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MISCELLANEA.

I. On the Value of the Teachers' Opinion of the General Intelligence of School Children.

Compiled from the Tables and Reductions of
H. GERTRUDE JONES, University College, London.

A great deal of random criticism has recently been made of school-teachers' estimates of general intelligence. We have been told that those estimates are absolutely without value, that any correlations obtained from them are idle and that the personal equation involved is so great that no use can legitimately be made of them. Good illustrations of this type of criticism will be found in the notices of Heron's memoir on *The Influence of Defective Physique and Unfavourable Home Environment on the Intelligence of School Children*, which Mr G. U. Yule has considered it desirable to publish in two separate journals*. As it does not appear that those who criticise the teacher's estimate of general intelligence in this way have made any experimental inquiry into the matter themselves, it may be of value to publish an investigation of a preliminary character made some time ago as an attempt to ascertain whether such classifications are really idle. More ample researches will shortly be published, but it may be said in advance here that they serve to confirm the present result.

The data are taken from schedules filled in by over 20 Aberdeen teachers†, who were not specially prepared for the task. 249 boys were taken from 4 different schools; their ages ran from 6 to 14 and they belonged to classes which were termed "Infants," I, II, III, IV, V, and VI. They were judged not only by different teachers, but in different schools, and their mental capacity was appreciated in four groups: (i) Excellent=E., (ii) Good=G., (iii) Moderate=M., (iv) Dull=D. This is a pure appreciation of general intelligence by a variety of teachers in a variety of schools. Next we have taken the individual boy's place in class as shewn by examination results and divided by the number of boys in the class. This may be adopted as a measure of the boy's examinational intelligence. If the teacher's estimate of general intelligence be of small value we should expect that when allowance is made for difference of class and age there would be little relation between examinational test and general intelligence.

The following characters were taken out and tabled, "Mental Capacity," Age, Position in Class (measured as above stated) and Class or Standard, and the following six tables obtained.

* *Journal of the Statistical Society*, Vol. LXXIII. p. 547, and *School Hygiene*, Vol. I. p. 473.

† For the Royal Commission on Physical Training (Scotland). We have gratefully to acknowledge the loan of these schedules by Professor Matthew Hay.

TABLE I.
Mental Capacity.

Age	E	G	M	D	Totals
6	4	11	11	5	31
7	2	15	10	6	33
8	5	19	6	4	34
9	3	18	12	—	33
10	2	20	11	1	34
11	2	9	12	5	28
12	1	11	10	3	25
13	—	9	13	2	24
14	—	4	3	—	7
Totals	19	116	88	26	249

TABLE II.
Mental Capacity.

Standards	E and G	M and D	Totals
Infants, I, II, III	77	61	138
IV, V, VI ...	58	53	111
Totals ...	135	114	249

TABLE III.
Class or Standard.

Age	Infants	I	II	III	IV	V	VI	Totals
6	30	1	—	—	—	—	—	31
7	—	30	2	1	—	—	—	33
8	—	12	21	1	—	—	—	34
9	—	3	3	21	6	—	—	33
10	—	—	—	10	22	1	1	34
11	—	—	1	—	4	22	1	28
12	—	—	—	2	1	9	13	25
13	—	—	—	—	—	7	17	24
14	—	—	—	—	—	—	7	7
Totals	30	46	27	35	33	39	39	249

TABLE IV.
Mental Capacity.

Place in Class	E	G	M	D	Totals
·03	7	9	2	—	18
·08	3	8	—	—	11
·13	4	10	1	—	15
·18	3	12	2	—	17
·23	1	12	3	1	17
·28	—	11	1	—	12
·33	—	10	3	—	13
·38	—	7	4	—	11
·43	—	5	5	—	10
·48	—	11	9	—	20
·53	—	8	5	1	14
·58	1	5	8	1	15
·63	—	2	7	—	9
·68	—	4	6	—	10
·73	—	2	4	3	9
·78	—	—	8	1	9
·83	—	—	11	—	11
·88	—	—	5	5	10
·93	—	—	2	6	8
·98	—	—	2	8	10
Totals	19	116	88	26	249

TABLE V.
Age.

Place in Class	6	7	8	9	10	11	12	13	14	Totals
·03	2	3	—	5	3	2	3	—	—	18
·08	3	1	—	2	2	1	1	1	—	11
·13	3	3	1	3	1	—	1	2	1	15
·18	4	1	2	3	3	1	—	3	—	17
·23	1	3	6	1	1	2	—	3	—	17
·28	—	2	3	1	4	—	1	1	—	12
·33	—	—	4	3	4	—	2	—	—	13
·38	2	1	—	—	3	1	2	—	2	11
·43	—	2	1	1	1	2	2	1	—	10
·48	3	1	3	1	1	4	4	2	1	20
·53	1	3	3	3	—	3	—	—	1	14
·58	1	—	3	2	1	4	2	2	—	15
·63	1	2	1	1	4	—	—	—	—	9
·68	—	1	2	2	3	—	—	2	—	10
·73	1	3	2	—	—	2	1	—	—	9
·78	2	2	1	2	1	—	—	1	—	9
·83	1	1	—	2	1	2	1	2	1	11
·88	—	1	1	1	1	2	1	2	1	10
·93	2	1	1	—	—	1	2	1	—	8
·98	4	2	—	—	—	1	2	1	—	10
Totals	31	33	34	33	34	28	25	24	7	249

TABLE VI.

Class or Standard.

Place in Class	Infants	I	II	III	IV	V	VI	Totals
.03	2	3	—	5	5	2	1	18
.08	3	1	—	1	2	2	2	11
.13	3	4	1	2	1	2	2	15
.18	4	2	2	2	2	2	3	17
.23	1	3	4	3	—	3	3	17
.28	—	3	2	1	5	—	1	12
.33	—	1	4	5	1	1	1	13
.38	2	—	2	1	2	1	3	11
.43	—	2	1	1	1	3	2	10
.48	3	2	2	1	1	5	6	20
.53	1	6	—	3	1	2	1	14
.58	1	1	2	1	3	5	2	15
.63	1	1	2	2	3	—	—	9
.68	—	2	1	2	3	1	1	10
.73	1	5	—	—	1	2	—	9
.78	1	3	1	2	1	—	1	9
.83	1	3	—	1	—	2	4	11
.88	—	1	2	1	1	3	2	10
.93	2	1	1	1	—	1	2	8
.98	4	2	—	—	—	2	2	10
Totals	30	46	27	35	33	39	39	249

Let us look at the results of these Tables in succession :

Table I. Mental Capacity and Age. The mean ages are as follows :

$$\left. \begin{array}{l} E : 8.87 \\ G : 9.89 \\ M : 10.33 \\ D : 9.38 \end{array} \right\} \text{All classes : } 9.91.$$

There is thus a decrease of intelligence with age until we come to the worst class and here there is a drop in age. There are very certainly cross-currents at work, e.g. clever boys go young to school, and leave early, and extreme cases of dullness go to "special" schools at 9 to 11, and school lessens at any rate the outward appearance of stupidity. Worked out by the correlation ratio method the correlation is $\eta = .1830$. This clearly should be considered as negative, but while the regression is not linear and therefore the correlation ratio sensibly greater than the correlation coefficient, we will take $r = -.1830$ because we believe the "dullness" of the younger children to some extent wears off with continued school life or the dull are drafted elsewhere*.

* The reader should examine the last column of Table I. We think several of the younger children would ultimately pass into "special schools" or be sharpened by school life. The same bi-modal character is obvious in column M, if to a lesser extent.

Table II. Mental Capacity and Standard. It is interesting to look at the data for this as a contingency table. This is given below as Table II *bis* :

TABLE II *bis*.
Class or Standard.

Mental Capacity.		Infants	I	II	III	IV	V	VI	Totals
	E	4	5	3	2	1	3	1	19
	G	11	19	15	18	21	10	22	116
	M	10	14	7	15	10	18	14	88
	D	5	8	2	—	1	8	2	26
	Totals	30	46	27	35	33	39	39	249

The greatest contributions to the contingency arise from (i) the defect of Dulls in Standard III and (ii) the excess of Dulls of Standard V, accompanied as it is by a defect of Good mental capacities. These may be personal to the teachers of these standards, or to their selection of children, which was made for the purposes of physical measurement. But the corrected contingency coefficient which should be much emphasised by personal equation is only .2123*. Now we shall see that the correlation between age and standard is very high, i.e. .9366; hence the correlation between mental capacity and age for constant standard = -.0461, or is practically negligible. In other words, allowing for the personal equation of the master with regard to intelligence, age counts for very little in his estimate of general intelligence. If we even out the irregularities of the above table by forming out of it a mere four-fold table as in Table II we obtain $r = -.0558$. We expect that this is really the more correct measure of the true relationship between standard and general intelligence.

Table III. Age and Standard. The correlation here is clearly very high; determined as a correlation ratio it is .9366. Practically children are moved up a class or standard a year.

Table IV. Mental Capacity and Place in Class. The correlation as found by correlation ratio is .7246. The actual mean places of each category are :

E: .122	} All categories: .456.
G: .312	
M: .500	
D: .851	

This list itself shews that the teacher's estimate of general intelligence represents very closely the examinational place which a student will take and for many inquiries may quite legitimately replace that estimate of ability.

Table V. Age and Place in Class. Found by the ordinary product moment method the correlation coefficient is .0484, shewing that with increased age a *slightly worse* class position is taken, i.e. any advantage from age is counterbalanced by the clever elder boys leaving school earlier. The value, considering the numbers dealt with, is, however, hardly significant.

Table VI. Place in Class and Standard. The mean places are as follows :

Infants .457	} All classes: .456.
I .494	
II .445	
III .393	
IV .388	
V .493	
VI .493	

* This must be taken negative if treated as a correlation coefficient.

This series is very irregular. The η for the series is .1553, but this is rather a measure of the irregularity than of anything else*. If we take the correlation coefficient for a four-fold table as follows

	Infants I, II, III	IV, V, VI	Totals
.05 to .45	71	53	124
.50 to 1.00	67	58	125
Totals	138	111	249

we find $r=.0580$, a number of scarcely any practical significance and shewing that really place in class is, as it should be, independent of standard.

We have then to sum up the following results :

Intelligence and Age	$r_{13} = -.1830$
Intelligence and Position in Class	$r_{12} = .7246$
Intelligence and Standard	$r_{14} = -.0558 (-.2123)$
Position in Class and Age	$r_{23} = -.0484$
Position in Class and Standard	$r_{24} = .0580 (.1553)$
Age and Standard	$r_{34} = .9366$

In the case of two of these correlations for which some doubt might exist, we have placed in brackets the higher values found by different processes. The results for both values of the partial correlation coefficient have been worked out.

Correlation of "General Intelligence" and Examinational Place, for constant age and constant standard :

With lower values of r_{14} and r_{24} :	$\rho_{12} = .70 \pm .02$.
With higher values of r_{14} and r_{24} :	$\rho_{12} = .99 \pm .01$.

We may safely draw from these results the conclusion that the teacher's estimate of general intelligence is not a purely idle character, wholly valueless owing to the personal equation of the teacher. Whatever else it may be, it is highly correlated with the place which the student will take in an examination test and accordingly has at least one quite definite significance.

The first of these results shews that with the lesser and more probable values of the correlations we obtain, allowing for standard and age, a high correlation (.70) between the teacher's estimate of general intelligence and actual examination measure of capacity. There are, however, cross-currents at work in elementary schools ; the one is the selection of the notably dull children about 10 who are drafted into "special schools." This causes rather a defect of dull children in the II, III and IV standards ; the next is the selection of the more intelligent children in the highest standards (this is most obvious in V) to leave the elementary schools. The total effect is to make a somewhat high correlation ratio for standard and intelligence. If we took all the children in a class there ought to be sensibly no correlation between position in class and standard, but we actually find for classes II, III and IV excess of good places (averages .445, .393, .388 instead of .456) and for the high classes V and VI excess of bad places (averages .493, .493). This seems to be the result of the same cross-currents, the selection of the

* It must be remembered that not every child, but only 30 to 40 in each standard were physically examined, and the number so dealt with is not by any means the number in the class. This selection of children accounts for the mean place in class being .456 and not .500.

dull to go and of the dull to stay at different ages. If we now give the higher values to the correlations produced by these tendencies in elementary schools, we find on correction not that they have tended to disguise the real value of the "general intelligence" character by giving it a spurious high intensity, but that they have tended to *lower* its true importance. Those who complain of the different percentages of the divers grades of intelligence of the children in the different standards of the same elementary school often seem unaware that the same sample does not pass through all standards, at one stage there is a rejection of the very dull and at another the retention of the dull class. The main facts brought out are the substantial correlation between teacher's estimate of general capacity and examination test, and the fact that extreme allowance for age and standard tends to emphasise this relationship rather than to shew that the teacher's estimate is of little value. These observations were not made *ad hoc*, but they have been confirmed by other observations made on far larger numbers with additional safeguards for accuracy. The results of these will shortly be published, but it seems worth while indicating at a time when hasty criticisms are being made of the value of "general intelligence" estimates that the teacher's appreciation of mental capacity does mean something, and has a very direct and practical value, when properly registered and handled.

K. P.

II. Note on the Separate Inheritance of Quantity and Quality in Cows' Milk.

By KARL PEARSON, F.R.S.

Under the above title Professor James Wilson, of the Royal College of Science, Dublin, read a paper in May, 1910, which is published in Vol. XII. pp. 470—479, of the *Scientific Proceedings of the Royal Dublin Society*.

He states that: "It is a very general opinion that the milk of high-yielding cows is usually poorer and that of low-yielding cows richer in quality" (p. 470), and again he writes:

"If we group together all the low-yielding cows, and find their milk *invariably* high in quality, we may infer that low yield and high quality are of the nature of concomitant variations. If we group the high-yielding cows together, and find their milk *invariably* of low quality, we may infer that high yield and low quality run together. But if we take these groups and any other groups we can form, and find that the quality *varies the same way in them all*—that is that there are low qualities, high qualities, and medium qualities in every one of them—then we are *justified in inferring* that the quantity and quality of the milk are independent of each other. And this is what we do find" (p. 471).

The italics are mine. It would be difficult to find a paragraph containing more fallacies in as many words. Two qualities may be associated together, even closely correlated, and yet one will not be *invariably* accompanied by the other. High, low and medium values of one character may occur with any given value of a second and yet there be high correlation between them. The whole problem turns on the *extent* of the variation of the first character for a given value of the second, and not the invariable appearance of one with the other. The author may have some conception of correlation other than absolute association, but neither this paragraph, nor his general treatment of the subject, shews any signs of it.

Professor Wilson's material is involved in the table below.

Now there can be no doubt of the value of such returns and of tabling them, although we regret the clubbing together of the tail frequencies, that common error of the non-statistical trained mind, which renders determination of the true correlation so difficult.