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**The Bulletin**  
of the  
**State Normal School**  
**Moorhead, Minnesota**

The Correlation of Secondary School Grades  
with Certain Standard Mental Tests as  
Evidence of General Intelligence

A Study by Edward Robert Collins, Ph. D.  
State Normal School, Moorhead, Minnesota

**Twenty-seventh Year**  
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## Introduction

This investigation is made in the assumption that there is some possibility of measuring mental factors by objective tests and of securing substantial evidence of the relations of these factors to each other. Correlations of mental tests and of general intelligence factors are becoming common studies. While based on the above assumption of possibilities, results of such investigations are as yet far from conclusive. To contribute to such researches, particularly in the field of secondary education, is the object of this study.

The problem of relations to general intelligence is complex. The term general intelligence itself is but a relative one to a great variety of functions. The problem of this study is one of the relations of tests or standards of measuring the complex usually denoted as general intelligence rather than a determination of its nature. In provisionally adopting the standings in school studies as perhaps the most reliable index to intelligence which is available for comparison in large numbers there is no supposition that the standard is infallible. In fact, one of the problems of this study is to discuss whether other tests may not be much more reliable than those usually made by means of the school studies. Light may be thrown upon the relation of the elements of general intelligence and upon our usual theories of values by tests of different functions involved in the whole. Educational problems of the value of general training and of the relation of different kinds of school work are also closely related to this study. We are seeking in correlational psychology evidences of laws and general tendencies, but we are constantly confronted by individual variations and differences. Another problem, then, involved in the study of correlations is the relative value of general tendencies and individual variations.

The study is undertaken with the recognition of many difficulties attending the securing of trustworthy results in the present state of the standard tests, the securing of accurate and sufficient data, and the choice in the variety of methods for refining the data. It is made interesting, however, by the great diversity of results so far attained in such investigations, and also by the value to education of the discoveries in this field.

The means of securing data were by laboratory methods for various phases of sense discrimination and by group methods for the various other mental tests performed upon high school and normal school students. The number of individuals tested is 525. Of these 240 were pupils from high schools, and 285 from a normal school. The latter, with the exception of one group, were of secondary rank in classification.

The supreme emphasis in this study is upon the discovery of relations existing between general intelligence as evidenced by standardized mental tests and general intelligence as rated by school marks. The objective tests chosen may be grouped roughly as sense discrimination tests, attention and perception tests, memory tests, association and logical tests, and tests of motor control. These are designated as Series I, II, III, IV, and V respectively in the presentation of data and comparison of results with other studies of this subject.

For the student of this subject a good explanation of correlations may be found in a text on mental measurements.<sup>1</sup> In brief, a + or positive correlation of 1.00 indicates a perfect correspondence between the functions or factors compared and a correlation, for example, of +.20 indicates a chance of only 20 in 100 or 1 in 5 of a high correspondence, and so on. A - or negative correlation indicates a lack of correspondence or a certain chance or proportion of opposite ranking. The factors measured have a possibility of varying positively all the way from 1.00, or perfect correlation, to zero, or no correlation, and negatively all the way from zero, or no correlation, to -1.00, or perfect opposition.

1. Whipple, "Mental and Physical Tests."  
Thorndike, "Educational Psychology."

## Section 1 Data and Comparison of Data SERIES I.

### Sense Discrimination Tests and Their Relation to School Grades.

Tests were prepared for discriminating shades of gray, length of lines, intensity of sounds, weights and muscular movements. A set of ten graded shades of gray, varying from one unit of difference from the standard to ten units, was arranged in pairs upon a circular card board and exposed conveniently through a slit in an exposure apparatus. One hundred comparisons were made and the observer graded in percentage of right choices. The range of differences in the ten units was sufficiently great to allow of discrimination on the part of the poorest observer and also sufficiently small to test the best. Although the observer was tested over the whole field and not alone on that part of it in which he could discriminate about seventy-five per cent of the differences correctly, yet the test serves as one by which to evaluate the discriminative ability as compared with that of other observers. The discrimination of length of lines was tested by the method of choice when two lines were presented on cards end to end. The series was of ten lines differing by 1 mm. each and the standard was 10 cm. Discrimination of intensity of sounds was made by the Will-Young audiometer. The units of difference used were 2, 1 ½, 1, ½, ¼. The test in weight discrimination was made by a graded series of weights varying by 20, 15, 10, 7, 5, 4, 3, 2, and 1 grams from the standard of 55 grams. The discrimination of distances by muscular movement was tested by free arm movements in pushing the index finger over a glass rod in repetition of a trial movement over the same, the subject being blindfolded. The scale of distances was 25, 40, 5, 30, 15, 35, 20, 45, 10, and 25 cm. The standard number of trials for each of the above tests of discrimination was one hundred except for weight which was ninety.

The foregoing tests of sense discrimination were made upon seventy-five junior normal school students. The results for the sixty-six girls are tabulated below.

Table I.

#### Correlation of sense discrimination tests with grades in studies.

1. Discrimination of shades of gray with grades in studies.....	+ .13
2. Discrimination of length of lines with grades in studies.....	+ .29
3. Discrimination of intensity of sounds with grades in studies.....	+ .03
4. Discrimination of weights with grades in studies.....	- .11
5. Discrimination of distance by muscular movement with grades in studies .	+ .16
6. Average sense discrimination with grades in studies.....	+ .05

Table II.

#### Correlation of sense discrimination with studies by tertial grouping for 66 fourth year normal school young women.

	I.	II.	III.
Average mark in studies.....	.889	.833	.728
Average mark in shades of gray.....	.805	.785	.786
Average mark in studies.....	.889	.833	.728
Average mark in hearing.....	.80	.752	.751
Average mark in studies.....	.889	.833	.728
Average mark in length of lines.....	.901	.883	.834
Average mark in studies.....	.889	.833	.728
Average mark in muscular movement.....	.94	.93	.922
Average mark in studies.....	.889	.833	.728
Average mark in weights.....	.877	.881	.891
Average mark in studies.....	.889	.833	.728
Average mark in average sense discrimination.....	.80	.799	.797

**1. The Correlation of Brightness Discrimination and Standards for General Intelligence.**—Numerous other correlations have been found in this field of sense discrimination. Gilbert<sup>1</sup> concluded that young children did not discriminate well and that there was no decided relation between visual discrimination and intelligence:

Spearman<sup>2</sup> who has calculated many correlations in the field of sense discrimination and intelligence found in 24 village school children a correlation of  $+0.58$  between brightness discrimination and common sense, school cleverness, and general intelligence. For a group of high class preparatory school boys,  $+0.13$  'raw' correlation. These are extremely high indexes of correlation and need checking by further investigations.

These last named results are discussed later, but the higher coefficients finally secured by Spearman in this and other tests of sense discrimination are calculated through correction and refinement of 'raw' correlations. However, the 'raw' correlations found by him seem high in comparison with other results.

Even the most reliable coefficient found in this study, or that in Table I, is of no considerable scientific reliability or positive value because of the large P. E., or probable error, in proportion to the size of the coefficient. A small group of boys of the same classification so tested as to give a negative coefficient of considerable amount. For the group of sixty-five young women there appears a correlation of slight amount when tested by a tertial grouping. There is a positive correlation here of small amount in this study.

**2. Discrimination of Lengths of Lines and Correlations.**—The correlation for the entire group of sixty-five young women is  $+0.29$ . The correlation for a smaller group was  $+0.17$ . The most probable relation here is a very slight positive one of some reliability.

This factor was not correlated by Thorndike<sup>3</sup> with academic records for young women, but for twenty-five high school boys he gives a correlation of  $-0.01$ . For the young men tested in the above studies the coefficient was  $+0.081$  with a probable error too large to give it much reliability.

Gilbert finds discrimination of length of lines slightly better in bright than in dull or medium children except at the ages of 9 and 13.

Percentiles show also a considerable positive correlation for the group of young women in this study when ranked by the tertial method.

**3. Discrimination of Intensity of Sounds and the Relation to General Intelligence Standards.**—Discrimination in sound has usually been tested in pitch. The test here used is one of intensity. The correlation of this factor with standing in studies was  $+0.03$ . A group of twenty-two young women correlated in this ability and in studies  $+0.14$  and the boys of this class,  $+0.09$ .

There are many studies of acuity of hearing but the author of this paper has found no study of this factor of discrimination of differences in intensity between two sounds and its relation to general intelligence except the one mentioned in a following paragraph. Pitch discrimination is an entirely different factor from intensity discrimination, but it is of interest to note here in comparison the estimate of no correlation for pitch discrimination and intelligence (Seashore),<sup>4</sup>  $+0.94$  (Spearman)<sup>5</sup>, and  $+0.27$  (Whipple).<sup>6</sup> Spearman's result is a 'corrected' correlation. His methods are being reviewed at present by several with diverse opinions as to the validity of such high correlations. As stated in comparing the correlations of the factors of intensity and pitch with general intelligence there is no assumption that the two are at all closely related to each other or to intelligence. There may be relation or not. One student<sup>7</sup> of the subject in working upon the relation of discrimination of pitch and discrimination of intensity has so far found no decided correlation with each other or with intelligence. Another<sup>8</sup> finds the remarkably high correlation of  $+0.70$  for boys and  $+0.63$  for girls between pitch discrimination and general intelligence, when general intelligence is estimated by the teacher on brightness and reliability.

1. Researches on mental and physical development of school children, Yale Studies 2: 1894, 40-100, and Researches upon school children and college students—Iowa Studies 1: 1897, 1-39.
2. General intelligence objectively determined and measured, American Journal of Psychology 15: 1904, 201-293.
3. The relation of accuracy in sensory discrimination to general intelligence, American Journal of Psychology, 20: 1909, 364-369.
4. Hearing ability and discriminative sensibility for pitch, Iowa Studies 2: 1899, 55-64.
5. Op. cit.
6. Mental Measurements.
7. Study not yet published.
8. Effect of training in Pitch Discrimination—Franklin O. Smith, Psycho. Mon., Vol. 16 No. 3.

Nothing very definite appears in this study in the way of a positive correlation between intensity discrimination and intelligence as estimated by grades in studies. The attached percentiles of the group method show some little positive relation.

**4. Discrimination of Weights.**—The test given to young women showed no correlation with studies, all coefficients being slight, negative quantities with large P. E. The few boys tested gave a correlative result of  $+0.51$ , P. E. large.

Gilbert<sup>1</sup> and Whipple<sup>1</sup> found no correlation in this field while Spearman<sup>1</sup> gives a 'corrected' index of  $+0.44$ . There is probably no marked relation at all for normal individuals. The Binet tests involve the use of weights but the subject is rated more as to intelligence in method of handling them and in gross discrimination rather than close, keen discrimination. Further, the test is more one of immature judgment of discrimination for young children.

**5. Discrimination of Distances by Muscular Movements.**—The correlation here with studies was  $+0.16$  for sixty-six young women of junior standing in normal school. The small group of young men showed the remarkably high correlation of  $+0.49$ , P. E.  $.16$ , and again this is very close to the correlation of  $+0.51$  in weight discrimination. When this comparison is made, the results, so far as they go for these groups, seem to be corroborative of a distinct difference in the two sexes in respect to discrimination in the muscular sense. The cases, however, are too few to draw very definite conclusions. This will be further discussed under tracing or motor control. Here again is a test which is probably unusual and no data are available for comparison. It is a test of the muscular sense and results are possible of comparison with the test in weight discrimination.

**6. Acuity of Sight.**—This test is introduced here only for the sake of comparison with the discrimination tests of vision and for the interest there may be in its relation to progress in studies. But mere acuity is not a safe test for defects of vision and hence but brief comparison is made with relations discovered between defective vision and intelligence. The correlation of the acuity index with studies for those tested was found to be  $-0.26$  with a P. E. of  $.13$ . Hence of some slight probability. For comparison in other factors of vision the same group correlation for discrimination of brightness and studies was  $-0.02$ , and for discrimination of length of lines and studies,  $+0.17$ . A negative correlation for acuity here in such a group as these students is, in the writer's opinion, due to the use of lenses until the adaptation modifies any positive relation which might exist between acute vision and satisfactory progress in studies, or lack of it and slow progress in school work. It is a common fact from investigation that a large per cent of children are defective in vision and that myopia increases rapidly with the amount of school work until the number in secondary schools and higher institutions approximates one-third of the pupils in higher classes, while defective vision of some sort is claimed by many to be very much higher.

In his investigation of the more direct relation to intelligence Van Bervliet<sup>2</sup> found an acuity correlation determined upon the ten brightest and the ten dullest of three hundred university students in which he relates mean variation in a series of tests of acuity as varied by attention and the average distance at which the test was visible. The first factor is the numerator of a fraction, the second, the denominator. The relation between the ten brightest and the ten dullest when reduced to a common denominator was  $19-1000$  to  $62.5-1000$ .

Smedley<sup>3</sup> tested 4,765 pupils, finding 35 per cent of all defective, 37 per cent of the girls and 32 per cent of the boys. Even 32 per cent of 6-year-old pupils were defective, the per cent at different ages increasing rapidly until from 10 to 14 it decreases, due, he concludes, to the improved health of this period of growth.

1. Op. cit.
2. La Mesure de l'intelligence, Journal de Psychologie I: 1904, 225-235.
3. Child Study in Chicago, Report of Commission of Education, 1902, 1: 1095-1115.

TABLE III.

Correlation between school standing and defective sight.<sup>1</sup>

Age		No. Tested	Per cent Defective
8	At and above grade.....	296	40
	Below grade.....	65	32
9	At and above grade.....	245	47
	Below grade.....	98	34
10	At and above grade.....	220	39
	Below grade.....	144	48
11	At and above grade.....	172	39
	Below grade.....	213	43
12	At and above grade.....	185	34
	Below grade.....	179	40
13	At and above grade.....	206	27
	Below grade.....	167	33
14	At and above grade.....	321	32
	Below grade.....	129	33
15	At and above grade.....	436	32
	Below grade.....	85	34
16	At and above grade.....	256	31
	Below grade.....	219	32
17	At and above grade.....	178	30
	Below grade.....	161	33

The relation of defective vision and school standing is shown in Smedley's table. The larger per cent of defects among the pupils at and above grade in early school life is probably due to the greater use of the eyes by these pupils at a time when they are yet poorly adjusted. This is confirmed by his further investigation in which it was found that the more advanced pupils in this case had started to school younger and this longer time in school is supposed to account for the advanced standing and for the increased per cent of defective eyes. While one would expect acuity of vision to aid very materially in advancement in studies one might also expect this superior acuity to be rendered defective by use with the better students. But the results here on large numbers is convincing that there is a slight positive correlation between acuity and progress in studies from 10 years of age up to 18. Van Bervliet's results indicate that there might be also better acuity in the more intelligent of university students.

**7. Acuity of Hearing.**—Results of tests in acuity of hearing in this study correlated with school grades +.17. This is a higher correlation than was evidenced for the same individuals in the tests of discrimination of intensity of sound. This was so low as +.03. As explained in the following paragraph, the relation of ability to hear, or acuity, seems much closer to ability to progress in studies than would mere discriminative ability of differences in sound. Again, as shown from the individual records, acuity and discrimination of differences within a field where each subject is able to hear do not necessarily correlate to any high degree. In other words, an individual may not hear well but yet may distinguish the differences of the sounds he does hear very well and vice versa.

According to Seashore<sup>2</sup> there is no indication from his test that bright children hear better than dull children. But the general trend of the results of investigations shows a considerable degree of positive correlation between defective hearing and poor school work. A table from Smedley's<sup>2</sup> report is inserted on this point also. The considerable literature on this subject will not be examined here. The practical bearing of the relation between acuity of hearing and results in school work is large, but the relation between acuity and native general ability as it may show itself in school studies is not so apparent.

1. Smedley, Rept. Com. of Ed., 1902, 1, 1112. Table XI.  
2. Op. cit

TABLE IV.

Hearing and School Standing—Pupils Having One or Both Ears Defective to 4 Points Below Normal.<sup>1</sup>

Age		No. Tested	No. Defective	Per cent Defective
8	Above grade.....	138	25	18.1
	Below grade.....	85	22	25.8
9	Above grade.....	107	18	16.8
	Below grade.....	141	32	22.6
10	Above grade.....	101	6	5.9
	Below grade.....	178	40	22.4
11	Above grade.....	77	10	12.9
	Below grade.....	205	48	23.4
12	Above grade.....	118	10	8.4
	Below grade.....	242	45	18.5
13	Above grade.....	145	20	13.7
	Below grade.....	213	34	15.7
14	Above grade.....	248	32	12.9
	Below grade.....	176	36	20.4
15	Above grade.....	164	32	19.5
	Below grade.....	145	32	22.0
16	Above grade.....	93	12	12.8
	Below grade.....	239	38	15.9
17	Above grade.....	61	9	14.7
	Below grade.....	162	27	16.6
18	Above grade.....	75	13	16.0
	Below grade.....	91	23	25.2

**8. Muller-Lyer and Poggendorf Illusions.**—Since illusions of perception are a quite universal factor in normal life the correlation of these with intelligence should be as significant as such correlation of other phases of perception with the reservation as to whether amount of illusion should be in proportion to intelligence. For the Muller-Lyer illusion tested on a small group of normal school juniors the index was +.30, P. E. .21. The Poggendorf illusion tested on the same general group gave the much higher correlation index with studies of +.46, P. E. .17. The above individuals were graded on the positive amount of illusion present. The indices therefore indicate some positive correlation of amount of illusion with rank in school studies or general intelligence so rated, but nothing reliable can be judged from these few cases. Exhaustive studies of these illusions show no correlation with intelligence. "Comparison reveals no constant tendency for the illusion to vary with the 'brightness' of the children".—Seashore<sup>2</sup>.

Williams<sup>3</sup> found the Muller-Lyer illusion to be stronger for children than adults but due as she thought to unprejudiced answers more than to maturity. "The illusion was found not to vary with intelligence."

**9. Sense Discrimination in General.**—The most important consideration here is the relation between sense discrimination in general so far as tested and general intelligence as evidenced by school grades. When the average standing, estimated upon a percentage basis, in the five discrimination tests proper (tests in grays, length of lines, intensity of sounds, weights, and muscular movements) is compared with the average of grades in studies for each individual the correlation index is +.05.

Though this indicates some probability of no correlation or none of any considerable positive quantity, Table I is more significant as to slight correlations of different phases of sense-discrimination with studies as an index of general intelligence. The positive relation as judged from the indices there given from these tests is but slight. Were there a high degree of positive correlation it must certainly have appeared to a greater

1. Smedley, Rept. Com. of Ed., 1902: 1, 1114. Table XIV.  
2. Visual perception of interrupted linear distances, Iowa Studies, 2: 1899, 1—35.  
3. Normal illusions in representative geometrical forms, Iowa Studies, 3: 1902, 38—139.



degree than here indicated. This will be discussed under general conclusions of this study.

**10. Individual Differences.**—It is not the purpose of this investigation to make a thorough study of individuals and of individual variations by standard methods. But in the study of individual records the lack of correlation is quite as noticeable as its presence. These variations have long been a subject of interest, and comparisons of ranking in different traits have sometimes been made as an illustration of the variance. The relations of the individuals in each trait are, of course, not at all proportional to the position in the series but extremes of position in the two series may indicate a considerable difference in the standing of the individual in the two traits.

The discussion of this subject is deferred until the general discussion in Section II, but the comparative ranking in the average of sense discrimination tests and in studies for a group of twenty-two young women of junior rank in normal school is given following. The Roman numerals indicate rank in sense discrimination (I) and rank in studies (II). The letters represent the individuals.

TABLE V.

## Comparative Ranking in Average Sense Discrimination and in Studies.

	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.	O.	P.	Q.	R.	S.	T.	U.	V.	
1.	.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
11.	.....	14	20	7	8	4	11	2	22	19	18	21	15	3	9	1	12	6	13	5	10	17	16

## SERIES II.

## Attention and Perception Tests in Their Relation to Grades in Studies.

Group studies are open to many variations and sources of error which may be more carefully controlled in the laboratory, but laboratory tests are sometimes impracticable for the collection of data on a large scale. Much schoolwork is group work, and it may not be unfair to compare results of certain group tests with school standings secured largely through the group method of instruction. Some serious limitations to the mental tests are due to the single or few trials by which the subject is tested, the lack of control of conditions, and the difficulty of securing proper material for the test. The tests selected for this series were such as are commonly used for attention and perception factors. They and others of the following series were chosen from standardized blanks prepared at Columbia University. The cancellation tests were those of "marking out A's" and "marking misspelled words." Besides these "marking familiar English words," was used to some extent. The material and the method of these are rapidly becoming standardized<sup>1</sup>. Samples of these and the tests of the following series also are inserted in the appendix to the original copy of this study.

The grading was upon the factors of accuracy and speed combined into a general efficiency mark by the arithmetical mean where accuracy had been graded by the formula  $a = \frac{v-w}{v+w}$  and speed by the ground covered in the allotted time. In a few instances the general efficiency was calculated by the formula<sup>2</sup>  $E = S. A.$  This method penalizes great differences and low standings where present in the two factors of accuracy and speed and it also distinctly lowers all ratings. It is used by some, and is used here in a few of the correlations by way of comparison. When used it is designated by E.

Correlations are calculated by the product moments in the Pearson method of correlation. Other simple methods of illustrating the correlation are by the tertial grouping according to rank in studies and a comparison of the averages for these groups with the averages of the same groups in the particular test, and the plotting of results in curves.

The tests of this and the following series were given to 445 pupils of secondary rank in high school and normal school.

1. Committee of American Psychological Association in Psychological Review Monograph Supplements, 13: 1910, No. 1 or Whole No. 53 and Subcommittee of American Psychological Association in Psychological Review Monograph Supplements, 13: 1911, No. 5 or Whole No. 47.

2. Explanation in Whipple, Mental Measurements.

TABLE VI.  
Correlation of "Marking Out A's" With Grades in Studies.

Cases	Classification	r or cor.
335	Total pupils, tested in two of three schools.....	+.05
82	Total pupils tested in third school.....	+.29
83	Third and fourth year girls.....	+.41
88	First year girls.....	+.12
88	First year girls.....	+.17 ac
90	First and second year high school boys.....	+.26
48	Second year normal school girls.....	+.08 ac

Twelve smaller groups, so tested as to eliminate factors of sex and degree of advancement, with two exceptions showed a considerable degree of positive correlation but the probable error was too large in most cases to admit of their consideration.

TABLE VII.

## Correlation by Quartiles of Crossing out A's With Studies.

	I.	II.	III.	IV.
Average mark in studies.....	.868	.806	.762	.678
Average mark in crossing A's—accuracy.....	.938	.935	.906	.908
Average mark in studies.....	.868	.806	.762	.678
Average mark in crossing A's—speed.....	.734	.731	.724	.727
Average mark in studies.....	.868	.806	.762	.678
Average mark in crossing A's—average A & S.....	.841	.833	.837	.821
Average mark in studies.....	.868	.806	.762	.678
Average mark in crossing A's—efficiency by products A & S.....	.689	.683	.693	.646

The above is a table of averages for each quartile of a group of 88 first year normal school young women. To show the results of other studies as indicating correlations here of even slighter positive value or of a negative value the following three are briefly quoted before the discussion of results as tabulated above.

Whipple<sup>1</sup> gives a study of his own on 50 grammar school boys in which he finds no correlation between accuracy in this test and class standing, and an inverse correlation of  $-.32$  between general efficiency of the test and class standing.

Winteler's<sup>2</sup> table as to the number of letters cancelled in crossing three and in crossing five letters shows a superiority of the intelligent, but his general conclusion is that on the whole the unintelligent show no inferiority in the steadiness of attention throughout the series.

Wissler<sup>3</sup> in a study of Columbia students found for 242 cases a correlation of  $-.09$  for marking A's and average standing in studies, but seniors were slightly better than freshmen and women than men.

In this study there is evidence of some positive correlation between ability in marking A's and standing in school studies. The older normal school young women show a higher correlation than the younger ones of the first year class, and the boys of the first and second years also have a higher coefficient here than have the girls of the first year and lower than that of the third and fourth year young women.

The attached tables show the correlation by grouping and averages, and also the differences in correlation for the factors of accuracy, speed, efficiency by average, and efficiency by the products method for a group of 88 first year girls.

TABLE VIII.

## Correlation of "Marking Misspelled Words" With Grades in Studies.

Cases	Classification	r or cor.
335	Total pupils tested in two of three schools.....	+.18
82	Total pupils in third school.....	+.23
81	Third and fourth year girls.....	+.13
88	First year normal school girls.....	+.29
88	First year normal school girls.....	+.24 ac
90	First and second year high school boys.....	+.12

ac. Accuracy only instead of general efficiency from both accuracy and speed.

1. Op. Cit. A test of 50 grammar school children not yet published in full.

2. Correlation of mental and physical traits, Psychological Review Monograph Supplements, 3: No. 6, 1901.

3. Experimentelle Beitrage zur einer Bagabungslehre, E. P. 2: 1906, 1—48, 147—247

Small groups classified to eliminate differences in degree of advancement, sex, and school conditions gave no correlation of reliability on account of small numbers. Most groups showed a positive relation, however.

The test as compared with the simple A test in cancellation certainly involves more of knowledge in discrimination and formed associations for word forms. But the correlation, as would be expected from the greater similarity to school work, is higher and more consistent.

TABLE IX.

Correlation of Misspelled words With Studies by Tertial Grouping for 88 First Year Normal School Young Women.

	I.	II.	III.
Average mark in studies.....	.857	.786	.697
Average mark in misspelled words, accuracy.....	.824	.789	.696
Average mark in studies.....	.857	.786	.697
Average mark in misspelled words, speed.....	.896	.869	.789
Average mark in studies.....	.857	.786	.697
Average mark in misspelled words, average.....	.843	.832	.743
Average mark in studies.....	.857	.786	.697
Average mark in misspelled words, efficiency.....	.712	.692	.53

TABLE X.

Correlation of "Familiar English Words" With Grades in Studies.

Cases	Classification	r
88	First year normal school girls.....	+ .22
83	Third and fourth year girls.....	-.06
83	First and second year high school boys.....	+ .43

Perception and Attention Factors in Relation to General Intelligence.—

These tests of cancellation have been used by some as rate of perception or reaction time tests. Discrimination as a factor of sense perception is considered in the first series of this study. Quickness and accuracy of perception are usually considered by the practical mind as qualities applicable in any direction. Ability in such a test as that of cancelling familiar English words distributed among nonsense syllables would be to such persons evidence of ability to perceive accurately and quickly in studies or in every day affairs of life. Judged in this light the slight correlation between studies and the tests in this series would give little support to such a practical general ability, except that the elements of the test seem to approximate those of school studies. This similarity of elements may explain the higher correlation of the marking of misspelled words and familiar English words with studies than the marking of A's with studies.

Bolton<sup>1</sup> in discussion of memory in children makes in his conclusion the following statement in regard to attention: "Intellectual acuteness, while more often accompanied by a good memory span and great power of concentrated and prolonged attention, is not necessarily accompanied by them."

Present day authors quite commonly call attention the center of consciousness. Wundt<sup>2</sup> makes the statement that "intelligence" is a complex and indefinite term. He says that if it be analyzed into elementary processes we come to "the apperceptive process in which, on the objective side, a certain contents becomes clear in consciousness and on the subjective side, certain feelings arise which as referred to any given content, we ordinarily term the state of attention."

Pillsbury<sup>3</sup> makes attention a central factor in perception and association processes of all sorts, discussing experimental methods for testing attention, and the fundamental relation of attention to intelligence.

Burt<sup>4</sup> concludes that in the newer coordinations and complex situations of the more recent human development the directing agent is attentive consciousness. And in this sense we may agree that so-called "voluntary" attention is of all recognized psychological process, the essential factor in "General Intelligence."

1. Memory in children, American Journal of Psychology, 15: 1891, 362—380.

2. Principles of Psychology—Titchner Translation Vol. 1, 1904.

3. Attention, 1908.

4. Experimental tests of general intelligence, British Journal of Psychology, 3: 1910, 94—177.

From one point of view one is surprised when such results are quoted as those of Bolton. From another point of view the profuse apperceptive data of intelligence may be but very slightly related as a whole. The fact that attention tests show no higher correlation with intelligence may be due more to the relation of the material with which attention is concerned than with the function itself as a process.

Spearman<sup>1</sup> in historical review of the work on correlation of this sort states that in many instances attention and ability are contrasted instead of being identified. The preponderance of experimental evidence, however, is opposed to any high correlation. The discrepancy between points of view in the psychology of the process and the experimental tests where such discrepancies do exist may be chiefly one of definition of terms. But this difference does not seem to exist in most present day psychologies and in pedagogical literature. It is quite common to say that there are a number of conditions both objective and subjective affecting the clearness with which an object appears in consciousness and hence the relation between such tests of attention as the above and the objective and subjective conditions of attention in securing results in school studies may not be very close. The material and conditions may be quite different.

## SERIES III.

Memory Tests and their Relation to School Grades.

Two tests were used; one test of geometrical figures of various modifications of squares, which were used by the method of recognition of the first series presented for study when represented for identification among others in a second series, and a second test of a set of irregular and unfamiliar geometrical figures associated in a meaningless way in each case with a word which had certainly not been previously associated with the figures by the subject tested. The lists were Columbia lists. The first is chiefly a test of a visual imagery type of memory and the second of a visual imagery and association type. In tables XI and XII are the results for the two different types.

TABLE XI.

Correlation of Memory of Geometrical Forms With Grades in Studies.

Cases	Classification	r
335	Total pupils tested in two of three schools.....	+ .07
81	Third and fourth year normal school girls.....	No cor
88	Third and fourth year normal school girls.....	+ .03
56	First and second year high school boys.....	-.03
48	Second year normal school girls.....	+ .24

TABLE XII.

Correlation of Memory of Irregular and Unusual Geometrical Forms and Associated Words With Grades in Studies.

Cases	Classification	r
82	Total third school.....	-.15
88	First year normal school girls.....	+ .11
48	Second year normal school girls.....	-.12
34	Fourth year normal school girls.....	+ .11

TABLE XIII.

Correlation of Memory of Geometrical Figures With Studies by Tertial Grouping for 88 First Year Normal School Young Women.

	I.	II.	III.
Average mark in studies.....	.857	.786	.697
Average mark in memory geometrical figures.....	.381	.298	.352
Average mark in studies.....	.857	.786	.697
Average mark in memory figures and associated words.....	.839	.781	.673

1. Op. cit.

Of the entire list of correlations in tables XI and XII tabulated in this series all are too small in proportion to the number of cases to be of any considerable reliability, the probable error being greater than to entitle the correlations to scientific value. If, therefore, they indicate anything, they indicate that the correlation is small or practically no correlation at all. The 335 cases are sufficient to indicate any considerable degree of correlation did it exist regardless of classification of subjects. Such a number of cases might indicate with a slight degree of certainty a correlation of  $+.07$  when judged by the criterion that the correlation be at least twice as large as the possible error. This it barely does. One other case does the same. Judging the data as a whole, the relation between the standings in memory tests and school grades is very slight and uncertain, or, in other words, there is probably no correlation at all or only a slight one for memory of this type.

Bolton<sup>1</sup> in a study some years ago (1891) upon memory in children concludes: "The memory-span increases with age rather than with growth of intelligence. Experience in this matter is a better school than books." And as already quoted<sup>2</sup> he says: "Intellectual acuteness, while more often accompanied by a good memory-span and great power of concentrated and prolonged attention, is not necessarily accompanied by it." And again: "The girls have better memories than the boys."

Wissler,<sup>3</sup> found a table of correlations of memory with reaction time and with different types of memory, even, in which the correlations were very small, not being pronounced in any case unless between auditory and visual memory. Class standing and logical memory and class standing and auditory memory gave correlations of  $+.19$  and  $+.16$  respectively in his tests upon college students. The general conclusion was "that the markings of students in college classes correlate with themselves to a considerable degree but not with the tests made in the laboratory." While Latin and mathematics, for example, correlated  $+.58$ , logical memory and mathematics gave the index  $+.11$  and logical memory and Latin  $+.22$ , and as already quoted the correlation of logical memory with class standings as a whole was only  $+.19$ .

Winch<sup>4</sup> in a test of auditory memory in school children states two results pertinent to this discussion; "School proficiency as measured by age and standard and position in school appears to be generally accompanied by good memory of the kind we are here testing, though not invariably so." . . . "That when the comparison is narrowed to children of the same grade or standard, it is still found that memory is positively related to position in school, though, as we should expect, with less exactitude than when a wider range of age and standard of school proficiency is taken for comparison."

In the second study<sup>1</sup> he concludes "that pure memory is remarkably improved by practice" and "that there is generally a direct relation between 'good memory' of this kind and intellectual proficiency, so far as this can be measured by success in school studies."

Burt<sup>1</sup> finds high correlations between estimated intelligence and memory by tests. Experiments upon children by groups of bright and dull have given results in favor of the brighter, as for example, with Winch,<sup>1</sup> Binet,<sup>5</sup> and Smedley.<sup>6</sup> Neumann<sup>7</sup> is quite certain that the brighter will always average better in memory efficiency in memory tests. Smedley's tables<sup>8</sup> show a uniformly better memory rating for pupils above grade when tested in the ages from 9 to 17.

Ebbighaus, whose work in testing memory seems to have resulted in doubt as to improvement in a general way by practice on a particular exercise, and who has been quoted and supported by James,<sup>9</sup> Bolton, F. E.,<sup>10</sup> and others, presents a table<sup>11</sup> of results on three groups of bright, average, and dull which shows very slight variation and hence very slight, if any, relationship.

1. Op. cit.

2. Quoted in relation to attention.

3. The correlation of mental and physical tests, Psychological Review, Monograph Supplement, 3: 1901

4. Immediate memory, British Journal of Psychology, 2: 1906, 52-57 and 127-134.

5. Attention et adaptation A. P. 6: 1899-1900, 248-404.

6. Child Study in Chicago, Rep. Com. Ed., 1: 1902, 1095-1138.

7. Die experimentelle Padagogik 1: 1905, 35-101.

8. Op. cit., 1135.

9. Talks to Teachers.

10. Principles of Education.

11. Über eine neue Methode zur Prüfung geistiger Fähigkeiten und ihre Anwendung bei Schulkindern, Z. P. 13:1896, 401-457.

Thus experimenters are very much in disagreement as to the amount of correspondence between ratings in memory tests and class standings. The preponderance of evidence when comparisons are made upon the brightest and dullest of groups seems in favor of considerable difference in memory ability.

When a curve made of the tertial grouping is examined, for the relation of ability in the memory tests as compared with ability in studies, it also shows a slightly better memory test for the best in studies as compared with the poorest in a group of 88 normal school young women, but the middle group is much lower in average in the memory test than is the third group. It is probable that the kind of test here used, which is one of visualization, may be the explanation of the slight relation between these memory tests as a whole and marks in studies. But the second test which is a test involving new associations also, showed only a slightly higher positive relation for the group represented in the curve and showed no higher coefficients as far as tested in other groups, even indicating a considerable negative relation for one normal school class of forty-eight.

A logical memory test, or memory of ideas, should give better results for positive relation. As already quoted, Wissler found a correlation of  $+.19$  for such a test with standings in studies and no relation between logical memory and rote memory.

#### SERIES IV.

##### Association and Logical Tests and Their Relation to Standings in School Studies.

The tests selected here were addition tests, opposites, and a test which is a combination of genus-species test and a reasoning test. The first are simple in which speed is a large factor as evidence of complete and accurate control. The opposites are not so definitely fixed as the first for the subject, and the logical test is least so as a matter of associations. The last test, in particular, would approximate many tests of the school in determining class standings.

The computation tests are graded on efficiency of both speed and accuracy and the opposites are also so graded, but the mark is almost identical with accuracy in the latter test, as almost all finished in the time allotted. The logical test is graded on accuracy as the directions were "Do not hurry, but do your best work." This test and this grading then more nearly resemble tests in school subjects.

TABLE XIV.

##### Correlation of "Addition Test" and Grades in Studies.

Cases	Classification	r
335	Total pupils tested in two schools.....	$+.26$
81	Third and fourth year girls.....	$-.08$
88	First year normal school girls.....	$+.23$ ac
56	First and second year high school boys.....	$+.08$
48	Second year normal school girls.....	$+.24$
18	First year high school girls.....	$+.28$
18	Fourth year high school boys.....	$+.26$

A positive correlation of about the same degree as above indicated persisted quite regularly and consistently even in the small class groups.

TABLE XV.

##### Correlation of "Addition Test" (long List, as Endurance Test Also) and Grades in Studies.

Cases	Classification	r
88	First year normal school girls.....	$+.35$ ac
48	Second year normal school girls.....	$+.24$
33	Fourth year normal school girls.....	$+.15$



TABLE XVI.

## Correlation of Addition With Studies by Tertial Grouping for 88 First Year Normal School Young Women.

	I.	II.	III.
Average mark in studies.....	.857	.786	.697
Average mark in addition, ac.....	.93	.933	.884
Average mark in studies.....	.857	.786	.697
Average mark in addition, ac. and speed.....	.769	.759	.708
Average mark in studies.....	.857	.786	.697
Average mark in addition (endurance) ac.....	.837	.735	.717
Average mark in studies.....	.857	.786	.697
Average mark in addition (endurance) ac. and s.....	.713	.704	.683

The correlations of addition tests with grades in studies are consistent for the groups enumerated in tables XIV. and XV. of this study. While the coefficients are not high the relation indicated is, as stated, fairly constant and certain. This may be due to the fact that such work is under control by any ordinary school pupil largely in proportion as he has been a good student, and therefore, may be due to a considerable extent to his school experiences. There would seem to be reasons for expecting some considerable relation between the quickness of reaction and results in securing school marks because of the favorable impression this quickness might make in school ratings. However, by reference to the table it may be seen that whether the ability be estimated by accuracy or by an efficiency rating from both accuracy and speed the correlations are quite constant.

As an endurance test the longer addition test of fifteen minutes should evidently correlate to a considerable degree with results in school studies. This it does. The test was not given to all students but is evidently a desirable one in estimating the subject's ability so far as that can be done by any single test. The advantages of this test are further discussed in Section II. under "Validity of Mental Tests."

Fox and Thorndike<sup>1</sup> find an addition test to correlate with a multiplication test  $+ .75$ , with a fraction test  $+ .19$ , with a second and similar fraction test  $+ .44$ , and several other arithmetical processes correlated from  $+ .20$  to  $+ .58$ .

With such indices of correlation between arithmetical processes one would hardly expect any very considerable correlation between addition tests and studies in general. Aiken, Thorndike and Hubbell,<sup>2</sup> by a method of comparing from a first test what the lowest of a group did in comparison with the average, then calculating what they should do in a second test if correlation were perfect, and finally comparing this with what they did do, got a correlation of  $+ .50$  between efficiency in addition and efficiency in misspelled words.

TABLE XVII.

## Correlation of "Opposites Test" with Grades in Studies.

Cases	Classification	r
335	Total pupils tested in two schools.....	$+ .18$
88	First year normal school girls.....	$+ .08$
75	Third and fourth year girls.....	$+ .22$
56	First and second year boys.....	$+ .05$
50	Second year normal school girls.....	$+ .06$
34	Fourth year normal school girls.....	$+ .19$

Four of seven small groups showed a comparatively high, and three a very low, correlation.

TABLE XVIII.

## Correlation of "Opposites Test" with Grades in Studies by Tertial Grouping for 88 First Year Normal School Young Women.

	I.	II.	III.
Average mark in studies.....	.857	.786	.697
Average mark in opposites test.....	.585	.531	.54

1. The relationship between different abilities involved in arithmetic, Columbia Contributions, 11: 1903, Feb. 32-40.
2. Correlation among perceptive and associative processes, Psychological Review, 9: 1902, 374-382.

The table shows a correlation of small amount, probably most nearly that of the large group,  $+ .18$ . The ability of girls quite regularly correlated only slightly, with the larger coefficients for older girls. Boys of smaller groups showed decided variations in the relation of their abilities in the test to their standing in school studies. Here again is a test quite similar to school exercises and some degree of correlation might be expected. The point of view that this test has something in common with the school work well done which would show in a knowledge of opposites seems confirmed by the higher correlations for the older school girls as compared with those for the younger ones.

In studying the correlation of vocabularies and class standing, estimates ranging from slight relation to one of considerable degree have been made. Whipple<sup>1</sup> found the correlation as high as  $+ .45$ . The knowledge of correct opposites as learned in school should therefore be a factor in the correlation with school studies.

Further, as would be supposed for this test, feeble-minded children have been found markedly inferior to normal children,<sup>2</sup> but twins in Thorndike's<sup>3</sup> study correlated to the high degree of  $+ .85$  with a small probable error of  $.05$ .

TABLE XIX.

## Correlation of "Logical Test" with Grades in Studies.

Cases	Classification	r
335	Total pupils tested in two schools.....	$+ .24$
82	Total pupils tested in third school.....	$+ .21$
88	First year normal school girls.....	$+ .14$
83	Third and fourth year girls.....	$+ .20$
72	First and second year boys.....	$+ .09$
44	Second year normal school girls.....	$- .16$
33	First and second year girls.....	$+ .05$
24	First and second year boys.....	$+ .32$

Nine of eleven small groups show quite regularly positive correlations still larger than the above.

TABLE XX.

## Correlation of Logical Test with Studies in Tertial Grouping for 88 First Year Normal School Young Women.

	I.	II.	III.
Average in studies.....	.857	.786	.697
Average in logical test.....	.835	.865	.785

So far as the writer knows this combination of genus-species and reasoning test, chiefly the latter, has not been correlated with school standings. The test is one which approximates much of the written test work by which pupils are often rated. The material is such that practically any secondary school pupil should be informed upon it. The test is largely a matter of perceiving logical relations and of stating logical associations. Five minutes was given to the test with directions not to hurry but to do one's best. The test was graded on the accuracy of results over the ground covered, practically all completing the test since there was little writing to do. Judging the groups arranged to eliminate the sex factor and irregularities of classification, the most probable correlation is about  $+ .25$ .

Boys, all groups considered, showed much greater extremes of correlation than the girls. Girls were tested in larger numbers, but even when tested in small groups, the results for them showed less variation.

1. Op. cit.
2. Norsworthy, The psychology of mentally deficient children, Arch. of Phil. & Psy. 1: 1906, 1-111.
3. Measurement of twins, Columbia Contributions, 13: No. 3 or Arch. of Phil. & Psy. No. 1, September 1905.

## SERIES V.

Tests of Motor Control and the Correlation with Standings  
in School Studies.

The materials for this test were two standard forms for tracing as prepared in blanks for Columbia University. The one was the circular labyrinth and the other the rectangular form. Either is designed to test movement to and from the subject as well as to right or left. The grading of accuracy is based on an estimate of the average distance which the individual traces without allowing the pencil point to come in contact with either marginal line of the pathway or course outlined for tracing. The average of both accuracy and speed, or ground covered, is then considered the general efficiency.

TABLE XXI.

## Correlation of "Tracing Test" with Grades in Studies.

Cases	Classification	r
327	Total two schools.....	+ .04
82	Total third school.....	— .12
88	First year normal school girls.....	+ .09
83	Third and fourth year girls.....	— .27
72	First and second year boys.....	+ .09
31	First and second year girls.....	— .15

TABLE XXII.

Correlation of Tracing Test with Studies by Tertial Grouping for 88 First  
Year Normal School Young Women.

	I.	II.	III
Average in studies.....	.857	.786	.697
Average in tracing test.....	.53	.56	.528

Bolton<sup>1</sup> in several sorts of motor control tests of children correlated with good and poor social status of two groups rather than class standing finds that "good" are steadier than "poor" children. Bagley<sup>2</sup> found a decidedly inverse relation between ability in tracing and class standing, and in general between motor ability and mental ability in the extremes of each.

Comparing weight discrimination and muscular sense test again and the results for the groups tested here in tracing the correlations still seem to indicate higher positive relations for young men. On this point of the apparent differences in motor ability in the sexes Bagley<sup>3</sup> states in his summary to the study of mental and motor ability that, "in general, the boys slightly surpass the girls in motor ability, while the reverse obtains in mental ability."

In studying the correlation, in general, of motor ability and class standings Bagley finds an inverse tendency, and the tracing test is one of the tests that show this inverse relation. A further point with this investigator is that there is a gradual increase of motor ability with age. This may have a bearing on the results for young men as compared with results for children. Bryan<sup>4</sup> found in several types of tests of voluntary motor ability that boys usually excelled the girls slightly. He makes no comparisons with intelligence except to discuss the relation of certain tests to nervous disorders. The data in this present study call for similar conclusions to those of Bagley as cited.

1. The relation of motor power to intelligence, *American Journal of Psychology*, 14: 1903, 615-631.  
2. On the correlation of mental and motor ability in school children, *American Journal of Psychology*, 12: 1901, 193-205.  
3. *Op. cit.*  
4. On the development of voluntary motor ability, *American Journal of Psychology*, 5: 1892, 125-204.

## Section 2

## General Discussion and Conclusions

## 1. The Validity of Mental Tests.

The hope of the psychologist and of the experimentalist in education is to be able to measure mental traits or functions and their interrelations. For a long time subtle analysis was the means, but the objective test has been used with such efficiency in revising ideas of mental life that it is at once the interest and ideal of present day workers. Many who consider their views as those of common sense minimize, at least in their own thought, the value of what they term trivial investigations into matters which common sense should answer a priori. But the present interest, as stated, is large in the attempt to test and measure mental processes. The American Psychological Association has for one of its problems the standardization of mental tests.<sup>1</sup> A glance at the studies of correlation and its history is convincing of the present progress.<sup>2</sup>

But the tests are not yet generally accepted as satisfactory especially if judged by their results. There are serious limitations to the satisfactory examination of a subject by brief tests and a single or few trials.<sup>3</sup> The results in this study for the long addition test as compared with the short one show much better correlation for the long one. To control conditions properly and to secure the trial when mental functioning is normal are difficult matters. There is no claim in these tests nor in any study of the sort that they are anything nearly free from sources of error. The belief is that they should discover mental functioning of a distinct type if it is present to any great degree. The failure to secure uniform results has not yet discouraged these investigations. The correlations found in this study are in general very slight. How much of this is due to the tests in such instances is a subject for further analysis and experimentation. While the results in this study are largely negative as to any considerable amount of relation between the factors compared, the writer is inclined to draw the conclusion that the tests, though having decided limitations, would have brought out the relations much more strongly than they did, had those relations been pronounced.

A second factor here and a large one is the unreliability of marks in school studies as a standard of ability. As stated already it seems the only standard practicable for large numbers. But in absence of correlation it may also be doubted as a correct measure. It is a common observation that lack of interest and application may give poor standings where considerable native ability is present or medium ability with application may give high standings. But the selection which has gone on through the grades and high school has done much to unify results in the case of normal school students, in particular. They are fairly consistent in interest and effort and are also marked in their professional work largely on the estimate of natural capacity. But the only safe comparison in this study is between the tests as evidence of ability and the actual achievements in school grades. One problem upon which light will be thrown when the mental tests become reliable is the validity of the school marks as indicating ability. This is discussed in another paragraph. But, in general, ability ought to show in the course of time and in the average of the individual's studies.

Other factors which invalidate the results are the necessity of tests in large groups and the personal equation of the experimenter in errors of application. But the difficulties of tests and methods are still not the only source of unreliability. Securing data in sufficient quantity from groups of sufficient homogeneity is another problem in securing results. In the literature of the matter only a few studies are found which were made where subjects in proper numbers and of proper classification were used to give convincing results. Where, however, our studies of smaller numbers are confirming each other we are adding to our knowledge of mental traits and correlations. Again, if the method of correction of raw correlations proves valid much higher relations will be shown, but at present there is question as to results so achieved.

1. *Com. American Psychological Association, Op. cit.*  
2. *Correlations—Miner, J. B.*  
3. *Reliability of single measurements with standard tests—Curtis, S. A. El. Sch. Rev. 13: 326.*

## 2. The Bearing of Standards of General Intelligence.

There are doubts as to the possibility of agreement upon the term general intelligence and its employment. If it stands as in the older sense for capacity for knowing, the difficulty remains of considering this as general. If we can as yet place any reliance in the tests made for various capacities, such tests throw much doubt upon a general capacity as anything more than a name for a number of capacities very loosely related indeed. Whatever the difficulties of such a point of view, most correlations would seem to support it rather than any central ability. Were it not for the prejudice of older views we might be surprised at finding high correlations of intellectual factors rather than surprised to find them so low.

Provisionally and for comparison, the grades in school studies were assumed as an only available estimate of general ability. This study was conducted throughout with a question in mind as to the most reliable methods of judging this general intelligence. It must be concluded from their results that such brief tests are also not at all reliable as compared with the more extended test in school work. There may be, however, a very distinct service which they may render even in the opinions of teachers as to pupils. This and other relations here will be discussed in other connections.

There remains also the question as to whether school marks actually measure the ability of a pupil or only his achievements secured through application and industry. How to test the actual native ability rather than the accomplishment is another problem. No doubt some of the failures of the mental tests to correlate with school studies as a test of general ability is the difference in the two phases of ability to which each may appeal. Desirable as it is to measure the real native ability is also valuable to measure actual accomplishments, i. e., efficiency results as well. In this sense the standings give some measure of what is actually accomplished in intellectual work.

Again, where the method of grouping is into brightest and dullest according to school marks, which method is so extensively used for estimating the relation of the one group to the other in average ability in some mental test, there is little doubt that the selection of extremes is a fairly accurate selection of true ability to accomplish results. In the tests made by this method in this study the results are a fairly close confirmation of the coefficients of correlation by the "product moments" method, that is, they may indicate some positive or negative relation between items of comparison.

## 3. Differences in the Correlation of Mental Tests and of School Studies.

There was no intention in this study of attempting to find the relations of all the different tests with each other. In the few tested for comparison "marking A's" correlated with "marking misspelled words,"  $+0.17$ , and "memory" with "tracing,"  $-0.05$ . This is about the same degree of correlation which each had with studies.

But observation of the variation of their relation to each other in general would lead to the same conclusion as that reached by Wissler<sup>1</sup> where the correlations were actually made. His summary is, "That the laboratory mental tests show little inter-correlation in the case of college students." In standardizing tests some sets have been found to correlate to a considerable degree. On the other hand, the usual correlations found between studies are much higher. Wissler's statement on this point is, "That the markings of students in college classes correlate with themselves to a considerable degree, but not with the tests made in the laboratory."

Several investigations show a considerable degree of correlation between school studies. One is exclusively upon relations in secondary school subjects.<sup>2</sup> Another upon high school and grammar school subjects.<sup>3</sup>

The test of the relation, made for comparison, here, shows a correlation of  $+0.70$  for algebra with the average of studies. Wissler gives correlations of mathematics with several other subjects of study in which the correlations range from  $+0.51$  to  $+0.58$ .

## 4. Individual Variations Versus General Tendencies.

As stated in the introduction, a study of correlations is a search for general tendencies, for laws or principles. The hope in each study is to find some positive, definite

1. Op. cit.

2. The relationships between the abilities involved in secondary school subjects, Brinckerhoff, Morris & Thorndike, C. C. II: No. 2.

3. A comparison of elementary and high school grades, Miles, Studies in Education, Iowa, 1: No. 1, also Ped. Sem., Dec. 1910.

relations and to arrive at their explanation. This study has not seemed to yield large positive results. Few marked relations were found between the tests and standings in studies. If the methods of refinement of correlations now used by Spearman<sup>1</sup> and others finally point to the true relations, general tendencies will be shown in a much more marked way. In the meantime any contribution ever so slight to the knowledge of any relations which are general is valuable to education where so much attention is necessarily given to mental laws, to principles, and to group instruction. On the other hand the individual variations stand out so prominently in the calculation of correlations that the attention is constantly drawn to them and to the question as to whether they are not after all the important consideration. In the close inspection of data the many cases showing opposite abilities in the traits compared and these again in so many varying degrees cause the seeming strength and variety of individuality to appear rather than general tendencies or positive relations. This is shown in Table V. at the close of the discussion of sense-discrimination.

## 5. Common Factors and General Training.

The assumption in the use of mental tests is a common factor of mental life, at least in the function under consideration, an associative process in thinking, for example. But the results of tests and of analysis are not so clear as to a common factor to all sense processes, memory, and association ones. Results vary much as to relations between these tests and a common standard or in their relations to each other. Individuals vary in their abilities in the different mental tests and in their various studies. There still remains an aggregate which we designate as general ability, but is not the sum of abilities the better term rather than a one common factor, common to all sense-discrimination and to all the other tests, which corresponds to, or is the common factor of, general intelligence?

The study which has been most influential in its suggestions of a common factor and high correlations of tests and general ability is the study of Spearman<sup>1</sup> in sense discrimination and general intelligence.

In the investigation in which Thorndike<sup>1</sup> studies the same problems, he quotes Spearman<sup>1</sup> as calculating that "the factor common to school marks and ratings as to common sense by fellow students and teachers correlates perfectly with, and hence is identical with, the factor common to discrimination of pitch, light intensities, or weight, and concludes that there may be a correspondence between what may provisionally be called 'general discrimination' and 'general intelligence' which works out with approximation to one or absoluteness."

"The measurements obtained in my own investigations," says Thorndike, "do not in the least support that hypothesis. In fact, the correlation between whatever is common in the tests of sense discrimination in length of lines and weights and general intelligence as measured by pupils' and teachers' estimates and by scholarship comes out as from  $.15$  to  $.26$  according to the method of correction applied (in Spearman formulas) and not  $1.00$  as Spearman would hold, and the mos. common relation to intellect judged in the three ways of pupil judgment and teacher judgment, combined judgment, and scholarship is  $.23$  not  $1.00$ ."

The study of Thorndike further confirms the criticism of school grades already made in this discussion but nevertheless agrees with the point of view as to a rather high degree of reliability of grades as an estimate of ability in such students as normal school young women. The correlation between the combined judgment of pupils and teachers and scholarship records is found by him to be  $.95$  when allowances are made for the inaccuracies of the latter. Judging then by the correlations for the normal school young women in sense discrimination, there is a very slight relation indeed between anything called general ability in sense discrimination and general ability in studies, or general intelligence so measured. The most probable relation from the data of this study is  $+0.10$  to  $+0.15$ .

Another of Spearman's conclusions is, "that all branches of intellectual activity have in common one fundamental function, or group of functions, whereas the remaining or specific elements of activity seem in every case to be wholly different from that in all others."

Thorndike concludes "that this is, of course, contradicted by the correlation of  $.23$  instead of  $1.00$  and by the fact that a much higher correlation is shown between

1. Op. cit.



discrimination of lengths and discrimination of weights than between either of them and general intelligence." . . . "In general there is evidence of a complex set of bonds between the psychological equipment of both what we call the formal side of thought and what we call its content, so that one is almost tempted to replace Spearman's statement of one sole common element as the cause of all positive correlations by the equally extravagant one that there is nothing whatever in common to all mental functions or to any half of them."

As bearing on the question of general training and common elements the relations in this present study seem so varied and the correlations so slight that instead of the claim that there is a common fundamental function or group of functions as shown by a high degree of correlation, the claim that there is probably very little in common to all mental functions or to any great part of them seems more nearly true.

#### 6. Motor Correlations.

The great interest of the present in motor education has led to much discussion of the value of muscular training and development. There are undoubtedly many ways in which the relation is close between motor ability, health, mental ability and expression. But the relation between motor control in tracing and standing in studies is very slight if positive, and indeed, may be slightly negative. The relation for the muscular sense in discrimination was found to indicate much the same, the weight test showing a negative relation and the measurement of distances by muscular sense a slightly positive one. Except for the abnormal, tests of motor control seem to have little of significance for general ability. The slightly higher relation for boys is suggestive if studies continue to indicate that relation. This does not mean that there is not a close relation between a thinking process and its particular motor accompaniment or expression.

#### 7. Simpler and Older Functions in Comparison with Later and More Complex.

Spearman's<sup>1</sup> conclusion supports the hypothesis that "the efficiency of the general mammalian foundation of the nervous system is closely correlated with the specifically human nervous connections."

Thorndike's<sup>1</sup> results are to the contrary "that the efficiency of a man's equipment for the specifically human task of managing ideas is only loosely correlated with the efficiency of the simpler sensori-motor apparatus which he possesses in common with other species."

In general the correlation of sensory tests with grades was lower than the correlation of association and logical tests. This, of course, should be expected from the more intimate relation of the processes involved in the latter to the processes involved in the management of ideas in school work. Again the hierarchy of correlations among themselves in sense discrimination seems to indicate that the simpler and older functions are correlated to a less degree with intelligence in general than are the later and more complex.

And finally there is a considerably higher correlation between studies and the tests more nearly approaching in similarity the intellectual exercises of the school than between studies and those which do not.

#### 8. Degree of Advancement.

A classification of first year girls and of third and fourth year girls was maintained throughout the second, third, fourth, and fifth series of tests.

The correlations for freshmen were higher in the misspelled words test, the familiar English words test, and the addition test. The difference is significant in the opposites test and the logical test where the knowledge element and logical associations are evidently the explanation. Here the correlations for the older girls were higher. The degree of advancement is only the same recognition of the age element as that made for school. The age element, however, was probably not a very serious factor of disturbance in the normal school classes, in particular. Further, for several of these tests it has been found that the variations are less for slight differences in age after the stage of early adolescence is passed. The writer intends a study of the same individuals grouped by age.

1. Op. cit.

#### 9. Correlation as Varying for Sex.

Boys and girls were studied in separate groups in all except the first series of tests. When so divided the numbers do not give very reliable results. Some tendencies for boys have been already discussed under motor tests. Tests for a group of first and second year boys correlated lower with studies than those of a group of girls of similar classification and age in all but three instances, those of marking A's and marking familiar English words, and in these the girls of this group for some reason showed a lower correlation in the A test in proportion to all the other groups than in most of the other tests, while in the motor test the correlation for one group of girls was the same as that for the boys. It is the common judgment that boys' abilities are not shown in school standings to the same extent as those of girls and that they show greater extremes of variation in traits.

#### 10. Methods of Grading and Estimates of General Ability.

This study was undertaken also for a study of methods of grading or testing pupils. This does not seem to be the only instance in which the thought has been that mental tests should aid in grading. Kirkpatrick,<sup>1</sup> in a paper on individual tests of school children, introduces the topic by "In connection with tests made upon about five hundred school children to determine defects of sight and hearing, I made a few other tests that may be of interest to this Association, which has devoted considerable time and some money to formulating a series of individual tests for college and university students, with the idea that a test of ability, better than an examination test, or supplementary to such a test, may be found. Such a test is needed more for public school children than for college students, and it is reasonable to suppose that accuracy and rapidity in the sensory and motor activities would be a better indication of general ability in school children than in college students, whose activities are more complex and less concerned with simple sensory and motor operations."

The thought in the present study has been that if some rather high degree of correlation existed between mental tests and other evidences of general intelligence that tests might be easily given which would indicate quite clearly general ability or lack of it. This method then might aid very materially in estimating pupils rather than the less satisfactory one of examination and school marks. This would be particularly true of new or strange pupils, making their classification easier. But the varied and uncertain results as to the correlation do not seem to warrant such methods of testing as giving any very certain evidence of how a pupil will get on in his studies. The examination of individual cases shows this in a marked way. For a great number of cases tested in this study either the mental test is unreliable or the standings in studies. It is at this point that the mental test may render a service. When properly standardized it may give a fair idea of the real ability and also point out the deficiencies where they exist. This service it may sometimes render though it may not indicate what the pupil does through application and effort in school work. But here again we are confronted by the fact that so slight, if any, relation is found between sense discrimination and progress in studies, and also between memory and motor ability and studies. Others of the tests have given the writer no better results in other studies of these relations. But the divergence of results is so great here that we should have much further evidence. The mental tests, will, however, certainly assist in grading and in discovering difficulties.

But far more hopeful than most conclusions from studies of correlation are those of Spearman.<sup>2</sup> In discussion of the hierarchy of the intelligences "Mathematics, for example, has a saturation of 74 and common sense one of 96; but in actual use the worth of these indications becomes reversed, so that a subjective impression as to a child's 'brightness' is a less reliable sign than the latter's rank in the arithmetic class; almost as good as either appears a few minutes' test with a monochord." . . . "However it may be with these or any other special facts, here would seem to lie the long wanted general rational basis for public examinations.

"Instead of continuing ineffectively to protest that high marks in Greek syntax are no test as to the capacity of men to command troops, or to administer provinces, we shall at last actually determine the precise accuracy of the various means of measuring general intelligence, and then we shall in equally positive, objective manner

1 Psychological Review, 7: 1900, 274-280

2 Op. cit.



ascertain the exact relative importance of this general intelligence, and then we shall in equally positive objective manner ascertain the exact relative importance of this general intelligence as compared with other characteristics desirable for the particular part which the candidate is to assume.

"Thus it is to be hoped, we shall eventually reach our pedagogical conclusions, not by easy subjective theories, nor by the insignificant range of personal experiences, nor yet by some catchpenny exceptional cases, but rather by an adequately representative array of established facts."

The author of this present study could hardly find any data which would warrant anything like such hopeful prophesies for the mental, or ability, tests of present use, desirable as it may be to find reliable standards of measurement.

### 11. Further Investigations

When the present discussion, and also investigation, of correlation methods crystallizes light will be thrown upon the refinement of raw correlations and the probable amount of relation to be claimed for a coefficient or index or correlation. This as well as better control of conditions means to get at the more nearly true relation actually existing.

At present, to the many students, more exhaustive data as free as possible from the disturbing factors of age and sex, will give more convincing results. The present investigation will be continued on still greater numbers for the evidence thus to be adduced.

In such an indefinite complex as that of general intelligence only the grossest of approximation seems possible. The standards used to rate this factor will be estimated by the combined method of teacher judgment, and perhaps student judgment, with grades in studies for comparison of results with the standing in school studies only, when this investigation is continued.

In such investigations as the present we make the mistake, very gross to some psychologists, of experimenting with the complex instead of the elements. But the present study of many psychologists on standard tests is in the direction of as great simplification as possible, and we await the results for application in experimental pedagogy.