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THE EXAMINATION
OF
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OF SCHOOL CHILDREN



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THE EXAMINATION OF SCHOOL CHILDREN

A MANUAL OF DIRECTIONS
AND NORMS

BY

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PREFACE

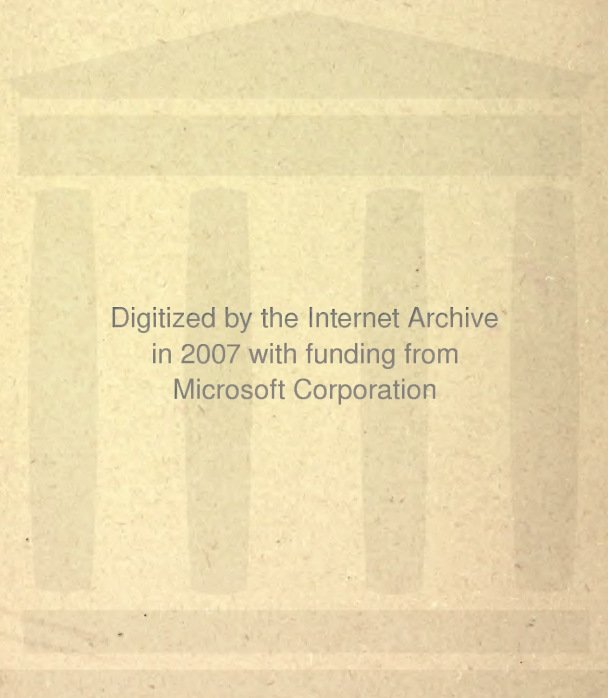
THE purpose of this manual is to provide, in convenient form for teachers, directions for the examination of school children and tables of norms for the various ages. No originality is claimed for the tests; they have been in use for some time. After extensive trial of nearly all the forms of mental tests that have been proposed, I have selected those that, all things considered, seem best for group tests. I give the complete tables of norms for the tests essentially as described in Whipple's *Manual of Mental and Physical Tests*, because these tests are already known and the material available. Additional tests with the norms will be published annually. In the present volume, supplementary material is provided for nearly all the tests.

It is hoped that the publication of this material in this form will aid the teacher somewhat in the scientific study of school children.

To the many superintendents, principals, and teachers who have assisted in giving the tests, I am under great obligation; also to Mr. C. W. Bock, who prepared the graphs, and to Miss Dora Ross, who for two years has assisted me in grading and working up the material.

W. H. P.

UNIVERSITY OF MISSOURI,
COLUMBIA,
October 6, 1913.



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THE EXAMINATION OF SCHOOL CHILDREN

MENTAL AND PHYSICAL TESTS OF SCHOOL CHILDREN

THE farmer knows his cows. He knows from which breeds he gets the most return. He knows what kind of food is best for the cows. He knows how they respond to different kinds of treatment. In a similar way he knows his hogs, his horses, his chickens and his sheep. He knows the relative values of different kinds of fruit trees and their relation to soil and climate. But the teacher of his *children* has no adequate knowledge of *them*. Is the teacher ignorant because it is impossible to have definite knowledge of children's minds or because such knowledge is useless? It is true that she may know in a general way that some pupils do well in their studies and that others do not. She may know that some pupils do well in certain branches of study and not in others. But even such knowledge is quite general and indefinite, not accurate and specific. And besides, she knows next to nothing of the causes of such conditions. If a certain child does poorly in his school work, she does not know whether it is due to lack of ability or to lack of industry, or to some general

or specific mental deficiency. Such a case may be due to no deficiency at all, but to some sensory defect or to some disease of a vital organ. The backwardness may be due to improper development of the child, caused, perhaps, by some neglect on the part of parents, to insufficient or improper clothing, or to lack of exercise. But which of these factors is the cause of the child's failure, the teacher seldom knows with certainty.

There is no longer any excuse for such ignorance, for surely such knowledge would help in a high degree to solve the problem of the child's education. And furthermore, the knowledge can be obtained. The sense organs can be examined by the teacher herself, and the school physician can assist in a physical and medical examination of the child. To set forth the means of making a mental diagnosis of all the children of the school and to give norms for the different ages, is the primary purpose of this book.

In the case of a child that does well in one subject and not in another, is the cause to be found in the unequal development of different mental characteristics? Or is it to be found rather in poor methods of teaching the subject in which the child does poorly? Is the child's failure due to an unfortunate experience in getting started in the subject? Or may it possibly be due to the attitude taken toward the subject by the child's parents or teachers? General observations only will seldom enable a teacher to answer these questions. They can be answered only after special investigation

and specific tests. And it must not be thought that such cases are of rare occurrence. They are quite common. In fact it has been found that a child's experience and his environment play a very important part in determining his attitude toward subjects of study. And it must be remembered that early attitude toward a study and early training in the study are very important factors in determining further progress in that study.

An accurate knowledge of the mental and physical natures of each child under a teacher's charge would assist her very much in the actual teaching. She could adapt her teaching to the various types and degrees of capacity before her, and particularly she could know how to direct the study of each child. Some children are quick to learn, as shown by the substitution test; others are slow. Some are quick at perception, as shown by the cancellation test, and others are slow. The associative processes of some children are quick, of others, slow. Some have good memories, while the memories of others are poor and inaccurate. These differences make it necessary to teach a child to study in such a way that he will get the largest return for his efforts. There is a method of study best adapted to the various types of memory, ideation, and imagination. The teacher must determine these specific mental characteristics and then teach the child to use the appropriate method of study.

It will be quite worth while to follow the mental development of each child through the grades, from the

time when he first enters school or as soon thereafter as accurate tests can be given to him, till he leaves school at graduation. If these tests are given annually, or oftener, and careful records kept of the results, comparisons can be made of these records with the child's age and with his actual school work. This will give the teacher much information of value in deciding upon the proper course to pursue in individual cases. To illustrate: A Kansas City principal, after giving the mental tests discussed in this book, discovered some children doing poor work but standing high in ability as determined by the tests. He at once turned his attention to these pupils and was able to get them to do the work of which they were capable.

Finally, if these tests are given and records¹ kept of them for years, facts of great value to education will be discovered. Particularly will this be true where psychological and medical experts can direct and supervise the mental and physical examinations.

The ideal procedure which we have in mind in this connection is as follows: Each unit system of schools, — a city, a county or township, should be in charge of a psychological and physical expert who should devote his whole time to the work of examining children and advising teachers concerning the proper treatment of them. Every child should be carefully watched and studied. Of course, the majority of children will not

¹ In the author's *Outlines of Educational Psychology*, a system of keeping the records of mental and physical tests is explained.

give a great deal of trouble, but all need some attention, and the growth of each one should be carefully watched. There will be, however, a large per cent that will need especially careful attention and study. In cities of 10,000 inhabitants, for example, there will usually be found enough children who are subnormal and backward to occupy the time of one or two special teachers. All such children should be most carefully studied so that the kind of work that they are able to do and the way they should do it can be scientifically determined. Besides the subnormal and backward children that should be under a special teacher, there will be found many children scattered through the grades who, because of some minor peculiarity or defect, need special study and attention. We need, also, to give much more attention to the supernormal than we have ever done before. The supernormal child, the child that is far above the average, should be picked out on the basis of actual work in school and on the basis of the mental tests and physical development, and then allowed to pass through the grades as fast as his ability and development warrant. In all this work, the mental tests will be of great assistance.

THE CHILD EXPERT AND THE SPECIAL TEACHER

For every system of schools, then, there should be a mental and physical expert devoting his whole time to the study and examination of the children. He assists in picking out the able ones who are to be allowed to go

on and finish the elementary school course in less than the normal time. He assists in finding the child of special and unusual ability in some certain direction, as in drawing, painting, music, mechanical invention and construction, etc. This child is to be given opportunity for the development and training of his unusual ability. He assists in picking out the subnormal and mentally deficient. These, many of them, should be put under a special teacher, — a teacher of ability and with much special preparation and training for dealing with such children. Under this special teacher should be placed, temporarily, children backward in their work though not mentally weak, behind because of misfortunes of one kind or another, or because of some sensory defect. These children, backward but of good mentality, should be able sooner or later to return to the regular school.

The benefit to be derived by a community from the services of the child expert and the special teacher can hardly be overestimated. Let us think again of the city of 10,000 people. It has several thousand school children. These need the daily attention of a child expert. They are so many thousands of growing organisms. They have many defects and diseases. Their teeth, mouth, throat, nose, eyes, ears, digestive and excreting systems, and vital organs need constant attention. If they were so many plants, apple trees, let us say, they would need the attention of a trained horticulturist, who would prune them, spray them, and see that the soil were properly fertilized. As children

they need even more careful and constant care. In quite a true sense they need to be sprayed and pruned. They, too, need the services of an expert, a child expert, to watch over them constantly, and to direct their teacher in their proper care, now sending a child to an oculist, now to a dentist, now to the special teacher. We do not believe in wasting a lot of money on the subnormal children, but it will be a saving of money to segregate them and give them just the kind of training which they are capable of receiving. The subnormal children should have only such training as will profit them. There is possible for them only the humblest of careers. But the determination of the degree of subnormality and the direction of their education should be under the direction of a most competent person.

All children need constant care. It is quite safe to say that a child expert would give a community more return for the money paid him than does any other public servant. The state has for some time had all sorts of experts in other fields. The child expert is the last to arrive. We venture to predict that the time will soon come when he will be the most valuable expert in the service of society. He must, of course, be thoroughly trained for his work. He should have extensive training in psychology, physiology, hygiene, and medicine.

. THE MENTAL TESTS

General Directions. — Unless these tests are given in the right way, it is worse than useless to give them at

all. Therefore the person administering them should understand the procedure perfectly. Before the pupils begin a test *they* should understand *exactly* what they are to do. In most of the tests it will be well to illustrate the procedure with different material from that to be used. The teacher must be careful to see that the work is all honestly done by the pupil; there should be no copying or cheating. Some means should be used to get all the pupils to take the proper attitude toward the tests so that each will do his best.

The tests should be given in the morning immediately after the opening exercises. To give the mental tests properly requires a little more than an hour. It will therefore be best to take two mornings for the tests, setting aside 40 or 50 minutes for the work each time, and give the same tests throughout the schools the first morning and the remainder of the tests the following day. If some pupils take a test before other pupils in the same building, the later tests would be vitiated by communication on the part of the pupils.

Too much reliance must not be put upon the results of a single test; for that reason supplementary tests are added. The tests for which the norms are given should be administered first. The supplementary tests can be given later.

LOGICAL MEMORY

Object. — The object of this test is to determine the child's immediate memory for ideas. It is a test

of one's memory for meaningful material. A pupil's standing in this test may serve as an index of his ability to remember the subject matter of the school studies which deal with logical material.

Method. — The procedure in this test is to read the selection to be reproduced, slowly and distinctly. After the reading, the pupils write down all of the story that they can remember. Let each pupil have sufficient time to write all that he can readily recall. Since this is not a test of one's speed in writing, the time of reproduction should not be limited, except to this extent, — when each child has written all that can at the time be recalled, the papers should be taken up. Care should of course be taken to see that each pupil does his own work. Before giving the test, give the following instructions :

“I shall read to you a story entitled the *Marble Statue*. After I have read it, 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.”

To older pupils, it may be well to add: “Try to get not only the main facts, but also the details.”

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.

Grading the Results. — The child's written reproduction of the story is compared, unit by unit, with the story as divided above. Allow one credit for each idea or unit adequately reproduced. There are 67 ideas in all.

TABLE I

NORMS¹

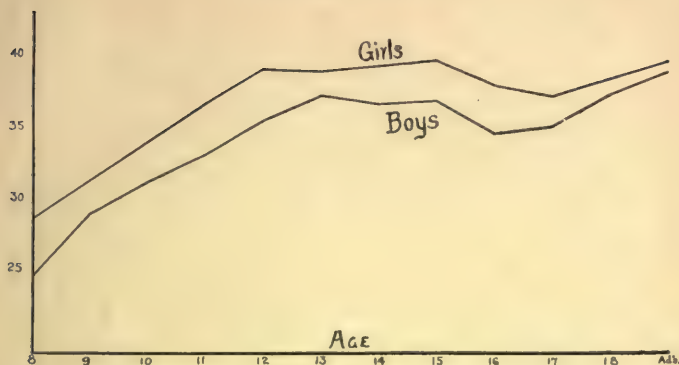
BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	33.7
Av. Dev. .	6.7	9.1	6.7	5.6	7.4	6.3	7.0	6.7	5.6	8.7	6.0	7.0	6.9

GIRLS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	37.1
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	7.1

¹ In this and all the tables of mental norms that follow, "age" means the age at the last birthday. The averages would therefore be 8½, 9½, 10½, etc.



Logical Memory. Upper line, girls; lower line, boys. In this and all the graphs that follow, age is represented on the horizontal and standing in the test on the vertical axis.

Additional Material

For additional tests, especially for further examination of special cases, the following selections may be used.

The Boy Who Would not Drink

An old / sailor / tells the following story / of a boy / who suffered / much / in refusing to break a promise. / When ordered to drink, / the lad said, / "Excuse me; / I would rather not." / They laughed at him, / but they never could get him to drink liquor. / The captain said to the boy, / "You must learn to drink liquor / if you are to be a sailor." / "Please excuse me, / captain, / but I would rather not." / "Take that rope," / commanded the captain, to a sailor, / "and whip the boy, / that will teach him / to obey orders." / The sailor took the rope / and beat the boy / most cruelly. / "Now drink that liquor," / said the captain. / "Please, sir, / but I would rather not." / "Then go to the

top of the mast / and stay all night." / The poor boy / looked up into the sails, / trembling / at the thought of spending the night there, / but he had to obey. / In the morning / the captain / looked up / and cried, / "Hello, there." / There was no answer. / "Come down." / Still no answer. / One of the sailors / was sent up, / and what do you think he found? / The poor boy was nearly frozen. / He had lashed himself / to the mast / so that when the ship rolled / he would not fall / into the sea. / The sailor brought him down / in his arms / and they worked over him / until he showed signs of life. / When he was able to sit up / the captain poured out some liquor / and said, / "Now drink that." / "Please, sir, / I would rather not, / because my father was a drunkard / and I promised / my mother / when she was dying / that I would never taste drink. / Do you want me to break / a promise / to my dying / mother?" / Tears / came into the captain's eyes, / and he said: "No, my boy, / I shall never try / to make you drink / again."

The Golden Goose

A man had three / sons. / The youngest / was considered silly / because he was kind / and gentle. / The oldest / son cut wood / in the forest / and his mother / always gave him a good lunch of cakes / and wine. / One day / as he was eating, / a little / old man / came up / and asked for something to eat. / But the young man / harshly / replied that if he gave food away / he would have none left / for himself. / Shortly afterward / he began cutting down a tree. / He slipped / and cut his arm / badly. / The next day / the second son / went to the forest / and he also had a fine / lunch / put up by his mother. / Again the little old man / came / and asked for something to eat. / The young man angrily / told him to go away / as he had no more than he

wanted himself. / The old man / went away / but the selfish / fellow / had scarcely struck / two blows / with his ax / when he cut / a deep / gash / in his leg. / The next day / the third son / went to the forest, / but his mother / put up for him / only some coarse / bread / and sour / beer. / Again the old man came / and asked for food. / The young man said / that he had only some bread / baked in the ashes / and some sour / beer / but that the man was welcome to a share of it. / As they began to eat, / the bread turned to cake / and the beer / to wine. / The old man said: "Because you have been kind to me / I will make you lucky. / There stands an old / tree; / cut it down / and you will find something good / at the roots." / The young man / cut down the tree / and found sitting at the roots / a goose / whose feathers / were of pure / gold. / This brought him great / good fortune / and a princess / for a wife. /

The average performance in this test is, for adults, 63.5.

The Two Ways

A man once / got positions / for two boys. / Afterward / he was called to the police station / to get one / out of jail. / He went to the men / who had hired the boys / and inquired about them. / He learned that one boy / when he came down to work / before the regular hour / stood on the curb / till the last stroke. / The other / was always / about a half-hour ahead of time, / working away. / The one always left work / on the stroke of the minute. / The other / never paid any attention / to the closing hour, / until his work was finished. / The one growled / and complained at the tasks / thrown upon him / outside of the regular work. / The other / did everything asked / in a smiling way. / The one / spent his evenings / amusing himself / in the dance

hall / or nickel show, / the other / spent his evenings / reading / or studying / about the different parts of his business. / The one / is on the road / to success, / the other / is already a drinker / and a gambler / and is on the road / to ruin.

The average performance in the above test is, for adults, 32.4.

ROTE MEMORY

Object. — The object of the rote memory test is to determine the immediate memory of the pupil for unrelated impressions. It tests merely verbal memory, memory for discrete impressions. A high relative standing in this test probably indicates ability in studies which demand simply verbal memory; *i.e.* in such work as learning spelling, tables, formulas, dates, and all similar material.

Method. — There are two lists of words, concrete and abstract, with six groups in each list. The *concrete* words are given first. The first group should be pronounced and the children given time to write the words. Then the second group should be given, and so on till the six groups of concrete words have been pronounced. Then the *abstract* words should be similarly given.

Instructions. — The teacher should say :

“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 that they are given. If you can not remember some words, leave their places vacant and write in the proper places the words you do remember.”

The teacher should furnish the pupils with prepared blanks or have them prepare blanks as follows :

First list. Concrete	Second list. Abstract
1.	1.
2.	2.
3.	3.
1.	1.
2.	2.
3.	3.
4.	4.
etc.	etc.

Material. — The following words :

Concrete	Abstract
1. street, ink, lamp	1. time, game, scheme
2. spoon, horse, chair, stone	2. grade, fact, work, thing
3. ground, clock, boy, chalk, book	3. pluck, love, blame, fear, proof
4. desk, milk, hand, card, floor, cat	4. space, force, pride, fright, joy, size
5. ball, cup, glass, hat, fork, pole, cloud	5. length, light, style, rate, cause, youth, hate
6. coat, girl, house, salt, glove, watch, box, mat	6. law, thought, plot, glee, life, call, price, strength

Method of Grading. — The work is to be graded not only on the basis of memory for the words but for their positions. A word remembered is to count one point, and its correct position, one point. The word in its correct position, therefore, counts for two points. If the three words of the first group are remembered and

put in their proper order, they count for six points. A perfect score would be 66 points for the concrete list and 66 points for the abstract list.

TABLE II

CONCRETE. NORMS

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	34	58	64	55	60	60	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.
No. . . .	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

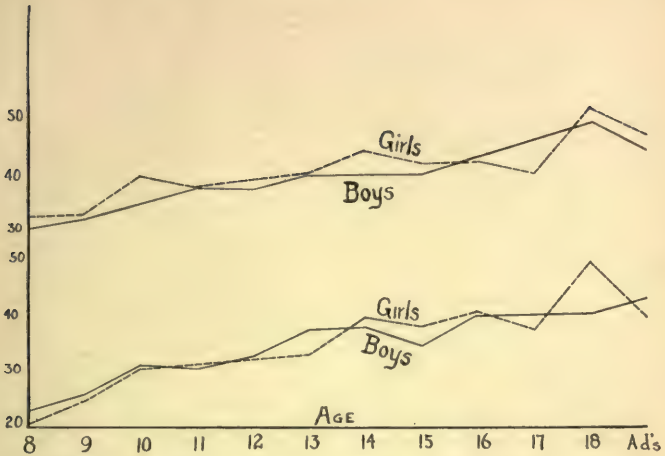
ABSTRACT. NORMS

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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.
No. . . .	23.7	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



Rote Memory. Solid line, boys; broken line, girls. The upper graphs are for concrete rote memory and the lower ones for abstract rote memory. The sex differences in this test appear to be very small.

Additional Material

Concrete

1. cat, tree, coat
2. mule, bird, cart, glass
3. star, horse, dress, fence, man
4. fish, sun, head, door, shoe, block
5. train, mill, box, desk, oil, pup, bill
6. floor, car, pipe, bridge, hand, dirt, cow, crank

Abstract

1. good, black, fast
2. clean, tall, round, hot
3. long, wet, fierce, white, cold
4. deep, soft, quick, dark, great, dead
5. sad, strong, hard, bright, fine, glad, plain
6. sharp, late, sour, wide, rough, thick, red, tight

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. It is in part, of course, a memory test, but it is more. In the two memory tests, the material is presented but once; in this test, by repeating the same impressions over and over, we determine how fast the pupil can build up habitual connections.

Method. — The pupil is provided with the proper forms, copies of which are shown on pp. 20–21, and instructed to fill in the blanks according to the key at the top of the page of the test sheet. The sheets should be distributed and placed face down on the desks. For the digit-symbol test, the instructions should be :

“In the circles at the top of the sheet before you, are written the nine digits and nine symbols which are to be written in the blank squares below for the digits to which they correspond. Work as fast as you can and try to fill as many of the squares as possible, without making mistakes.”

In the symbol-digit test, say :

“In the blank squares below, you are to write the digits which correspond to the symbols.”

Before beginning the test, the teacher should explain, by using the blackboard, just how the experiment is to be performed. Allow *eight* minutes in grades up to the fourth and *five* minutes in grade five and above.

Material. — For material, use the Whipple digit-symbol and symbol-digit test sheets. Give the symbol-digit sheet first.

Method of Grading. — Count each square correctly filled, one point, and determine the speed per minute, by dividing the number of squares correctly filled by the number of minutes spent in filling them. A perfect score would be 200 points for each test. If the test were done in eight minutes, the grade of the pupil would, of course, be 25. If the test were done in five minutes, the grade would be 40.

TABLE III

NORMS

Digit-symbol Test

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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

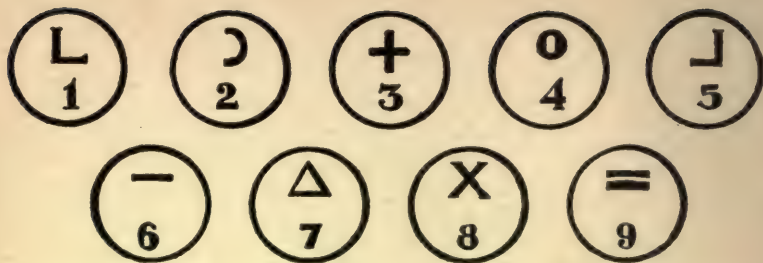
GIRLS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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

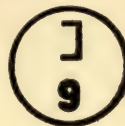
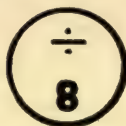
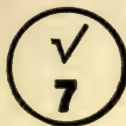
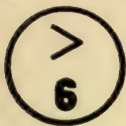
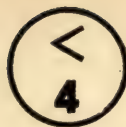
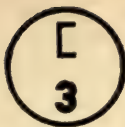
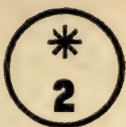
Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	37	72	76	62	75	78	59	45	38	20	17	56	
Norm . . .	10.0	13.2	16.5	17.7	19.3	20.7	23.3	25.8	27.8	26.1	28.0	33.0	21.78
Av. Dev. .	5.3	5.0	5.8	5.4	5.4	5.7	5.4	5.9	6.3	7.4	5.1	9.3	6.00



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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Name..... Date.....

Sex..... Age..... Grade.....

GIRLS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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



Learning capacity as determined by the two substitution tests. The upper line represents the improvement in learning capacity with age in girls and the lower line, in boys.

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 is by no means simple, — memory, attention, association, and ideational type are doubtless involved.

Method. — The pupil is given the letters *a, e, o, b, m, t*, and told to make as many words as possible in five minutes. For the second test, use the letters *c, a, i, r, l, p*. The words must be real English words, no word must contain a letter not in the list, and no word

must contain one of these letters more than once. After explaining the test, pronounce the letters to be used and at the same time write them on the blackboard. The pupils should copy the letters, writing them at the top of the sheet on which they are to write their words. The instructions should be :

"I wish to see how many words you can make in five minutes by using only the letters which I give you. The words must be real 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, of course, have to use all the letters in each word. A word may contain only a part of the letters."

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

For additional tests use the letters *o, e, u, b, n, r* and *a, e, i, c, h, s*. The norm for the first for adults is 15.5 and for the latter is 12.2.

TABLE IV

Invention — a e i r l p

BOYS.

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	13.14
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	3.83

GIRLS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	14.60
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	4.5

Invention — a e o b m t

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	12.35
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	3.61

GIRLS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	13.48
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	3.79



Invention. Solid line, boys; broken line, girls.

THE ASSOCIATION TESTS

Object. — The object of the association tests is to determine the quickness of the association processes. In the uncontrolled or free association test, the pupil is started with a word and then he writes as fast as possible the other words that come into mind. No restriction

is put upon the subject ; he writes whatever comes into mind. The result of the test is a criterion of the rapidity of flow of one's ideas when no limitation is put upon this flow. While the results would be more accurate if the subject merely spoke the words as fast as they came to mind, nevertheless, it gives a high degree of accuracy when the pupils write the words, and it is not possible to have the words spoken when the test is given as a group test.

In the controlled association tests, — opposites, genus-species, and part-whole tests, — a limitation is put upon the flow of ideas. The subject is not to write *any* word that may come to mind, but only words that satisfy certain conditions ; *i.e.* a word that is the opposite, that is of lower order, or that names a whole of which the word names a part. The association tests are of great significance in mental diagnosis, for they test functions that are at the basis of the reasoning process. When a person is given a problem to solve, he is given a test in controlled association. The problem starts the flow of ideas and puts the limitation upon this flow. The problem is solved only if the right ideas come. Of the three controlled association tests, the opposites test gives the most significant results, probably only because the conditions of the test are more readily understood by the pupils than are the conditions of the other two tests. These association tests, if carefully given and especially if several tests are given, are among the most valuable of all the tests.

UNCONTROLLED OR FREE ASSOCIATION

Method. — The pupil is 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.”

When you are sure that the test is understood by the pupils, give them the word *play* and start the stop watch. The only material needed for the test is paper on which the words are to be written.

Method of Grading. — This test is graded by merely counting the number of words written. It furnishes valuable material also for studying association from the qualitative point of view. The words written by a pupil give some indication of his past experience. But we are not here concerned with that aspect of the test.

TABLE V

NORMS

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	35.12
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	11.69

GIRLS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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	12.83

SUPPLEMENTARY TESTS

Additional tests may be given by starting the pupil with a different word, such as the following: *cloud, dog, car, book, mother, ball.*

THE OPPOSITES TEST

Method. — The pupil is provided with a printed slip containing the twenty words. These test slips are placed face down on the pupil's desk and the following instructions are given :

“ You have on these slips of paper twenty words. I wish you to write after each word, another word that has the opposite meaning. For example, if one word were *far*, you could write as its opposite, *near*.”

When you are sure the pupils understand, have them take hold of the test slip, and at the signal, turn it over. At the same instant, start the stop watch. Allow 60 seconds in grades two, three, and four, 45 seconds in grades above. A considerable per cent of adults finish the test in less than 45 seconds; therefore, for the most accurate test, one should allow only 30 seconds when giving the test to adults.

Method of Grading. — The grade is the number of words correctly written. Some of the words have more than one meaning, so allow credit for the opposite of the word in any of its meanings. In the table of norms for this and the two tests following, the grades are reduced to speed per minute.

Material. — Use printed slips containing the following words. There should be space to the right of the words for writing the opposites.

1. good	11. like
2. outside	12. rich
3. quick	13. sick
4. tall	14. glad
5. big	15. thin
6. loud	16. empty
7. white	17. war
8. light	18. many
9. happy	19. above
10. false	20. friend

For adults the foregoing test may be merely a test in speed of writing; therefore the third list on page 29 may be more satisfactory. The norm for the first list, page 29, is for adults 16.2, and for the second list the norm is 15.6, time 30 sec.

TABLE VI
NORMS

BOYS													
Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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.
No. . . .	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	16.55
Av. Dev. .	4.0	2.9	3.1	3.0	3.6	4.3	3.9	5.1	4.2	4.9	3.1	4.0	3.84

ADDITIONAL TESTS

I	II	III
1. long	1. north	1. best
2. soft	2. out	2. weary
3. cheap	3. sour	3. cloudy
4. far	4. weak	4. patient
5. up	5. after	5. careful
6. smooth	6. guilty	6. stale
7. early	7. clean	7. tender
8. dead	8. slow	8. ignorant
9. hot	9. large	9. doubtful
10. asleep	10. true	10. serious
11. lost	11. dark	11. reckless
12. wet	12. front	12. join
13. high	13. love	13. advance
14. dirty	14. ugly	14. honest
15. east	15. open	15. gay
16. day	16. summer	16. forget
17. yes	17. new	17. calm
18. wrong	18. come	18. rare
19. empty	19. male	19. dim
20. top	20. failure	20. difficult

I and II are adapted from Woodworth and Wells

THE GENUS-SPECIES TEST

Method. — The method of giving this test is the same as for the above. The instructions should be :

“You have before you a slip containing 20 words. These words are class names. I wish you to name an example or species under the class. For example, if one word were *food*, you could name *bread*, or if one word were *clothing*, you could write *coat*, etc.”

Method of Grading. — Allow one point for each word

correctly written. A word is correct if it really names a species under the genus named by the word of the list.

Material. — For this test, use printed slips containing the following words :

- | | |
|--------------|-------------|
| 1. mountain | 11. ocean |
| 2. city | 12. fruit |
| 3. weed | 13. country |
| 4. metal | 14. animal |
| 5. furniture | 15. bird |
| 6. machine | 16. food |
| 7. author | 17. lake |
| 8. planet | 18. tool |
| 9. river | 19. fish |
| 10. book | 20. money |

TABLE VII

NORMS

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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.
No. . . .	34	65	84	63	81	64	55	40	45	32	25	86	
Norm . . .	5.5	5.4	7.8	8.2	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

ADDITIONAL MATERIAL FOR GENUS-SPECIES TEST

From Woodworth and Wells

- | | |
|------------|--------------|
| 1. color | 4. tool |
| 2. holiday | 5. metal |
| 3. fish | 6. vegetable |

- | | |
|-------------|---------------|
| 7. coin | 14. drink |
| 8. city | 15. month |
| 9. insect | 16. ocean |
| 10. food | 17. language |
| 11. fruit | 18. river |
| 12. disease | 19. newspaper |
| 13. grain | 20. tree |

THE PART-WHOLE TEST

Method. — The general procedure for this test is the same as for the two preceding tests. The instructions should be :

“The slip before you contains 20 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 *engine*, you could write *wheel*. If one word were *foot*, you could write *toe*, etc.”

Allow 60 seconds for grades two, three, and four; 45 seconds for grades above.

Material. — For material use the words in the list below.

- | | |
|---------------|--------------|
| 1. window | 11. page |
| 2. leaf | 12. cob |
| 3. pillow | 13. axle |
| 4. button | 14. lever |
| 5. nose | 15. blade |
| 6. smokestack | 16. sail |
| 7. cogwheel | 17. coach |
| 8. cover | 18. cylinder |
| 9. letter | 19. beak |
| 10. petal | 20. stamen |

Method of Grading. — Grade as in the preceding test. Allow one credit for each word written that satisfies the conditions.

TABLE VIII

NORMS

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	
No. . . .	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.	
No. . . .	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

ADDITIONAL MATERIAL FOR PART-WHOLE TEST

From Woodworth and Wells

- | | |
|-------------|-------------|
| 1. elbow | 11. sleeve |
| 2. hinge | 12. brick |
| 3. page | 13. deck |
| 4. finger | 14. France |
| 5. wing | 15. pint |
| 6. morning | 16. fin |
| 7. blade | 17. steeple |
| 8. mattress | 18. month |
| 9. chimney | 19. hub |
| 10. cent | 20. chin |



The Association Tests. The upper graphs represent the results of the free or uncontrolled association test. The lower graphs represent the results of the controlled association tests combined. The solid lines are for boys and the broken lines for girls.

THE IMAGINATION OR INK-BLOT TEST

Object. — This test has been called a test of the imagination, and so it is a test of an aspect of imagination, but it seems to test much the same sort of ability as do the association tests. 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. The method of giving this test first used by the author was to allow the child to look at each card for a minute, recording the different things suggested by the blot. The test is of little value when given in this way. However, when given as indicated

below, the test will probably prove a valuable one. But the data for norms under the new method are inadequate. They are given in the table and may serve as some indication of the probable norm.

Method. — The ink-blots are distributed, one set to each pupil, and placed face up on the pupil's desk, the top blot being covered by an opaque square of paper of the same size as the blots. The instructions are as follows:

“You have before you 20 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 and so on as fast as you can until the time is up. You will probably not have time to finish all, but you must work as fast as you can. 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 blot. Of course these blots are not really meant to look like anything in particular but they will suggest things, as clouds sometimes do.”

Allow three minutes for the test. 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 him is to be counted. The blots should be placed with the number on the card turned toward the pupil, and the pupil, in looking at the card, should keep it in this position and not turn it around into other positions. In spite of the definite statement in the instructions that the blots were intended to represent nothing in particular, many pupils think they were so intended and try to discover what the blots were really intended to represent.

TABLE IX

NORMS

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	Av.
No. . . .	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.
No.	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

THE CANCELLATION TEST

Object. — This test has been called an attention test, a quickness of perception test, etc. It certainly does test quickness of perception and discrimination and to some extent quickness of reaction. As far as I have been able to determine, it has no very close relation to general intelligence. But further and more thorough study will probably reveal certain relations between abilities tested by this test and some aspects of the learning process. I therefore include the test, although its usefulness has not as yet been fully justified.

Material. — For this test, use the printed sheets beginning *h p l g*.

Method. — Distribute the sheets and allow the pupils to look at them, then have the sheets turned face down upon the desks. Give the following instructions :

"You have before you a sheet printed, as you have seen, with all the letters of the alphabet placed close together and in no definite order. You are to take your pencil and cancel all the *a*'s you can in the time allowed. Do this by making a little vertical stroke through every *a*. Work as fast as you can without omitting any *a*'s, and you must cancel no other letter."

Then give the signal and begin. Allow two minutes in grades two, three, and four; 90 seconds in grades above.

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

TABLE X

NORMS

BOYS

Age . . .	8	9	10	11	12	13	14	15	16	17	18	Ad.	
No. . . .	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	7.6	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.	
No. . . .	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

ADDITIONAL TESTS

The same test sheet can be used for further tests. For a second test, cancel *e*; for a third test, cancel *o*. The norm for adults canceling *e* is 24.8, and for canceling *o* is 27.



The Cancellation Test. Upper line, girls; lower line, boys.

In the following table, the data from all the tests, except imagination, are brought together. That each test might have about the same bearing in the averages, the original figures were modified as follows: To obtain the grades in substitution, add the results of the two tests and take three fourths. Logical memory is the same as in the original tables. Rote memory, the concrete and abstract grades are added and divided by two. The cancellation grades are doubled. The three grades in controlled association are added together. The two grades in invention are added together. 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.

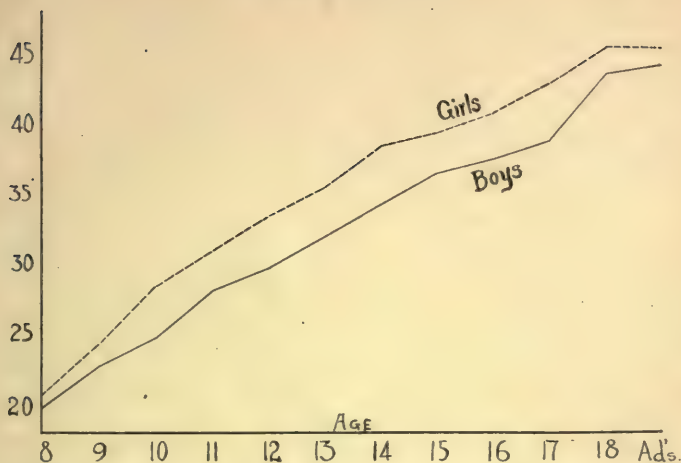
TABLE XI

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 Memory	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	39	39	39	37	37	38	40	37.1
Rote Memory	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	64	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. These graphs show the improvement in the various tests—except imagination—combined. The upper line is for girls and the lower for boys. The data for these curves are to be found in Table XI.

THE PHYSICAL TESTS

The correlation between mental and physical development has been established beyond doubt. It is therefore very important that physical measurements and tests be made along with the mental tests. Careful records of a child's physical growth should be kept from the time of entering school till the school work is finished. It must be remembered, however, that a child's absolute physical measurements are not of much significance unless account is taken of the hereditary stock to which the child belongs. But regardless of whether the child is to be a tall adult or a short adult, a heavy-weight or a light-weight, etc., his growth can be followed, and the

relation between the different measurements also can be considered. Especially is this true with the measurement of vital capacity. Here the lung capacity can be compared with the weight and very valuable information be obtained.

The most significant physical measurements are measurements of weight, height, vital capacity, muscular strength, and muscular speed. We therefore give simple directions for making these measurements, and norms for the various ages.

Height. — For this measurement, a stadiometer is required for accurate measurement. One can be bought from the dealer, or possibly one could be made by the school that would be satisfactory. The essential requirement is a box at the bottom and an upright extending up at right angles at the back of the box. On this upright slides a wooden piece which is to be brought down upon the top of the head when making the measurement. On the upright should be, on one side, a scale in inches, and on the other, one in centimeters.

Standing Height. — The pupil is to stand on the box with heels, buttock, and head against the upright. The shoes should be removed, or allowance made for the height of the heels. The chin of the pupil being measured should be moderately elevated, not too high nor too low. The headpiece should be brought down firmly against the top of the head. A little experience soon gives the teacher accuracy in taking the measurement.

Sitting Height. — The pupil being measured should sit well back on the box with the shoulders and head touching the upright, and the headpiece is then brought down as in measuring standing height.

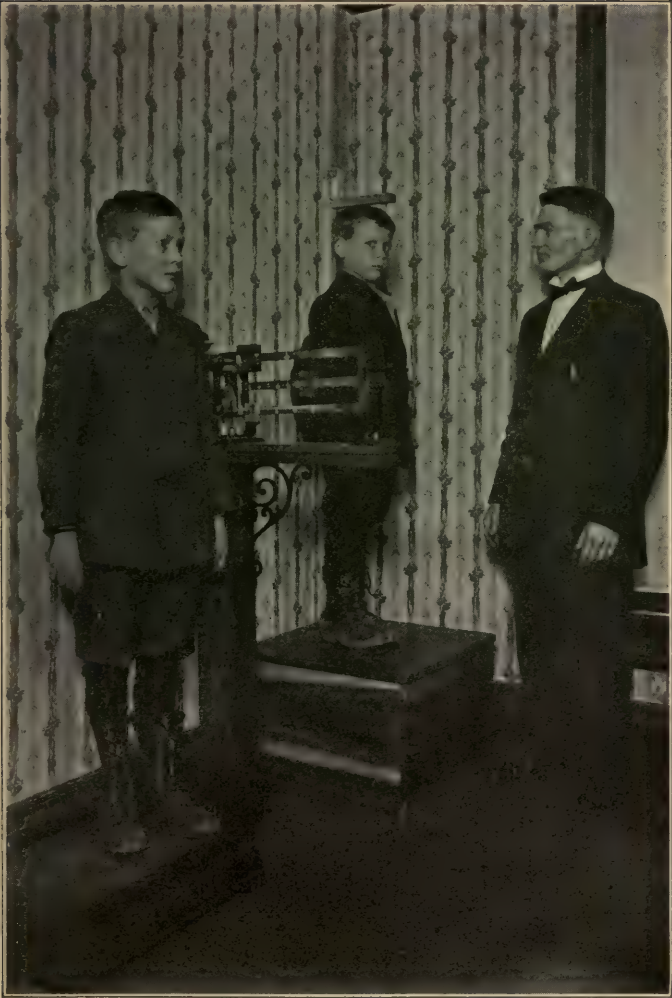
Weight. — For determining the weight accurate scales are required. The weight includes the ordinary clothing.

Vital Capacity. — For this measurement a wet spirometer is required. It is one of the most significant of the physical measurements, for the relation of the vital capacity to weight can be determined by dividing the vital capacity in cubic centimeters by the weight in kilograms. This ratio shows whether the pupil has a lung capacity adequate for his body. This ratio as determined by Kotelmann for the different ages from 9 to 20 is shown in Table XII. The average vital capacity for the different ages as determined by Smedley is shown in Table XV.

Method. — First of all, it is important to be hygienic. The mouthpieces of the spirometer should be kept in a little jar of alcohol. There should be a dozen or more of the mouthpieces. When one has been used, it should be rinsed a little in a pan of water and then dropped into the jar of alcohol. The teacher first should demonstrate the method to the pupil. The lungs are filled as full as possible and the air is gradually blown from the lungs into the spirometer. The child must be encouraged to fill his lungs as full as possible. The air should be blown into the apparatus not too fast nor too slowly for the



Measuring sitting height by means of a stadiometer.



Determining standing height and weight.

best result. Three trials should be given the pupil and the best record recorded.

The pointer on the apparatus indicates the result in liters. This reading can be turned into cubic centimeters by multiplying by 1000.

Children showing up poorly in vital capacity should have their cases further examined. In many cases it will be found that they need more exercise, particularly of a type that will develop the chest, but any vigorous outdoor exercise will be beneficial.

TABLE XII
THE VITAL INDEX

The following table from Kotelmann shows the relation of vital capacity to weight. This index is computed by dividing the vital capacity in cubic centimeters by the weight in kilograms. The index therefore represents the number of cubic centimeters of air space in the lungs for each kilogram of weight.

Age	9	10	11	12	13	14	15	16	17	18	19	20
Index	69.32	69.37	69.18	67.51	66.75	64.07	63.18	65.94	65.77	64.28	66.22	65.01

Taking Smedley's norms of weight and vital capacity shown in Tables XIV and XV, I have computed the vital index in terms of the number of cubic centimeters of air capacity per pound of weight, by converting the weight in Kg. to pounds and dividing this weight in pounds into the vital capacity. It will be noticed that the girls show a falling off after the age of 11. This may be due to tight lacing. The first horizontal column gives the age, underneath is given the vital index for boys, and in the bottom column, for girls.

AGE	6	7	8	9	10	11	12	13	14	15	16	17	18
Boys . .	23	24	25	25	25	25	25	25	25	25	26	27	27
Girls . .	22	23	23	23	23	23	22	21	20	20	20	20	20

Muscular Strength. — For this test a Smedley dynamometer is required. The handpiece should be adjusted to fit the hand of the pupil.



Testing lung capacity by means of a wet spirometer.



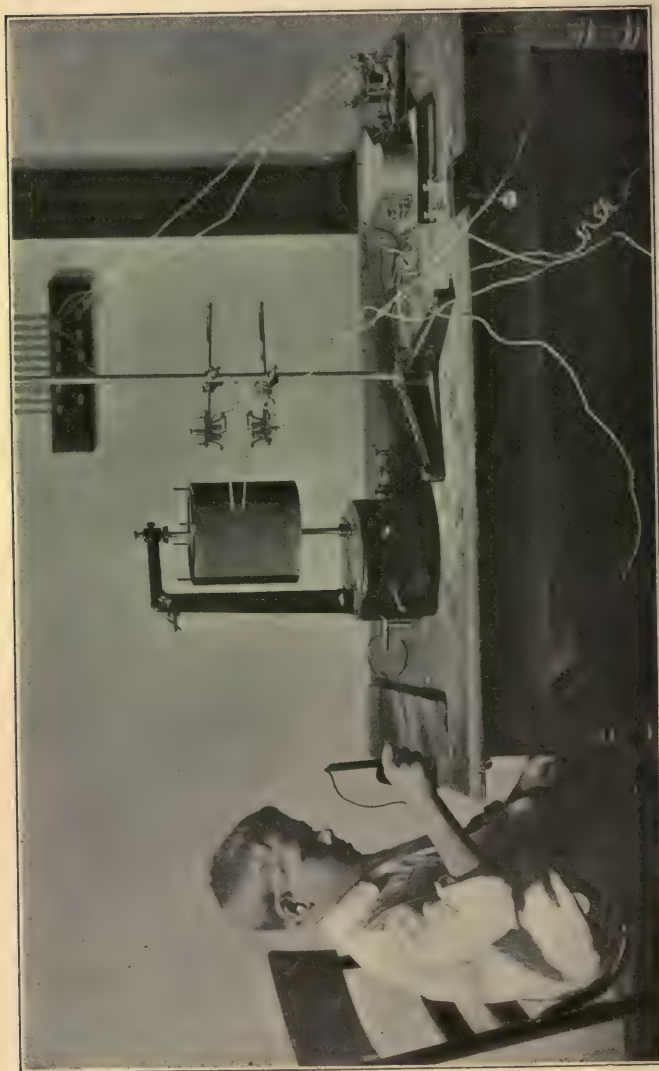
Testing muscular strength by means of a Smedley dynamometer.

Method. — The pupil takes the dynamometer in the hand, holds it by his side but not touching the body, gives the handpiece a squeeze as hard as possible, and then releases his grip. There is a second indicator that gives the record. Three trials should be given and the best record taken. Since both hands are to be tested, try first with the right hand and then with the left, then with the right again, and so continue to alternate till each hand has had three trials. The teacher should be careful to see that the child manipulates the instrument properly, not touching his body with his hand nor using both hands at once. The trial with one hand should not be prolonged, but one good hard grip given and then the instrument released.

Muscular Speed. — For this test, some sort of tapping apparatus is needed. The best form is the tapping board and kymograph for record, but this is very expensive. A cheaper, and fairly satisfactory apparatus is the electrical counter.

Method. — The pupil is instructed to take the stylus in his hand and tap as fast as possible. Take the record first with the right hand and then with the left. The record is for a thirty second test.

The norms are shown in the tables. The teacher should note whether one hand is better than the other. It is a common thing for speech defects to be associated with ambidexterity, equal speed with the two hands. A small per cent of children are normally left-handed, and it is probably a dangerous thing to interfere with



Testing muscular speed. Every tap on the metal plate is recorded on the drum. For schoolroom use, an electrical counter can be used instead of the kymograph.

this, at least early in life. Such interference has been known to bring on speech defects. If a child is to be trained to ambidexterity, this training should probably be postponed to later school life. This question is not definitely settled, however.

TABLE XIII

NORMS OF STANDING AND SITTING HEIGHT, IN CM. (SMEDLEY)

AGE	STANDING HEIGHT		SITTING HEIGHT	
	Boys	Girls	Boys	Girls
6.0	110.69	109.66	62.40	61.72
6.5	113.25	112.51	63.54	62.90
7.0	115.82	115.37	64.67	64.07
7.5	118.39	118.22	65.78	65.25
8.0	120.93	120.49	66.75	66.34
8.5	123.48	122.75	67.72	67.43
9.0	126.14	125.24	68.79	68.32
9.5	128.80	127.74	69.85	69.21
10.0	130.91	130.07	70.56	70.05
10.5	133.03	132.41	71.26	70.89
11.0	135.11	135.35	72.10	72.23
11.5	137.19	138.30	72.93	73.58
12.0	139.54	141.31	73.80	74.93
12.5	141.89	144.32	74.70	76.29
13.0	145.54	147.68	76.24	77.91
13.5	149.09	151.04	77.79	79.54
14.0	151.92	153.64	79.21	80.99
14.5	154.74	156.24	80.64	82.43
15.0	158.07	156.83	82.18	83.21
15.5	161.41	157.42	83.68	83.99
16.0	164.03	158.30	85.43	84.54
16.5	166.65	159.18	87.17	85.09
17.0	167.85	159.26	88.16	85.20
17.5	169.04	159.34	89.14	85.30
18.0	171.23	159.42	90.30	85.51
18.5	173.41	159.50	91.46	85.72

TABLE XIV

NORMS OF WEIGHT, IN KG., WITH CLOTHING (SMEDLEY)

AGE	BOYS	GIRLS	AGE	BOYS	GIRLS
6	19.738	18.870	13	38.084	38.974
7	21.613	20.974	14	42.696	44.210
8	23.817	23.010	15	47.993	48.161
9	26.336	25.257	16	53.238	50.652
10	28.707	27.795	17	57.384	52.386
11	31.223	30.662	18	61.283	52.923
12	34.151	34.373			

TABLE XV

NORMS OF LUNG (VITAL) IN C. C. CAPACITY (SMEDLEY)

AGE	BOYS	GIRLS	AGE	BOYS	GIRLS
6	1023	950	13	2108	1827
7	1168	1061	14	2395	2014
8	1316	1165	15	2697	2168
9	1469	1286	16	3120	2266
10	1603	1499	17	3483	2319
11	1732	1526	18	3655	2343
12	1883	1664			

The absolute lung capacity is of no great significance, unless compared with the child's height or weight. In Table XII the lung capacity is compared with weight. This relation is known as the vital index.

TABLE XVI
NORMS OF STRENGTH OF GRIP, IN KG. (SMEDLEY)

AGE	Boys		GIRLS	
	Rt. Hand	L. Hand	Rt. Hand	L. Hand
6	9.21	8.48	8.36	7.74
7	10.74	10.11	9.88 ^a	9.24
8	12.41	11.67	11.16	10.48
9	14.34	13.47	12.77	11.97
10	16.52	15.59	14.65	13.72
11	18.85	17.72	16.54	15.52
12	21.24	19.71	18.92	17.78
13	24.44	22.51	21.84	20.39
14	28.42	26.22	24.79	22.92
15	33.39	30.88	27.00	24.92
16	39.37	36.39	28.70	26.56
17	44.74	40.96	29.56	27.43
18	49.28	45.01	29.75	27.66

TABLE XVII
NORMS OF TAPPING RATE (SMEDLEY)

AGE	No. TESTED	Boys		No. TESTED	GIRLS	
		Rt. Hand	L. Hand		Rt. Hand	L. Hand
8	31	147	117	31	146	117
9	60	151	127	44	149	118
10	47	161	132	48	157	129
11	49	169	141	48	169	139
12	44	170	145	50	169	140
13	50	184	156	45	178	153
14	40	184	155	67	181	157
15	37	191	169	48	181	159
16	21	196	170	50	188	167
17	13	196	174	40	184	162
18	3	197	183	24	193	169

The records in the above table represent the number of taps in 30 seconds. The number tested, however, is so small that the table is not very reliable.

TEST OF EYESIGHT

Importance of Test. — If all school children were examined by competent oculists, it would be found that one third to two fifths of them have defective vision; and in most of these cases of defect, the wearing of glasses would improve vision. There is a pretty general popular prejudice against wearing glasses, also a feeling that oculists prescribe them without good reason. Such notions are due to ignorance, — ignorance of the causes of defective vision and of the way in which glasses correct the defects. Glasses are worn to correct abnormal curvatures of the eyes. Nature never makes a pair of perfect eyes. And in a very large number of cases, this abnormality is sufficient to impair vision considerably. In practically all such cases, glasses should be worn to correct the effect of the misshapen eyeball.

A child suffering from defective eyesight is at a great disadvantage in school. A nearsighted child can not see work on the blackboard, *nor does he see any distant object clearly*. The farsighted child has difficulty in reading or doing any near work. The child with astigmatic eyes sees nothing clearly at any distance. Not only does defective vision incapacitate a child for his work at school, but the eye strain has many and far-reaching effects, causing inflamed eyes, abnormal growths in and about the eyes, headaches, nervousness, indigestion, and many other troubles. Poor eyes, making the child unable to do his school work, may make him dislike school and so lead to truancy.

Method of Testing. — The teacher's object is to discover those cases that need the service of an oculist. To do this, the only apparatus needed is a Snellen's test chart. The chart should be hung on the wall in a good light. Mark off on the floor a place 20 feet distant from the chart. Place the child under examination at this place. Examine the eyes one at a time, placing a cardboard before the other eye. The child is asked to read the larger letters on the chart, proceeding to the smallest letters that can be read. The vision of each eye is recorded separately, 20/20 if the 20-foot line and no smaller can be read. If the child can read up to the 25-foot line only, the vision is recorded as 20/25. If the child can read the 15-foot line, then the vision should be recorded as 20/15. If a child sitting 20 feet from the chart can read the 15-foot line or even the 10-foot line, he may be farsighted. In such a case the teacher should ascertain whether there are any symptoms of eyestrain, such as headaches, and should see if the child has any difficulty in reading a book at the normal reading distance, 14 inches. If a child has only two thirds vision, or if there are any indications of farsightedness, he should be referred to an oculist.

If the teacher has any reason at all to suspect eyestrain in a pupil, the pupil should be referred to an oculist, and the oculist should be the best obtainable. Opticians and jewelers are not competent to examine eyes and prescribe glasses.

There are other forms of test for children who do not



Testing vision.

know their letters. One of these is the *E*-test. In this test, both the examiner and the child hold in their hands a cardboard with a large *E* printed on it. By asking the child to hold the *E* pointed in the same way as that held by the examiner, it can be determined whether there is any visual defect. The other test is the McCallie test. On the McCallie test cards are little circles and in some of the circles are little dots. The principle of the test is to determine whether the child can see the dots in the circles.

TESTS OF HEARING

Importance of Test. — It is unnecessary to discuss the importance of accurate determination of a child's ability to hear. Fifteen to twenty per cent of school children have defective hearing. Cornell says that defective hearing constitutes the greatest bar to school progress. Not only is a child of defective hearing thereby retarded in his studies, but it is often also the case that the defect grows worse. Yet in many cases the defect can be cured, especially if treated in time.

Method. — The best device for testing hearing is the Pilling-McCallie audiometer. Every school that makes any pretense of careful examination of pupils should have this instrument and use it according to the directions that accompany it. A little use of the instrument makes one able to detect defective hearing very quickly. Twenty to thirty children can be examined in an hour. The records obtained for each



Testing hearing by means of a Pilling-McCallie audiometer.

child should be carefully recorded, and, of course, separate tests made for each ear.

If the Pilling-McCallie audiometer is not available, the watch test may be used in individual examinations. The principle of examination is very simple. The ear not being examined is closed by a rubber plug. The eyes also of the pupil are kept closed during the examination. A watch is carried out from the ear being tested, and the distance at which the ticking of the watch becomes inaudible is noted. Then the watch is carried in toward the ear from a distance at which it is inaudible, and the distance at which the ticking becomes audible is noted. The average of these two points is taken to indicate the sensitivity of the ear. Practice enables the examiner to know at once whether hearing is defective. Watches differ much in the loudness of their ticks, and an examiner should determine the distance at which a person of good hearing can hear the watch used. A quiet room is necessary for the performance of the watch test.

It is possible to get some idea of the defective hearing of children by employing group tests. The teacher or examiner prepares a list of numbers, 43248, 98374, 59136, etc. These are numbered, as 1, 2, 3, etc. The child prepares a paper numbered in accordance with the number of groups of digits that are to be given. Then the groups of digits are pronounced and the child writes them down in their places as well as he can. The teacher can seat the children in three groups, a near, a

far, and an intermediate group, and by interchanging them three times, tests each child at all of the distances. By comparing the numbers written by the child with the numbers pronounced, the teacher may get an idea of those that have defective hearing. If the teacher uses three distances for seating the children, she will then need three lists of numbers. The digits may be pronounced in a whisper, or they may be pronounced in a very low tone of voice, or both procedures may be used.

Whatever the means used to determine the defects, the child showing any indication of defective hearing should be advised to consult a physician. If there is an ear specialist in the community, he is the man who should be consulted.

CORRELATIONS

After giving the mental tests, we wish to know what relation exists between them, what mental functions are most alike or have most in common, and also, what indication each test is of general intelligence. In order to determine these relations, we can use the Pearson formula for computing correlations. This formula enables us to compare the relative standing of each pupil in one test with his standing in another test. Of course, one can do this in a rough way by inspection. One can note whether the best in one test are also best in another; whether the poorest in one test are also poor in another test. The Pearson formula not only enables us to do this, but enables us 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 moreover, we can give an exact quantitative statement which takes account of all the individual variations. 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, provided the grades are determined in a careful manner. Not only will it be advantageous for the teacher to compute the correlation between the average grade for all the mental tests with the average school grade, but it will be profitable to compute the correlation between each separate test and the standing in the different school branches.

The principle embodied in the Pearson formula is essentially as follows: Suppose the pupils have been tested in logical memory and we wish to compare their standing in this test with their standing in rote memory. We find the average of the group in logical memory and compute each individual's deviation from this average. We find the average of the group in rote memory and compute each individual's deviation from this average. Now if there is a perfect correlation between the two tests, each individual's deviation will be relatively the same in the two tests. But if the correlation is not perfect, an individual may deviate more in one test than he does in the other, or may even be above the average in one test and below in the other.

The formula takes account of the deviation and of its direction above or below the average. The Pearson formula :

$$r = \frac{\Sigma XY}{n \sigma_1 \sigma_2}$$

r = correlation.
 Σ = the sum of.
 X = the individual deviations in one test.
 Y = the individual deviations in the other test.

I.e., the numerator of the fraction is found by multiplying each individual's deviation in one test by his deviation in the other test and finding the sum of these products. In this process account must be taken of the direction of the deviation. If the deviation is above the average, it is called *plus*, and if below the average, *minus*. The algebraic product and the algebraic sum of these products are found.

n = the number of persons tested.

σ_1 = the standard deviation in one test.

σ_2 = the standard deviation in the other test.

The standard deviation may be found by multiplying the average deviation by 1.2533. This method of finding the standard deviation is fairly accurate. If absolute accuracy is desired the standard deviation is to be found by taking the square root of the average of the squares of the individual deviations. The procedure would be: square each individual deviation, add these squares, divide by the number of pupils considered and extract the square root. The average deviation is found by finding the sum of the individual

deviations — without regard to sign — and dividing by the number of pupils in the test. The denominator of the fraction, therefore, is the product of the number of pupils considered and the standard deviation in one test and the standard deviation in the other test. In order to make the matter quite clear, we give below a theoretical case in logical and rote memory.

PUPIL	LOG. MEM.	DEVIATION	ROTE MEM.	DEVIATION	PRODUCTS OF DEVIATIONS
A . .	62	19.4	70	22.7	440.38
B . .	58	15.4	65	17.7	272.58
C . .	60	17.4	60	12.7	220.98
D . .	56	13.4	58	10.7	143.38
E . .	50	7.4	50	2.7	19.98
F . .	40	- 2.6	45	- 2.3	5.98
G . .	35	- 7.6	40	- 7.3	55.48
H . .	30	- 12.6	35	- 12.3	154.98
I . .	20	- 22.6	30	- 17.3	390.98
J . .	15	- 27.6	20	- 27.3	753.48
Average	42.6	14.6	47.3	13.3	2458.20

The standard deviation in logical memory = $1.2533 \times 14.6 = 18.29$.

The standard deviation in rote memory = $1.2533 \times 13.3 = 16.66$.

We therefore have

$$r = \frac{2458.20}{10 \times 18.29 \times 16.66} = .806$$

This correlation is high, and we would find a correlation between logical and rote memory, although not so high a one as our hypothetical figures give. Now let us take a supposed case that will not give us a high correlation. We should not expect to find a correlation between memory and weight, so let us suppose the following figures:

MEMORY	DEVIATIONS	WEIGHT	DEVIATIONS	+ PRODUCTS	- PRODUCTS
65	17	200	50	850	
60	12	160	10	120	
60	12	155	5	60	
55	7	124	- 26		- 182
50	2	110	- 40		- 80
45	- 3	112	- 38	114	
40	- 8	122	- 28	224	
38	- 10	154	4		- 40
37	- 11	165	15		- 165
30	- 18	198	48		- 864
Av. 48	10	150	26.4	+ 1368	- 1331

$$1368 - 1331 = 37$$

Standard deviation in memory = $1.2533 \times 10 = 12.53$.

Standard deviation in weight = $1.2533 \times 26.4 = 33.09$.

The number tested = 10.

$$r = \frac{37}{10 \times 12.53 \times 33.09} = \text{practically nothing } (.008).$$

The following tables show the raw correlations:

Cancellation with	Invention with
substitution = .02	ink blots = .25
invention = .07	association = .16
ink blots = .16	log. memory = - .22
association = .02	rote memory = .25
log. memory = - .27	
rote memory = .00	

Substitution with	Ink blots with
invention = .13	association = .49
ink blots = .24	log. memory = - .01
association = .23	rote memory = .12
log. memory = .37	
rote memory = .15	

Association with

log. memory = .03

rote memory = - .05

Log. memory with

rote memory = - .07

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 logical memory = .63; with ink blots = .21; with invention = .35; with cancellation = .28. Logical memory with cancellation = - .81.

GRADES IN SCHOOL SUBJECTS

It is the custom in most schools to send to parents reports showing the grades of their children in the different school subjects. We need not discuss here the value of such reports. It is almost a universal custom to make some sort of report to parents. Some educators believe that these reports should be of a general character,—that parents should be told that the work of their child is satisfactory or unsatisfactory, or satisfactory in some particular but unsatisfactory in others, etc. Now, it may be that they are right. The value of reports is a thing that can be measured, like anything else. The position that we wish to take here is that if reports to parents are to contain grades, as is the general practice at the present time, such grades should be relative, not absolute.

If a child takes to his parents a card stating that he has a grade of 90 per cent in arithmetic, this means nothing of value to the parents. They do not know whether the child is the poorest or the best in the class. He could be either and still make a grade of 90 per cent. It all depends on the teacher and the examination questions. Now, what a parent would like to know about the child's work in arithmetic is how it compares with that of the other members of the class. Is the child among the best in the class, or among the poorest, or among the average or medium students? The report to parents should, therefore, give the rank of the child. The child is first in arithmetic, tenth in geography, fifth in spelling, etc.

It has been objected to this scheme, that it does not give what the parent wishes to know; that the parent wishes to know whether the child knows arithmetic, absolutely, without reference to the other members of the class. Now, there is no absolute knowing of a subject, not even of the multiplication table. One does not merely *know* the multiplication table, but one has a *certain degree of facility* in the use of the table; — the associations may come quickly or slowly, one may make many errors, or none, or few, when working at a certain speed. The same thing is true with all our knowledge, *i.e.* we do not merely *know* facts, but we have a certain facility in the *use* of facts. It is always a relative matter. And it is for this reason that all grades are relative. Moreover, since it is impossible to give

examinations of the same degree of difficulty, if absolute grades are given, they go up or down according to the difficulty of the examinations and not necessarily in accord with the student's work and attainments. For example, in two successive examinations a child may make 98 and 58. The child may have equal ability and attainments in the two cases. He may even be best in his class in the two cases, but the grades 98 and 58 do not tell these facts. The parent might very reasonably infer from the grades that his child was first in the class when he received the grade of 98 and poorest when he later received the grade of 58. It is evident that the information sent to the parent — if any quantitative statement is to be sent at all — should be the relative standing of the pupil.

There are two ways of reporting rank. One is merely to say that a child is first, second, third, fourth, etc. The other method is to report how a child stands with reference to the average of the class. The latter method is probably the best. It does not give the exact rank of the child, but it reveals whether a child is among the best, medium, or poorest children, and this is probably accurate enough. A good scheme, recently proposed by Mr. A. P. Weiss, and tried out by myself in keeping my own class records, is as follows: When an examination is given, the grades are changed to grades whose average is 50. Then, as grades go above 50, the parent may know that the child is so much above the average; as they go below, the parent knows that

the child is below the average. The use of a slide rule makes this change of the grades to the basis of an average of 50 very easy. Without a slide rule, the change would necessitate a little labor. To illustrate, suppose in a certain examination the average of the class is 70 and a certain pupil makes a grade of 60, we would have the proportion, $70 : 50 = 60 : x$. $x = 50 \times \frac{60}{70} = 43$. Of course, with a slide rule, we set $70 = 50$ and then read off the grades as fast as we can write them down.

This plan of comparing grades with the average makes it possible for a teacher to give as many supplementary mental tests as she desires, and in the absence of norms for the tests, compare each child with the average of the class. That is, the mental tests also could be recorded with reference to an average of 50 for the class or age or grade.

MATERIAL AND APPARATUS

All the material and apparatus for these tests and measurements can be obtained from C. H. Stoelting Co., 121 North Green Street, Chicago. The teacher, however, could have prepared by the local printer all the material for the mental tests except for substitution, imagination, and cancellation. And it would doubtless be better to get all the material from the above firm.

MENTAL TESTS

For Logical Memory, — *Marble Statue*, from the text.

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- For Strength, — Smedley dynamometer.
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For more extended discussion of the whole subject of mental and physical measurements, the reader is referred to Whipple's *Manual of Mental and Physical Measurements*, Warwick and York, Baltimore.

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