

PREPARED FOR THE INTERVENING DEFENDANTS IN GRUTTER V. BOLLINGER  
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**EXPERT REPORT OF MARCUS W. FELDMAN**

I have been on the faculty of the Department of Biological Sciences at Stanford University since 1971. I direct the Morrison Institute for Population and Resource Studies and the Center for Computational Genetics and Biological Modeling. I have written extensively on the quantitative aspects of population genetics and on how genetic and cultural transmission interact to produce the statistical variation observed in behaviors and in measured traits. I append my complete curriculum vitae as well as a list of my publications as Appendix A. I have not previously testified as an expert at a trial or in a deposition. I am being paid \$500 as a fee for my services.

My remarks concern the meaning of race and commonly made mistakes in the interpretation of observed differences between races. One such error is that the existence of differences in performance on standardized tests between two or more groups, within each of which there is genetic variation in performance, entails that the difference in average performance between the groups must be genetic. This erroneous reasoning has led to the suggestion that environmental interventions in education cannot succeed. Some of the scholars advocating this position have received funding from the Pioneer Fund, which has promoted racist initiatives for many years and which is supporting the plaintiff in the present case.

The truth is that group differences in performance on standardized tests can be very well explained by differences in neighborhood conditions, differences in the level of expectations, differences in the quality of school teachers, differences in family poverty, and differences in

learning experiences, all of which are part of the growing child's environment. Thus, in assessing qualifications for admission to programs of tertiary or graduate education, these environmental differences should be taken into account. By placing appropriate weight on these environmental dimensions, we have the potential to eliminate the persistent inequality that characterizes our society.

### **Definitions of Race**

Over the past 30 years, scientists have used advancing genetic technologies to study genetic variation among the world's human populations. The most recent of these studies found that 85 percent of variation in gene frequencies occurs within populations and only 15 percent between populations. Thus, less than 15 percent of these differences can occur between what were traditionally thought of as races. Historically, racial categories were based on externally visible characters such as skin color. These characters do not predict the distribution of actual genetic variation among populations. Race is not definable by any set of genetic variations, nor does an individual's self-identification with a race predict genetic characteristics of that individual. As concluded by the American Association of Physical Anthropologists, race reflects a cultural framework of societal, institutional, and civilizational values. The biological concept of race is not tenable; race is a social construct produced by a nation's social and political history. Thus, in Brazil, where non-Europeans were historically in the majority, terminology referring to an individual's color, which seemingly should connote ethnicity, actually refers as much to his or her wealth as to ethnic origin.

From these arguments, it follows that sociopolitical and socioeconomic factors are more important than the traditional biological understanding of race in determining outcomes as measured in social science research, such as school performance, or in medical research, such

as prevalence of some diseases. The importance of this revised understanding of race as a social construct rather than a genetic "fact" lies in the discussions that have permeated the social science literature on the causes of differences in performance and achievement between groups. I now discuss the issue of within- and between-group variation.

### **The Partition of Variation**

Most individuals of any living species differ from one another in some way. In the early part of this century, agricultural scientists recognized that related individuals differed less than those chosen at random from the population at large. They developed a statistical framework to exploit this correlation between relatives, a framework that allowed them to predict the effect of animal and plant breeding programs on the rate at which they could improve economically important traits such as butterfat percentage in cows' milk or yield per acre of cereal crops. The measure of amenability to this process of selective breeding was called "heritability". Its successful use relied heavily on the ability of the breeder to control or even eliminate environmental variation that might affect the trait under study. Heritability is still used in animal and plant breeding as an index of the ease with which artificial selection can take place. For my purposes, we can define heritability as the fraction of variation in a measured trait in a specific population in a specific environment that is due to genetic differences between the individuals in that population.

The term heritability came into wide use in the human behavioral literature after Arthur Jensen published his 1969 opus "How Much Can We Boost IQ and Scholastic Achievement?" in the authoritative *Harvard Educational Review*. Jensen used heritability to summarize the extent of genetic variation in IQ inferred from published data much of which had been reported by Sir Cyril Burt. Jensen wrote that about 80 percent was "probably the

best single overall estimate for the heritability of measured intelligence." Among the many problems with Jensen's estimate is the fact that Burt's data are now known to be completely unreliable and most likely fabricated. Jensen later wrote that this estimate could not be trusted because of the problems with Burt's data, but he published his caveat in a technical journal called *Behavior Genetics* read by few psychologists at the time, fewer educators, and certainly not by the congressmen who had read the original article into the congressional record.

Following the publication of Jensen's opus, Jensen and William Shockley joined forces in promoting what became a profoundly racist position, namely that because IQ was largely genetic (recall the 80 percent figure) and because American whites and blacks differed in their performance on IQ tests, these differences must be genetic and, as a result, environmental interventions whose aim was to improve the school performances of blacks were doomed to failure. Shockley's nationwide promotion of this position, as well as his program of paying people of below average IQ to be sterilized, was supported by the same Pioneer Fund that is backing the plaintiff in the present case.

In the early 1970's at Stanford, it was impossible for those of us working in population to avoid the hue and cry over the publicly racist advocacy of Jensen and Shockley. It was at this time that L.L. Cavalli-Sforza and I introduced models of cultural transmission into the statistical framework underlying estimates of the heritability of human traits such as IQ. Over the next ten years, inclusion of cultural transmission in analyses of familial data on IQ produced ever-decreasing estimates of the genetic contribution to variation within populations.

In carrying out these explorations on the statistics of IQ, there is no acceptance of any deep significance ascribable to the IQ scores in terms of abilities or life skills. Our purpose

has been to use the large data set with its wide array of relationships represented to discern non-genetic contributions. Our most recent analysis estimates the genetic to be about the same as the cultural contribution, namely 33 percent, with the remaining variation due to interactions and non-transmitted effects. There is no doubt that estimates of this magnitude for the genetic heritability of IQ, had they been available in 1969, would have produced different policy proposals from Jensen.

One final point on the assessment of within-group variation in IQ (and other traits); most studies work only with twins, or siblings, or adoptees and do not include enough categories of relatives to permit estimation of the amount of variation due to cultural transmission. This is why the social science literature is replete with estimates of 50 percent or higher. Very selective referencing on the part of behavior geneticists (psychologists who work in this area often refer to themselves as "behavior geneticists") has become the norm, and those studies that produced estimates of 33 percent for genetic heritability of IQ are never cited, even though they appeared in the most reputable of genetics journals.

The question arising from this history is whether a heritability of IQ of 90 percent or 10 percent should affect the policies advocated by educators, lawyers, geneticists, and social scientists. The figure of 80 percent certainly had a profound effect on Jensen in 1969, just as the number 60 percent had on Herrnstein and Murray in their widely discussed 1994 book *The Bell Curve*. From what we know about genetics and environments and their interactions, can any statements be made about differences between populations, between poor and rich, between white and black Americans or between Eskimos and Australian aborigines? This is the subject of the following section.

## **Interpretation of Heritability**

Why was the number 80 percent so important to Jensen? Why was 60 percent important to Herrnstein and Murray in their 1994 polemic against the utility of societal interventions to improve the socioeconomic status of the disadvantaged? In Jensen's case and in the view of many genetically uninformed authors "the fact that intelligence variation has a large genetic component... makes it a not unreasonable hypothesis that genetic factors are strongly implicated in the average Negro-white intelligence difference". Jensen's conclusion was directed at educational policymakers; because blacks had limited genetic potential, enriched educational programs could not "push the child above this potential." There are two famous fallacies in this reasoning that I will now discuss.

The first fallacy concerns the relationship between high (or low) heritability of a trait and the potential for environmental intervention to change that trait. Quite simply, there is no relationship between the heritability measured in one environment and how the trait will turn out in another. The classical example is the genetic disease PKU (phenylketonuria), which is determined by a single gene. Children born with this disease will become severely retarded unless an environmental adjustment is made, namely removing phenylalanine from their diet. With this environmental intervention, patients will in most cases grow up with normal intelligence. Here is a case where the trait in question is entirely genetic in origin, but environmental intervention is extremely effective in alleviating the symptoms. Height is another highly heritable trait within every population where it is measured. Yet the height of Japanese has changed, on average, several inches with dietary improvements since 1945. In other words, heritability of a trait, whether it is 100 percent or zero percent within a population tells us nothing about whether environmental intervention may change the distribution of that trait in that population.

Jensen was not the only one to suggest that environmental intervention would be futile in the face of high heritability. Another study headed by the economist P. Taubman found a high heritability for earning capacity and concluded that as a result "hard choices... between equality and efficiency will have to be made". British newspapers found these findings extremely important; the *Times* wrote that, since genetic factors play a huge role in determining an individual's earning capacity, attempts to make society more equal by breaking "cycles of disadvantage" are likely to be unsuccessful. As economist Arthur Goldberger has written, this is tantamount to proposing that if a large proportion of variance in eyesight were due to genetic causes, we should cease the distribution of eyeglasses. It goes without saying that a culturally acquired trait may also be subject to change under environmental intervention. After all, most of the statistical models include cultural transmission only from parents; other components of the environment are largely ignored.

As I stated in the first part of this report, geneticists do not use heritability estimates to assess the effect of environmental intervention, but to assess the likely effectiveness of selective breeding when the environment is held constant.

The second fallacy concerns the relationship between the heritability of a trait within a population and differences in that trait between groups. Suppose we take two packets of seed from a barrel of an open-pollinated variety of corn. A variety like this has a lot of genetic variation in it. Now one packet is planted in an environmentally controlled well fertilized garden while the other is planted in exactly the same kind of garden except that the essential trace element zinc is absent from the soil. After some time, we measure the heights of the plants and see that within each garden the heritability is 100 percent because each environment was uniform. But the difference between the gardens will be large and due to the

presence or absence of zinc, a component of the plants' environment. In this example, heritability is 100 percent, but group differences are environmental.

A second experiment involves two inbred lines of corn. Within each line, inbreeding has eliminated any genetic variation so when we plant seeds of these two lines, one seed to a pot filled with ordinary potting soil, the variation between the plants of the same inbred line must be entirely environmental. But there will be a difference between the average height of the two lines measured after a few weeks that is entirely due to the genetic differences between the lines. Here the within-line heritability is zero percent, but all differences between the lines are genetic.

These examples involve plants because it is ethical to control their environments, and we are able to make large numbers of genetically identical individuals. These are liberties we cannot take with humans. But the principle should be clear; whatever the heritability of a trait within a group, we cannot make inferences about the causes of differences between groups in that trait. This applies to IQ, earnings, height, and skin color—the logic is the same.

### **Genes, Environments, and Affirmative Action**

We have argued above that within-group estimates of the extent of genetic contribution to test performance are exaggerated by the failure to include culturally transmitted factors in the statistical analysis. I have also argued that whatever the estimate of heritability of test performance, it provides no information as to how performance would have been altered if the environment in which a candidate taking the test was raised had been different. These arguments impinge on the use of standardized test scores in admission to college or professional school (or more generally as a criterion for any qualification). The question is to what extent prediction of a student's ability to perform in college (or on a job) should ignore

the role that the student's environment might have played in contributing to the score on which the prediction is based. The environment here includes the suite of experiences that form the fabric of socioeconomic status, elevated or lowered expectations, better or worse teachers, absence or presence of discrimination, etc.


Here we have a straightforward dichotomy in the literature. Those who follow in Jensen's footsteps, such as Herrnstein and Murray, claim that innate intelligence (as measured by standardized tests) is much more important than socioeconomic status in determining economic and social success. Others such as Jencks et al. (1979) find that education, family background, and non-cognitive abilities are all as important as measured IQ in determining various economic outcomes. More details of this relationship can be found in the recent volume *Meritocracy and Economic Inequality*. In their contribution to this volume, for example, Ashenfelter and Rouse found that educational interventions do have the potential to decrease existing and growing inequalities in income. Indeed, the general finding of the book is that schooling improves occupational success in ways that are unrelated to cognitive ability. It is also found that IQ is not a strong predictor of economic success and that socioeconomic conditions like neighborhoods, working groups, and other social ties explain many observed poverty traps.

These findings by economists and sociologists should not be surprising in light of studies on children's intelligence test scores that show that economic and social differences in the lives of black and white children are able to explain almost all of the differences in the two groups' scores. The small gap that remains after adjustment for differences in neighborhood economic conditions, family poverty, maternal education, and learning experiences reflects the impossibility of accounting for all environmental factors (Brooks-Gunn et al. 1996). It is

certainly not ascribable to genetic differences in scores nor is it due to any general difference in intellectual or creative abilities.

Since socioeconomic variables are not assessed in standardized tests, it behooves the individuals and institutions that make decisions on whether an individual is qualified to enter a program of higher learning, or to receive an offer of economic advancement in employment, to consider these variables in whatever manner is possible. After all, standardized tests are used as predictors of ultimate performance in college, work, and society. If other variables predict these outcomes as well, they should also be used. It is not discriminatory to include in the class of predictors all factors that work equally well. Expanding the class of predictors beyond what is viewed by hereditarians as innate ability, as reported by standardized test scores, offers the opportunity to reduce economic inequality while offering more equal access to economic advancement. Increasing equality of opportunity is an issue of social policy, and the studies I have referred to make it clear what interventions are likely candidates for such policies: improvement of neighborhoods, reduction of family poverty, evening out the quality of teachers across school districts, and reduction of discrimination. There is no compelling reason to base what amounts to a de facto social policy on two or three numbers from a standardized test when the data show the importance of these other variables as predictors of performance.

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Signed: 

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## References

- Arrow, K., S. Bowles, and S. Durlauf (eds). 2000. *Meritocracy and Economic Inequality*. Princeton University Press, 348 pp.
- Brooks-Gunn, J., P.K. Klebanov, and G.J. Duncan. 1996. Ethnic differences in children's intelligence test scores: role of economic deprivation, home environment, and maternal characteristics. *Child Development* 67: 396-408.
- Cavalli-Sforza, L.L., and M.W. Feldman. 1981. *Cultural Transmission and Evolution: A Quantitative Approach*. Princeton University Press, Princeton, NJ.
- Feldman, M.W., and R.C. Lewontin. 1975. The heritability hangup. *Science* 190: 1163-1168.
- Goldberger, A.S., and C.F. Manski. 1995. Review article: The Bell Curve by Herrnstein and Murray. *Journal of Economic Literature* 33: 762-776.
- Herrnstein, R.J., and C. Murray. 1994. *The Bell Curve: Intelligence and Class Structure in American Life*. Free Press, New York, 845 pp.
- Jensen, A. 1969. How much can we boost IQ and scholastic achievement? *Harvard Educational Review* 39(1): 1-123.
- Otto, S.P., F.B. Christiansen, and M.W. Feldman. 1995. Genetic and cultural inheritance of continuous traits. Morrison Institute for Population and Resource Studies Working Paper No. 64.
- The President's Cancer Panel. 1997. The Meaning of Race in Science—Considerations for Cancer Research: Highlights and Recommendations From the President's Cancer Panel Meeting, April 9, 1997. NIH, National Cancer Institute.