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SHORT COMMUNICATION

Parent–Offspring Correlations and Regressions for IQ[1]

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Studies of family resemblances for measured intelligence show a substantial heritability for this conglomeration of characteristics. We have 2029 pairs of parents with one or more offspring. The IQ values for both parents were obtained when they were in their "teens," and their offspring were likewise tested during their teens. The regression coefficient for each offspring's IQ on the midparental average IQ, for the 2029 pairs, was 0.613 ± 0.022. The regression for the offspring when the midparental average IQ was above 114 (+1σ), with 259 pairs, was 0.496 ± 0.139. The regression for the offspring when the midparental IQ averages were from 74 to 114 was 0.481 ± 0.034 (−2σ to +1σ), with 1664 pairs. The regression when the midparental IQ average was below 74, with 106 pairs, was 1.531 ± 0.324. Statistical truncations, such as the above, can cause gross aberrations in the correlations and regressions of the subsamples. The effects of such truncations on the relevant literature are discussed. The average correlation between siblings was 0.387 with 95% confidence intervals of 0.318–0.451.

KEY WORDS: parent–offspring correlations; regressions; measured intelligence; sex differences; sibling correlations.

INTRODUCTION

The study by Reed and Reed (1965) is the only one of adequate size and representativeness for the analysis of the correlations and regressions for

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tested intelligence of parents and offspring in which both groups were tested while in their "teens." This involved two generations of investigators, as well as the two generations of subjects.

In Fig. 1 of Bouchard and McGue (1981) there is a weighted correlation of 0.47 for 69 combined samples of 26,473 pairs of siblings reared together. However, the correlations for the 69 samples ranged from 0.13 to 0.90, clearly an undesirably wide range of values.

The major purpose of the present paper is to demonstrate the great importance of the composition of the sample population studied because the sample composition might well explain much of the large variation in correlation coefficients from sample to sample such as in the review cited above. We explore what happens when, with our sample of 2029 midparent–offspring IQ values, the sample is truncated into subsamples. We also look at parent–offspring comparisons for IQ in relation to the sex of the parent and the offspring. Finally, we present the correlations between siblings depending upon their sexes.

MATERIALS AND METHODS

The study by Reed and Reed (1965) included several thousand persons whose IQs had been determined when they were schoolchildren and collected by us later. There were hundreds of cases where we had IQ values for both parents and for one or more of their children. There were thousands of cases where the IQ value for one or both of the parents and some or all of the children were missing, and these had to be omitted from the present study. However, we did have a residue of 2029 cases where we had the midparental IQ average to compare with the value for the child. [See Reed and Reed (1965) for details of the methods used in obtaining the sample.] The subsamples used in the work reported here are parts of the 2029 pairings just mentioned.

Parent–offspring regressions were obtained, with the linear regression coefficient of offspring on midparent estimating the narrow-sense heritability. Standard errors of regression of offspring on midparent also serve as the standard errors of heritability.

We also present intraclass correlations for the siblings in the sample when grouped according to sex.

RESULTS AND DISCUSSION

We had classified the probands of our original study, all of whom were mentally retarded, as being retarded because of factors which were primarily genetic, probably genetic, primarily environmental, or of un-

Table I. Correlation and Regression Coefficients for Midparent–Child Pairs for Families Sorted According to the Classification of the Proband (Midparental Average with Each Child in the Family)

	Primarily genetic	Probably genetic	Primarily environmental	Unknown causes	Total (all 4)
Midparent–child (*N*)	688	544	163	634	2029
Correlation coefficient	0.543	0.582	0.362	0.439	0.531
95% confidence intervals	0.488–0.594	0.523–0.635	0.220–0.488	0.374–0.500	0.489–0.553
Regression coefficient ± SE	0.640 ± 0.038	0.615 ± 0.037	0.485 ± 0.098	0.548 ± 0.045	0.613 ± 0.022

known cause. Few of the probands were included in this present work, but it was natural to sort the selected parents and offspring of the present study into the four categories, just mentioned, from which they came. We did not expect that there would be any significant differences among the four groups. We were surprised to find that there were striking differences, as shown in Table I. We are not concerned with these differences in this paper and do not discuss them further, except to say that the reduced correlation–regression estimates for the "primary environmental" group suggest a reduced importance of genetic factors in this group compared with the other three groups.

Sex Effects

It is often assumed that the mother has a greater influence upon the IQ of the child than does the father. This should be primarily environmental in the sense that she spends more hours with the child in the early years than does the father. However, she also transmits an X chromosome to every child, while the father fails to provide an X for his sons. It can be seen in Table II that while the correlations and regressions between mothers and their children are higher than those between the fathers and their children, the differences are barely significant and very modest, assuming, of course, that they are real differences and not biases of some kind. However, a sex effect is suggested, and the subsamples are large. The correlations between siblings gave the highest value for sisters and the lowest for brothers, as shown later.

Table II. Correlation and Regression Coefficients for Each Parent and Each Offspring According to Sex of the Individuals

	Correlation (95% confidence interval)	Regression ± SE	*N*
Mother–offspring	0.464 (0.426–0.498)	0.460 ± 0.020	2029
Mother–daughter	0.486 (0.436–0.533)	0.474 ± 0.027	990
Mother–son	0.443 (0.392–0.491)	0.442 ± 0.027	1039
Father–offspring	0.423 (0.405–0.441)	0.397 ± 0.019	2029
Father–daughter	0.438 (0.385–0.488)	0.408 ± 0.027	990
Father–son	0.411 (0.358–0.461)	0.385 ± 0.027	1039

Truncations of the Sample

The reviews of Erlenmeyer-Kimling and Jarvik (1963) and Bouchard and McGue (1981) show a wide range of correlation coefficients for a particular relationship such as midparent and child for studies of different samples. We consider now our midparent–offspring correlations and regression coefficients. The whole sample was divided into three subsamples. The "top" subsample included the midparent IQ averages of 114 and above (1 SD or more above the mean). The "middle" subsample included all the midparent IQ average values between 74 and 114. The "bottom" subsample included all midparent IQ averages below 74 (−2 SD and below). This truncation of the total sample of 2029 pairings into three very unequal subsamples has extremely striking effects upon the correlation and regression coefficients, as shown in Table III.

The great departures in the sizes of the correlation and regression coefficients from the values for the whole sample are primarily due not to the decrease in sample size for the three subsamples, but rather to the effects of the truncations by which the subsamples were obtained. The variances of the offspring remain relatively constant, while the variances of the midparental IQs decrease dramatically. The parental groups are severely constricted by being truncated into three IQ groups (top, middle, and bottom), which sharply decreases their variance in relation to the whole sample. Ordinarily, we expect the standard deviation of the midparental average IQ (13.45) to be lower than that of the average IQ for the individual offspring (15.54). These normal values for our whole population change drastically when the sample is truncated. Thus, for the top sample, the midparental standard deviation for the 259 pairs has plunged to 5.87. It is only 8.84 for the 1664 pairs of the very large middle subsample and only 5.93 for the smaller bottom sample of 106 pairs. On the other hand, in the bottom sample the range of the IQ values of the children is increased because of many cases of mental retardation, so that the standard deviation of the offspring is increased significantly to 21.65. Consequently, it is not surprising that the regression coefficient for the bottom group turns out to be 1.531 ± 0.324, indicating, roughly speaking, that an offspring can increase 1.531 IQ points for each IQ point increase in the midparental average. Any significant changes in the standard deviations will result in substantial changes in the correlation and regression coefficients.

It should be clear that it is the composition of the subsamples, resulting from the truncation involved in their selection, that results in the large fluctuations in the correlation and regression coefficients, because of the greatly changed standard deviations. It is not sample size per se

Table III. Correlation and Regression Coefficients for the Whole Midparent–Offspring Sample and the Three Subsamples Selected from It for IQ Values of the Midparent Averages

Sample	Correlation (95% confidence interval)	Regression ± SE	*N*	Midparent		Offspring	
				Mean	SD	Mean	SD
Whole	0.531 (0.489–0.553)	0.613 ± 0.022	2029	100.59	13.45	106.07	15.54
Top (IQ 114 and above)	0.218 (0.097–0.334)	0.496 ± 0.139	259	119.27	5.87	114.91	13.36
Middle (IQ 74 to 114)	0.327 (0.255–0.373)	0.481 ± 0.034	1664	100.15	8.84	106.68	13.02
Low (IQ 74 and below)	0.419 (0.261–0.563)	1.531 ± 0.324	106	64.78	5.93	76.59	21.65

that brings about the large fluctuations just observed, although it could contribute to some degree to the size of the fluctuations. Neither the correlation nor the regression curve is linear, partly because of the effects of mental retardation.

It is reasonable to assume that the samples assembled in the review by Bouchard and McGue (1981) vary, in part, because of the small size of most samples, but also that the composition of each sample could well be quite different from author to author. A truncation bias (presumably unintentional) could be of considerable importance in explaining the wide variation in the correlation coefficients obtained for the various samples for a particular relationship (such as siblings reared together, which range from 0.13 to 0.90 in their Fig. 1). Their weighted average correlations are probably much more valid than the wide divergence of correlations presented by different authors would lead one to expect.

An Extreme Truncation

Professor Thomas Bouchard referred us to the paper by McAskie and Clarke (1976) which presents a correlation of only about 0.08 between 559 gifted parents and 1027 offspring who were in the well-known Terman study of the gifted. The gifted parents all had tested IQ values of over 135, so this is the most extremely truncated sample of large size available. We know from the last report in the series, Oden (1968), that the average IQ for 1571 offspring of the gifted parents was 133.2, far above the average for the population as a whole. The children resembled their parents as a group, but the lack of correlation for IQ on an individual basis must be a statistical phenomenon rather than a lack of transmission of favorable environmental and genetic factors (as suggested by the failure of the correlation coefficient to be significantly different from zero).

Correlations Between Siblings

It was an interesting finding that all of the correlations between a parent and an offspring (Table II) were higher than those between the offspring (Table IV) compared with each other. Presumably these siblings had more similarities of environment than did parents and offspring. Parents and offspring cannot have exactly the same environment, as they are born in different generations. We have no explanation for this unexpected result.

In our material we had 1048 comparisons of siblings of whatever sex for an average correlation of +0.387 with a 95% confidence interval of +0.318 to +0.451. This correlation was corrected for the bias due to

Table IV. Correlations for Siblings According to Sex

	Male–male	Male–female	Female–female	All
N	213	595	240	1048
Correlation coefficient	0.364	0.371	0.382	0.387
95% confidence interval	0.241–0.475	0.299–0.438	0.268–0.485	0.318–0.451

different sibship sizes. Table IV presents the data *corrected for size* of sibships, in relation to the sex of each sibling. All the values are highly statistically significantly different from zero but they are not statistically different from each other. Clearly, correlations for siblings show no statistically significant sex differences, and if any do exist, they are very small. One cannot make a claim for sex modeling for measured intelligence.

Our conclusion from our data is that truncation, or the constriction of the parental group, results in drastic reduction of the size of the correlation coefficient and also causes large aberrations in the regression coefficients of the subsamples involved and may be an important component of the errors arising from sampling strategies.

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