Correlational Statistics and the Nature-Nurture Problem

McCall's conclusion (*1*) that genetic similarity appears to be less related (if at all) to changes in IQ than it is to the IQ level itself may be surprising to some. Part of the reason for such surprise rests upon some obvious limitations of correlational measures, which, although they follow directly from the derivations of these techniques, are nonetheless often overlooked.

The first such limitation is that correlational measures are systematically constructed to eliminate the influence of absolute mean values; that is, since the correlation between two distributions of scores is dependent only on the deviations of corresponding pairs of scores from their respective distribution means, the actual magnitude of the means does not directly enter into the correlation. Let us assume, for example, that a group of children whose IQ's correlate highly with those of their parents are retested, after having experienced a year in a compensatory education program, and that the children show considerable mean IQ gain. The second set of filial IQ scores will correlate as highly with parental IQ as the first did, provided that each child's IQ score deviates from the second mean in a manner comparable to the way his initial score deviated from the initial mean. For this reason it is obviously inappropriate to conclude that there is an inverse relationship between correlations demonstrating genetic relationships in a trait and the changeability of that trait. Studies demonstrating such relationships, however (for example, high correlations between the IQ's of foster children and their biological parents despite environmental changes), are often taken as evidence of the unmodifiability of IQ.

As McCall's data illustrate, however, there is nothing inconsistent in maintaining that even abilities reflecting a high genetic "loading" may be quite amenable to change. This interpretation is also consonant with the data obtained from several older studies, such as that of Honzik (*2*). She reported that, despite high correlations between the IQ's of a sample of foster children and those of their biological parents, the IQ's of the children shifted on the order of 20 points in the direction of that of their foster parents.

A second often overlooked limitation of correlational statistics concerns their generalizability and their meaning. Specifically, since the magnitude of a correlation coefficient is directly dependent upon the variation present in both distributions, in cases where the variation of either distribution is restricted the magnitude of the correlation coefficient is correspondingly lowered. Intelligence quotient scores, for instance, predict academic success relatively well overall. They do not, however, predict success in graduate school with any great degree of accuracy, because graduate school applicants tend to cluster around the high end of the IQ distribution. Thus, although an obtained correlation accurately describes the relationships between two variables for a given sample, if the range of sample scores is truncated, that relationship will not generalize to more representative samples containing a wider range of variation.

This limitation is especially prominent in studies in which an attempt is made to relate environmental variables to IQ. As Wachs and Haywood (*3*) note, in many of these studies only very restricted ranges of environments have been used. Furthermore, correlations obtained between environment or heredity and IQ are often converted into percentages of trait variance accounted for by the respective factors and the results are generalized to all ranges of environment and heredity. This error is frequently compounded by a second logical error in which it is assumed that the percentage of trait variance accounted for is indicative of a factor's relative importance in "causing" a trait. This assumption is logically equivalent to the conclusion that learning arithmetic is irrelevant to learning calculus because, as a result of the fact that the students of a given sample achieved near-perfect arithmetic scores, low achievement-test correlations between the two related mathematical areas were obtained. Similarly, if one rears genetically identical rats in different environments and then obtains "maze brightness" scores, one could conclude that heredity had nothing to do with maze brightness. Conversely, however, if one rears genetically dissimilar strains of rats in identical environments, one might conclude that environment had played no role in the development of resultant maze brightness. What correlations *can* legitimately tell us in these latter two cases is how much heredity and environment contributed to the difference in maze brightness scores (not maze brightness itself) for genotypes and environments actually sampled.

Although these two limitations, that of insensitivity to mean change and lack of generality, have been discussed only in terms of correlation statistics, it should be noted that they also apply to heritability coefficients. [For a fuller discussion of the uses and limitations of heritability coefficients, see the excellent discussions of Roberts (*4*) and Hirsch (*5*).] Perhaps I may best conclude by suggesting that data derived from and legitimately restricted to the study of differences between individuals or populations, although interesting, do not provide a sufficient basis for the explanation of ontogenetic development.

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References and Notes

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4. R. C. Roberts, in *Behavior-Genetic Analysis*, J. Hirsch, Ed. (McGraw-Hill, New York, 1967).
5. J. Hirsch, *Seminars Psychiat.* **2**, 1 (1970).
6. I thank Drs. R. McCall and T. Wachs for their helpful comments on an earlier draft of this paper.

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