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COMMON FALLACIES ABOUT HEREDITY, ENVIRONMENT, AND HUMAN BEHAVIOR

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ABSTRACT

Misconceptions about the role of heredity and environment in human behavior can lead to inappropriate decisions for social action and public policy. Several of these common fallacies are examined and proper interpretations of the relations of heredity and environment are discussed. In particular, the limited meaning of the heritability ratio is described along with misinterpretations stemming from the work of Jensen. Finally, attention is directed to the potentially more useful considerations of how specific hereditary and environmental conditions lead to particular behavioral outcomes. It is argued that only through a clear understanding of the operation of hereditary and environmental factors in behavior development can effective decisions be made for the individual and for society.

COMMON FALLACIES ABOUT HEREDITY, ENVIRONMENT, AND HUMAN BEHAVIOR

Anne Anastasi[1]

Much of our thinking about contemporary social problems reflects tacit presuppositions regarding the operation of heredity and environment in human behavior. Here is a mixed bag of statements illustrating opinions expressed by persons in responsible positions:

The use of Test X is discriminatory because members of a minority group score lower on it than do members of the majority culture.

If an intellectual or emotional difficulty can be attributed to environmental handicaps in the individual's background, it should be discounted and overlooked because it is not part of his real nature.

Specially developed culture-fair tests are needed to rule out the effects of prior cultural deprivation in assessing a child's educational readiness or an applicant's job qualifications.

And from a somewhat different angle:

Congenital defects are hereditary.

If such traits as mathematical talent, an irascible disposition, or a fear of snakes run in families, they are of genetic origin.

This child's mental retardation cannot be attributed to cultural conditions because it results from an organic brain deficiency.

Because the heritability index of intelligence is high, compensatory education programs cannot accomplish very much.

Each of these statements exemplifies a common fallacy, but the list is far from complete. Many other examples could undoubtedly be found. The beliefs these statements represent have important implications for practical decisions. The range of their influence extends from the formulation of public policy and the design of programs for social improvement to the treatment of an individual school child and the interpersonal relations of two co-workers from diverse cultural backgrounds. Advances in genetics, psychology, anthropology, and other disciplines have contributed much to a clarification of the operation of hereditary and environmental factors in human development. These contributions, however, have not yet been adequately incorporated into the tacit assumptions that underlie the day-by-day solution of practical problems. Thus it behooves us to bring the presuppositions into the open and reexamine them periodically in the light of pertinent research findings.

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Some Questions of Terminology

Some of the statements cited may reflect little more than a loose use of words. In fact, the survival of certain terms in the English language adds to the difficulty of clear communication in discussions of heredity and environment. The terms "innate," "inborn," "inbred," and "congenital," for example, refer to that which is present from birth. But to a greater or lesser extent all are employed as synonyms for "hereditary." This semantic confusion dates from a time when the effects of prenatal environment were largely unrecognized and it was generally assumed that whatever existed at birth could be attributed to heredity.

Another prevalent confusion is that between organic and hereditary etiology of behavioral characteristics. A behavioral defect or other psychological characteristic may have an organic or a purely experiential basis. The latter is traceable to some features of the individual's prior environment, such as parental attitudes or quality of available schooling. Organic etiology, on the other hand, may involve either hereditary or environmental factors, or some combination of both. It follows that to demonstrate an organic basis for a given psychological condition, such as mental retardation, does not necessarily imply that the condition is hereditary.

Interrelation of Heredity and Environment

Let us now inquire more directly into the operation of heredity and environment in behavior development. To ask whether a specific psychological trait results from heredity or environment is a meaningless question, since both enter into all behavior. The reacting organism is a product of its genes and its past environment; and the individual's present environment provides the immediate stimuli for current behavior. Nor can we arrive at a generalized estimate of the proportional contribution of heredity and environment to individual differences in any given psychological trait. To be sure, heritability ratios, representing the proportion of the total variance of a trait attributable to heredity, have been computed in many studies. It should be borne in mind, however, that such heritability ratios apply to populations, not to individuals. Moreover, they are descriptive of a particular population under existing conditions at a given time. When conditions are altered, the heritability ratio will change. If environmental conditions become more uniform in a given population, the heritability ratio rises; if genetic similarity increases by inbreeding, the heritability ratio drops.

Heritability ratios thus depend upon the range of individual differences in both heredity and environment in the population under consideration. To take an extreme example, susceptibility to diphtheria has been shown to depend upon a recessive hereditary factor, and immunity upon a corresponding dominant factor. This disease will not be contracted, however, without infection by the diphtheria bacillus. Thus in a population all of whom have inherited susceptibility, individual differences in the development of the disease can be attributed entirely to environmental factors, that is, exposure to infection. On the other hand, in a population in which all are equally exposed to the bacillus, any individual differences would be attributable to differences in heredity, namely, whether the dominant gene for immunity was present. To the question, "What proportion of the variance in the development of diphtheria is attributable to heredity?" opposite answers would be obtained in these two populations. And a whole range of intermediate answers would be reached in other populations, depending upon the relative frequency of exposure and the relative frequency of persons with the dominant gene for immunity in each population.

The relation between heredity and environment is further complicated by what is technically known as interaction. In this sense, interaction means that the effect of any one variable will itself vary as a function of another variable. When this concept is applied to heredity and environment, it means that any given environmental factor will exert a different influence depending upon the specific hereditary material or genotype upon which it operates. Similarly, any hereditary factor will be differently manifested under different environmental conditions.

Such interaction can be illustrated by the familiar experience of persons who try to control their weight by dieting. Under the same conditions of food intake and activity level, individuals will lose or gain weight at different rates because of genetic differences in metabolism. To take a more psychological example, the availability of symphonic recordings in the home is likely to affect the musical development of a normal child but will have little influence on a deaf child. Similarly, growing up in a culturally disadvantaged or in an intellectually stimulating home would make little difference to a child with a severe hereditary brain deficiency; but it would probably make considerable difference in the abilities manifested at school entrance by a normal child.

It has been argued that the proportional contribution of interaction to the total population variance in human intelligence is slight. Apart from the fact that the empirical evidence for this conclusion is meager and questionable, the implications of such an argument are quite limited. Even if interaction of hereditary and environmental factors accounts for a very small part of the total trait variance in a given population, such interaction may still be highly important for an understanding of individual development and for the planning and implementation of treatment programs.

Many different questions can be asked about the operation of heredity and environment in human development. Those who discuss heritability ratios and proportional contribution of different factors to population variance are answering one type of question. Those who are interested in assessing the effect of environmental change upon the development of individuals and subgroups of the population are asking a different set of questions. Heritability ratios (and similar measures based on population variance) do not provide appropriate answers to the second type of question. Much controversy and confusion have arisen from the failure to recognize the differences among such questions. One prominent example is the article by Arthur Jensen published in 1969 in the *Harvard Educational Review* which has engendered great furor and led to many heated arguments. Although there are many aspects to this controversy and the issues are complex, it is my contention that one element in the controversy is the failure to differentiate among the questions asked by different participants. When each assumes that the other is trying to answer *his* question, the answers do not fit and each side feels that the other is talking nonsense.

An extreme example may serve to highlight my point. Even if the heritability ratio for a trait in a given population is 100%, it does not follow that the contribution of environment to that trait is unimportant. Let us consider a hypothetical community of adults in which everyone has the identical diet. All are given the same food in identical quantities. In this population, the contribution of food to the total variance of health and physical condition would be zero, since food variance accounts for none of the individual differences in health and physique. Nevertheless, if the food supply were suddenly cut off, the entire community would die of starvation. Conversely, improving the quality of the diet could well result in a general rise in the health of the community.

Failure to understand what a heritability ratio can—and what it cannot—tell us may lead to highly fallacious conclusions, as illustrated by some of the popular misinterpretations of the Jensen article. A high heritability ratio does not, for example, imply that the trait is fixed and immutable. Any modification of environmental conditions may change the population variance and thereby alter the heritability ratio itself. Environmental change may also raise or lower the level of the trait in the population. Finally, environmental manipulations may shift the relative position of an individual or subgroup within the population, since the effect of such manipulations may vary among persons with different characteristics.

To summarize, heritability ratios are applicable to populations, not individuals; they are descriptive of existing conditions in a specified population and cannot be generalized to other populations or to the same population under different conditions; and they do not indicate the degree of modifiability of a trait.

How Can Heredity Affect Behavior?

We have seen that traits cannot be classified into those that are inherited and those that are acquired. We have likewise found that to the question "How much does heredity contribute and how much does environment contribute to a given trait?" no meaningful answer can be given for individuals. And

with regard to population variance, no single, generalizable, or stable answer is possible. From both a theoretical and practical point of view, a more fruitful question pertains to the modus operandi of heredity and environment in individual development. How do specific hereditary and environmental conditions lead to particular behavioral outcomes? What are the actual chains of events through which any given hereditary or environmental factor may ultimately influence the individual's intellectual or personality traits?

First consider the operation of heredity. It should be noted at the outset that the influence of heredity upon behavior is necessarily *indirect.* No psychological trait is inherited as such. Through its control of the development of physical structures such as eyes, hands, or nervous system, heredity sets limits for behavior development. If some essential chemical is lacking in one of the genes, or if there is an imbalance in the proportion of different substances, a seriously defective organism may result, with stunted body and severely retarded intelligence. In such individuals, some of the minimum physical prerequisites for normal intellectual growth are lacking. Except in the case of such pathological deviants, however, heredity sets very broad limits for behavior development. Within these limits, what the individual actually becomes depends upon his environment. In man, as contrasted with lower organisms, heredity permits greater flexibility of behavioral development, thus providing for more effective adaptation to environment.

If, now, we examine some of the specific mechanisms through which hereditary factors may influence behavior, we cannot fail but be impressed by their wide diversity. At one extreme, we find certain rare forms of mental retardation associated with hereditary metabolic disorders, such as Tay-Sachs disease and phenylketonuria (PKU). In these cases, considerable progress has been made in tracing the causal steps from defective gene, through metabolic disorder and consequent cerebral malfunctioning, to mental retardation and other overt symptoms. Unless the physical deficiency can be corrected early in life—as in the dietary treatment for PKU—such individuals will be mentally retarded, regardless of their training or experience.

A somewhat different situation is illustrated by hereditary deafness, which may lead to intellectual retardation by interfering with normal social interaction, with language development, and with schooling. In such a case, however, the hereditary handicap can be offset by appropriate adaptations of training procedures. It has been said, in fact, that the degree of intellectual backwardness of the deaf population is an index of the state of development of special instructional facilities. As available training procedures improve, the intellectual retardation arising from deafness is correspondingly reduced.

For a third example, let us turn away from pathology and consider sex differences. A major hereditary difference between males and females is to be found in the developmental acceleration of the female. Girls not only reach physical maturity earlier, but throughout childhood they are also farther advanced toward their adult status. Investigations by both cross-sectional and longitudinal methods have shown that, at each age, girls have attained a higher percentage of their adult height and weight than have boys. A similar acceleration is found in other aspects of physical development. It is well known that girls reach puberty earlier than boys, the difference averaging from 12 to 20 months in various populations. In skeletal development, as measured by the ossification or hardening of the bones, girls are also ahead of boys at every age. A similar difference occurs in dentition, girls shedding their deciduous teeth and acquiring their permanent teeth at an earlier age than boys. In the case of certain teeth, these differences amount to as much as a year or more. It is noteworthy that the general developmental acceleration of the female begins before birth. On the average, girls are more mature than boys at birth and there is some evidence that they tend to be born after a shorter gestation term than boys.

The indirect, psychological effects of sex differences in developmental rate probably vary widely from trait to trait. For example, the developmental acceleration of girls in infancy may be an important factor in their more rapid progress in the acquisition of language and may give them a headstart in verbal development as a whole. Because boys and girls enter school at the same chronological age, it has been suggested that the sex difference in linguistic readiness may account in part for the greater frequency of speech disorders and reading disabilities found among boys. Even more broadly, girls' developmental acceleration at school entrance may contribute to their better adjustment to the school situation and their tendency to earn higher grades than boys in elementary school.

Still another possible implication of the developmental acceleration of the female is a social

one. Because of their physical acceleration, adolescent girls tend to associate with boys older than themselves. The same condition probably accounts also for the usual age discrepancy in marriage. Since the girl is generally younger than the boys with whom she associates—and younger than the man she marries—she is likely to be surpassed by most of her male associates in education and general information. This situation may well be at the root of many social attitudes toward the sexes. A younger person is likely to have less knowledge, wisdom, and sense of responsibility than an older one, and such an age difference may have been traditionally interpreted and fostered as a sex difference.

As a final illustration, consider how heredity may influence psychological development through the mechanism of social stereotypes. A wide variety of inherited physical characteristics has served as visible cues for identifying such stereotypes. These cues lead to behavioral restrictions or opportunities and—at a more subtle level—to social attitudes and expectancies. The individual's own self-concept tends gradually to reflect such expectancies. All of these influences eventually leave their mark upon his abilities and inabilities, his emotional reactions, goals, ambitions, and outlook on life.

Many social stereotypes tend to be perpetuated through this mechanism. If an athletic physique is associated with the stereotype of a leader, persons with such a body build will tend more often than others to be perceived as leaders, treated and accepted as leaders, and given an opportunity to serve in leadership positions. The experience thus gained in childhood and adolescence makes the individual better qualified for successful leadership in later life. In addition, his or her own self-concept may be affected, so that he or she comes to regard himself or herself as having leadership abilities and to approach leadership situations with confidence. This mechanism has been aptly described as the self-fulfilling prophecy. The mere fact that a behavioral outcome is predicted increases the probability of its occurrence. This self-fulfilling prophecy is likely to operate in the case of any group about which social stereotypes exist, such as persons with high foreheads, red hair, or brown skins. In another culture, of course, the behavioral correlates of such hereditary physical traits may be quite different. A specific physical cue may be completely unrelated to individual differences in psychological traits in one culture while closely correlated with them in another. Or it may be associated with totally dissimilar behavior characteristics in two different cultures.

The four examples cited to illustrate the operation of heredity fall along a *continuum of indirectness.* Along this continuum are found varying degrees of remoteness of causal links, from the relatively direct and immediate behavioral effects of hereditary metabolic disorders to the more indirect and subtle influence of physical cues that evoke social stereotypes. It should also be noted that, the more indirect the hereditary influence, the greater will be the range of possible behavioral outcomes. This follows from the fact that at each step in the causal chain there is fresh opportunity for other concomitant circumstances to alter the course of development. Thus the more indirect the role of heredity, the greater the feasibility of behavioral modification through environmental manipulation.

How Can Environment Affect Behavior?

Turning now to the operation of environment, we must recognize at the outset that man's environment covers a vast multiplicity of factors, ranging from air and food to Grand Opera and TV commercials. An important part of our environment consists of the people with whom we interact—family, teachers, friends, co-workers. Environment comprises not only physical but also psychological surroundings. It includes the social and emotional climate of home, school, and community, as well as the beliefs, preferences, and attitudes of our associates.

For modern man, environment is virtually coextensive with culture. From the viewpoint of the developing individual, the culture in which he is reared comprises all man-made features of his environment. There is, in fact, little in his surroundings that has not been influenced by the actions of his predecessors. Perhaps the most obvious examples of culture are provided by such institutionalized activities as initiation ceremonies, marriage and burial customs, and college graduations. But there is much more to culture. Language is an extremely important aspect of the individual's cultural heritage. It not only serves as the most powerful medium for interpersonal communication and for the transmission of prior

human achievement, but it also provides a major tool for abstract thought and thereby helps to shape our concepts and ideas. Our physical surroundings too reflect influences at every turn—in the food we eat, the type of buildings in which we live and work, the clothing we wear. Today, we should certainly add to this list the characteristics of the water we drink and the air we breathe! It is thus apparent that, when we speak of environment in relation to human behavior, the term "culture" could be substituted for "environment" in much of what we say.

Another point to note is that environment, as well as heredity, may account for family resemblances and differences. The family is not only a biological but also an environmental unit. Moreover, the closer the hereditary relationship between two persons, the greater the likelihood of environmental proximity between them. We can identify at least three ways in which environment may produce similarities between siblings, between parents and children, and—to a lesser degree—among more remote relatives. *First,* members of the same family share many features of their environment, such as socioeconomic level of the home and geographical and cultural milieu of the community. For siblings, such common environmental elements extend even to characteristics of the prenatal environment. *Second,* family contacts provide opportunities for mutual influence. Close relatives thus constitute a part of each other's environment. A *third* important psychological factor contributing to family resemblances is social expectancy. The child is often reminded of the special talents and defects of his forebears; and any chance manifestation of similar behavior on his part may be accentuated by such references. Furthermore, the fact that people expect him to have inherited his father's administrative ability or his mother's musical talent will tend to influence his own self-concept—which in turn is likely to affect his subsequent development.

It should be added that family environment, like heredity, can also account for some of the observed *differences* among family members. Although alike in many fundamental respects, the environments of two brothers reared in the same home, for example, are not psychologically identical. For one thing, the environment of one includes an older brother, that of the other contains a younger brother—no small difference in itself! Then, too, parental attitudes and child-rearing practices may differ for the two siblings as a result of the parents' intervening experiences. Similarly, any common occurrence in the home, such as moving from a rural to an urban area, will occur at different stages in the development of the two brothers and hence may have a very different significance in their development. These and many other environmental conditions may explain why two siblings exhibit characteristic differences in aptitudes or personality, just as other aspects of family environment may help us to understand their similarities.

Because of the inevitable mixture of hereditary and environmental factors in family relationships, the mere establishment of family resemblance cannot indicate the reasons for the resemblance. Hence a large amount of the available data on familial likenesses is at best descriptive and limited to existing conditions. This is true of the previously cited heritability ratios, which have usually been computed from the relative degree of trait similarity found between different degrees of kinship.

Let us now consider some specific examples of mechanisms whereby environment may affect behavior development, as we did for heredity. Psychologically, the individual's environment comprises the sum total of the stimulation he receives from conception to death. It is now well established that environment begins to operate before birth. Many conditions of the prenatal environment exert a pronounced influence upon behavioral as well as structural properties of the organism. Both animal experiments and clinical observations of human cases have demonstrated the part played by prenatal physical and chemical conditions in the development of bodily anomalies and of many well-known varieties of mental retardation.

Of special interest is the finding that inadequacies of maternal diet during pregnancy may have deleterious effects upon the child's intellectual development. Several studies have likewise established a relation between various complications of pregnancy and parturition, on the one hand, and intellectual deficiency in the offspring, on the other.

It is also noteworthy that such irregularities in the process of childbearing and birth occur more frequently in lower than in higher socioeconomic levels, probably because of differences in nutrition, medical care, and the like. Such findings suggest one possible environmental mechanism whereby social class and minority group status may produce mental retardation and other psychological disorders. In this connection, let me reiterate two points. The fact that a condition is present at birth is no indication that it is hereditary. Nor does the

identification of an organic basis for a psychological deficiency imply hereditary origin. Adverse conditions in the prenatal environment can and do produce severe brain injury, glandular dysfunctions, and organic damage, which may in turn cause mental retardation or other psychological disturbances.

Insofar as environmental factors may cause organic disorders which then influence behavior development, they too, like heredity, can be ordered along a continuum of indirectness. This continuum closely parallels that of hereditary mechanisms. One end is typified by such conditions as mental retardation resulting from prenatal nutritional inadequacies or from cerebral birth injury. A somewhat more indirect etiological mechanism is illustrated by severe motor disorders, as in certain cases of cerebral palsy, *without* accompanying injury to higher brain centers. In such instances, intellectual retardation may occur as an indirect consequence of the motor handicap through the curtailment of educational and social activities. Obviously this causal mechanism corresponds closely to that of deafness cited earlier in the discussion of heredity.

Unlike heredity, environmental factors can also influence behavior directly. In such cases, the immediate effects of the environmental condition is a behavioral change. To be sure, some of the initial behavioral effects may themselves indirectly affect the individual's later behavior. But perhaps this relationship can be best conceptualized in terms of breadth and permanence of effects. Thus we might say that we are now dealing, not with a continuum of indirectness, as in the case of hereditary and organic-environmental factors, but rather with a continuum of breadth.

Many examples of direct behavioral effects of environment are provided by *child-rearing practices*. One factor that may play a significant part in early intellectual development is the way in which parents handle children's questions. What, for example, happens when the child asks "Why?" Is he rewarded or punished? Is he answered or ignored? If answered, is the explanation in terms of facts and logic or in terms of tradition and custom? Is the child encouraged to think about the answer himself, or is he actively discouraged from so doing? A related point pertains to parents' attitudes toward exploratory behavior in general. To what extent is the child given opportunities for first-hand contact with objects and situations through which he may arrive at his own answers? It is reasonable to expect that the habits built up through such childhood experiences would appreciably affect the child's later problem-solving behavior—in school, on intelligence and aptitude tests, and in other life situations.

In recent years there has been an increasing interest in the detailed comparison of lower-class and middle-class language patterns and their relation to perceptual and conceptual development. Data have been gathered through direct observations of parent-child interactions in the home and the laboratory. Such research has revealed a number of differences between the linguistic experiences of children from middle-class and those from lower-class or culturally disadvantaged homes. Middle-class parents not only use spoken language more extensively as a means of communication, but they also provide speech models that are more elaborate and more often grammatically correct. In addition, they encourage the child's own use of language, correct his errors, and reward proper word usage. In lower-class homes, on the other hand, language is employed more sparingly. Much communication occurs through gestures, facial expression, tone of voice, and other nonverbal means.

One investigator proposed two linguistic codes to characterize the differences between lower-class and middle-class language. Lower-class adults, he found, utilize a "restricted" code, in which few different grammatical forms are employed, verbal communication is terse and simple, and much meaning is assumed or implicit. In contrast, the middle-class adult is more likely to use an "elaborated" code that is grammatically more complex; allows for the development of meanings, feelings, and individual interpretations; and provides a conceptual hierarchy for organizing experience.

Somewhat related is the research on the development of perceptual responses in early childhood. An important environmental feature in this regard is the availability in the home of a variety of objects among which the child may observe differences in shape, size, color, texture, and other attributes. Attaching names to these objects and to their attributes, and calling attention to similarities and differences among them, will of course facilitate perceptual learning. Thus the importance of language and of active adult participation is again illustrated.

The examples of early experience and child-rearing practices we have considered thus far illustrate direct effects of environment upon the development of aptitudes. Environmental

conditions, of course, may also exert a profound influence upon motivations, attitudes, and other personality variables. Moreover, there is a growing body of research indicating that such personality differences may in turn account for individual and group differences in the development of certain abilities. These findings suggest another, more indirect or subtle mechanism whereby environmental influences may be manifested in behavior.

For example, on tests of mathematical reasoning, boys obtain consistently higher mean scores than girls—although, as in all group comparisons, there is extensive overlapping of the distributions and hence the relative performance of the two sexes may be reversed in individual cases. A similar sex difference in mean performance has been found in other problem-solving tests. Furthermore, the difference tends to be greater on tasks that require a restructuring of the situation, that is, reorganizing given facts in new ways and trying out different solutions. Of particular interest is the finding that performance in such problem-solving tasks is related to sex differences in attitudes toward problem solving and to degree of sex-role identification. Thus within each sex, closer identification with the masculine sex role, as indicated on a personality inventory, is associated with superior problem-solving skill.

Other studies provide evidence that individuals exhibiting more dependency and social conformity tend to be less successful in breaking a set or restructuring elements in problem solving. Hence, insofar as traditional female experiences and role models in our culture may have encouraged greater dependency and social conformity among girls than among boys, these personality differences could account for the observed sex differences on certain types of problem-solving. A similar mechanism could help to explain girls' superiority in such tasks as spelling and grammar, in which social conformity and dependence upon external, interpersonal cues provided by the teacher would represent assets.

The last example of the operation of environment in behavior development concerns the role of social expectancy. What is expected of an individual tends to affect what he does. When such expectation carries the force of social tradition behind it and is repeatedly corroborated in nearly all contacts with associates, it is difficult to resist. Consequently, the individual often becomes convinced that he is intellectually inferior or superior, or that he possesses this or that talent or defect according to the dictates of his particular culture. In his daily contacts with family, teachers, and playmates, the developing child finds constant reminders of what is expected of him. Gradually these expectations become a part of his own self-concept, which in turn may affect his motivation and achievement. By such a mechanism, social expectancy tends to influence what a person eventually becomes. It thus serves to perpetuate social stereotypes with regard to sex, race, nationality, and other culturally perceived categories.

This mechanism will be recognized as the same self-fulfilling prophecy cited earlier as an example of the operation of heredity. In that connection, we considered the association of a certain type of body build with the cultural stereotype of a leader. Now we have come full circle and are considering the same mechanism to illustrate the operation of environment.

There is no inconsistency here. The fact is, of course, that heredity and environment operate jointly in all the examples described. For purposes of analysis, we have drawn them apart; but they can more properly be regarded as two aspects of a single process. In most situations, the appropriate question is not whether heredity or environment operated, nor the proportional contribution of each—both are meaningless questions from the standpoint of the individual. Rather what we need to identify is the specific etiological mechanism or causal chain that led to a given condition. It is these mechanisms that have been illustrated.

Conclusion

This paper began with examples of popular misconceptions about heredity and environment. What are some relevant points that emerge from the intervening discussion?

A major point pertains to modifiability. The fact that a characteristic is hereditary does not imply it is fixed and immutable; it *can* be altered by environmental interventions, which may range from diet or medical treatment to remedial training programs or psychotherapy. Conversely, environmentally produced characteristics may be quite resistant to change, as illustrated by the behavioral

effects of severe prenatal damage. To find that a behavioral difference between individuals or groups has an environmental or cultural origin does not imply that it is evanescent, superficial, or "unreal." The degree of modifiability of a characteristic cannot be judged by identifying its etiology as hereditary or environmental.

The long-standing, cumulative effects of prior environment cannot be willed away by the magic device of pointing to their cultural origins. Some environmental conditions have persisting and broad effects on behavior. A psychological test may—and frequently does—serve as an indicator of such environmental effects, which extend beyond performance on the test itself. The relevance of any given test to a particular situation needs to be empirically investigated in terms of the specific behavior to be predicted. To ignore the test score or abolish the test because it reflects cultural deficit merely retards efforts to overcome such deficits and to ameliorate cultural conditions. It is only through a clear understanding of the operation of hereditary and environmental factors in behavior development that we can contribute toward effective decisions for the individual and for society.

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