

Though we can describe the characteristics of mental growth in childhood and mental decline in old age, there are great difficulties in demonstrating the main causal factors. A stimulating or a deprived environment has greater effects on the development of intelligence than used to be believed; but there are also strong grounds for recognizing that genetic differences, which underlie biological maturation and decay, determine human capacities to a large extent.

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## Heredity and Environment in the Growth and Decline of Intelligence\*

Human growth and decline have doubtless been portrayed far more vividly by novelists, biographers, and dramatists than by scientists. One thinks at once, for example, of Shakespeare's seven stages of man. Nevertheless, biologists and psychologists are greatly interested in the topic and have contributed much to our understanding of the underlying processes. As a psychologist, I will try to describe some of the findings in fairly non-technical terms. In particular I am concerned with the question of whether mental growth and decay are fixed in each of us by heredity, that is by our genes, or how far they are influenced by upbringing, education, and other factors in our environment.

It will be helpful first to make a few points about physical growth, since we can all observe physical characteristics and they can be accurately measured. Although the normal infant is born in a pretty helpless condition, he already has such vital functions as breathing, sucking and digesting, reacting to pain or other stimuli, and his body muscles, senses and nerves continue to grow more or less regardless of environment, unless he is severely mistreated or malnourished. One of the main signs of hereditary determination is when certain characteristics develop according to a regular sequence despite quite wide differences in upbringing or environment. Consider walking for example: all children follow the same progression of crawling, pulling themselves upright, taking steps while holding on to something, and eventually launching out without support, though some may do so at a faster rate than others. Note though that heredity is *not* the same as being present at birth; many characteristics mature later. A baby does not have to be taught how to walk; by the age of about 1 year, his muscles and nerve connections are sufficiently mature for him to walk on his own with very little practice to perfect the skill. Parents cannot hasten the development by special training nor, usually, can they retard it. The Hopi tribe of American Indians used to bind their infants tightly to cradle boards for several months, yet these children started walking at just about the same age as those not so treated. Similarly humans cannot consummate coitus until they have reached the age of puberty around 13 or later; but when sufficiently mature they can manage it with a minimum of instruction and practice.

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We are apt to think that when an offspring closely resembles his parents in some characteristic, this characteristic must be inherited — passed on through the genes. While this is sometimes true — for example, children of blue-eyed parents will have blue eyes — yet often it doesn't work out so. Heredity is responsible for many differences as well as for likenesses. Thus two black guinea pigs can have a white offspring because the parents carry an assortment of genes, and it is just chance whether the offspring inherits the genes for blackness or whiteness. Similarly it is a matter of common observation that tall parents tend to have tall offspring, but actually the children can vary widely, some being shorter, others even taller than the parents. Yet height is determined mainly by heredity, though also to some extent affected by nutritional and health conditions. A more important kind of evidence is — can one breed for particular characteristics by mating similar parents? Obviously this is possible with strains of dogs and cattle; and although we cannot carry out genetic experiments on mankind, there is no reason to doubt that we could, through selective mating, breed a very tall or a very short strain of humans, or equally breed for blue-eyedness, red-hairedness and so on.

At the other end of the age range, many of the characteristics of decline are pretty universal and follow a regular sequence: reduced muscular strength and flexibility, poorer vision and hearing, greater susceptibility of organs such as the heart and kidneys to disease, and so on. Thus aging is an innate characteristic of our species, though there are wide differences in age of onset, and it looks as though to some extent longevity runs in families. However it is difficult to prove whether differences are genetic, since obviously a person's rate of physical decay depends greatly also on how healthy a life he has lived. Thus the great increase in life expectation over the past 50 to 100 years is clearly attributable to advances in medicine. The fact that women tend to be longer-lived than men does suggest a genetic influence. There is also some evidence that flies and mice can be selectively bred for greater longevity, but we do not know how far this applies to man.

Now turning to the main topic — intelligence. This is far more difficult to deal with because it is not something that can be observed and measured with a ruler. Indeed, as Gilbert Ryle would point out, it is not a thing or entity in the brain or mind, but just a label which we apply to actions or words which seem to us clever, efficient, complex, or difficult. Moreover, a good deal of the controversy about it arises from the fact that we often use the label in two distinct senses: first to refer to the innate potentiality of the brain for development and learning — something which differentiates man from lower animal species. And, secondly, when we call a person intelligent, we mean that he is good at comprehension and seeing relationships, good at reasoning out problems and capable of using abstract ideas. D.O. Hebb, the dean of Canadian psychologists, as far back as 1949, clarified the matter by separating these two notions, and calling them Intelligence A and Intelligence B. Intelligence A is the genetic basis for intellectual growth and learning, whereas Intelligence B is the present level of a child's or adult's ability and mental efficiency. As Hebb showed, Intelligence B is by no means innate, even though it depends on Intelligence A in the first instance and is probably limited by the basic plasticity of the brain, that is by the genes. But it is built up gradually through the interaction between the child and his social and physical environment, and it depends considerably on the amount and kind of stimulation he receives. The relation of A to B is quite analogous to that of the seed and the plant. One needs good seed to get a healthy plant, but the plant will not grow at all unless it gets suitable nutrition, warmth, light, water, and fertilizer. Similarly, human intelligence requires suitable psychological nourishment and may be hindered in its growth by many adverse factors in the environment.

Now there are clearly wide differences between children in rate of building up their intelligent thinking capacities and some achieve a much higher level of complexity and effectiveness by a certain age than others do. It is these capacities or skills which constitute what we call Intelligence B and which we can measure fairly reliably by means of our IQ tests. Some children by the age of 12 have barely reached the thinking capacities characteristic of the average 6 year old. Thus they are said to have an intelligence quotient of 6 over 12, i.e. 50%. One should mention in passing that besides Intelligence B, which is the all-round level of thinking skills, there are also wide variations in more specialized abilities — say in music, number, constructional abilities, and so on. These likewise may be based initially on the possession of certain genes, but also do not develop unless provided with stimulation and opportunity.

Note that I am careful not to claim that IQ tests measure innate intellectual potentiality — Intelligence A. Indeed, we never can observe, let alone measure, it directly since it is not recognizable until it has been developed through reacting to environment.

Now how does intelligence compare in its growth and decline with physical characteristics? Does it show a regular sequence of development and maturation, irrespective of environment? To some extent this seems to be true according to the work of the Swiss psychologist, Jean Piaget. Children do tend to pass through the same series of stages of intelligence from infancy to adulthood, even in different societies or cultural groups. At birth they merely possess a number of reflex forms of behaviour, and sensitivity to touch, lights, and sounds. So, during the first year or two they are mainly engaged in building up their perceptions of a world of objects and people outside them, in developing their capacity to move around safely in this world and carry out simple actions effectively, also in the beginnings of language. Successively, they become better able to recognize, comprehend, and interpret incoming impressions, to store up in their memory traces of these experiences, to be able to draw on these traces or retrieve them when needed, to build up more abstract and complex ideas, to see relations between ideas and to solve problems logically. But Piaget, like Hebb, stresses that such development is not due solely to hereditary maturation; it occurs only through interaction with the child's environment. Moreover the actual content of the ideas and concepts he builds up are provided by the particular culture in which he is reared — its language, traditions and values, even though the basic processes are pretty universal.

Piaget's work is especially interesting to teachers who may be unaware of the kind of primitive concepts and level of complexity that young children are capable of. Another deduction that has been made from the regular progression of mental growth is that it is not only useless to try to teach children to read at too early an age, before their perceptual analysis of printed signs and understanding of words are sufficiently mature, but also harmful, since children who are not ready for it would find it frustrating and grow to dislike it. While there is some truth in this, actually there are a lot of preparatory skills that can be introduced earlier such as development of vocabulary and oral expression, and showing that pictures have printed names, which lead up to formal reading. This is what Sesame Street tries to do — train preparatory skills — though it is probably less successful than is generally supposed.

Now it is generally observed, and confirmed by our tests, that intelligence increases fairly regularly to age 15 or so, and then more slowly. So I will ask now, when does this process of cumulative growth reach its maximum, and at what age

can we expect decline to set in? An interesting book by H.C. Lehmann, called *Age and Achievement* was based on listing all the major achievements of large numbers of eminent scientists, writers, musicians, and others, and plotting these by age. His graphs showed that the peak of productivity for physical scientists, chemists, and mathematicians was quite early — around 30 years. By 45 years the rate of production had dropped to 60% of the peak, and by 65 years it dropped to only 12%. However the best products of philosophers and writers came later, in the 40s, and there was a very wide spread, some going on even beyond 70. For example Goethe's *Faust* was completed when he was over 80, and Verdi's *Falstaff* at just under 80. But one has to view such figures with considerable caution; one obvious objection is that academics in particular become increasingly involved in administration beyond 40 and therefore have less time for creative production. Lehmann also studied athletic records and found, as might be expected, that the peak occurs in the 20s and that there is rapid falling off thereafter.

Actually it is much more difficult than one might think to assess age changes, since we cannot readily follow through a representative group of people from birth till, say, 80 years. Some studies have in fact been done over 40 years or so; but of course quite a proportion of the participants are likely to die, or to disappear during long-term studies, and on the whole the most healthy and able are more likely to survive. More commonly, then, researchers have tested different samples of the population at different ages. The main trouble here is that the older samples are not really comparable in their upbringing to the younger. For example, the typical 70-year old probably received a less extensive education around 1910-20 than did the typical 30-year old when he was at school in 1940-50. In many other respects such as medical facilities, radio and TV, their environments were different.

Generally, however, we find that some abilities go on increasing, and stay up longer than others, and decline more slowly. Verbal comprehension and thinking tend to increase, on the average, till the 50s whereas in solving novel problems, especially those requiring perceptual analysis, adults may reach their limits much earlier, say around 30; and in skills dependent on muscular strength and dexterity, even earlier. One of the most widely used group tests of nonverbal intelligence is Raven's Progressive Matrices. It consists of 60 graded items. Each item shows a series of figures forming a sequence; but the last figure in the series is left blank. One has to puzzle out the principle underlying the sequence, and then choose the correct figure to complete it from a set of 8 alternatives at the bottom. The easiest items can be done by 5-year-old children; the most difficult would tax a superior college student. Now the interesting thing about this test is that maximum performance is achieved in the 20s and thereafter scores begin to decline till, by the age of 60, they have dropped back to the same level as that of the average 10-year old child. It is also found that people with high ability go on increasing and stay up longer before the decline sets in, whereas those with low ability decline earlier and more rapidly. One is tempted to quote from the bible: "Unto everyone that hath shall be given, but from him that hath not shall be taken away even that that he hath."

Here is another example. E.L. Thorndike showed a long time back that childhood is not necessarily the most effective age for learning. For example, in learning to read a foreign language, Esperanto, the curve went up continuously till 45 and declined only slowly until the 60s. On the other hand, language pronunciation is a very different affair; we probably all know European emigrés who speak English with a foreign accent after 30 or 40 years or more in North America or the U.K. But their children who emigrated, say at age 10, quickly became perfect speakers

of English. The difference seems to arise because reading and translating involve acquiring associations additional to their native language, but the alteration of pronunciation involves breaking down deeply ingrained habits, and the adult, even at 30, is already less flexible in some respects, less able to modify, than the 20 or 10 year old.

During World War II, one of my jobs as psychologist to the British Armed Services was to investigate the abilities and training of large numbers of army drivers and I discovered what I like to call Vernon's Law — namely that the number of hours of individual instruction required for training a reasonably efficient truck driver from scratch is equal to the man's age, at least from 18 to 40. Obviously this does not extend indefinitely: one could not expect to train a 5 year old in 5 hours. It might be objected that 18 year old drivers who learn quickly are much more accident prone than 40 year olds. But then 40 year old drivers have generally had more driving experience, and admittedly they do gain in caution and avoidance of risks with age, though not in ease of acquiring driving skill.

Some of the best studies of industrial workers and aging was done by A.T. Welford at Cambridge, England. He showed that although older workers tend to have poorer visual and auditory sensitivity, speed of reaction and movement, yet they compensate for these because of their experience and responsibility. They are usually more accurate than young ones at familiar tasks which they can perform at their own rate. Their major difficulties lie in understanding and organizing unfamiliar tasks, especially when they have to cope with many stimuli simultaneously, also in breaking down habitual skills and rebuilding new ones.

Another relevant and ingenious experiment on the effects of aging on memory was carried out by David Schonfield, in the Department of Psychology, University of Calgary. He got a lot of people over a wide age range to study and learn 2 parallel lists of nouns. On one list they were tested by reproducing as many of the words as possible, but on the other they simply had to pick out from a much longer list the words they had studied before. Everyone found this recognition task easier than the self-recall task, but the interesting thing was that there was virtually no decline with age in the recognition, and a very marked deterioration with age after 30 years in the reproductive task. As Schonfield puts it, their difficulty is not so much in learning as in retrieval from memory storage. Most of those who, like myself, have passed the age of 60, would probably admit that they have frequent difficulties in recalling names or incidents. But these are not really forgotten because the missing name is very apt to pop up again of itself a few minutes or hours later.

To summarize what happens during the decline with aging: brain cells, like other bodily tissues, tend to break down, and it has been stated that in a person aged 65 and over, 100,000 neurons or brain cells are dying off every day. I do not suppose that figure is particularly reliable, but clearly older people do find increasing difficulty in taking in and comprehending new materials, or adapting to new conditions; they are less able to solve intellectual problems and less likely to show creative originality; and although they have the advantage of a greater wealth of stored memories, their powers of retrieval often let them down. However they can compensate in many ways; for example, I find I have to make more detailed notes of things that have to be attended to, and to allow more time for lecture preparation, and so on. But in general a good deal of caution is needed in generalising about the declining mental efficiency of the elderly, since there is no doubt that their rate of decline depends a great deal on their expectation of decline —

what they, and society, expect them to be like, and on what might be called their morale. If they feel that they can continue a useful and productive life, they maintain much greater efficiency than when they feel useless and hopeless on retirement. Note also that the phrase "second childhood" is rather a misnomer. There may be superficial resemblances in the mental inefficiencies and incapacities of the old and the very young, but qualitatively their intelligences are very different.

Let us now consider the effects of heredity and environment. Although it is generally agreed that both are involved, as I pointed out in distinguishing Intelligence A from B, yet there are still wide differences of opinion as to their relative importance. The issue has become particularly controversial since Arthur Jensen, of the University of California, published an article in the 1969 *Harvard Educational Review* entitled: How much can we boost IQ and achievement? During the 1960s tremendous effort and expense had been put into the so-called Head Start programmes in the United States. The idea was to provide some kindergarten or other pre-schooling for deprived children, especially blacks, so as to improve their chances of achieving when they went on to Grade 1, i.e., to give them a head start and to compensate for the effects of poor social, economic, and psychological conditions in the early years. It was hoped actually to raise their intelligence as well as improving their attitudes to schooling. Unfortunately, when the effectiveness of the programmes was followed up, it was usually found either that there had been no gain in IQ, or that there might be some increase — perhaps up to 10 points — at first grade, which then virtually disappeared by a year later. In second grade, the Head Start kids were doing no better than similar children who had not received any such stimulation. Psychologists tried to explain this away by saying that the programmes were too little and too late; a few half-days a week for a few months could not be expected to overcome the cumulative effects of rearing in slum homes by poorly educated parents for about 5 years. Maybe so, but these psychologists and educators had expected the programmes to work because they believed that intelligence level is mainly or even wholly dependent on the kind of environment in which children are reared. Jensen however interpreted the failure as showing that the genetic component of intelligence is so strong that such minor modifications of environment do not make any appreciable difference. And he put together a wide range of evidence supporting his view that the relative effects of heredity as against environment are in the ratio of 4 to 1. His main data were based on several studies of identical twins who had been separated at or soon after birth and brought up in different homes. Identical twins are known to have identical genes, and when brought up normally in the same home, their IQs tend to be virtually identical, with an average difference of less than 5 points. But if reared in different environments, the resemblances in IQ should be greatly reduced if environment is the major factor. Only 122 such pairs have been discovered and tested, and some of the results claimed are ambiguous; but usually the two members of a pair do turn out to be quite close in IQ, with an average difference of only 7 points. Whereas if we take the opposite case of unrelated children, who have no genes in common, but who are brought up in the same foster home, these differ far more widely — an average of 14 points — which clearly suggests that the genetic factor is far more important than the environmental. However one study of identicals reared apart did reveal a few cases of much larger discrepancy, even exceeding 20 points of IQ, and these occurred when the kinds of foster homes and schooling were very different. Jensen claims that his 4 to 1 ratio does allow for these exceptional cases; they can occur although in the great majority the genetic similarity predominates over the environmental dissimilarity.

Unfortunately Jensen went a step further: he drew attention to the 15 to 20 point difference in average IQs between blacks and whites which has been confirmed in innumerable studies of black school children or adults in the U.S., and concluded — to use his own words — that “it is a reasonable hypothesis that genetic factors are strongly implicated.” This suggestion, which set off the explosion, came at a time when black activism was rampant, and when progressive opinion among whites agreed that the low school achievement and low performance of blacks on intelligence tests was attributable to the long history of oppression, and discrimination in employment and education against negroes by the white majority. Jensen appeared to be saying that the black race is innately inferior to the whites and always would be so. His views were widely publicized by the press, usually in exaggerated or distorted form. He was vilified by left-wing students and faculty, frequently in danger of physical attack, and was denied the opportunity to argue his case at many universities and professional congresses by riots. He and others who supported him, such as Herrnstein at Harvard, were subjected to a witch-hunt strongly reminiscent of the McCarthy era, with the difference that this time the leftist and environmentalist social scientists were the accusers and judges, instead of being the accused.

If one reads Jensen more carefully one sees that his main claim is that the question of genetic factors in intellectual development is an open one, though there is sufficient evidence from various sources to justify further scientific study. He believes that the dogma that any racial, ethnic, or social class differences are entirely attributable to environmental factors should not be allowed to inhibit us from free discussion and research. Moreover, this dogma has done social harm by encouraging false hopes and producing such costly failures as Head Start. To this extent I agree with him, though by no means do I accept all his arguments. Although he has never expressed any racist attitudes himself, it is true that some of his statements have been seized on by others as supporting the doctrine of negro inferiority. His major aim was very different, namely to devise alternate methods of education which would suit people with different patterns of genes, instead of subjecting everybody to the same system regardless of their genetic potentialities.

Another point about Jensen's alleged 4 to 1 ratio is that this was based on somewhat ambiguous data from American and British identical twins only. And although it strongly indicates the importance of genetic differences within a white population, it may not legitimately apply to differences between whites and a group brought up in a somewhat dissimilar environment. Thus, had we tried to compare very different cultures, such as white American with aboriginal Australian, on the same IQ tests, the results would, of course, be worthless for revealing genetic factors. My own position would be that we do not know enough about what are the crucial environmental differences between American blacks and whites, and other ethnic groups, and would therefore do better to refrain from pronouncements either way and I do not propose to comment further on this particular red herring.

What other kinds of evidence are more reliable? Firstly we know that all human physical attributes depend largely on the genes, and there is no reason why the structure of the brain cells which underly Intelligence A should be any different. Mental development and decline, as we have seen, show much the same orderly maturational sequence as physical. Moreover, we can actually breed animals like rats so as to improve their maze-running and problem solving, or breed dogs for retrieving and other skills. So we would expect the same with human abilities, though it is much more difficult to prove it.

Secondly, as observed earlier, we cannot deduce anything from resemblances between parents and offspring, or between children in the same family. They might be due to common genes *or* common upbringing, or to a mixture. What are interesting and significant are the differences that often appear. Professional parents can occasionally have a very dull child or one child can be much brighter than another. Surely the parents usually provide much the same environment, stimulation, and schooling to all their children; differences in treatment would be rather minor. Thus environmental explanations could not possibly explain the differences as well as the resemblances, whereas genetic theory can readily do so. Different children get different assortments of parental genes, and thus would be expected to differ, just like the black and white offspring of black guinea-pigs.

Thirdly, we have a lot of studies of adopted or foster children and these tend to show that children from a very poor background, scoring low on tests of early development, improve appreciably in good foster homes. On average the rise is not more than about 10 IQ points, though occasional cases show more spectacular gains. Admittedly this is an environmental effect which could probably be accounted for by the 20% influence that Jensen specified. However it has also been shown that the IQs of these foster children continue to correlate with their true parents' abilities more highly than they do with foster-parent abilities, although the true parents do not bring them up. To me this is irrefutable evidence of heredity, though the amount of correlation or resemblance is probably not sufficient to justify Jensen's 4 to 1 ratio.

On the other side, there is very good biological evidence of environmental effects, at least in higher mammals. Hebb showed that dogs brought up as pets in a free and rich environment developed greater problem solving ability than their litter-mates brought up in the restricted, unstimulating environment of a cage. It is also highly significant that, in comparison with lower animals, man is born less mature, less able to look after himself, and has an enormous period of 15 to 20 years or more in a sheltered environment to develop his capacities under the influence of parents, teachers, and other adults.

Another type of evidence is that the IQ has turned out to be a good deal more variable or unstable with growth than was at first believed. It is by no means fixed for life; and although, when measured between, say, 7 and 12 years, it will give quite useful predictions of probable intellectual performance over the next 5 years or so, it can fluctuate widely in a minority of cases. Also, if measured before 5 years it is virtually useless for predicting later childhood or adult intelligence level. We do not know much about the reasons for these variations with growth, but it seems plausible that changes in personal adjustment, the suitability of schooling, and other environmentally induced changes are involved.

The most striking evidence comes from cases of severe deprivation. Recently a Russian psychologist, Koluchova, reported on 2 twin boys who, up to the age of 7, were brought up almost as animals with scarcely any human contacts. When first rescued they were severely subnormal with IQs, in so far as they could be tested, at about 40. But after 4 years of normal upbringing they tested at 94-95, say a 50 point rise. A study of 24 orphaned children by Skeels is also very convincing. Up to about 1-1/2 years they were housed in a very unstimulating institution. Then 13 of them were transferred to another institution where they were cared for by mentally defective girls, who nevertheless provided the mothering and play activities that they needed. Later most of these were placed in good foster homes. After 25 years, both these 13 and the 11 left in the original institution were traced, and the

former group were now found to be self-supporting, normal adults, with a wide range of jobs; whereas the 11 who had never been transferred were still institutionalized, or in very low-grade jobs. Actual adult IQs were not available, but the difference between the two groups must be equivalent to at least 30, possible 40, IQ points.

Recently some reports have appeared in the press of the work of Heber at Milwaukee. Here 40 infants of mentally retarded mothers, who would normally be expected to average around IQ 80 when brought up in their own homes, were divided into an experimental group of 20 and a control group of 20. Nothing was done to the latter — the controls — except to test their development and IQs periodically. The experimentals, however, from 3 months on, spent 5 days a week at a special centre where the environment was designed to stimulate their language and intellectual skills. Simultaneously their mothers were provided with an educational programme including home-making and child-rearing. On tests given between 2 and 4-1/2 years the experimental group scored 27 IQ points higher than the controls, and more recent testing at 6 to 7 still shows a considerable superiority. This study is quoted fairly fully since it illustrates how wary one must be before jumping to any such conclusion as that intelligence can be improved by training and stimulation, quite regardless of heredity.

One weakness is that the full data have not been published for others to evaluate, and we can be pretty certain that press reports are exaggerated. Note, secondly that this programme, often referred to as "total immersion" is extremely expensive, and could not possibly be applied to all deprived children. Thirdly, the gains, though larger than those obtained in Head Start or other so-called intervention experiments, were limited and Heber admits that the pressure will have to be continued throughout childhood if the experimental group are going to maintain their superiority to the controls. Frankly I will be surprised if, in a few more years, the difference does not drop to 15 points or less, and if the experimentals don't finish up with an average IQ somewhat below the normal figure of 100. Obviously we must wait and see.

My own general conclusion would be that exceptionally bad environments such as the Koluchova twins and Skeels' control group of orphans experienced, can pull down intellectual functioning and IQ very considerably; but that within the ordinary range of environments, the kinds of interventions we can introduce, such as fostering in good homes, improved education, etc., do have positive, but quite limited effects, equivalent probably to less than 10 IQ points. In other words, although we know something about what kinds of upbringing favour the development of good intelligence, we certainly have not got any recipe which enables us to push it up at will. There is more truth than one would like in the old proverb: "You can't make a silk purse out of a sow's ear." Nevertheless this should not be taken to mean that we should not try. We are beginning to learn a lot more about training children's thinking, even if so far this training does not have much effect on intelligence as measured by IQ tests. And it is entirely possible that new advances in educational technology will achieve greater success. But remember that such advances are likely to help the initially bright at least as much as, if not more than, the initially dull. So in all probability they won't do anything to reduce the importance of genetic factors.

A further comment on press publicity may be pertinent. Many reports refer to the work of Rosenthal and Jacobson, which purported to prove that, if teachers were told that certain children were very bright, they would give them more stimulation, and their IQs would actually rise. In other words, intelligence as measured by tests is so unstable that it can be manipulated by teachers' expectations. This

claim has been widely quoted as though it were proven fact, but the press never bothered to mention that, as soon as trained psychologists began to look at Rosenthal's results, they found a whole lot of technical weaknesses which completely invalidate them. And subsequent attempts to demonstrate the same gains under better controlled conditions have proved entirely negative.

In conclusion we should admit that there is no simple, single answer to questions of heredity and environment. There is considerable evidence on both sides, though much of it is difficult to interpret and often misleading. This warns us then to be cautious about extreme statements, either claiming on the one hand that one group of people is always innately inferior in intelligence to another, or, on the other hand, that we can modify people's intelligence at will by appropriate environmental or educational changes. Similarly, while we understand a bit more about aging than we used, we are certainly not yet in a position to control or to retard it by psychological means.