

# THE JOURNAL OF EDUCATIONAL PSYCHOLOGY

## GRADED MENTAL TESTS.<sup>1</sup>

### PART I. ATTENTION, PERCEPTION, COMPREHENSION AND MEMORY.<sup>2</sup>

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#### OUTLINE.

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<sup>1</sup>I wish to acknowledge my indebtedness to Professors Angell, Dearborn and Judd for many valuable suggestions and for the privilege of giving these tests, and to Professor Whipple for assistance in preparing the results for publication. I am also indebted to the supervisors and teachers of the School of Education, who so kindly co-operated in arranging for the conduct of the tests.

<sup>2</sup>[This paper will be continued in the October and concluded in the November issue.—EDITORS ]

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## SUMMARY.

Certain defects in the Binet-Simon tests are pointed out and the attempt is made to develop a more satisfactory series of diagnostic tests. To determine age-norms of mental development the series of tests indicated in the above outline are applied to eight groups of ten children each, pupils aged six to thirteen years in the School of Education, University of Chicago, so selected that chronological, physiological, pedagogical and psychological ages shall correspond so far as possible. In the last six groups, however, one or more pupils are found who are pedagogically retarded by one or two years. The results are tabulated separately for the retarded and the unretarded pupils. A decided parallelism is discovered between the experimental results and the mental development and school performance of the pupils. The final summary shows the norms of performance for unretarded pupils for each test at each age from six to thirteen.

## INTRODUCTION.

How is the pupil to be classified? This is the problem which presents itself in varied and vexatious forms to the elementary school teacher. The mental measuring rod universally applied has been the amount assimilated of the knowledge specified in the school curriculum. There are accordingly as many measuring rods as there are courses of study. Whether conscious or not of the fallibility of this unit of measure or of the injustice of its universal application, the teacher has still been obliged to apply it, modified—if she is wise—by her own common sense and intuitive judgment of the child's ability, since no other standard was at hand. The effects of this

confusion of standards are patent. Miss Schmidt, from her study of retardation,<sup>3</sup> concludes that what we 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. "To say that more than half of our children are backward is certainly to make an anomalous statement." The application of these same faulty and diverse courses of study as tests of the child's mental capacity has greatly aggravated the evil.

The desirability of an accepted mental scale for the grades has long been granted. Kirkpatrick<sup>4</sup> in 1900 called attention to the great need of mental tests adapted to the grades. Naturally, mental tests were first elaborated for the adult who had reached a state of comparative mental equilibrium. The difficulty of the problem is greatly increased when one attempts to adapt the tests so that they shall accurately measure the mental capacity of the child at each stage of his development.

Is the presumption that age-norms of mental capacity can be established with a fair degree of precision well founded? Wallin's answer to the question<sup>5</sup> is fair and also conservative. He says: "Just as native capacity differs with individuals, 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 Binet-Simon tests of 1905, followed by the 1908 series and the more meager De Sanctis tests, were the first attempts to establish mental age-norms for the entire elementary school period. As a matter of fact, these tests were devised in the interest of the subnormal child, although based upon the capacity of a hypothetical normal child at each year of growth. We are indebted to Goddard and to other students of the subnormal child for the wide dissemination of the Binet-Simon

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<sup>3</sup>CLARA SCHMITT. *Retardation Statistics of Three Chicago Schools*. Elem. Sch. Teacher, 10: 1910, 492.

<sup>4</sup>E. A. KIRKPATRICK. *Individual Tests of School Children*. Psych. Rev., 7: 1900, 274.

<sup>5</sup>J. E. W. WALLIN. *Human Efficiency*. Ped. Sem. 18, 1911, 80.

tests in this country. These tests, like those in use in the Chicago Department of Child-Study, start from the correct assumption that "age-norms of native and acquired mental capacity" can have universal validity only when we eliminate all knowledge dependent upon the arts of the school.

The Binet-Simon tests have received their full share of criticism,<sup>6</sup> as could be expected in the case of pioneer work. Some of the defects that have been pointed out are: (1) Certain tests are too easy and others too difficult for the grades to which they are assigned, so that the tests for some higher ages may even be easier than those for a lower. (2) The tests are not entirely independent of school training. (3) The number of tests for different ages vary. This would create difficulty if one used the corrective formula recommended by Binet and Simon. (4) The tests are not standardized. Their advocates seem to believe that flexibility and adaptability can be obtained only when the precision required in the regular laboratory experiment is disregarded. But this belief does not seem well founded, for it has been found possible, in the tests that we report herewith, to retain the precision of method required in the laboratory and at the same time to gain the flexibility necessary to a graded series. (5) The tests for the different ages are not comparable; at one age certain specific mental capacities and at another stage entirely different capacities are tested. If we agree with Galton that the capacity of man can best be measured by "sinking shafts, as it were, at a few critical points," these critical points should first be chosen and the shafts sunk at corresponding points for the different stages of development. The failure to do this seems to be the most salient weakness of the Binet-Simon tests.

What are the "critical points" at which we must sink our shafts if we are to estimate mental efficiency correctly? This is the first question to be answered if we would establish a series of age-norms. Most will agree that some of the most significant factors in the determination of mental efficiency are degree of attention, keenness of perception, ability to discriminate and assimilate—in other words, ability to compre-

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<sup>6</sup>See particularly J. C. BELL. *Recent Literature on the Binet Tests*, this JOURNAL, 3: Feb., 1912, 101.

hend a situation—memory span, strength of associative connections (conditioning the rapidity and accuracy with which old associates may be recalled, as well as that ability to form new associates, which is commonly termed ability to learn), constructive or inventive power and, finally, judgment. These differentials of mental efficiency are very generally applied, both in the sphere of practical affairs and in the more limited field of the schools. Should it not be possible for schoolmen to agree upon a series of significant factors like these and to work out a series of age-norms that would furnish a far more accurate evidence of the child's stage of development than is obtainable from an examination of his knowledge of arithmetic, geography, etc.?

The tests described in this paper are offered as a tentative answer to this question. Having determined upon seven "critical points," it was next necessary to find adequate tests that might be applied at these particular points. The tests were chosen from a wide range; those that had been previously tried out in the laboratory were preferred if they were adapted to the requirements of a graded series. The Binet-Simon tests were suggestive; six of them were used in a more or less modified form.

While the criteria which determined the choice of tests were few in number, they debarred us from the use of many of the more familiar tests. These criteria were as follows: (1) Each test must be applicable to all stages of development. To obtain a series of mental norms—a truly genetic series—it is obviously necessary to use the same, or at least similar, tests for all the years covered by the elementary school period. Such a series of reactions should be comparable from age to age. This requirement alone ruled out many tests, since few of them are so arranged that they can be given equally well to children of six and seven years and to those of twelve and thirteen years. Most of the tests used in our laboratories are too difficult to be used with young children. (2) Each test must present a problem which the child can grasp, if not in its entirety, at least sufficiently to awaken his interest and arouse effort. (3) Each test must have content, or, lacking that, must make a sensory appeal to the subject. Much of the material

of the ordinary laboratory test is unsuited, both in form and matter, for use with immature children. Since, for the sake of analysis, the laboratory test has been reduced to its lowest terms and thereby largely divested of content, it can appeal only to the subject experienced with the psychological experiment. (4) Each test must be so arranged that it can be completed without causing undue fatigue. This criterion ruled out other laboratory tests which would have been too fatiguing to be employed with young children. (5) There should be a minimum of apparatus. The less machinery and unfamiliar apparatus, the easier it is to induce an 'at home' feeling at the beginning of the test. This is also a desideratum if the tests are to be utilized by teachers who do not have access to a psychological laboratory. No apparatus except a stopwatch was required with this series of tests. (6) The conditions of the experiment required that the complete series of tests should not consume more than two, or at most three, school periods, and no school period was longer than thirty minutes. This requirement necessitated the shortening and simplification of many of the tests chosen. All of the tests of attention, keenness of perception, ability to size up a situation, memory span, association, constructive ability and judgment were selected or modified so that they would conform to these six requirements.

It is obvious that to obtain graded norms the children tested should be representative of their age. So far as possible the chronological, physiological, pedagogical and psychological ages differentiated by Wallin<sup>7</sup> should correspond. I was particularly fortunate in my opportunities in this regard. The subjects were children from the School of Education at the University of Chicago. These children are given a very careful physical examination at the beginning of each year. Thus there exists at the service of the experimenter a complete physical record for each child during the years he has been in attendance at the school. Then, too, the promotion and grading is more carefully supervised than in the ordinary school. It seems fair to presume that when physical, pedagogical and

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<sup>7</sup>J. E. W. WALLIN, *Clinical Psychology and the Psycho-Clinicist*, this JOURNAL, 2: 1911, 198.

chronological ages correspond the psychological age may also be in agreement. The school life of these children is as healthful and normal as it is possible for school life to be.

Ten children were selected for each year. In order to restrict the distribution of ages within each year, I selected only those who had had a birthday within six months. Thus, the ages of all children in the six-year group fell somewhere between six years and six years six months.

The majority of the six-year-old children came from the lower first grade, the seven-year old from the second, the eight-year old from the third, the nine-year old from the fourth, the ten-year old from the fifth, the eleven-year old from the fifth and the sixth, the twelve-year old from the upper sixth and the seventh and the thirteen-year old from the upper seventh and eighth grades. Each group of ten above the second year contains a few who are slightly retarded or who have some physical defect which has hampered them in their school work as well as in the tests. The number of retarded pupils in the several age-groups is as follows: 8th year, 2; 9th year, 2; 10th year, 1; 11th year, 5; 12th year, 4; 13th year, 3. The results from these retarded children were tabulated separately. None of those marked retarded was more than two years, and most of them were not more than one year behind their grades.

*The careful correlation of physical, pedagogical and chronological ages and the separation of the records for those who do not show this correspondence ought to ensure a standard achievement for the unretarded class.* These records, then, may be safely taken as *norms* for the respective ages.

*The tests were all given individually.* While this consumes more time than group testing, it is the only method which gives every individual an equal opportunity. Individual testing is essential to reliability of results in working with children. The experimenter and the child come into close *rapprochement*; questions can be adapted to the comprehension of the individual child, and the exercise can partake of the nature of a pleasant game rather than of a test, as is requisite to a good working mood in a child. All this is manifestly impossible when the tests are given to a group. While standard conditions were maintained throughout the series, it was also deemed essential that the

tests be adapted to each age and individual in order to secure the most effective reaction; *e. g.*, with the six-year old group the responses to most of the tests were oral, and records were made by the examiner, but in those cases where the time-factor was not used as a determinant, the responses of the older children were written by the children themselves.

### THE TESTS.

1. *Attention*: The test for degree of attention which seemed best adapted to our purpose was the modification of the "a-test" used by the Chicago Department of Child-Study.<sup>5</sup> At the top of the page are printed 100 a's, distributed evenly in rows. Below there are 100 a's, distributed among one hundred nonsense syllables. This modification of the test enables the experimenter roughly to abstract the motor time—the time required to mark out the 100 a's—from the finding or perception time—the extra time required to mark out the a's when distributed among the one hundred words. We added a third set of a's identically the same as the second, but introduced the element of distraction by reading to the pupil during the time he was marking out the a's. He was expected to give the substance of the matter read after the completion of his test.

This test gives two measures of degree of attention: (1) Accuracy with which all a's in sets two and three are marked out; (2) the greater length of time required for the third series in which the element of distraction was added.

As the table shows, the second measure was somewhat ambiguous, for in several cases, on account of the counter-effect of practice, the time required for the third series was even shorter than for the second. Had we used a different distribution of a's for the third set, the effect of practice would not have counteracted the effect of distraction. The first measure, that of accuracy, proved more reliable. The errors made were all omissions.

The irregularity of results for the retarded groups is in marked contrast with the regularity found in records of the unretarded; but in determining norms of accomplishment we

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<sup>5</sup>D. P. MACMILLAN AND F. G. BRUNER. *A Special Report of the Department of Child Study and Pedagogic Investigation*. Chicago, 1906, pp. 49-57.



are concerned only with the results from the unretarded cases. These cases present a clear record of development in degree of attention with growth in years, whether we consider the average number of errors made or the maximum of error. This

TABLE I.  
*Degree of Attention Measured by Number of Omissions.*  
*Unretarded.*

Group Age.	Series II.				Av. No. Errors.	Series III.			
	Av. No. Errors.	Max.	Min.	M. V.		Max.	Min.	M. V.	
6	5.5	10	1	2.2	3.4	10	0	2.5	
7	4.5	11	0	3.3	3.5	8	1	2.2	
8	2.1	4	0	1.1	1.5	4	0	1.0	
9	2.2	5	0	1.2	3.0	8	0	1.6	
10	2.0	5	0	1.7	2.5	8	0	2.3	
11	2.3	4	0	1.5	3.6	9	1	3.5	
12	0.25	1	0	0.27	0.5	2	0	0.75	
13	0.6	2	0	0.7	0.5	2	0	0.6	

*Retarded.*

Group Age.	Series II.		Av. No. Errors.	Series III.	
	Av. No. Errors.	Max.		Max.	
8	3.0	6	2.5	3	2 cases
9	12.6	15	16.5	17	2 cases
10	3.0	3	6.0	6	1 case
11	9.6	14	6.9	41*	5 cases
12	3.7	6	1.7	3	4 cases
13	6.0	10	6.3	12	3 cases

*Degree of Attention Measured by Lengthened Time with Distraction.*

Group Age.	Unretarded	Retarded
	Av. in seconds.	Av. in seconds.
6	22.9	....
7	25.9	....
8	6.5	21.
9	-6.2	5.
10	13.6	-16.
11	14.9	11.
12	2.0	18.
13	-16.0	-5.

\*The large number of errors made in the third series with distraction by the retarded child of the eleventh group is not surprising to one familiar with the child, who was characterized by all who know him as a "day dreamer and very flighty."

table shows two decided breaks in the rate of progress which correspond very closely to our customary division of the elementary school period. These breaks occur between the seventh and eighth years, and again between the eleventh and twelfth; they mark the transition between the fluctuating atten-

tion of the primary grades, or sixth and seventh years, and the more sustained attention of the four years belonging to the intermediate period and again between this period and that of the grammar grades, or twelfth and thirteenth years, where the attention is under excellent control.

2. *Perception*: The a-test as used by the Chicago Department of Child-Study and Pedagogic Investigation\* affords one of the best measures for determining the correspondence between the rate of perception and age. Perception-time was found by subtracting the motor-time from the total time taken to mark out a's in the second series. In order to allow for error arising from undue shortening of perception-time in the case of many omissions, I have followed the practice of the Department of Child-Study, and in reckoning the length of perception-time have added to the actual time taken the amount of time it would have taken to mark out the a's which were omitted; i. e., perception is made comparable with motor-time on the basis of a perfect record.

The time-factor is not as satisfactory a unit in the determination of efficiency as is quality of the work done. Some of the strongest students tested had a slow reaction time, and others, who ranked low in the construction and judgment tests, surpassed them in rapidity of reaction. There is, however, a fair degree of correspondence between perception-time and age. The gain made in the eighth over the seventh and in the twelfth over the eleventh year is again noticeable.

TABLE II.  
*Perception-time in Seconds.*

Group Age.	Unretarded.			Retarded.		
	Av. Motor Time	M. V.	Av. Motor Perception.	Av. Motor Time.	M. V.	Av. Motor Perception.
6	219.5	33.2	393.6	174.1	...	...
7	144.1	28.7	226.4	82.3	...	...
8	99	12.7	155.5	56.6	3.5	70.
9	107.5	16.1	159.3	51.8	26.6	193.3
10	81	9.2	140.	59	...	180.
11	82.6	150.	20	67.4	9.1	141.2
12	81.	10.6	118.2	37.2	13.	120.5
13	76.	6.5	126.5	50.5	83.3	136.

\*MACMILLAN AND BRUNER. Op. cit.

The results (Table II) show a longer perception-time than that taken by the normal cases reported by the Department of Child-Study. This is perhaps due to a difference of emphasis; they may have laid stress upon speed, while we made the marking of a's the dominant requirement.

3. *Comprehension* (ability to comprehend a situation): The possibilities of studying mental growth are greatly enlarged if we use material rich in content and meaning in place of the discrete and—from the child's standpoint—uninteresting matter presented in the a-test. The material selected must not be too complicated to be comprehended by a six-year-old child, and must be deemed worthy of study by the oldest group. I chose for this test five pictures, all reproductions of paintings by artists of note. The first three were colored, and the last two were in black and white. The pictures in the order in which they were given were: *In Disgrace*, by Sigsbeekar—a pouting child sits with face to a corner, while a dog, the picture of dejection, crouches beside her; *In Summer*, by Van der Veer—six Dutch maidens sit in a circle on the grass, knitting; the landscape is typically Dutch; *Children of the Press*, by Thompson—poorly-clad children are shown in a crowded city street on a winter's day in the act of receiving their papers for the day's distribution; *The Goose Girl*, by Millet—too well known to need description; and lastly, *Embers*, by Eastman Johnson—an old man seated before a grate in which the fire is slowly dying.

The test was given in two forms: The first form required appropriate titles for each picture; the second, the formulation of pertinent questions. The first form gives an opportunity to study the development of interpretation and assimilation, the ability to unify discrete perceptions and to find meaning; the second tests the same capacity by an obverse method.

A. *Ability to supply titles*. It goes without saying that we did not ask the younger groups for the titles of the pictures. We asked them what they would like to call the picture. There was no time limit in this test. The children were given one picture at a time, in the order mentioned, and were allowed to study it until they found a name which suited them. The titles given varied from the mere enumeration of the objects

in the picture to appropriate phrases that displayed a complete apprehension of the artist's meaning. We have subsumed these titles under five rubrics: enumeration of objects, description of picture, unification in terms of action of principal figures, superficial unification in terms of relation to principal object and complete comprehension evidencing imaginative insight. "The lonely man," one of the titles given to *Embers*, illustrates what we mean by superficial unification; there is a partial comprehension of meaning, but a failure to see the significance of the dying fire pictured in conjunction with the old man. A very few in the twelfth and thirteenth group did comprehend the complete meaning, as titles like "The End" would indicate. "The Punishment," a title given several times for the first picture, shows complete comprehension of its meaning. The significance of this picture was grasped earlier and more frequently than that of any other.

With only ten children in each group and five rubrics it seemed unwise to distribute the results further by separate tabulations for unretarded and retarded. Had it seemed advisable to do this, the results would not have presented as many irregularities as appear in Table III.

TABLE III.

*Comprehension as Measured by Ability to Supply Titles.*

Group Age.	Enumeration of Objects Per Cent.	Description Per Cent.	Action. Per Cent.	In Relation to Principal Object Per Cent.	Complete Comprehension. Per Cent.
6	62	28	10	..	..
7	20	70	10	..	..
8*	16	28	40	12	..
9	8	42	28	20	2**
10	..	24	46	26	4**
11	6	10	38	36	10**
12	4	12	14	52	18
13	..	6	30	30	34

\*Four per cent. of this group failed to give a title.

\*\*These first instances of complete comprehension were interpretations of the meaning of the first picture. The artist has succeeded in expressing himself so clearly and forcefully upon a well known theme that even the younger groups succeeded in grasping the whole situation.

From these results it seems fair to say that: (1) No six-year-old child can be expected completely to comprehend a situation presented pictorially. (2) Neither can a seven-year-old child be expected to give an adequate title—a child of this age seems most interested in the appearance of the objects presented. (3) The eight-year-old children are inclined to interpret meaning in terms of action, and a few are able to give superficial titles. (4) In the ninth and tenth years, while descriptive phrases and activities of the objects are most likely to be considered, there is, in case of the first picture, complete comprehension of the artist's meaning. The descriptive titles, when given, are condensed into terse phrases, and no longer stretched out into disjointed sentences. (5) In the eleventh year the answers show a wide distribution, due mainly to the fact that the proportion of retarded pupils was greater in this year than any other (the table has not differentiated the retarded from the unretarded). This fact accounts for a small percentage of cases in both the eleventh and twelfth year that indicate only initial stages in comprehension of meaning. (6) In the twelfth year the majority of names given to the pictures would pass for titles, although a large proportion of them deal with superficial aspects. (7) There were many cases of complete comprehension in the thirteenth year. This imaginative insight could not be expected before adolescence.

*B. Ability to question.* To formulate in a pertinent question the main thought of a picture is more difficult than to find an appropriate title for it. There were numerous failures to frame any kind of a question. The questions asked have been classified as irrelevant when extraneous and irrelevant associations were called up, as minor when unimportant aspects of the picture were dwelt upon, and as essential when the main thought of the picture was indicated. The questions on essential features asked in the cases of the seventh and eighth-year groups were all with reference to *In Disgrace*.

*Comprehension as Measured by Ability to Formulate Questions.*

TABLE IV.

Group	Failure.	Irrelevant.	Minor.	Essential.
Age.	%	%	%	%
6	50	40	10	0
7	30	32	32	6
8	12	13	68	7
9	..	48	40	12
10	..	20	56	24
11	..	16	60	24
12	..	22	48	30
13	..	8	54	58

We note that in the sixth year there are many failures to frame questions, and that at best questions are likely to be irrelevant. In the seventh, and still more in the eighth year, the child's questions are relevant, but deal with minor aspects of the picture. There appears to be a fairly steady growth in the ability to frame essential questions through the remaining years.

I have selected a few questions from those asked regarding *Children of the Press* and *Embers* as illustrative of the growth with age in ability to comprehend meaning and formulate fitting questions. "What is that writing?" (The name of the artist) was asked by a six-year child. "Are the children going to school?" was asked by a seven-year old. Neither child had the slightest comprehension of the meaning of the picture before him and both questions were classed as 'irrelevant.' "What papers are they selling?" and "Is there a fire in the fireplace?" were asked by children in the eighth year. These questions are also typical of those which were classed as 'minor,' since they indicate only a superficial grasp of the artist's meaning. "Why do the children sell papers? Is it to make money for their parents?" and again "Is the old man thinking of his family who are gone and is he about ready to die?" were asked by a child of twelve and one of thirteen years. Questions which showed the fairly complete comprehension of meaning illustrated in these two examples were always classed as 'essential.'

4. *Memory*: Does memory develop during the elementary school period *pari passu* with mind? Investigators are not in complete accord. Allowances must be made for differences in method and material used, which would undoubtedly account for the many differences in result. The test with digits employed by Smedley has the advantage that it may be given in many ways, but it presents a serious disadvantage for six-year-old children, and even for an occasional normal seven-year-old child who may not have been to school. Familiarity with digits is gained very largely in the schoolroom. Several of the six-year-old children had difficulty with the six digits

we employed in our learning test. Neither would the digits seem worth remembering to children unless they could look upon the test as a game. A maximum of effort is gained only by interest, and we cannot measure the child's actual ability unless we can obtain sustained effort on his part. The material used by Binet in his tests seems best adapted to secure correct measures of development of memory.

I used two forms of material—pictures and sentences.

*A. Pictures:* The Binet method was varied in the following manner: Only one card was used, instead of a series of cards. This card measured 8 by 5½ inches. Upon it were arranged twenty pictures of unrelated objects, namely, a girl's head, a hen, a barking dog, a spool of thread, a feather, an automobile, a hammer, a Morris chair, a boy on a sled, a cow, a house, a hand, a pony cart, two camels, a bottle, a slipper, a shoe, a pan, a basket of puppies and a thimble. If I had presented only ten, or even fifteen, objects on the card, I should not have exceeded the memory span of some of my subjects.

The card was exposed for thirty seconds, then withdrawn, while the children were asked to give the names of as many of the objects as they could recall. The exposure gave them ample time to glance over the entire card. The interest felt in the experiment was evinced by the frequent request to see the card again, in order to find out what had been forgotten. There was greater effort on the part of the children than could possibly have been obtained had we used digits, letters or non-sense-syllables.

TABLE V.

*Memory Span as Measured by the Picture-Test.*

Group Age.	<i>Unretarded.</i>				<i>Retarded.</i>		
	Average No. Correct.	Max.	Min.	M. V.	Average Correct.	Max.	Min.
6	5.3	7	3	1.2	....	....	..
7	6.5	12	5	1.3	....	....	..
8	9.5	13	6	1.6	5.0	8	2
9	9.8	15	6	2.5	8.2	11	5
10	9.1	12	6	1.9	6.0	....	..
11	11.4	15	8	1.9	6.0	7	5
12	10.5	13	8	1.7	10.6	14	9
13	10.0	12	8	1.2	10.0	11	9

Here, as in the previous tests, the results reveal at a glance three well-marked stages. Children of six and seven do not seem able to retain much more than six objects, though occasionally a child will recall more. The average number retained by children of eight, nine and ten years seems to fall between nine and ten objects, though the exceptional child may recall as many as fifteen. As a matter of fact, the table does not show the gain of the ten-year over the nine-year group—four of the latter group came within one of the maximal record. The lower average for the tenth year is to be accounted for by the lack of any exceptionally good record like that made by one of the nine-year group. In the memory test the eleven-year group grades with the twelfth and thirteenth, instead of with the younger groups, as in the previous tests.

*B. Sentences:* Auditory memory was tested by the Binet method as modified by Whipple<sup>16</sup>. These sentences are arranged in a progressive series, beginning with two and ending with forty-two syllables. They have the same advantage that the pictures possessed over the material ordinarily employed in laboratories. We began with the second sentence for the six-year group; but with the older groups it was found to be economical of time to begin with the fourth or fifth sentence, since these were well beyond the range of possible error. Each sentence was given but once, slowly and distinctly, and the child was asked to reproduce it. During this test the child was always directed to sit with his back turned toward the experimenter.

The exclusion of the retarded group has brought out a very close correlation between mental growth and immediate memory. The substitution of a word, even though it did not distort the meaning of the sentence, a single insertion or omission, was counted an error. The figures, therefore, represent the number of sentences correctly reproduced. The number of syllables correctly reproduced can be roughly estimated by multiplying the number of sentences by two, though this rule will not hold entirely, especially for the longer records.

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<sup>16</sup>G. M. WHIPPLE. *Manual of Mental and Physical Tests*. Baltimore, 1910. p. 494.



TABLE VI.

*Memory Span as Measured by Sentences.*

Group Age.	<i>Unretarded.</i>				<i>Retarded.</i>		
	Av. No. Without Error.	Max.	Min.	M. V.	Av. No. Without Error.	Max.	Min.
6	7.8	10	6	0.8	....	....	..
7	8.4	10	6	1.0	....	....	..
8	9.8	11	8	1.0	8.0	8	8
9	10.1	13	8	1.4	9.0	9	9
10	10.9	14	9	1.2	6.0	6	6
11	10.9	13	10	1.2	9.5	12	8
12	13.5	16	11	1.5	10.5	12	9
13	14.5	16	12	1.5	10.6	13	8

Exceptions are due mainly to unevenness in two points of the series. The twelfth and seventeenth sentences are not as difficult as those immediately preceeding them, even though these sentences contain two more syllables than the eleventh and sixteenth. The twelfth and seventeenth sentences could easily be modified so that the series would be one of progressive difficulty. The twelfth sentence was found less difficult than the eleventh because of its simpler form, possessing fewer modifying words. The simplicity and familiarity of the idea presented by the seventeenth makes it range in difficulty with the eleventh and twelfth. Table VII shows the relative ease of the sentences.

TABLE VII.

*Relative Ease of Sentences Used for Testing Memory.**Percentage correctly reproduced.*

Sentence Age.	7th. Per Cent.	8th. Per Cent.	9th Per Cent.	10th Per Cent.	11th. Per Cent.	12th Per Cent.	13th. Per Cent.	14th Per Cent.	15th Per Cent.	16th Per Cent.	17th Per Cent.
6	60	50	40	0	0	30	0	0	..	..	..
7	90	70	30	20	0	30	0	10	..	..	..
8	90	100	50	40	0	40	10	10	..	..	..
9	90	90	90	50	20	60	0	10	..	..	..
10	100	100	80	70	20	30	40	20	..	..	..
11	100	70	50	40	10	70	40	20	..	..	..
12	100	90	70	100	30	70	50	50	10	10	50
13	100	100	90	80	10	70	70	50	30	30	70

There were so many complete failures on the fifteenth and sixteenth sentences that I did not try the seventeenth until the

twelfth year. But the results indicate that the seventeenth sentence is certainly no more difficult than the thirteenth or fourteenth. As previously stated, the errors were mainly cases of substitution, insertion and omission that did not destroy the meaning of the sentence. After the sixth year the ideas were correctly reproduced until the fifteenth and sixteenth sentences were reached.

*(Continued in the October number.)*