0	7.1	6.6	7.7	7.1	6.2	8.3	6.2	2.2	6.2	6.65
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	24	68	69	52	69	52	34	13	17	9	2	88	
Norm	20.5	24.0	31.0	31.8	34.0	36.0	39.0	37.8	41.0	37.0	49.0	39.8	35.07
Av.Dev.	7.8	5.8	6.1	7.1	7.5	4.0	8.4	7.3	5.2	7.3	4.0	6.1	6.38

Note Memory - Concrete

Rate Memory - Abstract

The Substitution Test.

Object.--The substitution test is a test of quickness of learning. It determines the speed with which a person can build up new associations.

Material.--The material used for this test was the Whipple digit-symbol and symbol-digit test sheets.

Method.--The pupils were provided with a copy each of the above named sheets. The symbol-digit sheet was given first. The sheets were placed face down on the desks as they were distributed. The following instructions were given: "On the top of the sheets before you are some circles in which are written the nine digits and nine symbols, one for each digit. These symbols are to be written in the blank squares below for the digits to which they correspond.* Turn the sheets over and start when I say 'Begin.' Stop immediately when the signal to stop is given, and at once turn the papers face down.* If you should get all the squares filled before I tell you to stop, signal me the instant you have finished, by raising your hand. Work as fast as you can and try to fill in as many of the squares as possible, without making mistakes."

In the symbol-digit test, say: "This is exactly like the preceding test, except that the key is changed and this time you are to fill in the blank squares with digits which correspond to the symbols. Eight minutes were allowed in all grades below the fourth. Five minutes in grade five and above."

*(Illustrate on the board.)

Method of Grading.--Each square correctly filled counted one point. The speed per minute was determined by dividing the number of squares correctly filled by the number of minutes spent in filling them.

84,976						27,516					
79,821						33,821					
63,442						97,473					
21,629						62,978					
57,183						31,542					
32,761						17,143					
95,146						26,981					
28,349						35,724					
73,862						16,315					
91,563						14,923					
37,628						34,762					
42,916						28,543					
23,729						83,936					
85,652						75,314					
35,486						56,283					
29,635						19,175					
72,518						36,293					
24,631						85,746					
19,852						15,283					
76,431						24,976					

Name _____ Date _____

Sex _____ Age _____ Grade _____

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/ √ ÷ [>					
] < □ / *					
√ □ / [÷					
□] √ * >					
√ [□ / ÷					
< * √ [<					
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Name Date

Sex Age Grade

Table III.

Norms.

Digit-Symbol Test.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	34	58	50	49	56	62	48	35	31	14	17	67	
Norm	10.3	12.6	15.4	16.3	19.1	22.6	21.1	24.7	24.8	23.8	28.7	29.3	20.7
Av.Dev.	3.5	4.1	3.9	3.6	5.1	5.8	4.5	4.6	5.4	4.3	3.5	8.7	4.7
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	37	61	58	49	68	49	46	34	46	38	29	88	
Norm	13.0	15.7	18.8	18.5	22.7	23.4	26.8	26.8	27.5	28.5	25.9	32.2	24.1
Av.Dev.	3.2	4.1	4.4	4.1	4.9	5.2	5.0	4.7	5.3	5.7	7.0	4.2	4.8

Symbol-Digit Test.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	37	72	76	62	75	78	59	45	38	20	17	56	
Norm	10.0	13.2	16.5	17.7	19.3	20.7	23.3	25.8	27.8	26.1	28.0	33.0	21.78
Av.Dev.	5.3	5.0	5.8	5.4	5.4	5.7	5.4	5.9	6.3	7.4	5.1	9.3	6.00
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	41	82	82	63	89	66	62	44	55	43	29	89	
Norm	10.9	16.0	19.9	19.6	23.1	25.6	27.4	29.7	29.1	32.0	33.1	31.3	24.80
Av.Dev.	5.3	5.2	6.4	6.3	6.6	6.4	6.1	6.7	5.3	6.3	4.4	5.4	5.86

Graphs.--The following graphs represent learning capacity as determined by the two substitution tests. The lines represent the improvement in learning capacity with age in girls and boys, respectively.

Substitution - Digit-symbol

Substitution - Symbol-digit

Invention or the Word-Building Test.

Object.--This test determines the pupil's ingenuity in constructing words, using certain prescribed letters. The ability tested is a type of inventiveness and perhaps involves memory, attention association and ideational type.

Method.--Give the following instructions: "I am going to write on the board a group of letters. I wish you to see how many words you can make in five minutes by using only the letters which I give you. The words must be good English words. You must use only the letters which I give you, and do not use the same letter more than once in the same word. You do not have to use all the letters in each word. A word may contain only a part of the letters. As soon as I have written the letters on the board you may begin and work as rapidly as you can for five minutes. Stop immediately when I tell you." I gave the a, e, o, b, m, t group of letters first, following with the e, a, i, r, l, p group.

Method of Grading.--The grade is the number of words that do not violate the rules of the test.

(35)

Table IV.

Invention.-- a, e, i, r, l, p.

Boys.												
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.
Number	18	45	48	51	55	62	46	30	29	21	20	22
Norm	6.5	7.3	9.4	11.0	11.0	12.4	11.8	16.0	16.4	18.9	14.3	22.7
Av.Dev.	3.9	3.6	3.1	3.8	4.1	4.9	4.3	4.4	3.6	3.0	4.1	3.2
Girls.												
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.
Number	17	53	66	52	66	41	51	36	50	37	29	38
Norm	6.7	8.4	10.4	12.2	14.2	15.8	16.0	17.1	16.5	16.4	19.6	22.0
Av.Dev.	4.0	4.5	4.1	4.0	5.4	5.3	5.8	3.4	4.9	5.3	3.7	3.6

Invention.-- a, e, o, b, m, t.

Boys.												
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.
Number	17	44	46	51	51	60	45	28	29	17	18	64
Norm	6.6	7.3	9.1	10.4	10.0	11.3	12.5	15.8	14.1	16.6	16.0	18.6
Av.Dev.	4.0	3.5	3.0	2.8	3.3	4.7	4.4	3.5	3.1	3.7	3.7	3.7
Girls.												
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.
Number	17	51	67	53	68	47	45	35	49	36	29	86
Norm	7.1	8.0	10.5	11.5	13.2	15.5	13.7	15.0	13.5	13.9	18.8	21.1
Av.Dev.	2.2	3.7	3.7	3.5	4.1	4.2	4.4	3.1	4.6	4.9	4.4	2.7

Invention - Word Building *Adults.*

The Association Tests.

Object.--The object of the association tests is to determine the quickness of the association processes.

Uncontrolled or Free Association.

Method.--The pupil was started with the word "play," and told to write as fast as possible the other words that came into mind. The pupils were given the following instructions: "I wish to see how many words you can think of and write down in three minutes. I shall name a word, you may write it down and then write all the other words that come to your mind. Work as fast as you can."

Controlled Association.

1. The Opposites Test.

The pupils were each provided with a printed slip containing twenty words. These test slips were placed face down on the pupils' desks and the following instructions were given: "You have on these slips of paper twenty words. I wish you to write after each word a word of opposite meaning. For example, if one of the words on the slip were 'far,' you would write in the blank by it, as its opposite, the word 'near.'" At the signal the stop watch was started and sixty seconds were allowed in grades three and four, forty-five seconds in grades above four. This latter time is found to be too long for adults.

2. The Genus-Species Test.

The method of giving this test is the same as for the Opposites test. The instructions were as follows: "You have on your desks a slip containing twenty words. These words are class names. I wish you to write after each word an example or species under the class. For example, if one of the words were 'food,' you could write 'bread' as an example of food; or if one were 'fuel,' you could write 'coal.'"

3. The Part-Whole Test.

The general procedure for this test is the same as for the two preceding tests. The instructions were: "The slip before you contains twenty words, each of which names the whole of something. I wish you to write after each word a word which names a part of the thing. For example, if one word were 'house,' you could write 'roof;' or if one were 'foot,' you could write 'toe.'" Sixty seconds were allowed in grades three and four, forty-five seconds in grades above the fourth.

Method of Grading.--In the free or uncontrolled association the grade was the number of words written. In the Opposites test the grade was the number of words correctly written. Credit was allowed for the opposite of the word in any of its meanings, in cases where the word had more than one meaning. In the table of norms the grades are reduced to speed per minute.

In the Genus-Species test, one point was allowed for each word correctly written. A word was considered correct if it really named a species under the genus named by the word in the list. The norm table shows speed per minute.

In the Part-Whole test the method of grading was exactly as in the preceding test.

Materials.--The following lists of words were given in each of the controlled association tests:

I. Opposites Test.	II. Genus-Species Test.	III. Part-Whole Test.
1. best	1. mountain	1. window
2. weary	2. city	2. leaf
3. cloudy	3. weed	3. pillow
4. patient	4. metal	4. button
5. careful	5. furniture	5. nose
6. stale	6. machine	6. smokestack...
7. tender	7. author	7. cogwheel
8. ignorant	8. planet	8. cover
9. doubtful	9. river	9. letter
10. serious	10. book	10. petal
11. reckless	11. ocean	11. page
12. join	12. fruit	12. cob
13. advance	13. county	13. axle
14. honest	14. animal	14. lever
15. gay	15. bird	15. blade
16. forget	16. food	16. sail
17. calm	17. lake	17. coach
18. rare	18. tool	18. cylinder
19. dim	19. fish	19. beak
20. difficult	20. money	20. stamen

I and II are adapted from Woodworth and Wells.

Table V.

Norms.--Free Association.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	33	60	66	66	77	80	57	38	36	16	21	64	
Norm	23.0	26.9	29.7	33.3	34.2	33.9	33.3	40.0	33.3	42.8	48.9	42.2	35.1
Av.Dev.	7.5	7.6	9.0	11.4	10.9	14.6	13.2	14.8	14.6	12.3	16.6	13.8	11.6
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	37	82	88	65	90	66	61	46	46	38	29	86	
Norm	23.7	31.0	32.2	36.8	36.6	38.3	39.1	40.2	40.9	41.6	47.1	38.3	37.15
Av.Dev.	8.2	8.9	10.8	12.1	15.4	16.8	12.9	13.8	14.1	14.0	13.9	13.1	12.8

Table VI.

Norms.--Opposites Test.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	33	65	60	61	72	65	61	40	33	17	22	62	
Norm	9.0	8.4	7.5	10.9	11.5	14.5	14.5	16.0	18.6	19.6	22.4	22.1	14.58
Av.Dev.	3.3	3.0	3.1	2.9	2.9	4.5	4.3	5.2	5.3	3.3	3.2	3.3	3.69
Girls													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	33	56	77	65	74	73	58	49	48	27	26	85	
Norm	8.0	7.6	10.9	11.2	13.9	14.9	17.4	17.3	19.3	31.4	23.4	23.4	16.5
Av.Dev.	4.0	2.9	3.1	3.0	3.6	4.3	3.9	5.1	4.2	4.9	3.1	4.1	3.8

Table VII.

Norms.--Genus-Species Test.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	29	67	66	62	69	68	64	41	33	18	16	65	
Norm	4.6	5.7	6.5	7.2	7.1	10.0	10.5	11.1	15.2	14.0	17.3	15.1	10.35
Av. Dev.	3.4	3.4	3.7	3.3	2.5	3.8	3.8	5.4	4.3	4.1	6.0	4.0	3.97
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	34	65	84	63	81	64	55	40	45	32	25	86	
Norm	5.5	5.4	7.8	9.2	9.3	9.5	11.8	14.0	16.4	16.0	18.3	15.5	11.47
Av. Dev.	3.6	2.5	3.2	3.7	2.9	3.2	3.2	4.2	5.4	4.9	5.3	3.8	3.82

Table VIII.

Norms.--Part-Whole Test.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	31	67	70	65	76	77	62	42	35	12	23	66	
Norm	5.5	6.5	7.3	8.9	8.91	1.11	2.2	14.8	15.9	15.8	19.3	18.5	12.05
Av. Dev.	3.6	2.9	2.5	2.8	3.4	4.3	4.1	5.5	5.3	4.0	5.6	3.6	3.96
Girls													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	43	64	88	67	87	71	63	48	51	38	28	87	
Norm	4.6	5.9	7.8	10.0	10.0	10.8	12.5	14.0	16.9	16.2	19.7	19.7	12.34
Av. Dev.	2.6	2.4	2.9	3.5	3.7	3.5	3.2	4.5	4.5	4.8	4.6	3.4	3.63

Uncontrolled Association

Controlled Association

32

28

24

20

16

12

8

4

0

*Adults.**Age.*

18

17

16

15

14

13

12

11

10

9

8

The Imagination or Ink Blot Test.

Object.--As stated in the historical survey, this test has been called a test of imagination. It is a test of an aspect of imagination, but seems also to test much the same sort of ability as do the association tests. That is, it tests the quickness of the association processes. The child has placed before him an ink blot; the time required for this blot to suggest anything is measured.

Method.--The ink blots were distributed, one set to each pupil, and placed face up upon the desk so that the number on the card was turned toward the pupil. The top card was kept covered by a piece of paper. The instructions were as follows: "You have before you twenty cards, each of which has on it an ink blot. When I give the signal to begin, you are to remove the paper on top and write down as quickly as possible what the blot suggests, and then proceed to the next as fast as you can, until the time is up. If you come to a blot that suggests nothing to you, do not spend all of your time on it, but proceed to the next. The blots are not really meant to look like anything in particular, but they will suggest things. Keep the cards in such a position that the number on each is turned towards you and do not turn them around into other positions." Three minutes are allowed for the test.

Method of Grading.--The grade is the number of blots for which names of objects were written. There is no limitation put upon the pupil. Whatever the blot suggests to the pupil is counted.

Table IX.
Imagination Norms.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	5	11	11	11	8	13	4					65	
Norm	11.8	8.8	7.7	6.4	9.1	9.0	6.7					10.6	8.8
Av.Dev.	5.7	3.0	2.3	4.9	4.6	4.7	2.2					3.1	3.8
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	6	16	16	18	15	17						86	
Norm	12.0	9.8	7.8	6.6	6.8	10.3						9.8	7.9
Av.Dev.	3.3	3.5	2.6	3.6	4.3	2.1						3.6	2.9

Note.--Owing to there having been a different method used from that indicated above, in giving this test, our data for norms under this method are inadequate. However, the table given may serve as some indication of the probable norm.

The Cancellation Test.

Object.--This is a test of quickness of perception and discrimination.

Material.--For this test, printed sheets of letters containing ten alphabets with letters promiscuously arranged were used.

Method.--The sheets were distributed and the pupils allowed to look at them. They were then turned face down upon the desks and the following instructions given: "You have before you a sheet printed, as you have seen, with all of the letters of the alphabet in indefinite order. You are to take your pencil and cancel all the a's you can in the time allowed. Do this by making a small vertical stroke through every "a." Work as fast as you can. Omit no a's, but do not cancel any other letter."

Two minutes were allowed in grades below the fifth; ninety seconds in grade five and above.

Method of Grading.--The grade is the number of a's marked per minute.

Table X.

Norms.--Cancellation Test.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	57	83	80	75	77	67	52	38	29	15	21	63	
Norm	7.8	9.2	10.4	11.4	13.8	13.2	16.9	15.2	17.5	(17.6)	21.5	22.2	14.72
Av.Dev.	2.3	2.3	2.8	3.0	3.8	2.8	4.1	3.7	3.8	14.7	4.5	4.4	3.51
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Number	53	89	80	68	85	60	57	49	46	42	28	87	
Norm	8.2	10.6	11.4	13.3	14.5	16.4	17.8	18.9	20.4	21.5	22.5	23.0	17.37
Av.Dev.	2.3	3.0	3.2	3.4	3.4	3.6	4.1	4.2	4.5	4.9	3.6	4.1	3.69

Cancellation

Age.

Adults.

28
24
20
16
12
8
4
0

8 9 10 11 12 13 14 15 16 17 18

In the following table the data from all the tests except imagination (on account of inadequate norms) are brought together. That each test might have comparable value with every other in the averages, the original figures were modified as follows: To obtain the grades in substitution, three-fourths of the sum of the results of the two tests is taken. In logical memory, the data are the same as in original tables. In rote memory the concrete and abstract grades are added together and the sum divided by two. The cancellation grades are doubled. The three grades in controlled association are added together. The two grades in invention are added. The averages in the horizontal columns make it possible to compare the sexes for any age in all the tests combined. The averages in the last vertical column make it possible to compare the sexes in any test, all ages combined.

Graphs.--The graphs of Mental Growth, plotted from the data found in Table XI, show the improvement in the various tests combined; except imagination.

Table XI.

Boys.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Substitution	15	20	24	25	29	32	36	38	39	37	42	47	31.8
Logical Memory	24	29	30	33	35	37	36	36	34	35	37	38	33.7
Rote "	27	29	31	35	34	35	39	37	37	38	45	43	36.7
Cancellation	16	18	20	23	28	26	34	30	35	35	43	44	29.4
Free Association	23	27	30	33	34	34	33	40	33	43	49	42	35.1
Controlled Association	19	21	21	27	27	36	37	42	50	49	59	56	36.9
Invention	15	15	18	21	21	24	24	32	28	35	30	40	25.5
Averages	19.8	22.7	24.8	28.1	29.7	32.0	34.1	36.4	36.5	38.8	43.5	44.3	
Girls.													
Age	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
Substitution	18	24	29	29	34	36	41	42	42	45	44	48	42.8
Logical Memory	28	31	33	36	38	38	39	39	37	37	38	40	37.1
Rote "	27	28	35	35	36	38	41	40	42	39	45	44	37.9
Cancellation	16	21	23	27	29	33	36	38	41	43	45	46	34.7
Free Association	24	31	32	37	37	38	39	40	41	42	47	38	37.1
Controlled Association	18	19	26	29	33	35	42	45	53	54	61	59	40.1
Invention	15	16	21	24	27	31	30	32	30	30	38	43	28.1
Averages	20.8	24.3	28.4	31.0	33.4	35.5	38.3	39.4	40.8	42.8	45.4	45.4	

Mental Growth

Age.

Adults

Correlations.

After giving the mental tests, we wish to know what relation exists between them, what mental functions have most in common, and what indication each test is of general intelligence. The Pearson formula was used in computing correlations to determine these relations.

The Pearson Formula.

$$r = \frac{\sum X Y}{N O_1 O_2}$$

r = correlation.

$\sum X Y$ = the sum of

X = the individual deviations in one test;

Y = the individual deviations in the other test.

N = the number of persons tested.

O_1 = the standard deviation in one test.

O_2 = " " " " the other test.

The individual deviation is the difference between the standing of each individual in a particular test and the average standing of all the individuals in that test. The standard deviation is found by multiplying the average deviation by 1.2533. The correlations computed by this formula enable us, (1) to compare the relative standing of each pupil in one test with his standing in another test, (2) to take account of how far each pupil varies from the average of the group in one test and compare this with his variation in another test, and (3) to give an exact quantitative statement which takes account of all the individual variations.

The following table shows the raw correlations for adults of each test with every other:

Table XII.

	Cancel- lation.	Substi- tution.	Inven- tion.	Ink Blots.	Associ- ation.	Logical Memory.	Rote Memory.
Cancellation	X	.02	.07	.16	.02	-.27	.00
Substitution	.02	X	.13	.24	.23	.37	.15
Invention	.07	.13	X	.25	.16	-.22	.25
Ink Blots	.16	.24	.25	X	.49	-.01	.12
Association	.02	.23	.16	.49	X	.03	-.05
Logical Memory	-.27	.37	-.22	-.01	.03	X	-.07
Rote "	.00	.15	.25	.12	-.05	-.07	X

Some of the correlations within the same test are as follows: Substitution .70; logical memory .44; ink blots .42; invention .91.

The following pure correlations have been computed:

Substitution with

- (1. Logical memory = .63.
- (2. Ink blots = .21.
- (3. Invention = .35.
- (4. Cancellation = .28.

The following tables show the correlation of each group of tests with every other for the grades:--

Table XIII.
Logical Memory.

Grade	Atten- tion	Associ- ation	Word Build- ing	Learn- ing	Imag- ination	Logical Memory	Rote Memory	Average
3	-.116	.476	.224	-.026	.158	x	.244	.193
4	-.066	.163	-.096	.091	-.121	x	.303	.13
5	.135	.24	.059	.142	-.093	x	.082	.077
6	.332	.170	.289	.20	-.315	x	.57	.208
7	.21	.455	.017	.439	.049	x	.213	.16
8	.29	.40	.197	.415	-.48	x	.392	.202
Av.	.130	.314	.131	.214	-.134	x	.23	
H.S.	.09	.40	.365	.52	.14	x	.0	

Table XIV.
Rote Memory.

Grade	Atten- tion	Associa- tion	Word Build- ing	Learn- ing	Imagin- ation	Logical Memory	Rote Memory	Average
3	-.152	.315	.156	.212	.127	.244	x	.150
4	-.325	.128	-.176	.048	.175	.303	x	.025
5	.152	.468	.250	.135	.165	.082	x	.209
6	.221	.004	.013	.458	-.154	.570	x	.185
7	.092	.220	.00	.094	.215	-.213	x	.068
8	-.041	.130	.286	.524	-.635	.392	x	.109
Av.	-.009	.211	.229	.245	.018	.23	x	
H.S.	.33	.54	.40	.24	.29	.0	x	.30

Table XV.
Word Building.

Grade	Atten- tion	Associ- ation	Word Build- ing	Learn- ing	Imagin- ation	Logical Memory	Rote Memory	Average
3	-.024	.25	x	-.13	.097	.224	.156	.095
4	.24	.13	x	-.038	.224	-.096	-.176	.047
5	-.102	.309	x	-.01	-.046	.111	.250	.087
6	.331	.368	x	.111	-.078	-.016	.013	.138
7	.131	.403	x	.145	.405	.017	.00	.183
8	.35	.064	x	.025	.370	.197	.286	.215
Av.	.156	.254	x	.017	.162	.073	.229	
H.S.	.51	.78	x	.562	.33	.365	.40	.49

Table XVI.
Attention.

Grade	Atten- tion	Associ- ation	Logical Memory	Rote Memory	Word Build- ing	Learn- ing	Imagin- ation	Average
3	x	-.018	-.116	-.152	-.024	.256	-.129	-.03
4	x	.336	-.066	-.325	.24	.296	.295	.13
5	x	.073	.135	.152	-.102	.346	.310	.15
6	x	.242	.332	.221	.331	.378	-.113	.231
7	x	.185	.21	.092	.131	.463	.301	.23
8	x	.381	.29	-.041	.35	.433	.128	.257
Av.	x	.199	.130	-.009	.154	.362	.132	
H.S.	x	.42	.09	.33	.51	.46	.32	.355

Table XVII.
Association.

Grade	Atten- tion	Associ- ation	Logical Memory	Rote Memory	Word Build- ing	Learn- ing	Imagin- ation	Average
3	-.018	x	.476	.315	.25	.359	.162	.257
4	.336	x	.163	.128	.13	.336	.333	.237
5	.073	x	.24	.468	.309	.058	.000	.191
6	.242	x	.170	.004	.368	.282	.25	.219
7	.185	x	.455	.220	.403	.441	.529	.372
8	.381	x	.40	.130	.064	.305	.343	.270
Av.	.199	x	.314	.211	.254	.297	.269	
H.S.	.42	x	.40	.54	.78	.562	.33	.505

Table XVIII.
Learning.

Grade	Atten- tion	Associ- ation	Logical Memory	Rote Memory	Word Build- ing	Learn- ing	Imagin- ation	Average
3	.256	.359	-.026	.212	-.13	x	-.016	.109
4	.296	.336	.091	.048	-.038	x	.160	.155
5	.346	.058	.142	.135	-.01	x	.20	.130
6	.378	.282	.20	.458	.111	x	.098	.254
7	.463	.441	.439	.094	.145	x	.123	.284
8	.433	.305	.415	.524	.025	x	.215	.319
Av.	.362	.297	.214	.245	.017	x	.130	
H.S.	.46	.562	.52	.24	.562	x	.10	.407

Table XIX.
Imagination.

Grade	Atten- tion	Associ- ation	Logical Memory	Rote Memory	Word Build- ing	Learn- ing	Imagin- ation	Average
3	-.129	.162	.158	.127	.097	-.016	x	.066
4	.295	.333	-.121	.175	.224	.160	x	.178
5	.310	.0	-.093	.165	-.046	.20	x	.089
6	-.113	.25	-.315	-.154	-.078	.098	x	-.052
7	.301	.529	.049	.215	.405	.123	x	.270
8	.128	.343	-.48	-.635	.370	.215	x	.007
Av.	.132	.269	-.134	-.018	.162	.130	x	
H.S.	.32	.33	.14	.29	.33	.10	x	.25

More important, perhaps, than the interrelations of the tests themselves is their relation to general intelligence. A good criterion of general intelligence is the school grades for the year, providing they are determined in a careful manner. The following table shows the correlation of the various tests given with school standing, in the different grades. It will be noticed the rote memory is not included in this tabulation, due to this particular

test not having been given in the schools which furnished the school grades. The figures for adults given in the table are the average of all the test with school standing, of fifty-three students in the School of Education, Missouri University.

Table XX.

Test	G r a d e s						High School				Adult	Aver- age
	3	4	5	6	7	8	1st year	2nd year	3rd year	4th year		
Atten- tion	.03	.183	-.133	-.10	.00	.43	.046	.422	.224	.379		.139
Associ- ation	.682	.44	.436	.222	.647	.69	.44	.47	.334	.29		.465
Learning	.121	.39	.074	.0	.22	.645	.483	.393	.412	.17		.291
Imagin- ation	.10	.248	-.124	-.221	.251	.103	.16	.252	-.493	-.198		.018
Word- Build- ing	.18	.276	.085	.074	.46	.163	.274	.212	.017	.207		.195
Logical Memory	.497	.38	.087	.379	.372	.467	.368	.602	.474	.454		.408
Average	.27	.319	.071	.059	.325	.416	.295	.393	.159	.217	.81	

Summary and Conclusions.

1. The work done proves that it is possible to establish norms of mental efficiency for all of the grades.

2. The tables in the preceding pages show that the mental functions having the most in common are association, logical memory, learning, ~~attention~~, word building and rote memory. The number of pupils given the ink-blot imagination test by the method herein described was not sufficient to draw any definite conclusions as to the value of this test.

3. The correlations with school standing, while not very high, are sufficient to indicate a direct positive relation with general intelligence for every test. Those having the highest coefficients with school standing are association, logical memory and learning.

4. The tables of norms and graphs show that the performances in mental tests improve gradually with age. In ~~almost~~ ^{or rise abnormally} cases where the curves fall, there were fewer pupils of that age in these particular schools, hence a smaller number of individuals were tested. This fact, no doubt, in part accounts for the fall. The physical condition of the pupils at these particular ages is another factor in the fall. Again, the fall at the end of the curves at the age of eighteen is influenced by the fact that most of the brighter pupils--those likely to do well in the tests--are out of high school by this age and only the slower ones left.

The norms established represent with considerable accuracy the average performances of all normal children in these

tests. The tests were in ^{all}most all cases carefully given, the number tested was sufficiently large from which to get an average and draw conclusions; the papers were graded with care and the correlations accurately ^{computed}figured. Most of the grading and ^{computations}figuring was done by the writer and one assistant, thus eliminating liability for errors. .

6. The ^{relation}~~coefficients~~ between the mental functions and ~~their relation to~~ general intelligence as measured by school standing are sufficient to justify their consideration in the classification of pupils and methods of teaching.

7. Much of the time of the school children might be saved and much useless effort eliminated by giving these tests and comparing each child's standing with these norms.

May 8, 1915.

Dr. Max F. Meyer,
4th Floor.

Dear Dr. Meyer:

It is customary for the Graduate Committee to refer dissertations, submitted by candidates for the degree of Master of Arts, to some member of the Group who is not connected with the Department in which the candidate's work has been done. I am sending you herewith a dissertation which has been submitted by Miss Dora Edna Ross. I shall be greatly obliged if you will kindly examine the same at your earliest convenience and report to us for the Graduate Committee whether in your opinion the dissertation meets the general standard which has been established in this University for the Master's dissertation.

Very truly yours,

Robert Miller

Chairman, Graduate Committee.

MAY 7 1915

I consider this thesis as acceptable
Max F. Meyer

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