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HEREDITY AND ENVIRONMENT IN HUMAN GENETICS*

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HUMAN genetics has become a field in which the principles of genetics and cytology determined by experiments with plants and animals can be applied to an ever-increasing extent. We speak of animal and plant breeding as applied genetics, but the need of applying genetical principles to the reproduction of mankind is even more urgent than is the case with domesticated plants and animals. With the latter, selection of the best individuals as parents of the next generation is continually practised, and defective individuals are rigidly excluded from reproduction. Man has hitherto failed seriously, however, in applying to his own species the rules which he finds so necessary for the improvement or even the maintenance of his flocks and herds and his plant crops.

Any student of human genetics knows that large numbers of the same aberrations and abnormalities, both physical and mental (nervous), occur in mankind and in the higher mammals. These deleterious parallel mutations are carefully weeded out from the animals over which we have control, and among wild animals natural selection weeds them out. One of the outstanding discoveries of modern genetics is that all organisms produce such mutations, the majority of them deleterious in their effects and some of them even lethal. That they flourish in our own species is well attested by innumerable published pedigrees of almost every conceivable abnormality of body and mind—pedigrees extending often to five or six and sometimes even to ten or more generations in a single family. How is it possible to think of the improvement of civilized man while these weeds grow unchecked in the human garden? It is a little-considered fact that the matings of this generation determine in their entire hereditary make-up the qualities of all future generations.

Selective mating is a well-known fact, that is, that like tends to mate with like. This applies not only to stature (in some cases), but also to the blind, the deaf and the congenitally maimed. They tend to marry each other and so perpetuate the condition if it is due to inheritance, as it is in a large proportion of cases. At the other end of the scale, it is clear that various types of ability are inherited. Mathematical and musical ability are outstanding cases, but there are many others. Any student of genetics knows that if a defect such as feeble-mindedness is inherited, its normal counterpart is also inherited. A few psychologists still quaver at the acceptance of mental inheritance, but anyone who faces the facts squarely will be obliged to admit that, however you analyze the mind, mental differences are inherited as well as their physical basis in the brain and the central nervous system. A few examples of such inheritance will be referred to later.

But heredity does not work in a vacuum. Heredity and environment are like the two sides of a shield, the shield being the developing organism. An optimum environment is just as essential, but no more so, than a good heredity, if a satisfactory result is to be achieved. Nature has taken infinite pains to ensure that the early environment of the developing embryo will be uniform and that it will have complete protection. What it becomes will then depend largely on the genetic composition of the two germ cells that united to begin its development. Incredibly small differences are found to be inherited through a whole series of generations. Most of the differences we see in any gathering of people are determined mainly by heredity. A very unfavourable environment may inhibit the developmental potentialities of the

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organism, making the individual stunted and starved either in body or mind, and by an unsuitable environment he may be warped or distorted in his mental and physical processes. But the inheritance carried in his or her germ cells will not be changed by such treatment. Cases are on record of identical twins, developed from a single egg cell and having the same heredity, one of whom developed scoliasis (curvature of the spine). This induced condition would obviously not be inherited.

Heredity and environment have played their part in producing the various races of mankind as we know them. But the active part in the differentiation of races has no doubt been played by inherited (germinal) variations or mutations. The beginnings of racial differentiation are lost in paleontological obscurity and it is impossible to draw any sharp distinction between the so-called racial differences among modern men and specific differences such as that between Neanderthal man (*Homo neanderthalensis*) and *Homo sapiens*. The conventional habit of applying the latter specific name to all living races of mankind is probably not justified. This view, which I first expressed some years ago, is strengthened by the recent discovery that three different species of Cebus monkey are inter-fertile and will interbreed. Many anthropologists believe that Neanderthal man interbred with Cromagnon man (who supplanted him in Europe) and is therefore a part of our direct ancestry. At any rate, the criterion of intersterility as a mark of species (either present or past) as distinguished from races, no longer exists.

When we consider the main types of living man from a genetical point of view, some of the racial characters appear to be adaptive in nature while others probably have no adaptive value. Since it has been found that the nasal index (length : breadth) of peoples from Terra del Fuego to the Arctic coast of Canada correspond roughly with the degrees of North or South latitude in which they live, it appears that the very narrow nasal passages of the Eskimo are an adaptation to breathing cold air while the broad, flaring nostrils of the African negro are advantageous for breathing the warm, moist air of the tropics. The thick lips and dark, glandular skin of the negro are probably also adaptations to the high temperature and intense sunlight of the tropics. On the other hand, the kinky hair, which is equally characteristic of the negro type, is probably not adaptive. The straight hair of the American Indian or the wavy hair of the Australian aborigine would do as well in a tropical environment. That this racial character of kinky hair has arisen as a single mutation appears to be indicated by the fact that it has appeared independently as a rare mutation inherited through several generations in families in Norway, England and Holland. The kinky or woolly condition is dominant in inheritance in these families, just as the kinky hair of the negro is dominant in crosses with other races.

It is now recognized that not only physical but physiological differences exist between the human races. We have already referred to adaptations of the negro to the tropics and the Eskimo to Arctic conditions. Negroes are also believed to be immune to the virus of yellow fever, although hypersusceptible to the bacillus of tuberculosis. Japanese similarly appear to be immune to scarlet fever and the Chinese relatively immune to the tetanus bacillus. Measles is a mild virus disease among Caucasians but very severe for North American Indians and Melanesians. Malaysians are more susceptible to beri-beri (lack of vitamin B_1) than other races. Some of these resistances have probably been gradually acquired by the selection resulting from exposure of successive generations to the disease organism over a long period. In other cases the racial resistance appears to be more of the nature of a happy chance. Experimental studies of resistance and susceptibility to many parasitic diseases in plants and animals lead to similar points of view. These differences persist even with different races living under essentially the same conditions. Thus in New York City, statistics show that Russians, Poles and Jews are much more resistant to tuberculosis than are the Irish.

These inherited differences in resistance to particular diseases apply not only to races but also to the individuals within a race. Thus some 50% of human beings and 30% of horses show natural immunity to diphtheria. Similarly, experiments showed that in Berlin in 1907 nearly 100% of the house mice were susceptible to tumour inoculation. The same was true of about 24% of the mice in Hamburg while

practically none of the mice in Oslo were susceptible. There are similar great variations in the susceptibility of pigs and rabbits to enteritis. Many cattle are immune to *Bacillus abortus* and over 50% of rats are immune to plague. Many of these resistances are probably Mendelian in their inheritance. Such cases of inherited resistance to particular micro-organisms could be largely multiplied from the experimental literature. They emphasize the importance of the inherited constitution of the individual, whereas medical attention has too frequently been concentrated entirely on the attacking bacillus.

Statistics show also that resistance varies at different stages of development. For instance, the mortality rate from diphtheria and scarlatina is at first higher for males and later becomes higher for females. It has been shown that constitutional factors also play an important part in the structure of the teeth, the intestines and the eye. The fact that the mortality rates for various diseases differ in males and females again shows the effect of genetic constitution.

From time to time epidemics of infantile paralysis (poliomyelitis) occur, the origins of which cannot be traced. In a study of this condition in 222 families in which a case of infantile paralysis had occurred, 35% of the other children had minor illnesses at about the same time, whereas in families without infantile paralysis only 9% of the children were ill. A part at least of this higher incidence of illness was due to an abortive form of infantile paralysis lasting from a few hours of indisposition to several days of illness. Nasal washings from such cases when inoculated into monkeys actually produced the typical symptoms of poliomyelitis. It is therefore clear that many children are highly resistant to the disease. They may be temporary carriers of the virus and yet have only minor symptoms. Quite possibly others who harbour the virus for a longer period without symptoms may be the infective source of the epidemic.

Other studies have shown that constitution of the child is more important than the virus in the development of poliomyelitis. From an anthropometric study of susceptible children it is found that the susceptible type is large and plump, with a broad, round face and frequently wide-spaced dentition. Those in whom the disease was most severe and often fatal were a more delicate, brunette type with high colouring of lips and cheeks and crowded teeth. The fathers and mothers also showed certain characteristic features. Anthropometric data from 57 male and 52 female affected children showed that the interpupillary distance was great, the hands short and broad, the pelvis wide in comparison to the shoulders. There were also certain mongoloid tendencies, suggesting thyroid deficiency. While the matter requires further investigation, it seems clear that susceptible children are distinguishable by a whole series of constitutional differences from other children.

Racial differences, however, are not confined to differences in susceptibility to attack by micro-organisms. Organic diseases which are a direct inheritance vary markedly in their incidence from race to race. Thus amaurotic idiocy is a metabolic and mental derangement, genetically determined and lethal in its effect, which appears to be largely or wholly confined to Jews. In Italy there is a disease, known as favism, caused by eating the broad bean (*Vicia faba*) or inhaling the pollen of this plant. In Sardinia there are thousands of cases every year. It also occurs in Greece and North Africa and occasionally in people of Mediterranean ancestry living in the United States. But it appears to be confined to peoples of the Mediterranean race and not to occur in more Northern countries where the broad bean is also commonly eaten. This is an allergic disease affecting the red blood cells, and it was recognized as early as the 5th century B.C.

Sicklemia is a non-pathological condition of the red blood corpuscles in which they are sickle-shaped, with long, spine-like ends. It is inherited as a simple Mendelian dominant. In a small proportion of cases the affected red cells are attacked and destroyed by cells of the spleen, causing anæmia. This condition is accompanied by atrophy of the spleen and disappearance of the malpighian corpuscles. Some 7% of negroes have these sickle-shaped cells in their blood. The condition was formerly believed to be confined to negroes but has also been found in people of Greek and Italian descent. So it may prove to be characteristic of the Mediterranean as well as the negro race. The medical literature

also contains reports of several white families in which many of the red corpuscles were elliptical or oval in shape. This condition is inherited and is not accompanied by any ill effects, so it is only discovered when the blood is examined for some other purpose. Its frequency in the population is unknown, but it is probably rare, because many people now have their blood examined in hospitals. This is an example of the many slight abnormalities which are inherited but do not reduce the efficiency of the organism to any appreciable extent.

Levit has developed a large Medico-Genetical Institute in Moscow, where human genetics was being studied by a medical and genetical staff on a larger scale than in any other country. The fact that Russian families are large is also an aid in such investigations. More than 800 pairs of twins were studied medically to obtain as full an understanding as possible of their genetical (constitutional) make-up and development. Formulæ have been developed for the more accurate determination of the parts played by heredity and environment in the various stages of ontogeny. In this country, Newman and others have made extensive studies of twins, including pairs of identical twins (monozygotic, derived from the fertilization of a single egg cell) reared apart from an early age. These cases, which are almost as satisfactory material as an actual experiment, show that the remarkable physical resemblance of identical twins persists, even when they are reared under quite different social and climatic conditions. Even the finger print patterns are remarkably similar and only the minutiæ of these patterns, which make every human being unique, are beyond the limits of hereditary determination. Corresponding with these on the mental side are the differences which appear in the personalities and intelligence of the twins reared under different conditions of life. It appears, as might be expected, that the city dweller has an acquired urbanity which the twin brought up in the country does not possess. Certain emotional differences also appear. As regards intelligence, while the I.Q., as measured by the ordinary tests, is somewhat higher in the twin with the better education, yet the difference produced in this way is generally not large.

The detailed study and comparison of twins thus remains one of the most useful methods for investigating the relative effects of nature and nurture. Levit and his colleagues have shown in this way the important role of heredity in connection with the time of teething, sitting up and walking and in connection with such features as susceptibility to scarlet fever in children. Weight at birth was found to be practically unconnected with the genetic composition of the child. By comparison of children and adults, the effect of heredity on blood pressure and pulse rate was found to be very strong. As regards the sinus system and its conformation, various parts were found to differ greatly in hereditary determination. In a Jewish family in Western Germany a pedigree of very acute sinus trouble has been studied. The condition was inherited as a simple Mendelian dominant character, 17 cases occurring in a pedigree of three generations. By the use of the electrocardiogram for identical twins, Levit discovered a relation between the size of the heart and the "T"-wave on the electrocardiogram which is obscured by other factors in the general population. Thus even the detailed relation of physiological activities to morphological factors can be discovered. Identical twins were also treated differently and the results compared. Thus when one member of rachitic twins was treated with ultra-violet rays his immediate improvement was clear, but some months later the untreated twin was found to be superior in general health and resistance to disease.

From these and many other results, Levit emphasizes the fact that the roles of heredity and environment do not form a constant ratio in the growing organism, not even in relation to any one trait. These roles vary with age from infancy to senility. They vary also with the genetic and especially the environmental conditions. The extensive twin study results are classified according to the age of the twins and also according to their living conditions and the result is a more intimate analysis of environmental effects in some respects than has previously been attempted. Thus the most refined techniques of medicine, biology and statistics are being applied to a detailed and very practical solution of the nature-nurture problem. Such studies serve to emphasize that the human body is an almost infinitely complex moving equilibrium of organ systems from birth to death.

There is another aspect of the nature-nurture problem which is of great interest to anthropologists and psychologists. In a book which is soon to appear,* will be published an account of two native jungle children rescued from a wolf's den in India some years ago. They ate raw meat, drank like wolves, ran on all-fours, were active at night and had no language. Over a period of several years the diary records their reactions after they were brought to an orphanage. The elder girl survived several years and learned, after continual massaging, to stand and walk erect,—a matter at first of the greatest difficulty. She finally acquired many of the habits of civilization, such as the wearing of clothing, and gradually learned to speak, picking up a vocabulary of 30 or 40 words. Such records show how many of our civilized habits and customs are of the nature of conditioned reflexes, learned in babyhood from contact with our parents. The brain of these wolf children had not been permanently impaired, but its human development was inhibited by these early contacts with animals. A new set of reflexes and reactions had to be learned, including that of speech in place of the wolf's howl.

Blindness is a condition which of course may arise from an accident. But a large proportion of the cases of blindness are due to inheritance, even including many in which the condition is not congenital. Recent statistics show that in the United States the proportion of blind persons who have blind relatives or blind parents is, in the aggregate, 33·3%, while the proportion of blind individuals with blind brothers and sisters is 71·2%. Dr. Loeb, in an earlier study, found that in 1,204 families in which hereditary blindness is recorded there were 4,155 children, of whom 2,523 (60·8%) were born blind. More recent estimates conclude that 10-15% or more of all blindness is due to heredity, the frequency of blindness being about 1 in 1,000 in this country. This frequency estimate is evidently too low, however, since in 1932 there were 14,400 blind children in the United States under 20 years of age. 50,000 others were partially blind and some of them would develop total blindness later. Waardenburg lists more than 120 types of hereditary ocular variation, many of which cause blindness. Among the latter is glaucoma, and there are many pedigree of its inheritance in the literature. Sometimes it appears early and sometimes only in old age. The condition is one of hydrostatic tension within the eyeball, resulting from closure of the canal of schlemm, which may take place from various causes, hereditary or otherwise; or the intra-ocular tension may be set up by rigidity of the scleral coat or by effects on certain nerves or vasomotor centres. In certain families it is associated with gout, and various authors find that dark eyes are more predisposed to glaucoma than light eyes. These are probably matters of genetic linkage between otherwise unrelated conditions.

In a well-known family in Virginia, 18 cases of glaucoma developed in five generations. The original male ancestor married twice. The descendants by his first wife developed a high frequency of glaucoma, while those descended from the second wife were all free from this condition and included some of the leading men in American history. This type of glaucoma appears in the second or third decade and rapidly leads to blindness.

Deafness is another widespread condition which is often of hereditary origin. When only one ear is affected the deafness is likely to be of exogenous origin. The two main types of hereditary deafness are (1) deaf-mutism, in which the individual is congenitably without hearing and therefore unable to learn speech; and (2) otosclerosis, which usually comes on gradually in middle age, due to ankylosis of the stapes bone in the middle ear. Otosclerosis is inherited as a simple Mendelian recessive character. This means that two normal parents, if they both carry this gene, will have children one in four of whom may be expected to develop deafness in middle-age. The evidence indicates that hereditary deaf-mutism is produced by two genes, one of which controls the development of the ectodermal part of the cochlea, while the other controls the auditory nerve and its ganglion. Probably the development of the middle and outer ear is controlled by an independent pair of factors.

An exceedingly rare cause of deafness is the development of bilateral tumors on the auditory nerve. This produces a gradual onset of deafness and an unsteady gait. As

* Gesell Arnold, *Wolf Child and Human Child.* (Harper Brothers), 1941.

the tumors grow the optic nerve may also be affected, ultimately causing blindness. In an extensive pedigree with many affected individuals the inheritance is dominant. It also shows what is called "anticipation", i.e., the age of onset in the second generation was 72 years, while in the three succeeding generations the average ages of onset were respectively 64, 41 and 28 years.

Statistics show that when the deaf marry the deaf, one-third of these unions produce deaf children. There is no present way of distinguishing the hereditary from acquired forms of deafness, except that evidence of inheritance may be obtained from the ancestry. Unilateral deafness is practically always due to extraneous causes. Snyder and his associates in Ohio studied 31 families in which both parents were deaf. Their children numbered 89, of whom 63 (70·8%) were deaf. The only danger from cousin marriages lies in the possibility that both may have inherited the gene for the same recessive abnormality. Deafness is such a serious handicap that it seems clear that persons afflicted with hereditary deafness should not have children. The tendency for the deaf to intermarry is so strong that Alexander Graham Bell in 1884 wrote a memoir "Upon the formation of a deaf variety of the human race", directing attention to this danger.

Microphthalmia is an inherited condition in which the eyeball is so small that the individual has weak eyesight or may be blind. In one unique pedigree this condition is inherited as a recessive sex-linked character, *i.e.*, it appears only in males but is transmitted by all their (normal) daughters. This is because the gene is in the X-chromosome and follows the zigzag course of that chromosome from male to female and from female to male in successive generations. Females, having also a normal X, do not develop the condition but transmit it to half their sons. In this pedigree of six generations, the microphthalmia is associated with mental deficiency in some individuals, while others are above average intelligence. As this association is also found in other pedigrees, these two conditions are probably both produced by a single gene, the microphthalmia itself being a very variable condition, like the end-results of an infective process in the eye. Fraser Roberts suggests that, since all those in this pedigree who are free from blindness are also free from mental defect, the mental defect must arise through extraneous influences at a critical stage in embryonic development which for genetic reasons, is abnormally sensitive.

Another condition which illustrates the pleiotropic or multiple effects of a single gene is known as acrocephalosyntactyly. Mohr describes such a family from a remote section of Norway. The father and five of the nine children showed the same conditions—syndactyly (webbing of certain fingers), a somewhat egg-shaped head with bulging forehead and underdeveloped occipital region, and intelligence somewhat below that of normal members of the family. In the inherited condition known as oxycephaly only the skull changes are present, without the associated abnormalities in the fingers.

Many families have been recorded in which the bones are so fragile that they are broken many times during infancy and childhood. In one such family the affected members are of short stature but have very long arms and legs. This is inherited as a dominant condition. In other families the condition of fragile bones is accompanied by blue sclerotics (due to the thinness or translucency of the white coating of the eyeball). A third condition associated with these two is otosclerosis. These three abnormalities, although one affects the bones, another the eye and a third the ear, are so commonly associated that they are probably all the effects of one gene. In those families where the effects on the eye or ear are suppressed this is probably due to some other feature present in the genetic constitution, or to the presence of modifying genes.

There are other pedigrees of anomalies which indicate that three or four genes are closely linked in the same chromosome. For example, anonychia (absence or defect of finger nails) may be closely associated with defect or absence of the patella and with luxation of the head of the radius. All three may be found together in certain pedigrees, in others the radius will be normal, while in still other families only the radius will be affected. These defects are very rare and are probably due to three separate genes which are so close together in a chromosome that they rarely or never cross-over, while the first two are in such intimate contact that they perhaps mutate

together. A fourth gene, for crooked little finger (camptodactyly), is associated with these three in some families. It is probably in the same chromosome but less closely linked.

A more complicated case is that of the Lawrence-Moon-Biedl syndrome, in which the cardinal symptoms are mental retardation, obesity, hypogenitalism, degeneration of the retina and polydactyly. After careful examination, no casual lesions are found either in the brain or the endocrine glands. These conditions have been regarded as the pleiotropic effects of a single recessive gene; but the pedigrees show that there is a preponderance of affected males and that the number of affected offspring is in excess of one-fourth in affected families. Dr. Madge Macklin has offered an explanation from a study of all the cases in the medical literature. She concludes that two factors are necessary for the production of this syndrome: (1) a dominant autosomal gene, (2) a recessive sex-linked gene.

Where the complicated effects of a gene involve more than one organ system it has sometimes been suggested that one germ layer, such as the ectoderm or the messoderm, has been involved. From a study of the creeper fowl, which shows many abnormalities from a single gene in the heterozygous condition which is lethal in the homozygous condition, Landauer concludes that the gene influences embryonic differentiation by producing a general retardation of growth. Thereby is determined a syndrome. Individual variations in the time and rate at which different embryonic organs appear will lead to frequent dissociation of the characters in the syndrome, but the gene will produce its effects by changes in the developmental pattern of the whole embryo. This type of explanation probably applies to many genes producing the more monstrous effects.

Another feature of the study of human heredity is that the same condition may be produced in one case by purely extraneous causes and in another by inheritance. The only way to distinguish them is by a study of the ancestors and collateral relations. Thus rickets is well known as a condition of children produced by lack of sunlight and vitamin D. But in certain cases where there has been no diet deficiency the same symptoms seem to have resulted from osseous dystrophy which was genetically determined. Hollow chest, also known as cobbler's breast, has long been supposed to be a result of the cobbler bending over his last. But it has recently been shown that this depression of the sternum is inherited in certain families as a simple dominant, and it is questionable whether it is an occupational disease at all.

To take an example of another kind, it is generally supposed that ingrowing toenails are the result of wearing tight shoes. I have no doubt that they are produced in this way sometimes, yet it is clear that the tendency to grow in will be greater if the nails show a strong lateral curvature. If the conditions were due solely to tight shoes, we might expect it to be more frequent in women than men, yet it is actually more frequent in men. In a recent case (*Lancet*, 1941, II: 410), a soldier who had been wearing army boots for 2½ years became ill and spent 14 months in hospital. During this time, in the absence of shoes, he developed an ingrowing nail which required attention. His nails were found to show an exceptional degree of lateral curvature. So even an ingrowing toenail has its inheritance element, which is by no means easy to disentangle from environmental effect.

Even the same symptoms may be due to different genetic causes. Thus hæmophilia is a condition in which the blood fails to clot, so that a slight wound causes a long period of bleeding. This is well known to be inherited as a sex-linked character. A rare condition has been described in a Russian family which shows the same symptoms of extreme abnormal bleeding, but this is caused by weakness of the capillary walls, the blood itself being normal, and it is not sex-linked in inheritance.

It seems that in many cases the genetic basis of an inherited peculiarity is quite different from what at first appears. Thus encysted tumors of the scalp are inherited, but the cause of their formation is probably an abnormally narrow duct to the sebaceous glands. Some of the inherited mental deficiencies have a biochemical basis. One form of oligophrenia (mental defect) is the result of failure to oxidize phenylpyruvic acid. It is inherited as a simple recessive condition. Albinism is biochemically related to this condition. Amaurotic idiocy (Tay-Sachs's disease) results from failure to oxidize the lipoid sphyngomyelin. Thus it is clear that even our mental condition has a biochemical basis.

Another peculiar inherited condition of

the nervous system probably has a biochemical basis. Several families are known in which excitement, a carbohydrate meal, cold or other causes will produce a temporary and more or less complete paralysis of the nervous system without loss of consciousness. The individual is helpless and speechless for a short time. Over 150 such cases have been reported from many parts of the world, and it is shown to be inherited in several families. It is known as temporary paralysis. The condition may come on periodically or under stress and it can be produced by excessive doses of desoxycorticosterone in the treatment of Addison's disease.

This condition is remarkably similar to that found in a breed of goats in Tennessee and Texas. When frightened, these goats become rigid so they can be pushed over and lie motionless for a short time before they recover. I have likened this condition to the death-feigning instinct in insects. It probably represents an essentially parallel mutation in these three groups of the animal kingdom. Somewhat similar is a white Vienna strain of rabbits which is spontaneously epileptic. By an injection of cardiazol, an epileptic seizure can be produced in animals or in man. It appears that a smaller dose will produce a fit in an inherited epileptic than in a non-inherited epileptic or in a non-epileptic, and so the method may be of diagnostic value.

Premature whitening of the hair is well known to be inherited in families. The gene in this case may in some way produce a lack of para-amino-benzoic acid, for it has been found that graying hair may become darkened by taking small doses of this substance. The relation of insulin to diabetes is too well known to need discussion here. But it may be pointed out that if this important medical discovery and the use to which it is put results in more diabetics passing on their inherited defect to the next generation, then the last state, from a racial point of view, is worse than the first.

An important study was made in Holland of the relation between physical resemblance and mental similarity. The thick-set eurosomics were found to be quiet, level-headed, giving a thoughtful impression, with relatively low temperature, slow pulse-rate and slow respiration. Slender leptosomics were psychologically more irritable and emotional. They tend to speak, walk and write with some haste, agitation and uncertainty. Their temperature is high, pulse and respiration rapid. Numerous psychograms were collected from parents and children. It was found that children who have a greater physical resemblance to one parent will also show greater mental similarity to that parent. No doubt many parents have made general observations of this sort on their own children. From a study of nearly 1,000 parents and nearly 2,000 children, it was concluded that the similarity between parent and child in activity, emotionality and in primary and secondary functions was greater when the physically resemble each other than when they do not. They also show greater similarity in intellectual performance, memory, etc. Physical resemblance was accompanied by similarity of all mental functions. While it is difficult to distinguish heredity from the effects of education, it was concluded that heredity far exceeds education in character formation and that the inheritance of moral qualities is greater than that of intellectual ones.

Finally, in connection with the nature and nurture problem I might point out how intimately we are all affected by the weather, and still more by climate. In a recent study of disease localization in the U.S. it was shown that meteorological conditions produce stimulation, overstimulation, fatigue and death, with effects on every shade of organ-function and disfunction, in every physical, psychical, economic and social sphere. We live at the bottom of an ocean of air and the normal individual is constantly reacting to his meteorological environment by a chemical and endocrine rhythm. Changes in barometric pressure, temperature and humidity may help or aggravate headaches, epilepsy, asthma, arthritis, gastric ulcer, neuroses, glaucoma, focal infections, urticaria and other conditions.

When we study anv one inherited condition we try to find its least common denominator, to separate the specific effect of a particular gene from the rest of the genetic make-up or constitution and from the disturbing effects of a varying environment. Heredity is the solid residuum which persists from generation to generation, no matter under what climate or conditions we live.

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