

## Genetics and Educability\*

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Everyone is educable; the blind can be taught to read, the deaf can be taught to speak, those without legs can be taught to walk.

Everyone can profit from an education appropriate to his needs, and, in so far as we are able, we should be giving everyone such an education.

These things are axiomatic. But they do not in any way imply that each of us could profit equally from the same given educational environment, for we are all different, each of us is unique genetically, as well as in environmental history. Hence, our needs may differ.

It is my contention that we shall not approach the ideal of giving each an education appropriate to his needs unless we frankly recognize that there are important genetic as well as environmental causes of human variety, and frankly discuss the implications of this genetic variety in relation to our concepts of the various functions of the educational process.

This I propose to try to do, briefly, in this paper, in which though it is in no way intended to be a black paper, I shall try to call spades spades whenever the facts or logic seem to me to require this, and I shall not mind if I offend some of those whose minds are for any reason closed on unresolved issues.

First, I must say something about the meaning of statements about people. We make such statements in reference to particular attributes of people, which are therefore always abstractions, and such statements are always comparative. The statement "This man is tall" is an abstraction in that it refers only to the man's stature. It is comparative in that it says nothing about the man's stature except that it is greater than that of some other man or men. We often confuse our-

selves about this by using words like "tallness", "intelligence", "character" or "trait" which tend to seduce us into thinking we are saying something about the character of a man in isolation. But whatever we say about a man is in fact a comparative statement expressing his differences from some other men (or women), unless our statement refers to some attributes of all men, in which case our statement is comparing men with apes or monkeys, fish, broad beans or pebbles on the beach.

Statements about the genetic or environmental causes of human attributes, such as stature or educability, are therefore statements about the causes of differences between individuals or groups of individuals. They are not statements about those individuals or groups themselves in isolation.

Further we should realize that, however resounding they may seem, and however politically effective they may be, most statements about *everyone* are not only abstractions but are also trivial. I begin with such a trivial statement "Everyone is educable". All it means, of course, is that you can teach everyone something, which is just as true of dogs or squids or flatworms. Everyone *is* educable. But the problems we have to face arise from the fact that in particular respects people differ in their educability.

Second, I must say something about causes of variation in educability and spell out as best I can the meaning and use of that grossly misunderstood concept "heritability".

When a new human being starts existence as a zygote it has a range of potentialities determined by its unique set of genes. It also already has a unique environment, which is provided by its mother and is affected by its mother's unique genotype and unique history. By the time it is born, a child will have been affected by that

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environment so that differences between individuals at birth are not only a consequence of genetic variation, but may have been contributed to by environmental factors, some of them themselves genetic, others determined by the mother's reaction to her conditions perhaps even long before the child itself was conceived.

I am surprised how seldom one comes across clear recognition of this, for there is no formal objection to the argument that differential nutritional conditions in different socio-economic groups in the 1930s may have affected say the I.Q.s of the descendants of these people now.

However, such formal arguments are of use only for political or heuristic purposes. Humans like other animals are homeostatic, and can in some measure compensate for the consequences of early disturbances of development especially if conditions improve later. Such formal statements are therefore statements only of what *might be* the causes of things. Truly informative statements have to be quantitative, assessing the *relative* effects of different causes. It is for this reason that the concept "heritability" is of importance to the present topic, for a heritability estimate is a statement about the relative importance of two sets of causes of variation in the circumstances in which that estimate was obtained.

Heritability estimates for human variables in particular populations may be obtained in many ways, from correlations with degree of biological relationship compared with the theoretical genetic correlations, from twin studies, from studies of adopted children, studies of children reared in orphanages, and so on. The derivation of such estimates, and the limitations and assumptions involved in each kind of estimate are complex matters, which I do not propose to consider, except to point out that there must be general agreement between the estimates derived from independent means if we are to place any weight on these estimates.

We must, however, consider much more carefully what a heritability estimate means when we have obtained one. It is here that there is much confusion.

I will discuss the meaning of heritability in relation to the psychometric variable "performance in I.Q. tests" without for the moment considering the relevance of I.Q. score to educability, because I.Q. has been extensively studied and there is general agreement that, in the European and white American populations in which those studies have been made, the heritability

of I.Q. variation is very high, of the order of 70% or so.

Now such an estimate only means that in the population studied, averaged over all the individuals studied, the environmental differences that actually affected the population account for about 30% of the variety in the population, the remainder being accounted for by the relevant genetic variety in that population.

Such an estimate, therefore, says nothing about any particular individuals in that population, says nothing about any other populations, and says nothing about the relevance of genetic or environmental differences in the causation of differences between that population and any other, as for example between racial groups. Furthermore, the same level of heritability can result from environmental factors of large effect that act upon a small proportion of the population or from the action of a large number of factors each of small effect, provided that unfavourable factors affecting the lower half of the distribution are more or less balanced by favourable factors affecting the upper half, for otherwise the distribution would not be approximately symmetrical. (This is true even if the symmetry of the distribution is mathematically imposed by scaling, because the genetic or environmental effects measured are effects on the relevant scale.)

Thus quite a high heritability is perfectly consistent with the concept that some individuals have been affected by distinctly unfavourable environments. A high heritability does not tell us that environmental modifications could have little effect on individual phenotypes.

What then does heritability tell us?

The measure was first invented to enable the prediction of responses to natural or artificial selection in animal and plant breeding. Though this sort of prediction must concern us with respect to the consequences for future generations of correlations between fertility and measures related to educability, the use of heritability for this purpose is of marginal concern to the present topic.

Heritability estimates, however, have something to tell us about the consequences that might result from manipulation of environmental factors that now affect our population. To illustrate this I have drawn up two tables showing what we might expect if we were able to manipulate environments—(1) so as to give everyone the most favourable of *present environments*, from this (and only this) point of view, or (2) so as to provide compensating environments such that

those now most favoured would be given the least favourable and those now most deprived would be given the most favourable of the *present environments*.\*

In looking at these figures we should bear in mind that the best estimates of IQ heritability we have, which are for European and American white populations *and these only*, are around 0.7 or 70%, or 80% if we correct for measurement error.

TABLE 1

*Effect that the most favourable existing environments would have had on the IQ means of samples whose present IQ is given, with different heritabilities*

Heritability %	Present IQ						
	70	80	90	100	110	120	130
100	70	80	90	100	110	120	130
80	82	90	98	106	114	122	130
50	100	105	110	115	120	125	130
20	118	120	122	124	126	128	130
0	130	130	130	130	130	130	130

TABLE 2

*Effect of compensating environments with varying present heritabilities*

Heritability %	Present IQ						
	70	80	90	100	110	120	130
100	70	80	90	100	110	120	130
80	82	88	94	100	106	112	118
50	100	100	100	100	100	100	100
20	118	112	106	100	94	88	82
0	130	120	110	100	90	80	70

These two tables are not to be regarded as anything but grossly oversimplified models which ignore important possibilities. But I hope they serve to illustrate two basic points. First, unless heritability is virtually 100%, improving the environment by manipulating the features that at present vary can have important effects. Second, fully compensating environments would only have egalitarian consequences if heritability were exactly 50%, and then, of course, they would ensure that there would be no individuals with high I.Q.s, which I doubt would be desirable.

The tables do not illustrate other points.

First, even if heritability is 100% *new* environmental factors may be found that are effective.

This is obvious, for heritability only measures the relation between existing genetic and existing environment variance. It tells us nothing about the possible effects of new environments. Thus the finding that heritability of I.Q. is high has no implications whatever concerning the possibility of boosting the attributes that are measured by I.Q. tests through the use of new techniques, educational and otherwise. This points to possible sources of failure of "head start" programmes which tended merely to use old techniques on new people.

Second, the tables ignore the possibility of genotype—environment interaction (see Thoday, 1965). There is genotype—environment interaction if a given genetic difference differs in its effect in different environments. The most recent available analysis of I.Q. data (Jinks & Fulker, 1970) suggests that genotype—environment interaction components of I.Q. variance are small. But for two reasons this does not mean that such interaction components are small for educability. For one thing I.Q. is only a partial measure of particular kinds of educability. For another the techniques for detecting such interaction will only detect some rather systematic kinds of interaction. Practising educationalists of course are well aware of individual interaction with educational processes especially in respect to the fact that some children will progress faster if pushed harder, whereas others will progress slower or even regress. Some need to be pushed. Others need *not* to be pushed.

Third, is a point that needs repeating again and again. Heritability estimates cannot be applied to populations different from those from which they were obtained. Neither can heritability estimates obtained from within populations be applied to between population differences.

Thus if we take the pair of populations whose I.Q. differences are most extensively discussed, US Negroes and US Whites, the high heritability of I.Q. in US Whites tells us nothing about its heritability in US Negroes. Neither does it tell us anything about the causes of the difference in average I.Q. between these two populations.

Incidentally, on the same grounds, such knowledge of American Negroes as we have must not be applied to Africans. Extrapolation from one Negro population to another is as unjustifiable as any other assumption about people made on the basis of their racial classification rather than their individual attributes.

Such extrapolations from population to population are illegitimate because the gene

\*The tables assume that environmental and genetic deviations are correlated. The results differ considerably from those to be read from the relevant distributions given by Jensen (1969).

frequencies of the populations may differ and the environments, cultural and physical, differ. We are nevertheless very prone to make such extrapolations. A nice illustration of their dangers is provided by the XYY sex chromosome situation. As everyone knows by now, XYY males have been found in higher frequency in British maximum security prisons than they occur in samples of male children. There is some doubt about the statistical validity of this finding, but, if it finally proves sound, it implies that our XYY males have a slightly higher probability of behaving in such a way that they end up in such prisons. Some might express this in a general sense by saying that XYYs tend to criminal behaviour. But of course this statement *must* be qualified by specification of its limitation to the particular social environment in which the finding has been made. If this qualified statement proves true our educational system needs altering so that special conditions are created for XYY individuals to ensure that they are less at risk.

I said a moment ago that knowledge of the heritability of a variable within a population can tell us nothing about the differences between populations. And I have spelt out elsewhere (Thoday, 1969) the reasons that make it clear that when the populations differ in obvious visible racial attributes such as skin colour as for most US Negroes and Whites, present techniques make it impossible to discover whether the average difference between the populations in a behaviour variable is all genetic or all cultural or any mixture of the two. We must face up to the implications of our ignorance in this respect.

The implication of this ignorance is that we must *not* implement policies whose justification derives solely from one extreme hypothesis unless it is clear that if that hypothesis is wrong there will not be harmful effects. It is for this reason that I and those who think like me get disturbed at the frequency with which discussions of educational policy with respect to race and class differences are based on extreme environmentalist assumptions.

I take an extreme example from the writings of the sociologists Davis & Havighurst, who wrote (1948) "any difference between the average response of different cultural groups to a mental problem may be attributed to their unlike cultures. Therefore, all problems that show socio-economic differences in performance should be ruled out of the tests as unfair".

Now I will leave aside the matter that fairness

and unfairness is not an attribute of tests themselves but of the uses to which test results are put. The quotation makes two points. It is the first of these that seems to me to have dangerous implications.

It is of course true that differences between average responses of different cultural groups *may* be attributed to their unlike cultures. But it is equally true that such differences *may* be attributed to differing gene frequencies.

As I have already pointed out, with respect to ethnic groups we cannot know how much either is true. With respect to socio-economic groups we do not know, though the correlation of I.Q. and social mobility (Gibson, 1970) must lead us to expect some part to be genetic (see Thoday & Gibson, 1970).

Let us then ask what the consequences of extreme environmentalist assumptions might be if it so happened that these assumptions are wrong.

Extreme environmentalist assumptions lead to the concept that it is unfair if different groups prove to have different average success in any educational process, and hence lead to pressure that the educational system be so geared that each cultural group become represented according to their proportionate numbers whether in grammar schools, universities, or among first, second and third classes in degree examinations in any subject. Such pressures are already with us and are reported to be very strong in some American universities.

Supposing however that part of the difference between some cultural groups in particular aspects of educability are in fact genetic, this sort of treatment can only ultimately mean that the standard of performance required of different groups will come to differ. Then we are taking an enormous risk because employers will rapidly discover that, for example, a first class degree held by a member of one group is worth less or more than that held by a member of another group. Members of the group whose degrees thus become to be held in low esteem will have had aspirations raised that must inevitably lead to disappointment and even to an acuter sense of injustice than we have known before. And these aspirations will have been raised and disappointed, not because of the merits of the individual himself, but because once again the individual has been treated in a particular way because of his membership of a race or class.

Thus the extreme environmentalist assumption provides no solution to class or race problems

unless that assumption be wholly and exclusively true, and if it be not true it is likely to exacerbate those very problems it is designed to deal with.

I am of course aware that many of those who hold extreme environmentalist assumptions argue that it is legitimate to hold them as true unless and until others prove that they are untrue. This is of course an old technique, to which Herbert Spencer drew attention in 1852 when he wrote ". . . the majority of men who are born to a given belief . . . demand the most rigorous proof of any adverse belief, but assume that their own needs none". I would merely point out that this attitude can provide no excuse for those who take it, if the policies they promote prove to have the unfortunate consequences to which I have drawn attention.

In concluding this section on the meaning and limitations of heritability estimates, I want to make it quite clear that nothing I have said should be construed as an argument against attempts to improve the environment, educational or otherwise, of cultural groups who live in conditions we have reason to believe may be disadvantageous. Such attempts should of course be made. But they should not be made on the basis of *a priori* assumptions that will provoke disappointment and the sense of injustice if the attempts are not 100% successful. Within any group there is a wide variety of potential talents and a great deal of this variety is genetic. But we have no reason to believe that all groups have precisely the same distribution of such talents. At the same time we have every reason to believe that all groups overlap in their distributions of such talents. For example 30% of US Negroes perform better than the average US White in I.Q. tests. The wide distribution of talents within groups means that our basic aim must be to promote the development of the talents of individuals regardless of the groups from which those individuals come. It is individual variation not group differences in educability we must concentrate on. Our educational system must be geared to the concept of unique individuals with unique needs, and with unique capacities to contribute to society.

Let us now turn to individual variation and forget group comparisons. With respect to difference between individuals, the relevance of genetics to educability depends both upon the meanings we attach to educability and upon the degree to which relevant aspects of educability are influenced by genetic variety.

Obviously neither of these can be discussed

without consideration of the manifold functions of education. Yet far too often we see such discussions almost confined to consideration of ability as measured by tests of I.Q. type. The variation in abilities that are assessed by I.Q. type tests is of course of great importance. But we have known that there are other variables also of importance ever since, in his critical investigations of Californian school children, Terman (1947) demonstrated that, within the high I.Q. sample he followed up, the 25% who performed least well by the criteria he used did not differ in mean I.Q. from the 25% who achieved most. We will never reach a situation in which we can make reasonable prediction of success in the educational process, or, even more important, predictions of the kind of education that is likely to be most profitable for a given individual, until we cease so much to rely on a single dimension such as I.Q. tests provide. We need to seek the widest battery of metrics that do not correlate with, or show the minimum correlation with, results of I.Q. tests.

Over-reliance on tests of ability of the I.Q. type has been ubiquitous. An example is provided by Floud & Halsey's (1957) demonstration that our process of educational selection led to lower socio-economic groups being under-represented in grammar schools or Universities in relation to their ability. But the authors only measure of ability was I.Q. so that their argument involves the implicit assumption that I.Q. tests measure *all* the variation in ability that is relevant to such education. I.Q. plays its part in these discussions because I.Q. variation is important. It has been extensively studied. We know a good deal about its correlation with educational achievement as defined in particular ways. We know it is correlated with social mobility, and we know it has very high heritability in some populations. But I.Q. should never be treated as a complete measure of educability. We must not neglect other aspects of educability, some of which of course will also be influenced by genetic variation. I.Q. is not even a complete measure of variation of *academic* ability, so that over-concentration on I.Q. would not be justified even if we were to regard promotion of academics as the sole function of the total educational process, which I suppose no one does. Our knowledge of the limitations of I.Q. tests should long ago have led us to extensive application of other tests whose results show the minimum correlation with I.Q., with the aim of discovering how we can best advise and educate particular individuals according to

their particular individual needs and abilities.

Education which begins at birth has a number of ends, all of which have to be compromised because they are not wholly compatible with one another. These aims of education may be divided into two groups, those concerning the needs of the individual, and those concerning the needs of society. Individuals vary in their capacity to respond to different modes of education in respect to all these aims.

Individuals have to be taught and vary in capacity to learn:

- (1) to look after themselves;
- (2) to get on with others who are different from themselves;
- (3) to acquire those skills that will maximize their potential contribution to society and hence their success in life;
- (4) to acquire appreciation of those of the good things of life that will make life rewarding for *them*;
- (5) to develop their peculiar individual creativities;
- (6) to develop their critical faculties as far as possible so that their gullibility or exploitability may be minimized.

Society needs:

- (1) individuals who can look after themselves;
- (2) individuals that can live with one another, which of course requires that the individuals recognize that others may have different needs;
- (3) individuals with vocational skills in frequencies proportional to the needs of the existing social system;
- (4) the transmission of tradition so that the society may have continuity over time, and may profit from the accumulated experience of earlier generations;
- (5) individuals of critical and creative ability so that society may change, and tradition shall not become a dead hand on change. Such critical ability must be such that it is able to distinguish between traditions that are sound and should be preserved and traditions that are ill founded and needing change. Change merely for the sake of change is not our need.

Not everyone can fulfil all these educational needs in equal measure, and it seems to me that our attitude to all these functions of the educational process must be affected by recognition that we are dealing with unique individuals with unique needs and unique capacities to contribute

to society. Furthermore, it is only when we recognize this uniqueness of individuals that we are brought face to face with a fundamental dilemma of society and of the educational system that fits people to society.

Many of the needs of individuals I have mentioned are compatible with the needs of society. But the need of individuals to be given the maximum chance to develop their own particular potentialities and the need that individuals with vocational skills shall be produced in proportion to the requirements of the social system are clearly incompatible to some degree.

If we allow ourselves to forget that the individual's need, what will be the best life for a particular individual, is an intrinsic property of that individual as well as of the society in which he has to live, and to some extent is an intrinsic genetic property of that individual, then we can too easily seduce ourselves into thinking that the needs of society are wholly compatible with the needs of individuals. But if we think these needs *are* wholly compatible, we will inevitably force individuals into occupations which will not suit them.

We may illustrate this concept of varying individual needs by a close analogy. Different people have different visual needs, the differences being in part genetic. Some are blind, some are long-sighted, some myopic, some astigmatic, and the degrees of myopia, etcetera vary from individual to individual. We can meet some of these needs by providing different glasses for different individuals. We would not meet them if we insisted that everyone needed the same kind of glasses. To insist that everyone has the same educational needs is comparable to insisting that they all need the same glasses.

We do not at present know as much about individual variety of educational need as we do about visual needs. But unless we recognize that individual needs vary we will never discover how to meet the variety of need.

Recognition of the basic genetic individuality of people is thus a prerequisite for a just educational system and for a just social system. As that famous Marxist Geneticist, J. B. S. Haldane, expressed it: "That society enjoys the greatest amount of liberty in which the greatest number of human genotypes can develop their peculiar abilities". I would only add "and satisfy their peculiar needs".

Such a society will never be approached if we deny the relevance of genetic variation in education.

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