DOCUMENT RESUME

ED 023 722 UD 005 796

By - Jensen, Arthur R.

How Much Can We Boost IQ and Scholastic Achievement?

Pub Date Oct 67

Note - 17p.; Speech given before the annual meeting of the California Advisory Council of Educational Research (San Diego, October 1967).

EDRS Price MF - $0.25 HC - $0.95

Descriptors - Ability Identification, Academic Ability, *Academic Achievement, Academic Performance, *Children, Disadvantaged Youth, Educational Improvement, Environmental Influences, Genetics, Individual Differences, Infants, Intelligence Differences, Intelligence Level, *Intelligence Quotient, Intelligence Tests, Learning Characteristics, Middle Class, Pregnancy

The importance and consequences of raising the average ability level (IQ) of the population requires consideration of the ability level that society requires, how the relevant abilities are distributed, and the efficiency of the current educational process. Within the framework of these factors, the document discusses the determinants of mental ability and the measures commonly used, the sources of variance in IQ, and the ways in which intelligence might be boosted. The latter include both genetic and non-genetic influences. Such prenatal factors as nutrition, length of pregnancy, maternal stress, and intrauterine environment have and effect on infant intelligence. Postnatal environmental influences have not been found to markedly affect IQ, with the exception of extreme isolation. In relation to disadvantaged children, whose learning and ability patterns are different from those of middle-class children, it is important that these differences be recognized as a precondition to developing appropriate educational strategies. (NH)

HOW MUCH CAN WE BOOST IQ AND SCHOLASTIC ACHIEVEMENT ?

Arthur R. Jensen

Arthur R. Jensen is Professor of Educational Psychology and Research Psychologist in the Institute of Human Learning of the University of California, Berkeley. He received his B. A. Degree from the University of California, Berkeley, and his Doctorate from Columbia University.

To answer this question, which I can blame no one but myself for posing, is a big order indeed. I doubt if it can be answered in any precise way at present. What I wish to attempt, however, is a preliminary analysis of the question which would indicate the nature of the answers that we might find and the kinds of research that might lead to improving the intelligence and educability of children.

First, let me make it clear that I am using the term IQ here as more or less synonymous with intelligence; it is merely a way of abbreviating the title of my paper. Also let us assume that we are dealing with intelligence as measured on an absolute scale. The usual IQ scale is, of course, an invariant one; its mean is always 100 and its standard deviation is 15. Systematic changes in the average level of mental ability in the population cannot show up in test scores that are standardized in such a way that the mean and standard deviation remain constant regardless of the absolute level of performance.

Why Boost Mental Ability?

Why should we think about boosting mental ability? Would there by any advantage, for example, in shifting the entire normal distribution up one standard deviation (i.e. 15 IQ points) or even in decreasing the spread of ability by pulling up those in the lower quartile by 10 or 15 IQ points? Some people have argued that, even if we boosted the average level of intelligence, we would still have a wide spread of individual differences; there would still be relatively bright and dull children and the material rewards in our society would still be correlated with differences in ability. Another question often raised is how important is a difference of, say, 10 IQ points, more or less, to the individual? Would any of us be much better or worse off

Invited Address at Annual Meeting of California Advisory Council on Educational Research. Oct. 1967. San Diego, Cal.

if 10 points were added to or subtracted from our IQ? Ten IQ points, I might add, is about the upper limit of average improvement when intensive systematic efforts have been applied.

One arrives at different answers to these questions depending on whether he thinks only in terms of the individual or in terms of populations. The real significance of an average of 15 points boost in IQ is seen most dramatically in the effect it has in the tails of the normal bell-shaped distribution. Even an average change of a few points can have drastic implications when we look at the part of the distribution that falls more than two standard deviations above or below the mean. For example, the minimum level of ability now required for passing grades in a good college corresponds to an IQ of about 115. Only 16 percent of our population falls above this point. A 15 point boost in IQ would mean that 50 percent of the population would be capable of this level of education. IQs over 130 would be increased from about 2 percent of the population to 16 percent. The advantages of such a boost in the proportion of more able persons, along with the corresponding reduction of persons in the lower tail of the distribution, is a matter for speculation.

The consequences of an equivalent lowering of the mean IQ of the population, on the other hand, seem far less uncertain. A lowering by as much as one standard deviation would probably make civilization impossible.

Given the methods of instruction now at hand, it is clear that the acquisition of certain skills required on an increasing scale in our technological society depend upon certain levels of mental ability, and it makes no difference what the ratio of supply and demand is in this case. For a particular job, given a certain instructional economy in terms of time, teacher-pupil ratio, and particular method of teaching, there is a minimal level of required ability. If this were not true, the Armed Forces would not have to use mental ability tests and would not have to reject anyone from service on the basis of insufficient mental ability.

A proper analysis of the importance and consequences of raising the average level of ability must take into consideration three major factors: (a) the ability requirements of the society, (b) the distribution of the relevant abilities in the population, and (c) the efficiency of the instructional process currently available.

Just a few words about each of these points:

(a) The increasing technological trend of our society suggests that the ability requirements must also be increasing. It probably takes more knowledge and cleverness to operate, maintain, or repair a tractor than to till a field by hand, and it takes more know-how to write computer programs than to operate an adding machine, and so on. What we must look out for, however, is our tendency merely to assume certain ability requirements for a job without establishing these requirements as a fact. How often do employment examinations, Civil Service examinations, high school diploma requirements, and the like, constitute hurdles that are actually irrelevant to performance on the jobs for which they are intended as screening devices? Before we go

overboard in deploring the fact that our disadvantaged minority groups fail to clear many of the hurdles we set up for many jobs, including service in the Armed Forces, we should determine whether the educational and mental test hurdles that stand at the entrance of many of these jobs are actually relevant. Wittingly or unwittingly, they may be only instruments of social or racial discrimination. If the hurdle is actually relevant, but only in the correlational sense that it predicts success on the job, we should also know whether the test actually measures the ability required in the job or only measures characteristics that happen to be correlated with some third factor that enters into success on the job. For example, it may be that a certain style of appearance and manners is essential for certain kinds of jobs that involve dealing with the public; and it may be that this combination of appearance and manners is correlated with the narrow range of abstract mental abilities measured by IQ tests, or with having had an academic major and a B average in high school, and so you can use these indirect criteria in selecting persons for the job, even though differences in abstract mental ability and high school record above some very minimal level may be quite unrelated to success on the job. The tests are then an artificial hurdle; they focus attention on what in many cases may be the irrelevant aspects of social and occupational attainment. Changing people in terms of the essential criteria for the job may be much more feasible than trying to boost their abstract intelligence and performance in academic subjects.

(b) What about the distribution of the relevant basic abilities in the population? Do we have a large enough ability pool for the jobs that have to be filled? If we measure ability by IQ tests or by school achievement in academic subjects, I think the picture is a gloomy one for society as a whole and especially for some of our minorities, especially our largest minority, the Negroes. Anyone who has read the Coleman Report, or who examines the results of ability and achievement testing in the schools of our largest cities, or who looks at the Armed Forces rejection rates of Negroes as compared with Whites based on the Armed Forces Qualification Tests (68 percent versus 19 percent), can readily see that the situation is critical and dismal -- if all we look at is whatever abilities are measured by our usual IQ tests. A few years ago I would have said that the IQ tests are not very good, that they are so culturally biased in favor of the white middle-class population and so biased against the disadvantaged minority groups in our population that the tests are practically worthless as ability measures outside the white middle-class population. I now seriously doubt that this is true, and I can honestly find little comfort in the popular cliché that there is gross cultural bias in our IQ tests. We have over-emphasized the cultural bias in tests as a means of rationalizing social class and ethnic group differences. Cultural bias in tests actually is not hard to identify; what is hard -- and I find it increasingly difficult as I examine more and more of the research evidence -- is to make out a strong case that the group differences we observe in our population are mainly attributable to cultural bias in the tests. Most of the IQ tests now in use in the schools, and I still put the Stanford-Binet at the top of the list in order of merit, measure mainly a certain kind of abstract intelligence. I am unable to find any compelling evidence that the individual and group differences that show up on these measures are due in the main to cultural or social environmental differences within our society. The fact that social and cultural differences do

in fact exist among different races and social strata in our population is not in itself evidence that these cultural factors are important determinants of IQ differences. The evidence indicates that they are not. The tests are very good for what they measure. Their validity is about the same in all segments of thepopulation, if we limit our concept of their validity to that of measuring the kinds of abstract intelligence that correlate highly with academic achievement under the present methods of instruction. The reason I am not as alarmed by this conclusion and some people might be, is that I see the IQ as representing only a portion of the total spectrum of human abilities.

The same sort of thing may be said concerning measures of school achievement. There are large group differences found in these also. But there is no evidence that these large group differences among segments of our population are due to inequalities of educational treatment, to inferior schools, inadequately trained and underpaid teachers, or otherwise poor educational facilities. I have seen schools in disadvantaged neighborhoods that on all counts are at least as good as, if not superior to, the best schools that exist anywhere in the United States today, and the average achievement level in these schools is far below the average of national norms. In view of the evidence, blaming society or the educational system for inequalities in scholastic achievement is to block the paths that might lead to solutions.

Inequalities in educational facilities still exist in many places and must be removed. But it now seems clear that the removal of all such inequalities barely sets the stage for the kinds of changes and improvements we will need to make in our educational system if the large segment of our population called disadvantaged is to benefit markedly. To aim merely at equality of educational opportunity and to stop there will fall far short of solving the educational problem.

(c) This brings me to the third point: the efficiency of instruction. When we say that IQ tests predict school achievement, we should remember that we are referring to the achievement that results from a particular instructional program. Like most other institutions that have been around for a very long time, our educational practices have evolved. They have not taken their particular form just by chance or decree. They were originally shaped, and have since evolved, in an Anglo-European culture and population, particularly in the upper-class part of this population. For this population and culture, the prevailing educational practices have seemed appropriate. They have not been unsuccessful by any reasonable criteria. The educational appropriateness of this approach for a segment of our U. S. population today, however, seems doubtful to me. Its obvious lack of success is attested by its failure to provide the many children we now called disadvantaged with the minimal essentials for economic self-sufficiency in our present urbanized society. Just as the IQ tests tap too narrow a band of the abilities spectrum, the educational system, through its particular evolutionary history, has developed in such a way as to capitalize on only a rather small range of abilities and patterns of ability. If a child is not in the modal group in these abilities, he falls more or less by the wayside and is never fully a beneficiary of our educational system. In fact, many children are probably worse off for their school experience than if they had never been exposed to

school at all. Children for whom the system does not work become "turned off" at an early stage of their schooling, so that at later grades little of the child's actual potential for learning is available to the teacher's efforts.

The Determinants of Mental Ability

As educators, our chief concern is with improving the scholastic achievement of pupils rather than with boosting IQ per se. Probably the reason we are inclined to think of the boosting of IQ as the main means of improving school performance is that IQ is undoubtedly the single highest correlate of school performance. No other single fact we can know about a child can tell us as much about his probable success in school as the IQ tells us. All the other variables we can take into account combined will not predict as much as the IQ. Naturally, if the IQ, or the mental abilities it reflects, is so important for school work, we are led to think in terms of raising the IQ itself as the chief means of improving school success. Indeed, the success or lack of success of various programs of compensatory education are often reported in terms of an increase or a lack of increase in IQ measures. Pre and post testing with the Peabody Picture Vocabulary Test or the Stanford-Binet are a standard part of the official procedures for assessing the effects of Head Start. Various research efforts are now being made to boost the IQs of disadvantaged children, mainly by enriching the early environment through preschool programs. Some slight degree of success was to be expected and indeed has been found. Boosts of 5 to 10 IQ points are often produced within a period of a few weeks. The size of the gain is usually in direct proportion to the degree of cultural bias in the tests and to the degree of cultural deprivation of the testees. To a large degree, "test wiseness," familiarity with interpreting and answering questions, working puzzles, and conforming to the requirements of a timed task, account for this boost. Middle-class children acquire some advantage along these lines at home. Disadvantaged children acquire some of this knowledge and skill in the process of taking tests, in their early encounters with Head Start, or in nursery school or kindergarten. An initial boost after brief exposure to certain educational advantages is easy to demonstrate and it is found repeatedly. What is harder to find is any appreciable gain after one or two years. The initial IQ boost seems to wash out. By this limited criterion, Head Start and other large-scale experiments in early compensatory education must be assessed as failures.

What we are really interested in, of course, are the educational correlates of IQ, not just the IQ itself. If the usual correlates of IQ do not show a boost along with the boost in IQ, practically nothing has been gained. Educators and psychologists who have aimed at boosting IQ directly have not reported significant gains in the educational or social correlates of IQ.

What little gains in IQ have occurred are often fleeting. They are attributable mostly to the culturally biased aspects of the tests - to those very features of IQ tests that many educators point to as a weakness of the tests, since these cultural aspects do not really get to the person's intelligence but only reflect his particular cultural background. It is this aspect of the test score that is easiest to change. But tests differ in their cultural loading, and tests with small cultural loadings are remarkably

resistant to the effects of cultural enrichment or even to direct coaching on similar items. The Educational Testing Service in Princeton has been experimenting with teaching children strategies for solving the test items of the Raven Progressive Matrices, for example. The training is intensive and specifically deals with kinds of problems that constitute the Progressive Matrices. The resistance of the Matrices to this type of coaching is rather astonishing. On the other hand, performance on the Peabody Picture Vocabulary Test, which correlates with the Matrices under normal conditions, is much more susceptible to coaching and cultural enrichment. The Stanford-Binet stands somewhere between these two extremes.

It is interesting that children we call disadvantaged actually make a better showing on the more culturally loaded items of tests; for example, they do better on the verbal subtests of the Wechsler or Stanford-Binet than on the performance tests.

Sources of Variance in IQ

In order to understand what is involved in boosting intelligence of the type assessed by tests like the Stanford-Binet, we must look analytically at the main sources of variability in IQ. The main sources of variance in IQs are shown in Table 1. The proportions of the total variance attributable to each of the sources are based on the average of the values of all the major studies in the literature concerned with this issue. (I have presented elsewhere a detailed discussion of the methodology of this research and summary tables of the results of all the major studies [Jensen, 1967]).

Table 1

Variance Components of IQ and Scholastic Achievement

	Between Families			Within Families		
V_{Total}	V_{G_b}	+	V_{E_b}	V_{G_w}	+	V_{E_w}
I.Q.	.45	+	.12	.35	+	.08
Sch. Ach.	.22	+	.54	.18	+	.06

It should be emphasized that the values shown in Table 1 are not constants or absolutes. These values will differ, within limits, according to the particular measures of IQ or scholastic achievement on which they are based and on the particular populations sampled. The figures in Table 1, however, are highly typical of results obtained with the Stanford-Binet in a cross section of the white school population in the United States and England. Since there have been no adequate studies of this type based on the Negro or other minority populations, we cannot be sure that the results would be the same in these groups. We are now obtaining relevant data in the Negro population, however, and so far there is no indication that the results of this type of analysis will be appreciably different for the Negro than for the white population.

Just what does Table 1 show? First of all, it divides the sources of variance into those that account for the average differences between families and those that account for individual differences among siblings within the same family. In these two categories of between families and within families, the variance is analyzed into a genetic component and an environmental component. This is a most interesting and revealing form of analysis, derived from the methods of quantitative genetics (e.g. Falconer, 1960). As shown in Table 1, something like 80 percent of the variance in IQ has a genetic basis; a little more than half of this genetic variance accounts for genetic differences between families, and a little less than half accounts for genetic differences between siblings within the same family. Only about 20 percent of the variance in IQ is abbributable to non-genetic or environmental factors. (About 5 percent of the variance in IQ is due to error of measurement or unreliability of the test, but I have left this out for the sake of simplicity; thus we are dealing in Table 1 with an analysis of only the "true score" variance.) We see that for IQ some 12 percent of the environmental variance is between families and only 8 percent within families.

This picture can be presented in still another way which may convey the message more directly to those who are not accustomed to thinking in terms of the analysis of variance. We can express the results in terms of the average difference in IQ between persons paired at random from the population. Given an intelligence test like the Stanford-Binet, with a standard deviation of 16 IQ points in the white population of the United States, the average difference among persons paired at random would be 18 IQ points. If everyone had inherited exactly the same genes for intelligence, but all nongenetic environmental variance remained as is, people would differ, on the average, by only 18 IQ points. On the other hand, if hereditary variance remained as is, but there were no environmental differences between families, the average difference among people would be 17 IQ points. If all environmental sources of differences were eliminated, the average intellectual difference among people would be 16 IQ points. In short, the effect of making heredity uniform in the population would result in an average difference among people of 8 IQ points instead of 18, while the effect of making the environment uniform would still leave an average difference of 16 points. If heredity and environment were both uniform, everyone in the population would be even more alike than identical twins -- a condition that could possibly provide the basis for a science-fiction horror story.

The results outlined above definitely belie some of the clichés we often hear in discussions of intelligence testing, such as the statement that IQ tests measure "only performance" or reflect only the child's cultural or socioeconomic background or only what he has learned at home or at school. All these statements are true; but they are also trivial and misleading. The important fact is that currently used IQ tests do indeed reflect innate, genetically determined aspects of intellectual ability in persons from the population on which the tests were standardized and validated. There is no way of getting around this fact, nor is there any good reason to wish to do so. The particular use we make of the fact is another issue, of course. Intelligence test results can be used stupidly or wisely. Let's hope we use them wisely, without having to belittle them with the false notion that they do not measure anything of educational or social importance. We should

be able to face the fact that a major portion of individual differences variance in IQ has a biological basis.

My main reservations about standard IQ tests are essentially two: (a) They are excellent as far as they go, but they do not assess certain abilities which may be educationally relevant, particularly for the disadvantaged; and (b) the IQ or the total score they yield is too much an undifferentiated conglomerate of various abilities for the single overall score to be very useful in analytic research or in educational counseling.

Returning to Table 1, we note an interesting and important difference between IQ and scholastic achievement. The scholastic achievement data have been subjected to exactly the same analysis as the intelligence test data. What we find is that genetic factors account for only about half as much of the variance in scholastic achievement as in IQ. Over half the variance is accounted for by environmental factors and by far the most of this is due to environmental differences between families. The fact that school achievement is considerably less heritable than is intelligence means, for one thing, that many other traits, habits, attitudes and values enter into a child's performance in school besides just his intelligence, and these non-intellectual factors are environmentally determined, mainly through the influence of the child's family. Siblings in the same family are much more alike in school performance than in intelligence. This means there is potentially much more we can do to change school performance through environmental means than we can to change intelligence. If compensatory education programs such as Head Start are to have any beneficial effect on later school achievement, it will most likely be through their influence on motivation, values, and other environmentally determined habits that play an important part in school performance, rather than through any direct influence on intelligence per se. The proper evaluation of such programs should therefore be sought in their effects on school performance, not on how much they raise the child's IQ.

Ways of Boosting Intelligence

There are two main ways of boosting intelligence. One way is to improve the use people make of their neural equipment for intelligent behavior. The other way is to improve the basic equipment itself. The first can be accomplished only through environmental means; the second can be accomplished through both genetic and environmental means. The first is presently much more feasible, though much more limited in what it can potentially accomplish, than the second.

Genetic Improvement of Intelligence

As we saw in Table 1, the largest source of variance in intelligence is contributed by genetic factors. There is little doubt that in the long run the surest way of changing the biological basis of intelligence is through genetic selection. It is a fact that many different behavioral traits, including those we would identify as intelligence, can be changed through selective breeding in lower animals. There is no reason to believe this does not also hold true for the human species. But I doubt that we will see any

move in this direction of systematic eugenics in the foreseeable future, for several reasons. For one thing, popular attitudes have generally been opposed to eugenic proposals, on the ground that this may be an infringement on the rights of individuals. And who is to say what the most desirable characteristics are that should be emphasized in eugenic selection? By emphasizing one set of characteristics, would we risk diminishing other traits that may be necessary for survival in the future? The reasonable answer, I believe, is to think at present only in terms of negative eugenics rather than in terms of positive eugenics. That is to say, there are probably traits which have no conceivable survival value and which all humane persons would agree are human misfortunes which should be prevented if at all possible. No parents, for example, would willingly choose to have a mentally retarded child. Yet it has been estimated by Elizabeth and Sheldon Reed, in their monumental study of mental retardation, that some five million of the estimated six million mentally retarded persons in the United States have a retarded parent or a normal parent who has a retarded sibling (Reed & Reed, 1965). The Reeds state: "One inescapable conclusion is that the transmission of mental retardation from parent to child is by far the most important single factor in the persistence of this social misfortune" (p. 48). "The transmission of mental retardation from one generation to the next, should, therefore, receive much more critical attention than it has in the past. It seems fair to state that this problem has been largely ignored on the assumption that if our social agencies function better, that if everyone's environment were improved sufficiently, then mental retardation would cease to be a major problem. Unfortunately, mental retardation will never disappear, but it can be reduced by manipulating the genetic and environmental factors involved... When voluntary sterilization of the retarded becomes a part of the culture of the United States, we should expect a decrease of about 50 percent per generation in the number of retarded persons, as a result of all methods combined to reduce retardation" (p. 77).

Another question which is relevant to the genetic basis of mental ability is whether or not dysgenic factors are exerting an influence on the distribution of abilities in our population or in certain segments of it. We know there is a negative correlation between family size and measured intelligence; and we know that a disproportionate number of the unemployed come from large families. No one to my knowledge is pursuing research that would elucidate the implications of these facts for the future.

One set of facts may be viewed as having potentially serious implications for the welfare of Negro Americans as well as of society in general. It appears that forces are at work which may create and widen the genetic aspect of the average difference in ability between the Negro and white populations, with the possible consequence that no amount of equality of opportunity or improvement of educational facilities will result in equality of achievement or in any improvement of the chances for the Negro population to compete on equal terms.

The factual basis of this concern can be found in a recent article by Moynihan (1966). The differential birth rate, as a function of socioeconomic status (SES), is greater in the Negro than in the white population of the United States. Negro middle- and upper-class families have fewer children

than their white counterparts, while Negro lower-class families have more. In 1960, Negro women of ages 35 to 44 who were married to unskilled laborers had 4.7 children as compared with 3.8 for non-Negro women in the same situation. Negro women married to professional or technical workers had only 1.9 children, as against 2.4 for white women in the same circumstances. Negro women below the so-called poverty line, with incomes below $2000, averaged 5.3 children. Three out of four Negroes failing the Armed Forces Qualification Test come from families of four or more children. The poverty rate for families with five or six children is 3-1/2 times as high as that for families with one or two children (Hill & Jaffe, 1966). I would like to see more thought and research given to the possible educational and social implications of these trends for the future. Is there a risk that present welfare policies may lead to the genetic enslavement of a substantial segment of our population? Our failure seriously to investigate these matters may well be viewed by future generations as our society's greatest injustice to Negro Americans.

Non-genetic Influences on Intelligence

Let us now turn to the nongenetic determinants, which in our population at present account for about one-fourth of the variance in measured intelligence. I refer to nongenetic variance rather than environmental variance, because the term environmental is usually identified only with the social-cultural environment and not with the physical environment. Yet there is considerable evidence to indicate that prenatal, perinatal, and postnatal physical factors contribute a substantial, probably a major, portion of the nongenetic variance. If this is true, advances in medicine, nutrition, and obstetrics may contribute as much or more to improving the intelligence of the population than will manipulation of the social environment.

Consider the following facts.

Children born prematurely are, on the average, slightly lower in IQ than full-term children; and we know that premature births have a higher rate of occurrence in the low socioeconomic group and particularly in the low SES Negro population. Lowering the prematurity rates in the disadvantaged population should be possible to the extent that the higher rates are due to maternal nutrition and health; and from improvements in nutrition and hygiene we should expect a slight overall upward shift in the distribution of IQs in the disadvantaged segment of the population. Complications of pregnancy and delivery also are associated with slight depression of the IQ. It is known that these complications have a much higher incidence among the disadvantaged.

Since all aspects of mental ability are not developed in the first two or three years of life and cannot be adequately assessed or predicted by means of our current psychological tests, the less severe forms of brain damage, nutritional deficiencies, and the like, may not show up until after the child is four or five years of age, when the specific abilities we recognize as the kinds of intelligence most necessary for school achievement reach a stage of development that permits their reliable measurement.

Nutrition during pregnancy affects the child's later IQ. Low socio-economic status women given vitamin supplements during pregnancy had children whose IQs were 8 points higher at four years of age than the children of mothers given a placebo over the same period (Harrell, Woodyard, & Gates, 1955). Vitamin supplements, of course, are beneficial in this respect only when they serve to remedy an existing deficiency.

Other prenatal effects on the later intelligence of the child are known to exist, but their mechanisms are still obscure. There is apparently a degree of variability in the uterine environment that contributes to the variability in children's intelligence. We know, for example, that twins are, on the average, about 7 points lower in IQ than the population of singletons, and this is true in every social class level. Furthermore, identical twins are slightly though significantly lower than fraternal twins. The reason presumably is that twins have a more crowded prenatal environment; having to share the intrauterine environment apparently results in some degree of prenatal disadvantage. This finding of twin-singleton IQ differences is a striking demonstration of the potency of prenatal effects.

The season of the year in which the child is born also affects intelligence, the summer months being the most advantageous time and winter the least. The reason for this seasonal variation in IQ is still unknown, but a likely hypothesis is that there are variations in dietary habits at various seasons which would affect maternal nutrition. Discovery of the precise mechanisms through which season of birth affects intellectual development is an important subject for future research.

A British psychologist, Dennis Stott (1966), has discovered impressive evidence that various forms of prenatal stress, such as an abnormal degree of physical and emotional stress on the mother during the later stages of pregnancy, can have a variety of adverse effects on the psychological development of the child. It was found, for example, that a much higher percentage of children who are problems in school were born to mothers whose pregnancies were stressful in one way or another. According to Stott, one of the commonest consequences of the subtle congenital impairment due to prenatal stress is juvenile delinquency in all its various forms. Stott believes there are genetically determined individual differences in susceptibility to brain damage through prenatal stress. The stress itself does not cause the damage in any direct way but triggers genetically determined mechanisms which bring about subtle impairments of the fetus, particularly in the brain. For reasons that cannot be elaborated upon here, this genetic triggering mechanism is a result of natural selection and evolution and at one stage of our remote past it had survival value for the species. The existence of a genetic mechanism of this type has been established in many animal species. In the past, congenital impairment of the type described by Stott resulted in much higher rates of infant mortality than we have today. Medical advances have increased the chances of survival probably much more than they have decreased congenital impairment. Slightly more than a century ago a male child born in America had four chances in ten of dying before age 20; today the chances are only four in 100. What are the implications of this? Stott points out: "The paradoxical result is that, so long as the crucial importance of the prenatal phase for the future development of the child remains unrecognized,

we shall have to reconcile ourselves to having an increasing number of disturbed children and also of potential delinquents."

Abdominal Decompression

The most important question, of course, is whether we can do much of anything about the quality of the prenatal environment beyond assuring good nutrition and hygiene during pregnancy. There is now evidence that the prenatal environment can be manipulated in ways that have important favorable consequences for the child's mental development. The technique, known as abdominal decompression, was invented by a professor of obstetrics (Heyns, 1963), originally for the purpose of making women more comfortable in the last months of their pregnancy and to facilitate labor and delivery. For about an hour a day during the last months of pregnancy the woman is placed in a device which creates a partial vacuum around her abdomen. This device greatly reduces the intrauterine pressure. The device is also used during labor up to the moment of delivery. Although invented for only obstetrical purposes, this practice was found to affect the child's development, and this may well become its most important use. Heyns has now used the procedure on over 400 women. Their children, when compared with appropriate control groups who have not received the treatment, show more rapid development in the first years of life and manifest overall superiority in tests of perceptual -motor development -- tests of the kind that measure infant "intelligence." The children sit up earlier, walk earlier, talk earlier, and seem generally more precocious than their siblings or other control children whose mothers have not been so treated. We do not yet know if this general superiority persists into later childhood or adulthood, but there is good reason to believe that some substantial overall gain should persist. At two years of age the children in Heyns's experiment had developmental quotients some 30 points higher than the control children (with a mean of 100 and standard deviation of 15). The explanation for the effects of abdominal decompression on early development, according to Heyns, is that the reduction of intrauterine pressure results in a more optimal blood supply to the fetal brain and also lessens the chances of brain damage during labor. The pressure on the infant's head is reduced from about 22 pounds to about 8 pounds. The obvious potential importance of this work warrants much further research on the postnatal psychological effects of abdominal decompression.

Postnatal Environmental Influences

The postnatal environmental influences on intellectual development may not be as easy to manipulate as one might expect, mainly because the total individual differences variance attributable to this source is a result of a multitude of small but significant effects. As we saw in Table 1, about 40 percent of the environmental variance in IQ is due to influences within the family. No one knows how such influences could be systematically controlled. For example, birth order is one of the sources of this variance; first-born children on the average have slightly higher IQs than later born children. The spacing of children is another source of variance; children spaced two or more years apart have an advantage over those spaced less than two years apart. Family size is another source of variance, larger families producing lower IQs. The presence or absence of the father in the home, which is often

given as an explanation for the lower IQs of disadvantaged children, has not been upheld by large scale research directed at answering this question. The father's presence may have other desirable influences, but the independent effect of his presence or absence on his children's IQs is nil (Wilson, 1966).

It can be estimated that the total effect of all these home influences working in the same direction amounts to about 8 to 10 points of IQ. It is interesting to note in this connection that the average difference between identical twins reared apart is about 6 IQ points, and the largest difference ever reported between a pair of identical twins reared apart, out of a total of over 150 such cases reported in the literature, is 24 IQ points (Newman, Freeman, & Holzinger, 1937).

What about children reared in extremely deprived environments, in which there is extremely little stimulation of any kind during the first few years of life? We know that such conditions can result in very low IQs, but the deprivation apparently necessary to cause decrements of as much as 20 or 30 IQ points must be more extreme than can be found among almost any children who are free to interact with other children or to run about out-of-doors. Also, fortunately, there is good evidence that even the most severe forms of deprivation in the first years of life do not preclude the later attainment of an average level of IQ, scholastic attainment, and social competence (Skeels, 1966; Davis, 1947). Children reared for the first 18 months to two years in cribs with sheeting on the sides to allow no view and fed with propped bottles and with almost no human contacts, when placed in ordinary middle-class homes, have shown a boost of about 30 IQ points within the first year of placement, with no further appreciable gain in IQ. But the final distribution of IQs in this group and their later adult behavior is indistinguishable from that of the general population (Skeels, 1966). A girl reared for the first six years of her life in an attic, without exposure even to human speech, had an IQ of about 25 when discovered by the authorities. After two years in a good environment she was of average mental ability for her age and at age 8 her scholastic performance was on a par with that of her classmates of the same age (Davis, 1947).

These findings are consistent with the research of Harlow (1967) on the effects of extreme restriction of environmental stimulation in the first year of life in monkeys. These isolated monkeys take somewhat longer than normally reared monkeys to overcome their fear of the apparatus used for testing their mental abilities, but once they overcome their fear, they are as intellectually able as are monkeys of the same age reared in open cages.

In short, psychologists have not yet found any postnatal environmental effects short of extreme environmental isolation which have any marked systematic influence on the IQ. The quality of the mother-child interaction is believed to affect the child's mental development, but the extent of this influence is not yet clear since the results of most studies (e.g. Hess & Shipman, 1965) have not separated the effects of the mother's intelligence from the quality of her interaction with her children. We do know, however, that the IQs of adopted children correlate not at all with the IQs of their foster mothers but correlate with their true mothers' IQs to about the

same degree as children who are reared by their true mothers (Honzik, 1957).

The Improvement of Scholastic Performance

At the present time I would conclude from the above facts that educators should not concern themselves with attempting to raise IQs as such. The best evidence indicates that the means for changing intelligence *per se* lie in the province of biology rather than in psychology or education. I would act according to this conclusion until evidence to the contrary comes forth.

A more realistic aim is to boost school performance directly. As we saw in Table 1, much of the variance in school achievement is due to family influences which are manifest in the child's behavior as interests, values, motivation, and the like. The middle-class child, unlike the disadvantaged child, gets more help with school work at home. Middle-class children, in effect, have a private tutor in the parent. This is extremely important in getting the child over the "humps" in his school work. Disadvantaged children who fail to receive individual parental help with school work and who do not have the experience of interacting with the parent in ways that promote an interest in learning, reading, and the other kinds of things children have to do in school, should be provided with such help and interaction. High school and college students are probably the best recruits for this kind of work.

Intelligence and Learning Ability

My current research at Berkeley is aimed at analyzing by means of the laboratory techniques of experimental psychology the ways in which disadvantaged children differ from middle-class children in their learning abilities when they begin school. In addition to measuring children's IQs and school achievement, we are measuring their ability to learn in the laboratory. This research has been described in detail elsewhere (Jensen, 1968).

One of our findings, I believe, is of major significance. It has been confirmed in several different studies, so that I can report it with considerable confidence in its validity and generality.

The finding is this: Children called disadvantaged who are in the IQ range below 90 are very different in their learning abilities from middle-class children in this same IQ range. Lower-class children in the low IQ range have markedly greater capacity for associative learning than do middle-class children of below-average IQ. It is a serious mistake to judge low-IQ and low-achieving disadvantaged children in terms of what we know about the overall abilities of their middle-class counterparts in IQ and school performance. The disadvantaged children have abilities for learning which make them actually much more advantaged than middle-class children of the same IQ. The same thing is not true, however, in the average and above average IQ range. Children from disadvantaged backgrounds whose IQs are in the average range or above appear to be no different in learning ability from middle-class children. I believe that one of the worst mistakes of educators and of our programs of compensatory education is that they tend to deal with disadvant-

aged children as if they were essentially like middle-class children with low IQs. But we are finding that they are very different indeed. The difference, I believe, is not due to cultural deprivation or to low socioeconomic status or to cultural bias in IQ tests. The difference is in their pattern of abilities. They have learning abilities that our IQ tests do not measure and which are not being put to use by our present methods of instruction. Literal equality of educational opportunity -- if interpreted to mean that we treat all children exactly alike -- makes as much sense as a doctor giving all his patients exactly the same prescription. Even giving every patient different amounts of the same medicine would be disastrous. The parallel in education is to be avoided, also.

We know from laboratory research on learning and from training methods now being developed in the Armed Forces that there is no single instructional procedure that is optimal for all individuals. Optimal educational results are produced by designing instruction in accord with individual differences, and this means something much more radical than merely having slow and fast tracks in school or simply allowing some students to take more time than others to learn the same amount of subject matter, taught to all students in the same way. The educational plight of the disadvantaged, I am convinced, is the result of our not having taken individual differences seriously enough. We have acted as though human abilities were distributed along only one dimension: that everyone learns in the same way, but that some are merely slower than others. The whole methodology of teaching the so-called slow learner has grown up around teaching middle-class slow learners, and the one thing our research now makes us most sure of is that middle-class slow learners have a different pattern of abilities -- a basically less advantageous pattern from the standpoint of occupational attainment -- from lower-class children who also achieve poorly in school under the present conditions of instruction. The blocks to learning exist primarily in the school, and the educability of the disadvantaged will have to be improved largely in the school itself, rather than by prevailing upon the parents of disadvantaged children to do a better job of child rearing or by trying to get to the child earlier and earlier in his life in order to make him over into something more like the middle-class child who responds relatively favorably to the school environment as it is now constituted.

Schools should by all means be as good as we know how to make them. But when equality of educational opportunity becomes interpreted as uniformity of facilities, instructional methods, and educational aims, I think we now know enough to say that we are on the wrong track. Diversity, rather than uniformity, of approaches and aims is the key to improving education for the disadvantaged.

The vast Federal funds appropriated for experimental educational programs under the 1965 Education Act testify to the public's willingness to support programs for educational improvement. About 80 percent of these funds were authorized for improving the education of the disadvantaged. But a billion dollars a year and the employment of nearly 400,000 persons in Head Start and other compensatory education programs have not shown signs of producing the promised results or, indeed, of any positive results at all with respect to scholastic achievement. The massive Coleman report of the U. S. Office of

Education, furthermore, reports that, contrary to a widespread belief, the schools attended by disadvantaged children do not differ in material terms -- qualifications and salaries of teachers, adequacy and age of buildings, etc. -- from those attended by other children. In fact, it was found that the correlation between these school factors and educational achievement was negligible (Coleman, et al., 1966). We can only conclude that what is required is not just more of the same, but something different, radically different.

If asked to prognosticate the future trends that will improve education for all segments of our population, I would say they will take two main forms: (a) increased diversity of instructional procedures, aided by the technology of programmed and computerized instruction and based upon full recognition of differences in patterns of individual differences in the structure of learning abilities, and (b) a re-evaluation of the criteria of appropriate educational attainment for full participation in the responsibilities and benefits of our society. When we come really to respect individual differences, rather than trying to minimize their importance in the educational enterprise, we will have made the first great stride toward improving education for all children.

References

Coleman, J. S., et al. Equality of educational opportunity. U. S. Dept. of Health, Education, and Welfare, 1966.

Davis, K. Final note on a case of extreme isolation. Amer. J. Sociol., 1947, 57, 432-457.

Falconer, D. S. An introduction to quantitative genetics. New York: Ronald Press, 1960.

Harlow, H., & Harlow, M. The young monkeys. Psychol. Today, 1967, 1, 4047.

Harrell, R. F., Woodyard, E., & Gates, A. I. The effects of mothers' diets on the intelligence of offspring. New York: Bureau of Publications, Teachers College, 1955.

Hess, R. D. & Shipman, V. Early experimence and the socialization of cognitive modes in children. Child Developm., 1965, 36, 869-886.

Heyns, O. S. Abdominal decompression. Johannesburg: Witwatersrand Univer. Press, 1963.

Hill, A. C., & Jaffee, F. S. Negro fertility and family size preferences. In Parsons, T., & Clark, K. B. (Eds.) The Negro American. Cambridge: Houghton-Mifflin, 1966, Pp. 134-159.

Honzik, M. P. Developmental studies of parent-child resemblance in intelligence. Child Developm., 1957, 28, 215-228.

Jensen, A. R. Estimation of the limits of heritability of traits by comparison of monozygotic and dizygotic twins. Proceedings of the National Academy of Sciences, 1967, 58, 149-157.

Jensen, A. R. Learning ability, intelligence, and educability. In V. Allen (Ed.) Psychological aspects of poverty. Glencoe, Illinois: Free Press, 1968.

Moynihan, D. P. Employment, income, and the ordeal of the Negro family. In Parsons, T., & Clark, K. B. (Eds.) The Negro American. Cambridge: Houghton-Mifflin, 1966. Pp. 134-159.

Newman, H. H., Freeman, F. N., & Holzinger, K. J. Twins: A study of heredity and environment. Chicago: Univ. of Chicago Press, 1937.

Reed, E. W., & Reed, S. C. Mental retardation: A family study. Philadelphia: W. B. Saunders Co., 1965.

Skeels, H. M. Adult status of children with contrasting early life experiences: a follow-up study. Child Develpm. Monogr., 1966, 31, No. 3, Serial No. 105.

Stott, D. H. Studies of troublesome children. New York: Humanities Press, 1966.

Wilson, A. B. Educational consequences of segregation in a California community. Univ. of California, Berkeley: Survey Research Center, Dec., 1966.