



A Study in Intelligence and Educational Correlations

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blotter on the book" and blurred them. His eyes were treated and fitted with glasses; and at the close of the year he scored 39 on the Gray Oral Reading Test.

K. T., a boy six years seven months old, was in the IA. His mental age was found to be seven years ten months; and his I. Q. was therefore 119. His score on the Gray Oral Reading Test was 63, which is much above standard. He was promoted to the IIA and did above average work. He was promoted to IIIA at the close of the year.

F. A., a boy in grade IIA, was eleven years old. He was found to have a mental age of nine years three months. His I. Q. was 84. He was suspected of being feeble-minded, but was really only slightly below normal. He was promoted to IVB grade and passed.

The chief value of the work in measurements for the year was that the teachers came to accept such measurements as of assistance in understanding children as individual problems, in grouping children according to ability, and in establishing more or less definite standards of attainment. Data were gathered to show the need of special classes for the subnormal. If these classes are established, the regular teachers will be relieved of their most difficult problems, and will thus be enabled to give more time to the normal pupils.

The work of the department in the future will be to organize the system so as to make possible a comparison of classes and schools; to apply the results in such a way as to affect methods of teaching, grouping of pupils, and modifications in the course of study; and to have direct and full supervision over whatever special schools are established, deciding which pupils are to be assigned to such classes, and what subjects are to be taught in them. The director should have authority to advise on special cases of double promotions and of failing pupils. The results of educational tests interpreted in the light of mental ratings would be very valuable in checking up the effectiveness of the various experiments in methods of teaching. Measurements should be extended into the junior and senior high schools where grouping according to ability is possible to a greater extent than in the grades. In order to carry work forward effectively every effort must be made to obtain the good will and cooperative spirit of teachers and principals.

A STUDY IN INTELLIGENCE AND EDUCATIONAL CORRELATIONS

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The study here presented was carried out with a unit group of seventh-grade pupils in one of the public schools of Fresno, California.¹ All the tests were given during a term of twenty weeks. Care was taken throughout to preserve uniform and normal conditions, and there was due observance of the instructions pertinent to the standard tests. The investigators had much previous experience in giving and scoring the various tests. Their purpose was to examine the reliability of the Binet-Simon Intelligence Test and the Otis Group Intelligence Scale as instruments in the adjustment and regrading of pupils.

Ninety-eight pupils participated in the experiment and, as far as possible, were given each of the following tests: Binet-Simon, Stanford revision, abbreviated scale; Otis Group Intelligence Scale; Courtis Standard Research Tests in Arithmetic; Ayres Spelling Scale, columns T and U, dictated; Trabue Language Scale C; visual vocabulary by the Thorndike Reading Scale B; comprehension in reading by the Courtis Silent Reading Test; writing for speed by the Ayres Scale, Gettsburg edition.

Before presenting the correlations between the intelligence and educational tests, it is interesting to note the extent of correlation between the Binet and Otis tests. This is indicated rather roughly in Table I. The figures in this table are based on the intelligence quotients derived from the respective tests.

TABLE I. COMPARISON OF RESULTS FOR THE BINET-SIMON AND OTIS SCALES

Tests	Highest Score	75-per-centile	Median	25-per-centile	Lowest Score	Average
Binet-Simon	133	100	89	83	56	92.4
Otis	154	103	88	67	40	87

These figures indicate a close correlation mathematically, especially in the upper range. The coefficient of correlation is 0.70

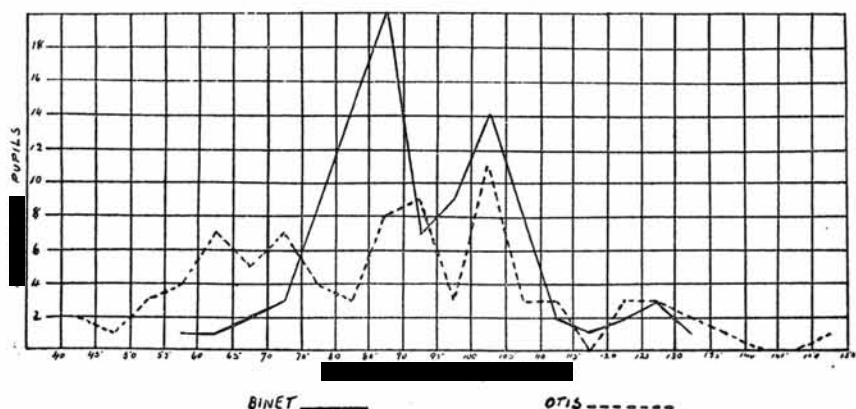
¹ Tests administered by Blanche Cummings, psychological expert in the public schools, Fresno, California.

by the Pearson formula (Probable Error, 0.04). This, though unquestionably high, is hardly large enough to prove a satisfactory general uniformity. This condition is emphasized by an examination of the rough data of the experiment, presented here only in part (see Table II). In these data a number of wide individual discrepancies occur, which may be due in some part to accidental vicissitudes in giving the tests. But whatever the cause, it is patent that the testimony of any single test should not be taken as final in estimating the intelligence of an individual.

The frequency distribution of intelligence quotients derived from each of the tests is shown on Figure 1. This discloses a wider range and greater irregularity of distribution in the case of the Otis test. It will be noticed that the distribution in the case of the Binet test is of fair normality.

Before taking up the educational correlations, a word should be said about the methods of scoring. In the case of the visual vocabulary test, the first, second, eleventh, and twelfth lines were omitted. The score was determined by the exact number of words defined, instead of by the method of inference suggested by Thorndike. In the spelling test, columns T and U of the Ayres scale were separately scored on the basis of 100 percent for perfect, and the results averaged.

FIGURE 1. COMPARATIVE FREQUENCY DISTRIBUTIONS FOR BINET AND OTIS TESTS



A difficulty was encountered in the scoring of results in the four fundamentals in arithmetic. The simple and commonly

An examination of the chart may disclose some apparent discrepancies. For example, are we justified in giving a small score to no attempts and no rights, and a zero score to six attempts and no rights? The principle of the scale demands this condition at its lower extreme; but it can well be justified by the assertion that it is better to know nothing and to know that you know nothing, than to know nothing and to think that you know something. But again, are we justified in giving a higher score to six attempts and three rights than to two attempts and two rights? And if we are so justified, then how about giving a larger score to two attempts and two rights than to six attempts and two rights? Can we say that power in addition, for example, ascends in this order: $6/2$, $2/2$, $6/3$? It must be admitted that there is some interesting ground here for debate; but to the writer the assumption seems reasonable. We must point out that some of the following computations show as great correlation between intelligence and arithmetic as here scored, as between intelligence and some of the other educational subjects. Further, it must be noted that the chart is a regular ascending scale from the poorest performance to the best. The plan is presented for what it is worth, and criticism is invited.

Table II shows how the rough data were arranged for the purpose of studying the correlative positions of the various scores. In all, there are four such tables, but only one of them—the smallest—is reproduced here. The method of arrangement in these tables demands a careful explanation. The study is one of rank correlation, and the procedure was as follows. The mental ages derived from the Binet tests were placed in a vertical range from the highest to the lowest, equal ages being placed in parallel. The entire range was found to be from nine and a half years to fifteen years. This range was divided into four equal parts. It was then found that 9 pupils fell into quarter 1, which was the highest quarter; 35 fell into quarter 2; 29 into quarter 3; and 22 into quarter 4. The nine pupils who fell into quarter 1 were entered on Table II. The scores of these same pupils in the Otis and various educational tests were then ranged and divided into quarters in the same manner as just explained for the Binet test. The table finally showed not only the scores but the number of the quarter into which each score fell, for each of the nine pupils respectively, in each subject. This same method of tabulation

TABLE II. HOW THE ROUGH DATA WERE TABULATED FOR THE NINE PUPILS WHO FELL INTO THE UPPER QUARTER OF THE MENTAL-AGE RANGE BY THE BINET TEST.^a

Pupil Number	BINET			OTIS			ADDITION		SUBTRACTION		MULTIPLICATION		DIVISION		SPELLING		VISUAL VOCABULARY		LANGUAGE		READING COMPREHENSION		WRITING SPEED	
	I. Q.	M. A.	Quarter	I. Q.	M. A.	Quarter	Score	Quarter	Score	Quarter	Score	Quarter	Score	Quarter	Score	Quarter	Score	Quarter	Score	Quarter	Score	Quarter	Score	Quarter
1	107	15	1	106	15	1	89	3	158	3	89	4	90	4	82	2	71	1	14	2	100	1	62	4
2	128	14-6	1	85			106	3	226	2	241	1	387	1	91	1	70	1	13	2	98	1	80	2
3	126	14-6	1	102	12-6	2	108	3	294	1	204	1	251	1	95	1	58	2	16	1	97	1	111	1
4	120	14-6	1	124	15	1	16	4	133	4	40	3	110	3	81	2	67	2	13	2	96	1	72	3
5	103	14-6	1				160	2	206	2	114	4	89	4	62	3	65	2			100	1	56	4
6	133	14	1	154	15	1	275	1	226	2	205	1	252	1	92	1	64	2	17	1	97	1	84	2
7	128	14	1	106	12-6	3	204	1	157	3	158	3	111	3	88	1	67	2	15	2	100	1	72	3
8	115	14	1	127	14-2	1	225	1	203	3	179	2	183	2	74	2	58	2	14	2	98	1	80	2
9	107	14	1				134	2	205	2	90	2	158	2	54	4			10	3	91	2		

The table shows the Intelligence Quotient (I.Q.), the Mental Age (M.A.), and the number of the quarter into which each pupil fell, according to each mental test. The score and number of the quarter for each of the other tests is shown.

^aThe scores are not comparable as between any of the subjects, except intelligence. The numbers of the quarters are comparable throughout, and form the basis for the study of the rank correlation, with the modification explained in the context.

was followed for the pupils falling into each of the other quarters by Binet mental age, thus producing four tables.

The preliminary theory was that pupils falling into quarter 1 by mental age should tend to fall into the corresponding quarter in the educational subjects; that those falling into quarter 2 by mental age should tend to fall into quarter 2 in the educational subjects; and so for the pupils in the other two quarters. But there is a fallacy in this simple scheme for studying correlations; for example, a child may score close to the bottom of quarter 1 in mental age and near the top of quarter 2 in addition, and his actual correlation in that case would be closer than that of a pupil who fell near the top of quarter 1 in mental age and near the bottom of quarter 1 in addition. This factor is inherent in the entire scheme, and practically negates the plan unless we provide a correction in our calculations.

In the matter of this correction, consider the group of pupils who fall into quarter 2 mental age. All of them who fall into quarter 2 in all the educational subjects show, for our purposes, a perfect correlation. But the pupils in the *lower* half of quarter 2 mental age may rightfully claim correlation with educational subjects to the extent that they fall into the *upper* half of quarter 3 in those subjects. And the pupils in the *upper* half of quarter 2 mental age may claim correlation with educational subjects to the extent that they fall into the *lower* half of quarter 1 in those subjects. To figure the total correlations for the pupils in quarter 2 mental age, we might count the number of times the educational scores rank in the identical group, and add half the times that educational scores rank in contiguous groups. This is admittedly a loose and a too liberal makeshift. To be true to the actual mathematical probabilities, we should have to take somewhat less than half the correlations with contiguous quarters although the difference would in fact affect our results but slightly. Our correction approximates the true condition.

The correction just explained applies to mental-age quarters 2 and 3. But since mental-age quarters 1 and 4 have each but one contiguous group, we may add, in each of these cases, *all* the times that educational scores rank in the contiguous group.

Thus for each mental-age quarter or group we allow a leeway for overlapping equivalent to one-quarter the range in each educational subject. The corrections as here explained will be made in the computations that follow.

Table III shows the frequencies of correlation with the nine educational subjects for the pupils in the respective mental-age quarters according to the Binet test. The second vertical column contains the nine pupils who, as already mentioned, fell into mental-age quarter 1. The table discloses that three of these correlated by rank with two educational subjects, one of them with three educational subjects, one with four, one with five, one with six, and two with seven. So for each of the mental-age quarters. Only pupils taking all the tests were counted. For the entire number it is found that the median number of educational sub-

TABLE III. FREQUENCIES OF CORRELATION OF EDUCATIONAL SUBJECTS WITH STANFORD-BINET INTELLIGENCE TEST FOR EACH MENTAL-AGE QUARTER

No. of Educational Subjects Correlating	No. of Pupils Correlating				
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Totals
1	0	0	0	2	2
2	3	1	0	6	10
3	1	3	3	4	11
4	1	3	9	2	15
5	1	10	5	2	18
6	1	8	4	2	15
7	2	3	0	0	5
8	0	0	0	0	0
9	0	0	0	0	0
Totals	9	28	21	18	76

Table reads (second line): Of the 9 pupils in the first mental-age quarter, three showed rank correlation with performance in two subjects; of the 28 pupils in the second mental-age quarter, three showed rank correlation with performance in three subjects; etc.

jects correlating with mental age by rank is 4.5 or, since there were nine subjects, a correlation of 50 percent.²

Table IV duplicates the method of Table III, except that the mental ages have here been determined by the Otis group test. The median number of educational subjects correlating by rank, for the entire number, is 4 or 44 percent.

TABLE IV. FREQUENCIES OF CORRELATION OF EDUCATIONAL SUBJECTS WITH OTIS GROUP INTELLIGENCE SCALE FOR EACH MENTAL-AGE QUARTER

No. of Educational Subjects Correlating	No. of Pupils Correlating				Totals
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	
1	0	0	1	2	3
2	1	0	1	2	4
3	3	1	0	3	7
4	6	2	8	4	20
5	2	9	3	2	16
6	4	3	4	2	13
7	2	1	0	0	3
8	0	1	0	0	1
9	0	0	0	0	0
Totals	18	17	17	15	67

It would seem, from this study, that there is only a fair relationship between attainment in either of the intelligence tests and attainment in the educational subjects taken as a whole, notwithstanding the contrary testimony of various investigations. Of the entire number of possibilities for correlation, only 50 percent of them were realized, even after allowing for the correlation

²This percentage statement of correlation is not to be confused with the coefficient of correlation. The above is simply a statement of the amount of rank correlation.

with contiguous groups as explained in a previous paragraph. From the present testimony there is not even the expectation that all pupils will come up to the 50 percent correlation, as equal numbers will fall considerably below and above that median. The writer admits the novelty of the method of study here used, and willingly submits the question of its validity to minds trained in the science of statistical research.

It might be suggested, as a check on results, that we take only those pupils whose mental-age quarters were identical for the two intelligence tests, and that we compare their intelligence rankings with their educational rankings. This would tend to obviate error in the intelligence tests. For such an analysis see Table V. Of 28 pupils who fell into identical mental-age quarters, this table shows how many of them found a rank correlation with one educational subject, how many with two, and so on. The median number correlating in this case is 4.25, or a correlation of 47 percent.

TABLE V. FREQUENCIES OF CORRELATION OF EDUCATIONAL SUBJECTS WITH BINET AND OTIS SCALES WHERE THE LATTER WERE IN AGREEMENT AS TO MENTAL-AGE RANK

No. of Educational Subjects Correlating	No. Pupils Correlating by Mental-Age Rank
1	1
2	2
3	3
4	6
5	8
6	7
7	1
8	0
9	0
Total.....	28

We may next take up the question of how each educational subject compared separately in rank with mental age. Table VI presents this comparison, the Binet mental-age rankings being used. We might here have expected a greater correlation for the more intellectual subjects than for those representing mere skill, but such distinction is not evident, except in the case of language which, it will be remembered, was measured by the Trabue Completion Scale. Various other investigations have shown a high correlation between this scale and certain standard mental tests, a fact that argues well for the validity of our own investigation. In the case of reading comprehension, we should have expected a high correlation if the Kansas or Monroe reading test had been used. The Courtis test is in fact standardized only through the sixth grade, and the indications were that it was too easy, in its intellectual elements, for the seventh. Our test did, in fact, show a fair range of performance, but the variation was probably due largely to sensory-motor factors.

TABLE VI. FREQUENCIES OF CORRELATION OF SEPARATE EDUCATIONAL SUBJECTS WITH MENTAL AGE BY THE BINET TEST

Subject	Addition	Subtraction	Multiplication	Division	Spelling	Visual Vocabulary	Language	Reading Comprehension	Writing Speed
No. pupils taking test.....	93	93	94	94	89	85	87	90	89
No. of correlations	45	45.5	40.5	45.5	49	43	56.5	46.5	46.5
Percent of correlation.....	48	48	42	48	55	50	64	51	51

The conclusion to be drawn from the entire study, if valid, is not encouraging. The tables show constantly a correlation that may be expressed as 50 percent, which means this: that the median pupil found a rank correlation with educational subjects to the extent of just half the opportunities. This is just the correla-

tion that would fall by chance. This last point is probable by the following reasoning: a pupil in mental-age quarter 2 would correlate with addition, for example, if he fell into quarter 2 in that subject, or in the lower half of quarter 1, or in the upper half of quarter 3. In other words, that pupil has a range of two whole quarters in addition in which to be marked plus in correlation, according to our scheme; leaving two quarters in which to be marked minus. That pupil has a "fifty-fifty" chance, which is almost exactly the amount of correlation that our investigation showed for the median pupil, counting all subjects.

We began this experiment with the purpose of testing the validity of the intelligence scale as an instrument in the regrading and regrouping of pupils. If our conclusions are to stand, the verdict must be colorless. Our results at any rate demonstrate that it is a dangerous thing to take the testimony of any single intelligence test as final proof of inferior or superior capacities in the conventional subjects. There is at present a tendency to push the intelligence tests into the hands of unscientific enthusiasts throughout the teaching force. Although these people may be trained in the accurate administering of the tests, it is in the uses they may make of results that the danger lies.