

## CHAPTER III

### DIFFERENCES AMONG MEN

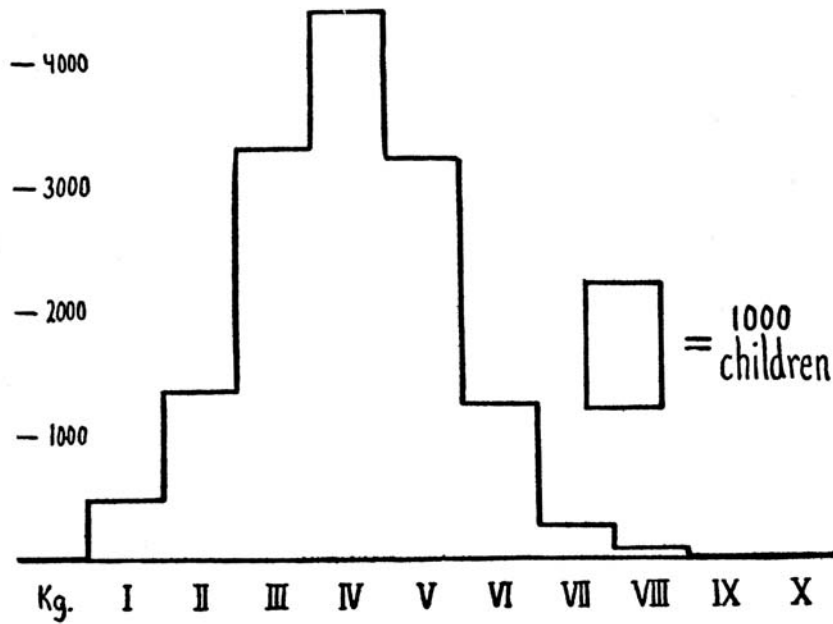
While Mr. Jefferson, when he wrote into the Declaration of Independence his belief in the self-evidence of the truth that all men are created equal, may have been thinking of legal rights merely, he was expressing an opinion common among philosophers of his time. J. J. Rousseau it was who made the idea popular, and it met with widespread acceptance for many years. It is not surprising, therefore, that the phrase has long been a favorite with the demagogue and the utopian. Even now the doctrine is by no means dead. The American educational system is based largely on this dogma, and much of the political system seems to be grounded on it. It can be seen in the tenets of labor unions, in the practice of many philanthropies--traces may be found almost anywhere one turns, in fact.

Common enough as applied to mental qualities, the theory of human equality is even more widely held of "moral" qualities. Men are considered to be equally responsible for their conduct, and failure to conform to the accepted code in this respect brings punishment. It is sometimes conceded that men have had differing opportunities to learn the principles of morality; but given equal opportunities, it is almost universally held that failure to follow the principles indicates not inability but unwillingness. In short, public opinion rarely admits that men may differ in their inherent capacity to act morally.

In view of its almost universal and unquestioned, although half unconscious, acceptance as part of the structure of society, it becomes of the utmost importance that this doctrine of human equality should be examined by scientific methods.

Fortunately this can be done with ease. Methods of mental and physical measurement that have been evolved during the last few decades offer

results that admit of no refutation, and they can be applied in hundreds of different places.



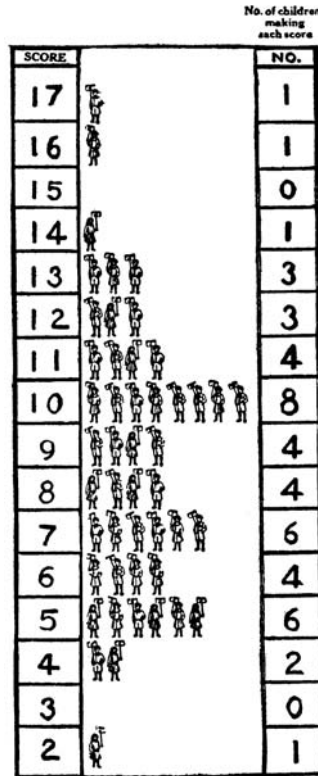
DISTRIBUTION OF 10-YEAR-OLD SCHOOL CHILDREN

FIG. 8.--The graph shows that 10-year-old children in Connecticut (1903) are to be found in every grade, from the first to the eighth. The greatest number is in the fourth grade, and the number who are advanced is just about the same as the number who are retarded.

It will not be worth while to spend any time demonstrating that all individuals differ, at birth and during their subsequent life, physically. The fact is patent to all. It carries with it as a necessary corollary mental differences, since the brain is part of the body; nevertheless, we shall demonstrate these mental differences independently.

We present in Fig. 8 a graph from E. L. Thorndike, showing the number of 10-year-old children in Connecticut (1903) in each school grade. If the children are all intellectually equal, all the 10-year-olds ought to be in the same grade, or near it. Numerous explanations of their wide distribution suggest themselves; as a working hypothesis one might adopt the suggestion that it is because the children actually differ in innate

ability to the extent here indicated. This hypothesis can be tested by a variety of mental measurements. S. A. Curtis' investigation of the arithmetical abilities of the children in the schools of New York City will be a good beginning. He measured the achievements of pupils in responding to eight tests, which were believed to give a fair idea of the pupil's capacity for solving simple arithmetical problems. The results were, on the average, similar to the result he got in a certain eighth-grade class, whose record is shown in Fig. 9. It is evident that some of the children were good in arithmetic, some were poor in it; the bulk of them were neither good nor bad but half way between, or, in statistical language, mediocre.

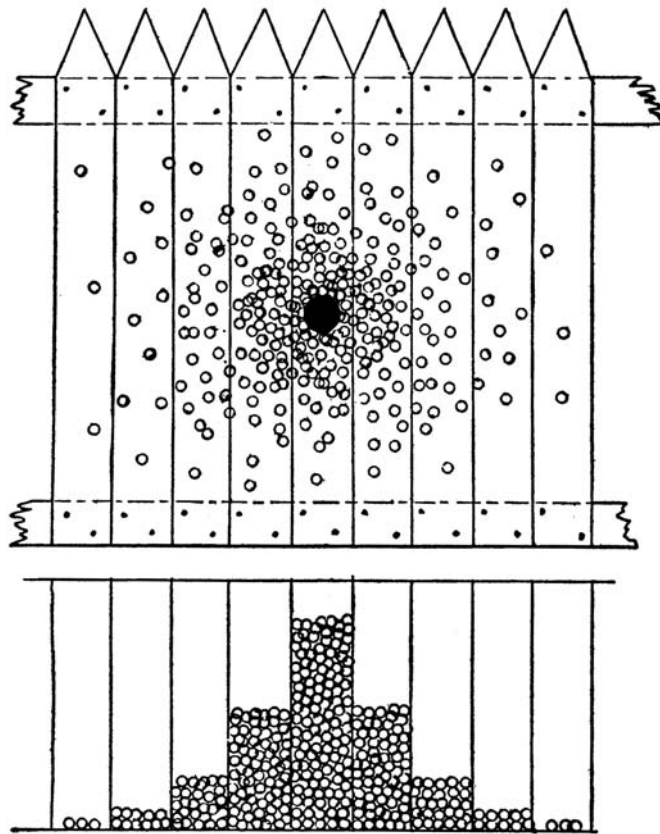


VARIATION IN ABILITY

FIG. 9.--Diagram to show the standing of children in a single class in a New York City school, in respect to their ability in arithmetic. There are wide divergences in the scores they made.

The literature of experimental psychology and anthropology is crammed with such examples as the above. No matter what trait of the individual be chosen, results are analogous. If one takes the simplest traits, to eliminate the most chances for confusion, one finds the same conditions every time. Whether it be speed in marking off all the A's in a printed sheet of capitals, or in putting together the pieces of a puzzle, or in giving a reaction to some certain stimulus, or in making associations between ideas, or drawing figures, or memory for various things, or giving the opposites of words, or discrimination of lifted weights, or success in any one of hundreds of other mental tests, the conclusion is

the same. There are wide differences in the abilities of individuals, no two being alike, either mentally or physically, at birth or any time thereafter.



ORIGIN OF A NORMAL PROBABILITY CURVE

FIG. 10.--When deviations in all directions are equally probable, as in the case of shots fired at a target by an expert marksman, the "frequencies" will arrange themselves in the manner shown by the bullets in compartments above. A line drawn along the tops of these columns would be a "normal probability curve." Diagram by C. H. Popenoe.

Whenever a large enough number of individuals is tested, these differences arrange themselves in the same general form. It is the form assumed by the distribution of any differences that are governed absolutely by chance.

Suppose an expert marksman shoots a thousand times at the center of a certain picket in a picket fence, and that there is no wind or any

other source of constant error that would distort his aim. In the long run, the greatest number of his shots would be in the picket aimed at, and of his misses there would be just as many on one side as on the other, just as many above as below the center. Now if all the shots, as they struck the fence, could drop into a box below, which had a compartment for each picket, it would be found at the end of his practice that the compartments were filled up unequally, most bullets being in that representing the middle picket and least in the outside ones. The intermediate compartments would have intermediate numbers of bullets. The whole scheme is shown in Fig. 11. If a line be drawn to connect the tops of all the columns of bullets, it will make a rough curve or graph, which represents a typical chance distribution. It will be evident to anyone that the distribution was really governed by "chance," i.e., a multiplicity of causes too complex to permit detailed analysis. The imaginary sharp-shooter was an expert, and he was trying to hit the same spot with each shot. The deviation from the center is bound to be the same on all sides.

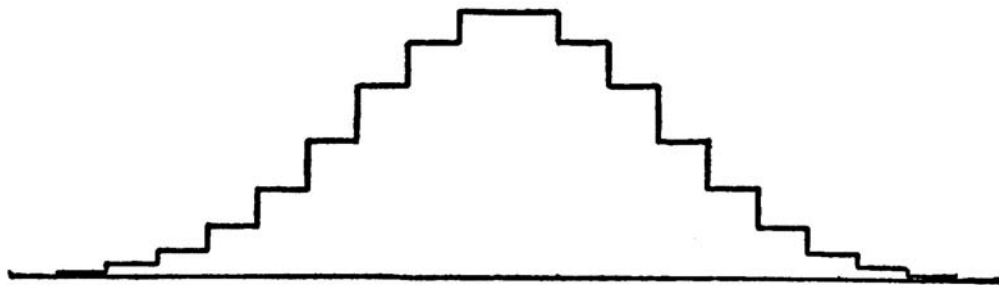


FIG. 11.--The "Chance" or "Probability" Form of Distribution.

Now suppose a series of measurements of a thousand children be taken in, let us say, the ability to do 18 problems in subtraction in 10 minutes. A few of them finish only one problem in that time; a few more do two, more still are able to complete three, and so on up. The great bulk of the children get through from 8 to 12 problems in the allotted time; a few finish the whole task. Now if we make a column for all those who did one problem, another column beside it for all those who did two, and so on up for those who did three, four and on to eighteen, a line drawn over the tops of the columns make a curve like the above from Thorndike.

Comparing this curve with the one formed by the marksman's spent bullets, one can not help being struck by the similarity. If the first represented a distribution governed purely by chance, it is evident that the children's ability seems to be distributed in accordance with a similar law.

With the limited number of categories used in this example, it would not be possible to get a smooth curve, but only a kind of step pyramid. With an increase in the number of categories, the steps become smaller. With a hundred problems to work out, instead of 18, the curve would be something like this:

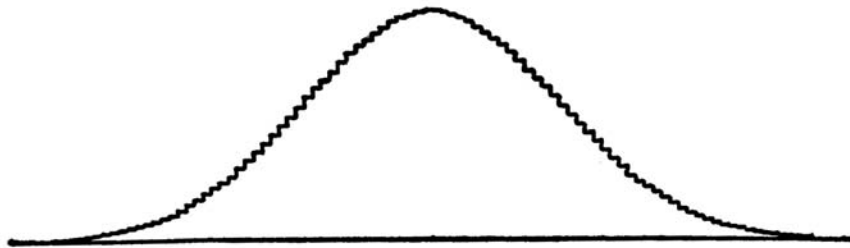
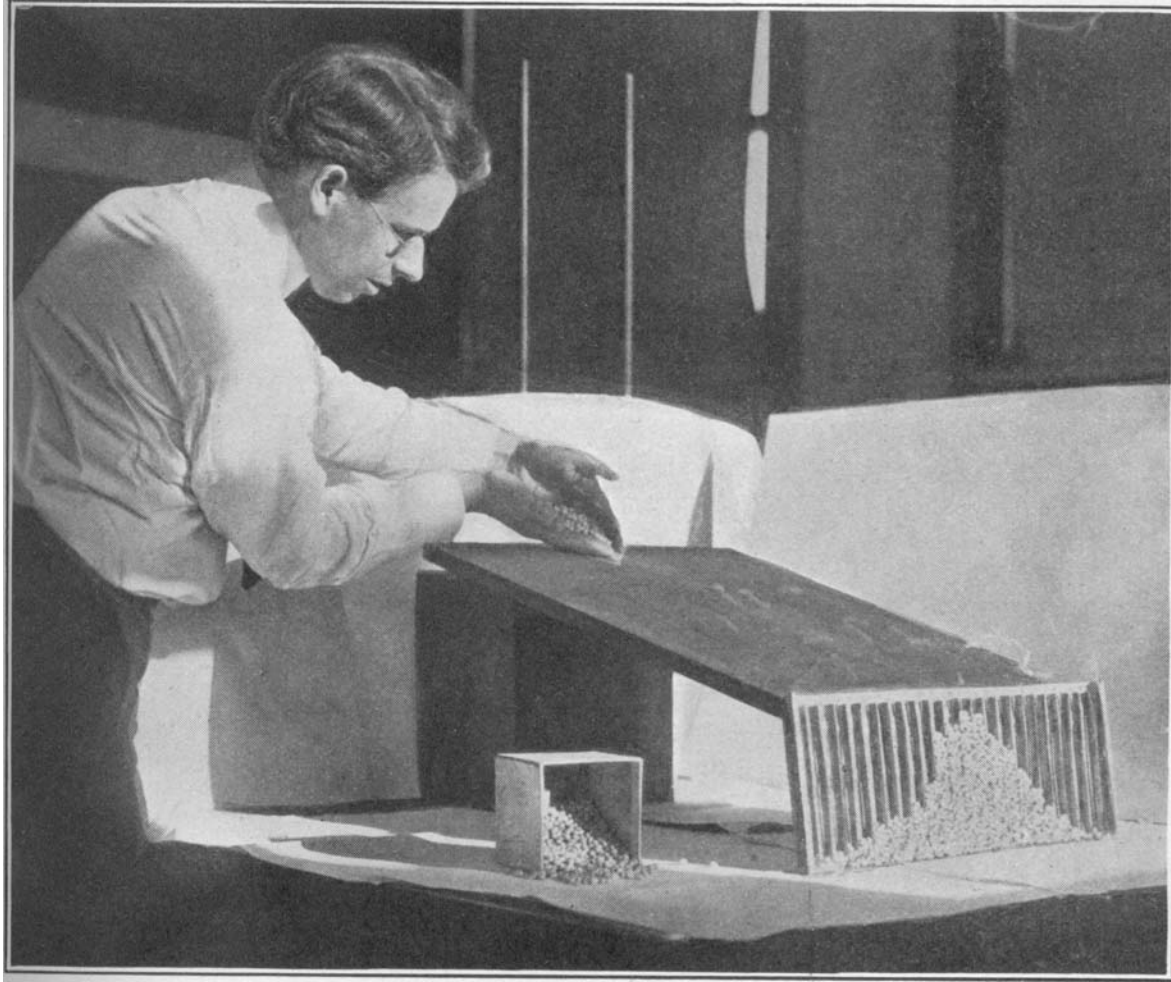


FIG. 12.--Probability curve with increased number of steps.

And with an infinite number, the steps would disappear altogether, leaving a perfectly smooth, flowing line, unmarred by a single step or break. It would be an absolutely *continuous* distribution.

If then, the results of all the tests that have been made on all mental traits be studied, it will be found that human mental ability as shown in at least 95% of all the traits that have been measured, is distributed throughout the race in various degrees, in accordance with the law of chance, and that if one could measure all the members of the species and plot a curve for these measurements, in any trait, he would get this smooth, continuous curve. In other words, human beings are not sharply divided into classes, but the differences between them shade off into each other, although between the best and the worst, in any respect, there is a great gulf.

If this statement applies to simple traits, such as memory for numbers, it must also apply to combinations of simple traits in complex mental processes. For practical purposes, we are therefore justified in saying that in respect of any mental quality,--ability, industry, efficiency, persistence, attentiveness, neatness, honesty, anything you like,--in



NORMAL VARIABILITY CURVE FOLLOWING LAW OF CHANCE

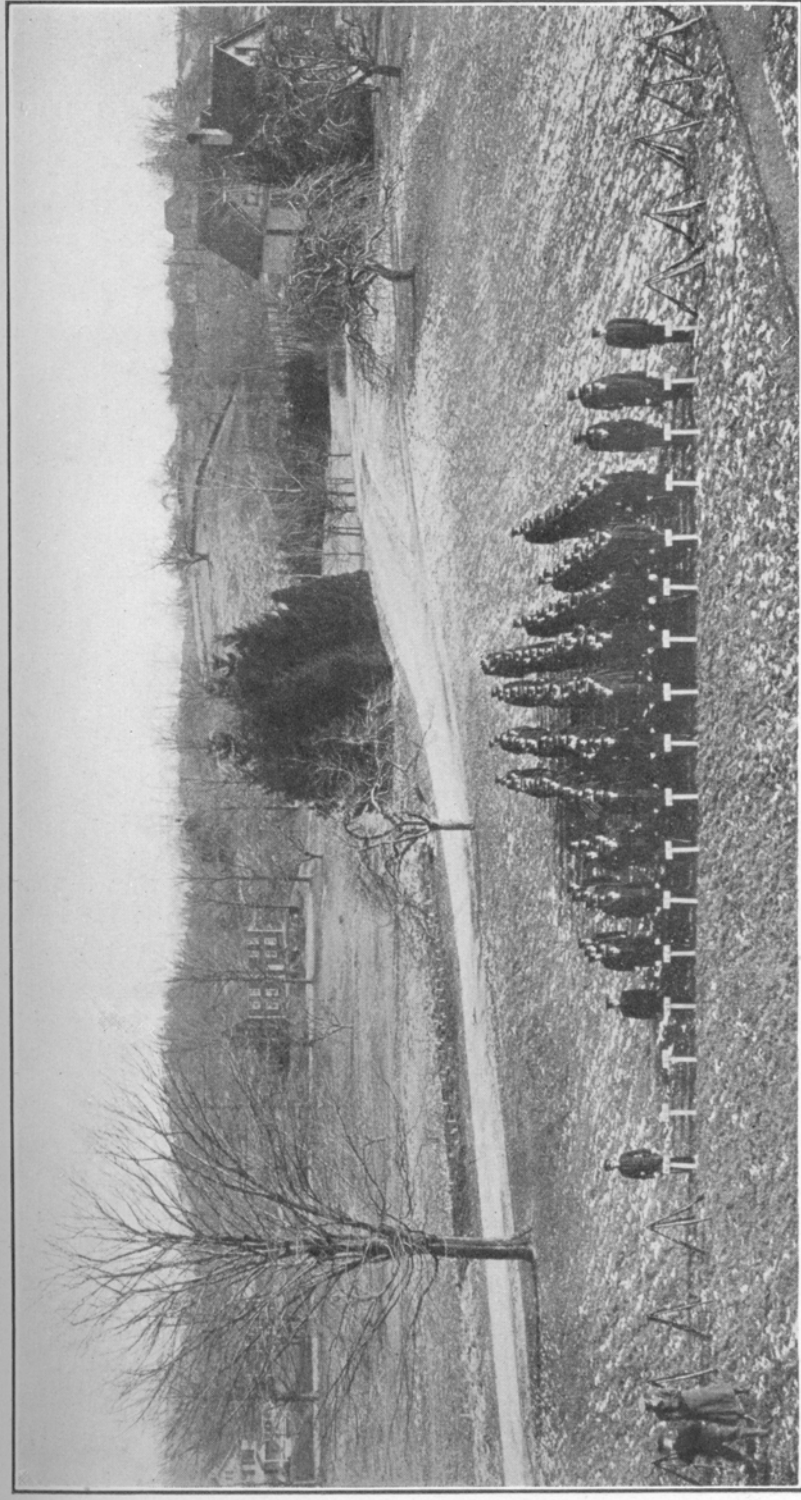
FIG. 13.--The above photograph (from A. F. Blakeslee), shows beans rolling down an inclined plane and accumulating in compartments at the base which are closed in front by glass. The exposure was long enough to cause the moving beans to appear as caterpillar-like objects hopping along the board. Assuming that the irregularity of shape of the beans is such that each may make jumps toward the right or toward the left, in rolling down the board, the laws of chance lead to the expectation that in very few cases will these jumps all be in the same direction, as is demonstrated by the few beans collected in the compartments at the extreme right and left. Rather the beans will tend to jump in both right and left directions, the most probable condition being that in which the beans make an equal number of jumps to the right and left, as is shown by the large number accumulated in the central compartment. If the board be tilted to one side, the curve of beans would be altered by this one-sided influence. In like fashion a series of factors--either of environment or of heredity--if acting equally in both favorable and unfavorable directions, will cause a group of men to form a similar variability curve, when classified according to their relative height.

any large group of people, such as the white inhabitants of the United States, some individuals will be found who show the character in question in a very low degree, some who show it in a very high degree; and there will be found every possible degree in between.

The consequences of this for race progress are significant. Is it desired to eliminate feeble-mindedness? Then it must be borne in mind that there is no sharp distinction between feeble-mindedness and the normal mind. One can not divide sheep from goats, saying "A is feeble-minded. B is normal. C is feeble-minded. D is normal," and so on. If one took a scale of a hundred numbers, letting 1 stand for an idiot and 100 for a genius, one would find individuals corresponding to every single number on the scale. The only course possible would be a somewhat arbitrary one; say to consider every individual corresponding to a grade under seven as feeble-minded. It would have to be recognized that those graded eight were not much better than those graded seven, but the drawing of the line at seven would be justified on the ground that it had to be drawn somewhere, and seven seemed to be the most satisfactory point.

In practice of course, students of retardation test children by standardized scales. Testing a hundred 10-year-old children, the examiner might find a number who were able to do only those tests which are passed by a normal six-year-old child. He might properly decide to put all who thus showed four years of retardation, in the class of feeble-minded; and he might justifiably decide that those who tested seven years (i.e., three years mental retardation) or less would, for the present, be given the benefit of the doubt, and classed among the possibly normal. Such a procedure, in dealing with intelligence, is necessary and justifiable, but its adoption must not blind students, as it often does, to the fact that the distinction made is an arbitrary one, and that there is no more a hard and fast line of demarcation between imbeciles and normals than there is between "rich men" and "poor men."





CADETS ARRANGED TO SHOW NORMAL CURVE OF VARIABILITY

FIG. 14.--The above company of students at Connecticut Agricultural College was grouped according to height and photographed by A. F. Blakeslee. The height of each rank, and the number of men of that height, is shown by the figures underneath the photograph. The company constitutes what is technically known as a "population" grouped in "arrays of variates"; the middle rank gives the median height of the population; the tallest array (5 ft., 8 in.) is the mode. If a line be drawn connecting the upper ends of the rows, the resulting geometric figure will be a "scheme of distribution of variates" or more briefly a "variability curve," such as was shown in several preceding figures. The arrangement of homogeneous objects of any kind in such form as this is the first step in the study of variation by modern statistical methods, and on such study much of the progress of genetics depends.

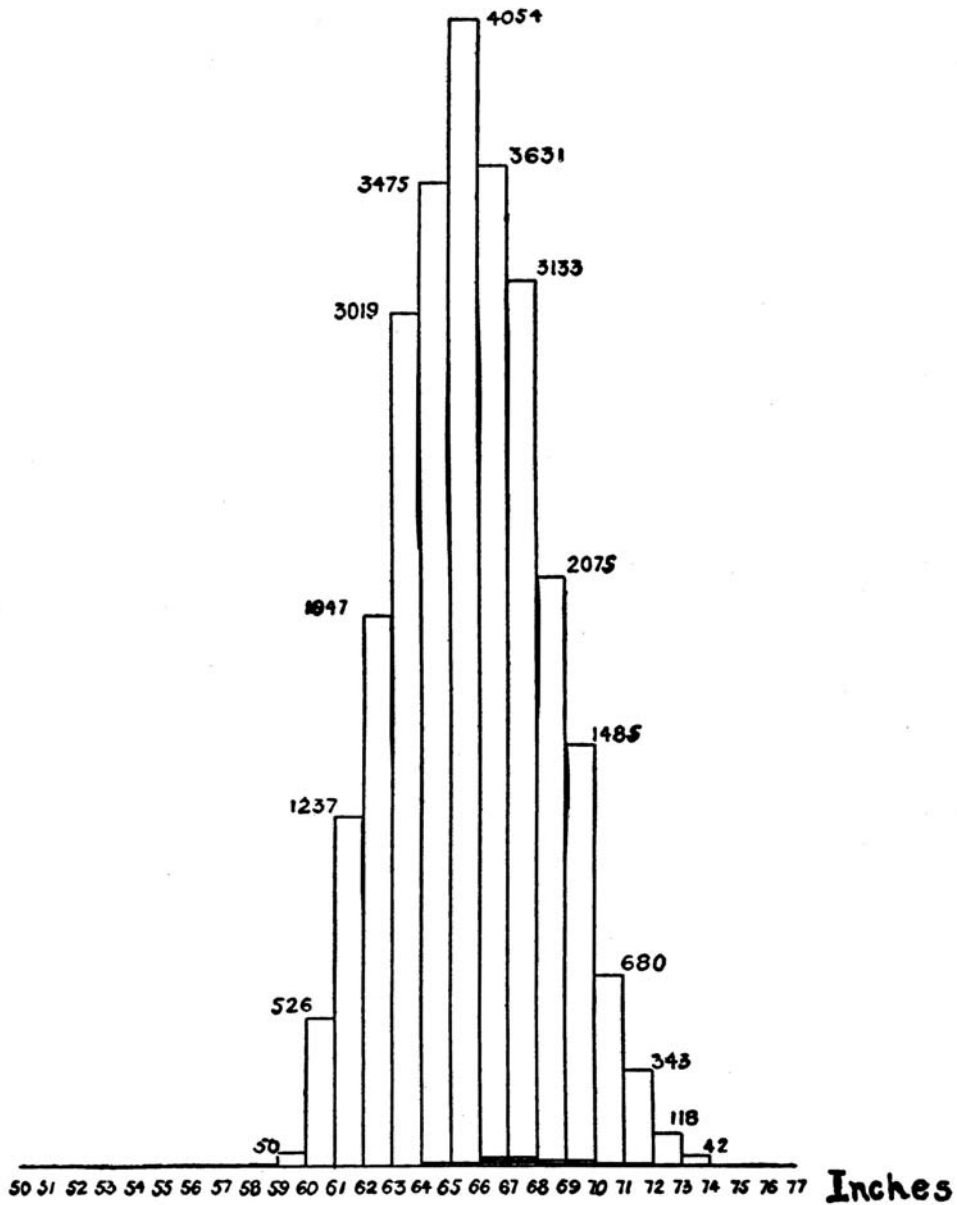


FIG. 15.--Height is one of the stock examples of a continuous character--one of which all grades can be found. As will be seen from the above diagram, every height from considerably under five feet to considerably over six feet can be found in the army, but extreme deviations are relatively rare in proportion to the amount of deviation. The vertical columns represent the total number of individuals of a given height in inches. From Davenport.

If a group of soldiers be measured as the children were measured for arithmetical ability, their height will be distributed in this same curve of probability. Fig. 14 shows the cadets of Connecticut Agricultural College; it is obvious that a line drawn along the tops of the files would again make the step-pyramid shown in Figures 10, 11 and 13. If a larger number were taken, the steps would disappear and give place to a smooth curve; the fact is well shown in a graph for the heights of recruits to the American Army (Fig. 15).

The investigation in this direction need not be pursued any farther. For the purpose of eugenics, it is sufficient to recognize that great differences exist between men, and women, not only in respect of physical traits, but equally in respect of mental ability.

This conclusion might easily have been reached from a study of the facts in Chapter I, but it seemed worth while to take time to present the fact in a more concrete form as the result of actual measurements. The evidence allows no doubt about the existence of considerable mental and physical differences between men.

The question naturally arises, "What is the cause of these differences?"

The study of twins showed that the differences could not be due to differences in training or home surroundings. If the reader will think back over the facts set forth in the first chapter, he will see clearly that the fundamental differences in men can not be due to anything that happens after they are born; and the facts presented in the second chapter showed that these differences can not be due in an important degree to any influences acting on the child prior to birth.

## CHAPTER IV

### THE INHERITANCE OF MENTAL CAPACITIES

We have come to the climax of the eugenist's preliminary argument; if the main differences between human beings are not due to anything in the environment or training, either of this or previous generations, there can be but one explanation for them.

They must be due to the ancestry of the individual--that is, they must be matters of heredity in the ordinary sense, coupled with the fortuitous variations which accompany heredity throughout the organic world.

We need not limit ourselves, however, to the argument by exclusion, for it is not difficult to present direct evidence that the differences between men are actually inherited by children from parents. The problem, formally stated, is to measure the amount by which the likeness of individuals of like ancestry surpasses the likeness of individuals of different ancestry. After subtraction of the necessary amount for the greater likeness in training, that the individuals of like ancestry will have, whatever amount is left will necessarily, represent the actual inheritance of the child from its ancestors--parents, grandparents, and so on.

Obviously, the subtraction for environmental effects is the point at which a mistake is most probable. We may safely start, therefore, with a problem in which no subtraction whatever need be made for this cause. Eye color is a stock example, and a good one, for it is not conceivable that home environment or training would cause a change in the color of brothers' eyes.

The correlation[30] between brothers, or sisters, or brothers and

[30] It will be recalled that the coefficient of correlation measures the resemblance between two variables on a scale between 0 and -1 or +1. If the correlation is zero, there is no constant relation; if it is unity, any change in one must result in a determinate change in the other; if it is 0.5, it means that when one of the variables deviates from the mean of its class by a given amount, the other variable will deviate from the mean of its class by 50% of that amount (each deviation being measured in terms of the variability of its own class, in order that they may be properly comparable.)

sisters--briefly, the fraternal resemblance--for eye-color was found by Karl Pearson, using the method described in Chapter I, to be .52. We are in no danger of contradiction if we state with positiveness that this figure represents the influence of ancestry, or direct inheritance, in respect to this particular trait.

Suppose the resemblance between brothers be measured for stature--it is .51; for cephalic index, that is, the ratio of width of skull to length of skull--it is .49; for hair color--it is .59. In all of these points, it will be admitted that no home training, or any other influence except heredity, can conceivably play an important part. We could go on with a long list of such measurements, which biometrists have made; and if they were all summed up it would be found that the fraternal correlation in these traits as to the heritability of which there can be no dispute, is about .52. Here is a good measure, albeit a technical one, of the influence of heredity from the near ancestry. It is possible, too, to measure the direct correlation between a trait in parent and the same trait in offspring; the average of many cases where only heredity can be thought to have had any effect in producing the result, is .49. By the two methods of measurement, therefore, quite comparable results are obtained.

So much work has been done in this subject that we have no hesitation in affirming .5 to represent approximately the average intensity of heredity for physical characters in man. If any well-marked physical character be measured, in which training and environment can not be assumed to have had any part, it will be found, in a large enough number of subjects, that the resemblance, measured on a scale from 0 to 1, is just about one-half of unity. Of course, perfect identity with the parents is not to be expected, because the child must inherit from both parents, who in turn each inherited from two parents, and so on.

So far, it may be said, we have had plain sailing because we have carefully chosen traits in which we were not obliged to make any

subtraction whatever for the influence of training. But it is evident that not all traits fall in that class.

This is the point at which the inheritance of mental traits has been most often questioned. Probably no one will care to dispute the inheritance of such physical traits as eye-color. But in considering the mind, a certain school of popular pseudo-psychological writers question the reality of mental inheritance, and allege that the proofs which the geneticist offers are worthless because they do not make account of the similarity in environment or training. Of course, it is admitted that some sort of a mental groundwork must be inherited, but extremists allege that this is little more than a clean slate on which the environment, particularly during the early years of childhood, writes its autograph.

We must grant that the analysis of the inheritance of mental traits is proceeding slowly. This is not the fault of the geneticist, but rather of the psychologist, who has not yet been able to furnish the geneticist with the description of definite traits of such a character as to make possible the exhaustive analysis of their individual inheritance. That department of psychology is only now being formed.

We might even admit that no inherited "unit character" in the mind has yet been isolated; but it would be a great mistake to assume from this admission that proof of the inheritance of mental qualities, in general, is lacking.

The psychologists and educators who think so appear either to be swayed by metaphysical views of the mind, or else to believe that resemblance between parent and offspring is the only evidence of inheritance that can be offered. The father dislikes cheese, the son dislikes cheese. "Aha, you think that that is the inheritance of a dislike for cheese," cries the critic, "but we will teach you better." An interesting example of this sort of teaching is furnished by Boris Sidis, whose feelings are outraged because geneticists have represented that some forms of insanity are hereditary. He declaims for several pages[31] in this fashion:

[31] Sidis, Boris, M.A., Ph.D., M.D., "Neurosis and Eugenics," *Medical Review of Reviews*, Vol. XXI, No. 10, pp. 587-594, New York, October, 1915. A psychologist who writes of "some miraculous germ-plasm (chromatin) with wonderful dominant 'units' (Chromosomes)" is hardly a competent critic of the facts of heredity.

"The so-called scientific method of the eugenists is radically faulty, in spite of the rich display of colored plates, stained tables, glittering biological speculations, brilliant mathematical formulæ and complicated statistical calculations. The eugenists pile Ossa on Pelion of facts by the simple method of enumeration which Bacon and the thinkers coming after him have long ago condemned as puerile and futile. From the savage's belief in sympathetic, imitative magic with its consequent superstitions, omens, and taboos down to the articles of faith and dogmas of the eugenists we find the same faulty, primitive thought, guided by the puerile, imbecile method of simple enumeration, and controlled by the wisdom of the logical *post hoc, ergo propter hoc*."

Now if resemblance between parent and offspring were, as Dr. Sidis supposes, the only evidence of inheritance of mental traits which the eugenicist can produce, his case would indeed be weak. And it is perfectly true that "evidence" of this kind has sometimes been advanced as sufficient by geneticists who should have known better. But this is not the real evidence which genetics offers. The evidence is of numerous kinds, and several lines might be destroyed without impairing the validity of the remainder. It is impossible to review the whole body of evidence here, but some of the various kinds may be indicated, and samples given, even though this involves the necessity of repeating some things we have said in earlier chapters. The reader will then be able to form his own opinion as to whether the geneticists' proofs or the mere assurances of those who have not studied the subject are the more weighty.

1. *The analogy from breeding experiments.* Tame rats, for instance, are very docile; their offspring can be handled without a bit of trouble. The wild rat, on the other hand, is not at all docile.

W. E. Castle, of Harvard University, writes:[32] "We have repeatedly

[32] In a letter to the *Journal of Heredity*, under date of August 4, 1916.

mated tame female rats with wild males, the mothers being removed to isolated cages before the birth of the young. These young which had never seen or been near their father were very wild in disposition in every case. The observations of Yerkes on such rats raised by us indicates that their wildness was not quite as extreme as that of the pure wild rat but closely approached it."

Who can suggest any plausible explanation of their conduct, save that they inherited a certain temperament from their sire? Yet the inheritance of temperament is one of the things which certain psychologists most "view with alarm." If it is proved in other animals, can it be considered wholly impossible in man?

2. *The segregation of mental traits.* When an insane, or epileptic, or feeble-minded person mates with a normal individual, in whose family no taint is found, the offspring (generally speaking) will be mentally sound, even though one parent is not. On the other hand, if two people from tainted stocks marry, although neither one may be personally defective, part of their offspring will be affected.

This production of sound children from an unsound parent, in the first case, and unsound children from two apparently sound parents in the second case, is exactly the opposite of what one would expect if the child gets his unsoundness merely by imitation or "contagion." The difference can not reasonably be explained by any difference in environment or external stimuli. Heredity offers a satisfactory explanation, for some forms of feeble-mindedness and epilepsy, and some of the diseases known as insanity, behave as recessives and segregate in just the way mentioned. There are abundant analogies in the inheritance of other traits in man, lower animals and plants, that behave in exactly the same manner.

If mental defects are inherited, then it is worth while investigating whether mental excellencies may not also be.

3. *The persistence of like qualities regardless of difference in environment.* Any parent with open eyes must see this in his own children--must see that they retained the inherited traits even when



they left home and lived under entirely different surroundings. But the histories of twins furnish the most graphic evidence. Galton, who collected detailed histories of thirty-five pairs of twins who were closely alike at birth, and examined their history in after years, writes:[33] "In some cases the resemblance of body and mind had continued unaltered up to old age, notwithstanding very different conditions of life;" in other cases where some dissimilarity developed, it could be traced to the influence of an illness. Making due allowance for the influence of illness, yet "instances do exist of an apparently thorough similarity of nature, in which such differences of external circumstances as may be consistent with the ordinary conditions of the same social rank and country do not create dissimilarity. Positive evidence, such as this, can not be outweighed by any amount of negative evidence."

Frederick Adams Woods has brought forward[34] a piece of more exact evidence under this head. It is known from many quantitative studies that in physical heredity, the influence of the paternal grandparents and the influence of the maternal grandparents is equal; on the average one pair will contribute no more to the grandchildren than the other. If mental qualities are due rather to early surroundings than to actual inheritance, this equality of grandparental influence is incredible in the royal families where Dr. Woods got his material; for the grandchild has been brought up at the court of the paternal grandfather, where he ought to have gotten all his "acquirements," and has perhaps never even seen his maternal grandparents, who therefore could not be expected to impress their mental peculiarities on him by "contagion." When Dr. Woods actually measured the extent of resemblance to the two sets of grandparents, for mental and moral qualities, he found it to be the same in each case; as is inevitable if they are inherited, but as is incomprehensible if heredity is not largely responsible for one's mental make-up.

4. *Persistence of unlike qualities regardless of sameness in the environment.* This is the converse of the preceding proposition, but

[33] Galton, Francis, *Inquiries into Human Faculty*, p. 167, London, 1907.

[34] Woods, Frederick Adams, *Heredity in Royalty*, New York, 1906.

even more convincing. In the last paragraph but one, we mentioned Galton's study (cited at some length in our Chapter I) of "identical" twins, who are so much alike at birth for the very good reason that they have identical heredity. This heredity was found to be not modified, either in the body or the mind, by ordinary differences of training and environment. Some of Galton's histories[35] of ordinary, non-identical twins were also given in Chapter I; two more follow:

One parent says: "They have been treated exactly alike; both were brought up by hand; they have been under the same nurse and governess from their birth, and they are very fond of each other. Their increasing dissimilarity must be ascribed to a natural difference of mind and character, as there has been nothing in their treatment to account for it."

Another writes: "This case is, I should think, somewhat remarkable for dissimilarity in physique as well as for strong contrast in character. They have been unlike in mind and body throughout their lives. Both were reared in a country house and both were at the same schools until the age of 16."

In the face of such examples, can anyone maintain that differences in mental make-up are wholly due to different influences during childhood, and not at all to differences in germinal make-up? It is not necessary to depend, under this head, on mere descriptions, for accurate measurements are available to demonstrate the point. If the environment creates the mental nature, then ordinary brothers, not more than four or five years apart in age, ought to be about as closely similar to each other as identical twins are to each other; for the family influences in each case are practically the same. Professor Thorndike, by careful

[35] *Op. cit.*, pp. 170-171.

[36] Thorndike, E. L., "Measurements of Twins," *Arch. of Philos., Psych. and Sci. Methods*, No. 1, New York, 1905; summarized in his *Educational Psychology*, Vol. III, pp. 247-251, New York, 1914. Measured on a scale where 1 = identity, he found that twins showed a resemblance to each other of about .75, while ordinary brothers of about the same age resembled each other to the extent of about .50 only. The resemblance was approximately the same in both physical and mental traits.

mental tests, showed[36] that this is not true. The ordinary brothers come from different egg-cells, and, as is known from studies on lower animals, they do not get exactly the same inheritance from their parents; they show, therefore, considerable differences in their psychic natures. Real identical twins, being two halves of the same egg-cell, have the same heredity, and their natures are therefore much more nearly identical.

Again, if the mind is molded during the "plastic years of childhood," children ought to become more alike, the longer they are together. Twins who were unlike at birth ought to resemble each other more closely at 14 than they did at 9, since they have been for five additional years subjected to this supposedly potent but very mystical "molding force." Here again Professor Thorndike's exact measurements explode the fallacy. They are actually, measurably, less alike at the older age; their inborn natures are developing along predestined lines, with little regard to the identity of their surroundings. Heredity accounts easily for these facts, but they cannot be squared with the idea that mental differences are the products solely of early training.

5. *Differential rates of increase in qualities subject to much training.* If the mind is formed by training, then brothers ought to be more alike in qualities which have been subject to little or no training. Professor Thorndike's measurements on this point show the reverse to be true. The likeness of various traits is determined by heredity, and brothers may be more unlike in traits which have been subjected to a large and equal amount of training. Twins were found to be less alike in their ability at addition and multiplication, in which the schools had been training them for some years, than they were in ability to mark off the A's on a printed sheet, or to write the opposites to a list of words--feats which they had probably never before tried to do.

This same proposition may be put on a broader basis.[37] "In so far as the differences in achievement found amongst a group of men are due to the differences in the quantity and quality of training which they had

[37] The quotations in this and the following paragraph are from *Thorndike's Educational Psychology*, pp. 304-305, Vol. III.

had in the function in question, the provision of equal amounts of the same sort of training for all individuals in the group should act to reduce the differences." "If the addition of equal amounts of practice does not reduce the differences found amongst men, those differences can not well be explained to any large extent by supposing them to have been due to corresponding differences in amount of previous practice. If, that is, inequalities in achievement are not reduced by equalizing practice, they can not well have been caused by inequalities in previous practice. If differences in opportunity cause the differences men display, making opportunity more nearly equal for all, by adding equal amounts to it in each case should make the differences less.

"The facts found are rather startling. Equalizing practice seems to increase differences. The superior man seems to have got his present superiority by his own nature rather than by superior advantages of the past, since, during a period of equal advantage for all, he increases his lead." This point has been tested by such simple devices as mental multiplication, addition, marking A's on a printed sheet of capitals and the like; all the contestants made some gain in efficiency, but those who were superior at the start were proportionately farther ahead than ever at the end. This is what the geneticist would expect, but fits very ill with some popular pseudo-science which denies that any child is mentally limited by nature.

6. *Direct measurement of the amount of resemblance of mental traits in brothers and sisters.* It is manifestly impossible to assume that early training, or parental behavior, or anything of the sort, can have influenced very markedly the child's eye color, or the length of his forearm, or the ratio of the breadth of his head to its length. A measure of the amount of resemblance between two brothers in such traits may very confidently be said to represent the influence of heredity; one can feel no doubt that the child inherits his eye-color and other physical traits of that kind from his parents. It will be recalled that the resemblance, measured on a scale from 0 to 1, has been found to be about 0.5.

Karl Pearson measured the resemblance between brothers and sisters in mental traits--for example, temper, conscientiousness, introspection, vivacity--and found it on the average to have the same intensity--that is, about 0.5. Starch gets similar results in studying school grades.

Professor Pearson writes:[38]

"It has been suggested that this resemblance in the psychological characters is compounded of two factors, inheritance on the one hand and training and environment on the other. If so, one must admit that inheritance and environment make up the resemblance in the physical characters. Now these two sorts of resemblance being of the same intensity, either the environmental influence is the same in both cases or it is not. If it is the same, we are forced to the conclusion that it is insensible, for it can not influence eye-color. If it is not the same, then it would be a most marvelous thing that with varying degrees of inheritance, some mysterious force always modifies the extent of home influence, until the resemblance of brothers and sisters is brought sensibly up to the same intensity! Occam's razor[39] will enable us at once to cut off such a theory. We are forced, I think, literally forced, to the general conclusion that the physical and psychical characters in man are inherited within broad lines in the same manner, and with approximate intensity. The average parental influence is in itself largely a result of the heritage of the stock and not an extraneous and additional factor causing the resemblance between children from the same home."

A paragraph from Edgar Schuster[40] may appropriately be added. "After considering the published evidence a word must be said of facts which most people may collect for themselves. They are difficult to record, but are perhaps more convincing than any quantity of statistics. If one knows well several members of a family, one is bound to see in them likenesses with regard to mental traits, both large and small, which

[38] *Biometrika*, Vol. III, p. 156.

[39] "William of Occam's Razor" is the canon of logic which declares that it is unwise to seek for several causes of an effect, if a single cause is adequate to account for it.

[40] Schuster, Edgar, *Eugenics*, pp. 150-163, London, 1913.

may sometimes be accounted for by example on the one hand or unconscious imitation on the other, but are often quite inexplicable on any other theory than heredity. It is difficult to understand how the inheritance of mental capacity can be denied by those whose eyes are open and whose minds are open too."

Strictly speaking, it is of course true that man inherits nothing more than the capacity of making mental acquisitions. But this general capacity is made up of many separate capacities, all of these capacities are variable, and the variations are inherited. Such seems to us to be the unmistakable verdict of the evidence.

Our conclusions as to the inheritance of all sorts of mental capacity are not based on the mere presence of the same trait in parent and child. As the psychological analysis of individual traits proceeds, it will be possible to proceed further with the study of the inheritance of these traits. Some work has been done on spelling, which is particularly interesting because most people, without reflection, would take it for granted that a child's spelling ability depends almost wholly on his training. Professor Thorndike's exposition[41] of the investigation is as follows:

"E. L. Earle ('03) measured the spelling abilities of some 800 children in the St. Xavier school in New York by careful tests. As the children in this school commonly enter at a very early age, and as the staff and methods of teaching remain very constant, we have in the case of the 180 pairs of brothers and sisters included in the 600 children closely similar school training. Mr. Earle measured the ability of any individual by his deviation from the average for his grade and sex, and found the coefficient of correlation between children of the same family to be .50. That is, any individual is on the average 50% as much above or below the average for his age and sex as his brother or sister.

"Similarities of home training might account for this, but any one experienced in teaching will hesitate to attribute much efficacy to

[41] *Educational Psychology* (1914), Vol. III, p. 235.

such similarities. Bad spellers remain bad spellers though their teachers change. Moreover, Dr. J. M. Rice in his exhaustive study of spelling ability ('97) found little or no relationship between good spelling and any one of the popular methods, and little or none between poor spelling and foreign parentage. Cornman's more careful study of spelling ('07) supports the view that ability to spell is little influenced by such differences in school or home training as commonly exist."

This is a very clear-cut case of a definite intellectual ability, differences in which might be supposed to be due almost wholly to the child's training, but which seem, on investigation, to be largely due to heredity.

The problem may be examined in still greater detail. Does a man merely inherit manual skill, let us say, or does he inherit the precise kind of manual skill needed to make a surgeon but not the kind that would be useful to a watchmaker? Is a man born merely with a generalized "artistic" ability, or is it one adapted solely for, let us say, music; or further, is it adapted solely for violin playing, not for the piano?

Galton, in his pioneer studies, sought for data on this question. In regard to English judges, he wrote: "Do the judges often have sons who succeed in the same career, where success would have been impossible if they had not been gifted with the special qualities of their fathers? Out of the 286 judges, more than *one in every nine* of them have been either father, son or brother to another judge, and the other high legal relationships have been even more numerous. There can not, then, remain a doubt but that the peculiar type of ability that is necessary to a judge is often transmitted by descent."

Unfortunately, we can not feel quite as free from doubt on the point as Galton did. The judicial mind, if that be the main qualification for a judge, might be inherited, or it might be the result of training. Such a case, standing alone, is inconclusive.

Galton similarly showed that the sons of statesmen tended to be statesmen, and that the same was true in families of great commanders, literary men, poets and divines. In his list of eminent painters, all the relatives mentioned are painters save four, two of whom were gifted

in sculpture, one in music and one in embroidery. As to musicians, Mendelssohn and Meyerbeer are the only ones in his list whose eminent kinsmen achieved their success in other careers than music.

Havelock Ellis, who likewise studied British men of genius, throws

additional light on the subject. "Painters and sculptors," he found, "constitute a group which appears to be of very distinct interest from the point of view of occupational heredity. In social origin, it may be noted, the group differs strikingly in constitution from the general body of men of genius in which the upper class is almost or quite predominant. Of 63 painters and sculptors of definitely known origin, only two can be placed in the aristocratic division. Of the remainder 7 are the sons of artists, 22 the sons of craftsmen, leaving only 32 for all other occupations, which are mainly of lower middle class character, and in many cases trades that are very closely allied to crafts. Even, however, when we omit the trades as well as the cases in which the fathers were artists, we find a very notable predominance of craftsmen in the parentage of painters, to such an extent indeed that while craftsmen only constitute 9.2% among the fathers of our eminent persons generally, they constitute nearly 35% among the fathers of the painters and sculptors. It is difficult to avoid the conclusion that there is a real connection between the father's aptitude for craftsmanship and the son's aptitude for art.

"To suppose that environment adequately accounts for this relationship is an inadmissible theory. The association between the craft of builder, carpenter, tanner, jeweller, watchmaker, woodcarver, ropemaker, etc., and the painter's art is small at best, and in most cases is non-existent."

Arreat, investigating the heredity of 200 eminent European painters, reached results similar to those of Ellis, according to the latter's citation.

Arithmetical ability seems similarly to be subdivided, according to Miss Cobb.[42] She made measurements of the efficiency with which children

[42] Cobb, Margaret V., *Journal of Educational Psychology*, viii, pp. 1-20, Jan., 1917.



and their parents could do problems in addition, subtraction, multiplication and division, and could copy a column of figures. "The measurements made," she writes, "show that if, for instance, a child is much quicker than the average in subtraction, but not in addition, multiplication or division, it is to be expected that one at least of his parents shows a like trait; or if he falls below the average in subtraction and multiplication, and exceeds it in addition and division, again the same will hold true of at least one of his parents." These various kinds of arithmetic appear to be due to different functions of the brain, and are therefore probably inherited independently, if they are inherited at all.

To assume that the resemblance between parent and offspring in arithmetical ability is due to association, training and imitation is not plausible. If this were the case, a class of children ought to come to resemble their teacher, but they do not. Moreover, the child sometimes resembles more closely the parent with whom he has been less associated in daily life.

From such data as these, we conclude that mental inheritance is considerably specialized. This conclusion is in accord with Burris' finding (cited by Thorndike) that the ability to do well in some one high school study is nearly or quite as much due to ancestry as is the ability to do well in the course as a whole.

To sum up, we have reason to believe not only that one's mental character is due largely to heredity, but that the details of it may be equally due to heredity, in the sense that for any particular trait or complex in the child there is likely to be found a similar trait or complex in the ancestry. Such a conclusion should not be pushed to the point of assuming inheritance of all sorts of dispositions that might be due to early training; on the other hand, a survey of the whole field would probably justify us in concluding that any given trait is *more likely than not* to be inherited. The effect of training in the formation of the child's mental character is certainly much less than is popularly supposed; and even for the traits that are most due to training, it must never be forgotten that there are inherited mental bases.

If the reader has accepted the facts presented in this chapter, and our inferences from the facts, he will admit that mental differences between men are at bottom due to heredity, just as physical differences are; that they are apparently inherited in the same manner and in approximately the same degree.

## CHAPTER V

### THE LAWS OF HEREDITY

We have now established the bases for a practicable eugenics program. Men differ; these differences are inherited; therefore the make-up of the race can be changed by any method which will alter the relative proportions of the contributions which different classes of men make to the following generation.

For applied eugenics, it is sufficient to know that mental and physical differences are inherited; the exact manner of inheritance it would be important to know, but even without a knowledge of the details of the mechanism of heredity, a program of eugenics is yet wholly feasible.

It is no part of the plan of this book to enter into the details of the mechanism of heredity, a complicated subject for which the reader can refer to one of the treatises mentioned in the bibliography at the close of this volume. It may be worth while, however, to outline in a very summary way the present status of the question.

As to the details of inheritance, research has progressed in the last few years far beyond the crude conceptions of a decade ago, when a primitive form of Mendelism was made to explain everything that occurred.[43] One can hardly repress a smile at the simplicity of those early ideas,--though it must be said that some students of eugenics have not yet outgrown them. In those days it was thought that every visible

[43] This is not true of the small English school of biometrists, founded by Sir Francis Galton, W. F. R. Weldon and Karl Pearson, and now led by the latter. It has throughout denied or minimized Mendelian results, and depended on the treatment of inheritance by a study of correlations. With the progress of Mendelian research, biometric methods must be supplemented with pedigree studies. In human heredity, on the other hand, because of the great difficulties attendant upon an application of Mendelian methods, the biometric mode of attack is still the most useful, and has been largely used in the present book. It has been often supposed that the methods of the two schools (biometry and Mendelism) are antagonistic. They are rather supplementary, each being valuable in cases where the other is less applicable. See Pearl, Raymond, *Modes of Research in Genetics*, p. 182, New York, 1915.

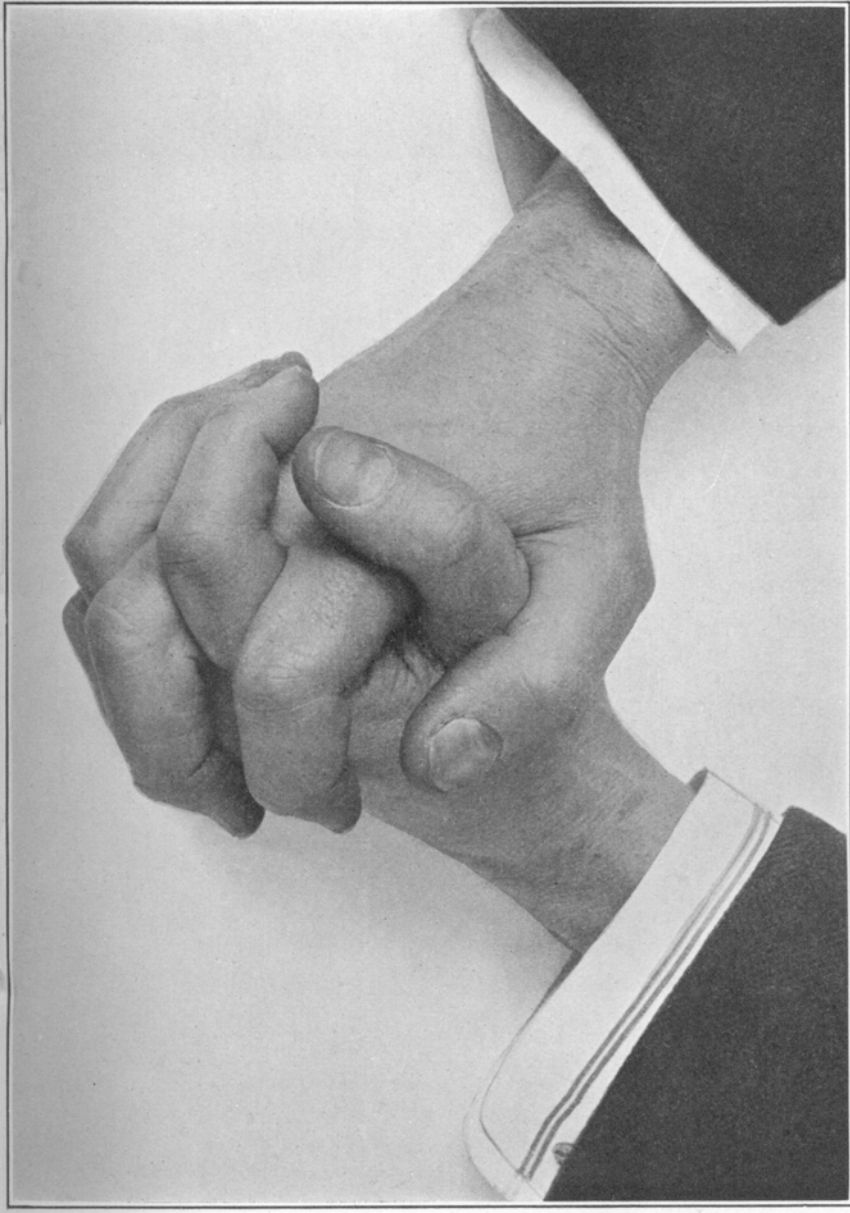
character in man (or in any other organism) was represented by some "determiner" in the germ-plasm; that by suitable matings a breeder could rid a stream of germ-plasm of almost any determiner he wished; and that the corresponding unit character would thereupon disappear from the visible make-up of the individual. Was a family reported as showing a taint, for instance, hereditary insanity? Then it was asserted that by the proper series of matings, it was possible to squeeze out of the germ-plasm the particular concrete *something* of which insanity was the visible expression, and have left a family stock that was perfectly sound and sane.

The minute, meticulous researches of experimental breeders[44] have left such a view of heredity far behind. Certainly the last word has not been said; yet the present hypotheses *work*, whenever the conditions are such as to give a fair chance. The results of these studies have led to what is called the factorial hypothesis of heredity,[45] according to which all the visible characters of the adult are produced by (purely hypothetical) factors in the germ-plasm; it is the factors that are inherited, and they, under proper conditions for development, produce the characters. The great difference between this and the earlier view is that instead of allotting one factor to each character, students now believe that each individual character of the organism is produced by the action of an indefinitely large number of factors,[46] and they

[44] Few people realize what large numbers of plants and animals have been bred for experimental purposes during the last decade; W. E. Castle of Bussey Institution, Forest Hills, Mass., has bred not less than 45,000 rats. In the study of a single character, the endosperm of maize, nearly 100,000 pedigreed seeds have been examined by different students. Workers at the University of California have tabulated more than 10,000 measurements on flower size alone, in tobacco hybrids. T. H. Morgan and his associates at Columbia University have bred and studied more than half a million fruit flies, and J. Arthur Harris has handled more than 600,000 bean-plants at the Carnegie Institution's Station for Experimental Evolution, Cold Spring Harbor, L. I. While facts of human heredity, and of inheritance in large mammals generally, are often grounded on scanty evidence, it must not be thought that the fundamental generalizations of heredity are based on insufficient data.

[45] For a brief account of Mendelism, see Appendix D.

[46] Of course these factors are not of equal importance; some of them produce large changes and some, as far as can be told, are of minor significance. The factors, moreover, undergo large changes from time to time, thus producing mutations; and it is probable small changes as well, the evidence for which requires greater refinements of method than is usual among those using the pedigree method.



#### HOW DO YOU CLASP YOUR HANDS?

FIG. 16.--If the hands be clasped naturally with fingers alternating, as shown in the above illustration, most people will put the same thumb--either that of the right or that of the left hand--uppermost every time. Frank E. Lutz showed (*American Naturalist*, xliii) that the position assumed depends largely on heredity. When both parents put the right thumb uppermost, about three-fourths of the children were found to do the same. When both parents put the left thumb uppermost, about three-fifths of the children did the same. No definite ratios could be found from the various kinds of matings. Apparently the manner of clasping hands has no connection with one's right-handedness or left-handedness. It can hardly be due to imitation for the trait is such a slight one that most people have not noticed it before their attention is called to it by the geneticist. Furthermore, babies are found almost always to clasp the hands in the same way every time. The trait is a good illustration of the almost incredible minuteness with which heredity enters into a man's make-up. Photograph by John Howard Paine.

have been further forced to adopt the belief that each individual factor affects an indefinitely large number of characters, owing to the physiological interrelations and correlations of every part of the body.

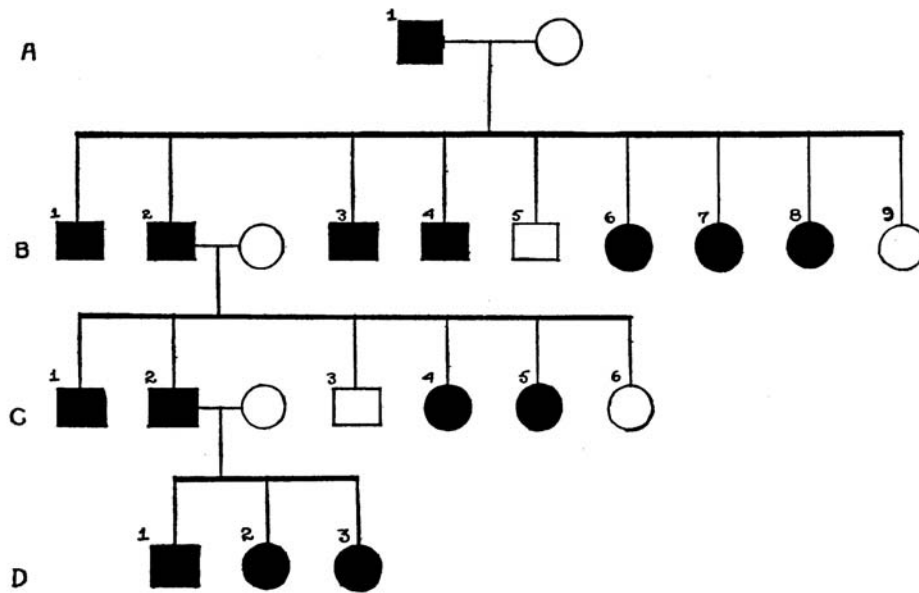
The sweet pea offers a good illustration of the widespread effects which may result from the change of a single factor. In addition to the ordinary climbing vine, there is a dwarf variety, and the difference between the two seems to be proved, by exhaustive experimental breeding, to be due to only one inherited factor. Yet the action of this one factor not only changes the height of the plant, but also results in changes in color of foliage, length of internodes, size and arrangement of flowers, time of opening of flowers, fertility and viability.

Again, a mutant stock in the fruit fly (*Drosophila*) has as its most marked characteristic very short wings. "But the factor for rudimentary wings also produces other effects as well. The females are almost completely sterile, while the males are fertile. The viability of the stocks is poor. When flies with rudimentary wings are put into competition with wild flies relatively few of the rudimentary flies come through, especially if the culture is crowded. The hind legs are also shortened. All of these effects are the results of a single factor-difference." To be strictly accurate, then, one should not say that a certain variation affects length of wing, but that its *chief* effect is to shorten the wing.

"One may venture to guess," T. H. Morgan says, [47] "that some of the specific and varietal differences that are characteristic of wild types and which at the same time appear to have no survival value, are only by-products of factors whose most important effect is on another part of the organism where their influence is of vital importance."

[47] *A Critique of the Theory of Evolution*, by Thomas Hunt Morgan, professor of experimental zoölogy in Columbia University. Princeton University Press, 1916. This book gives the best popular account of the studies of heredity in *Drosophila*. The advanced student will find *The Mechanism of Mendelian Heredity* (New York, 1915), by Morgan, Sturtevant, Müller, and Bridges, indispensable, but it is beyond the comprehension of most beginners.

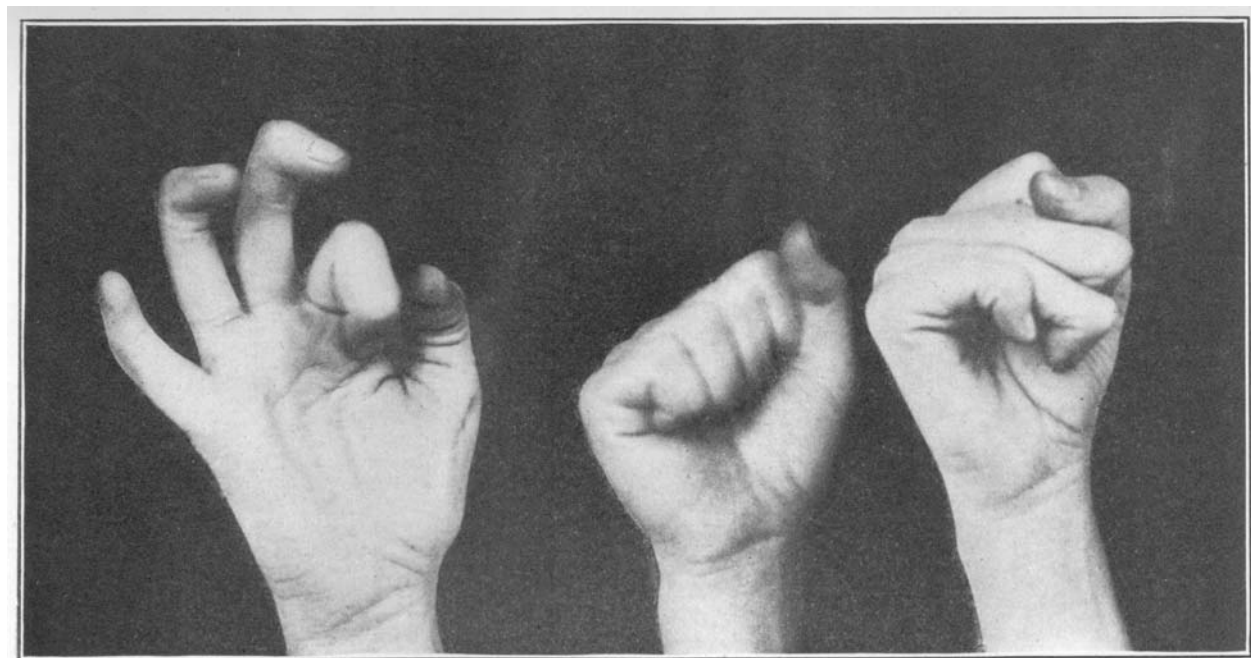
"I am inclined to think," Professor Morgan continues, "that an overstatement to the effect that each factor may affect the entire body, is less likely to do harm than to state that each factor affects only a particular character. The reckless use of the phrase 'unit character' has done much to mislead the uninitiated as to the effects that a single change in the germ-plasm may produce on the organism. Fortunately the expression 'unit character' is being less used by those students of genetics who are more careful in regard to the implications of their terminology."



A FAMILY WITH ORTHODACTYLY

FIG. 18.--Squares denote males and circles females, as is usual in the charts compiled by eugenicists; black circles or squares denote affected individuals. A1 had all fingers affected in the way shown in Fig. 17; B2 had all but one finger affected; C2 had all but one finger affected; D2 had all fingers affected; D3 has all but forefingers affected. The family here shown is a branch, found by F. N. Duncan, of a very large family first described by Harvey Cushing, in which this abnormality has run for at least seven generations. It is an excellent example of an inherited defect due to a single Mendelian factor.

One of the best attested single characters in human heredity is brachydactyly, "short-fingerness," which results in a reduction in the length of the fingers by the dropping out of one joint. If one lumps together all the cases where any effect of this sort is found, it is



#### THE EFFECT OF ORTHODACTYLY

FIG. 17.--At the left is a hand with the third, fourth and fifth fingers affected. The middle joints of these fingers are stiff and cannot be bent. At the right the same hand is shown, closed. A normal hand in the middle serves to illustrate by contrast the nature of the abnormality, which appears in every generation of several large families. It is also called symphalangism, and is evidently related to the better-known abnormality of brachydactyly. Photograph from Frederick N. Duncan.



evident that normals never transmit it to their posterity, that affected persons always do, and that in a mating between a normal and an affected person, all the offspring will show the abnormality. It is a good example of a unit character.

But its effect is by no means confined to the fingers. It tends to affect the entire skeleton, and in a family where one child is markedly brachydactylous, that child is generally shorter than the others. The factor for brachydactyly evidently produces its primary effect on the bones of the hand, but it also produces a secondary effect on all the bones of the body.

Moreover, it will be found, if a number of brachydactylous persons are examined, that no two of them are affected to exactly the same degree. In some cases only one finger will be abnormal; in other cases there will be a slight effect in all the fingers; in other cases all the fingers will be highly affected. Why is there such variation in the results produced by a unit character? Because, presumably, in each individual there is a different set of modifying factors or else a variation in the factor. It has been found that an abnormality quite like brachydactyly is produced by abnormality in the pituitary gland. It is then fair to suppose that the factor which produces brachydactyly does so by affecting the pituitary gland in some way. But there must be many other factors which also affect the pituitary and in some cases probably favor its development, rather than hindering it. Then if the factor for brachydactyly is depressing the pituitary, but if some other factors are at the same time stimulating that gland, the effect shown in the subject's fingers will be much less marked than if a group of modifying factors were present which acted in the same direction as the brachydactyly factor,--to perturb the action of the pituitary gland.

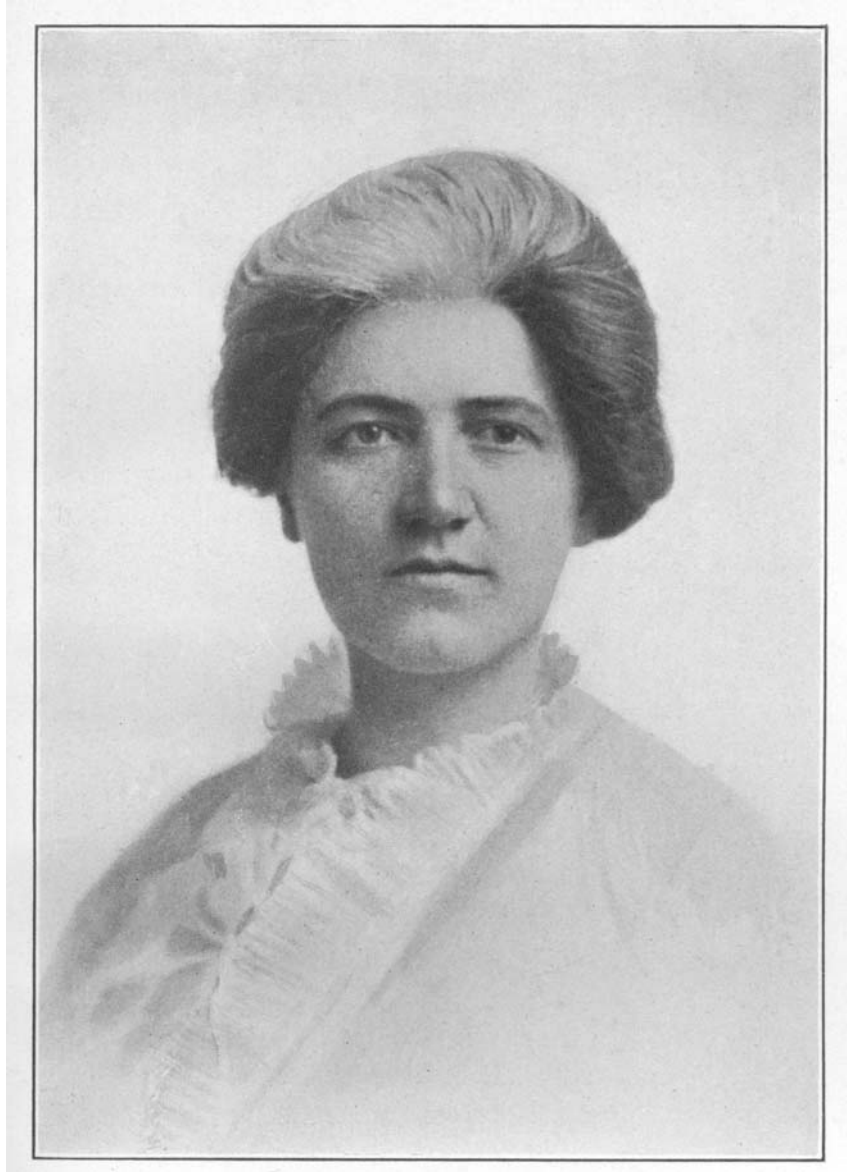
This illustration is largely hypothetical; but there is no room for doubt that every factor produces more than a single effect. A white blaze in the hair, for example, is a well-proved unit factor in man; the factor not only produces a white streak in the hair, but affects the pigmentation of the skin as well, usually resulting in one or more white spots on some part of the body. It is really a factor for "piebaldism."

For the sake of clear thinking, then, the idea of a unit character due to some unit determiner or factor in the germ-plasm must be given up, and it must be recognized that every visible character of an individual is the result of numerous factors, or differences in the germ-plasm. Ordinarily one of these produces a more notable contribution to the end-product than do the others; but there are cases where this statement does not appear to hold good. This leads to the conception of *multiple factors*.

In crossing a wheat with brown chaff and one with white chaff, H. Nilsson-Ehle (1909) expected in the second hybrid generation to secure a ratio of 3 brown to 1 white. As a fact, he got 1410 brown and 94 white, a ratio of 15:1. He interpreted this as meaning that the brown color in this particular variety was due not to one factor, but to two, which were equivalent to each other, and either one of which would produce the same result alone as would the two acting together. In further crossing red wheat with white, he secured ratios which led him to believe that the red was produced by three independent factors, any one of which would produce red either alone or with the other two. A. and G. Howard later corroborated this work,[48] but showed that the three factors were not identical: they are qualitatively slightly different, although so closely similar that the three reds look alike at first sight. E. M. East has obtained evidence from maize and G. H. Shull from shepherd's-purse, which bears out the multiple factor hypothesis.

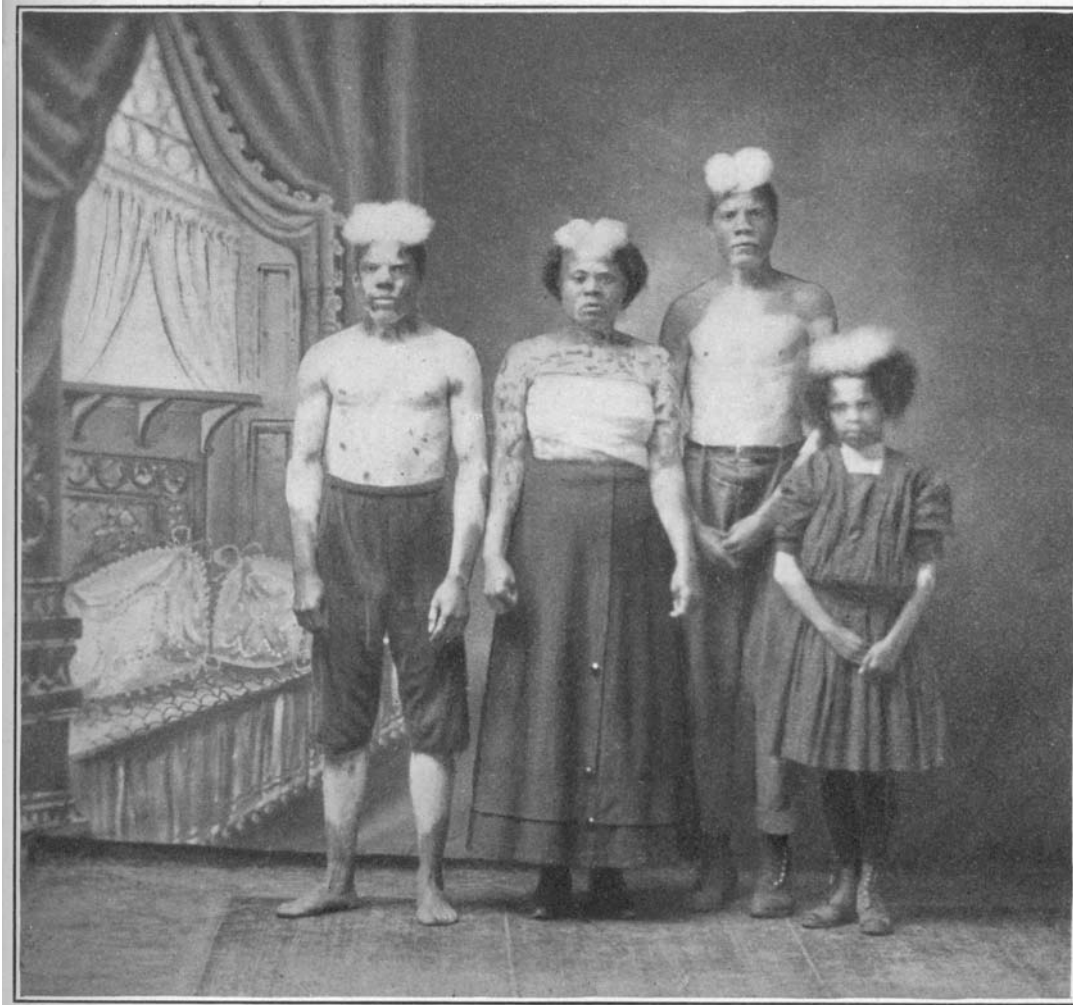
Apart from multiple factors as properly defined (that is, factors which produce the same result, either alone or together), extensive analysis usually reveals that apparently simple characters are in reality complex. The purple aleurone color of maize seeds is attributed by R. A. Emerson to five distinct factors, while E. Baur found four factors responsible for the red color of snapdragon blossoms. There are, as G.

[48] "On the Inheritance of Some Characters in Wheat," A. and G. Howard, *Mem. Dep. of Agr. India*, V: 1-46, 1912. This careful and important work has never received the recognition it deserves, apparently because few geneticists have seen it. While the multiple factors in wheat seem to be different, those reported by East and Shull appear to be merely duplicates.



WHITE BLAZE IN THE HAIR

FIG. 19.--The white lock of hair here shown is hereditary and has been traced back definitely through six generations; family tradition derives it from a son of Harry "Hot-Spur" Percy, born in 1403, and fallaciously assigns its origin to "prenatal influence" or "maternal impression." This young woman inherited the blaze from her father, who had it from his mother, who had it from her father, who migrated from England to America nearly a century ago. The trait appears to be a simple dominant, following Mendel's Law; that is, when a person with one of these locks who is a child of one normal and one affected parent marries a normal individual, half of the children show the lock and half do not. Photograph from Newton Miller.



A FAMILY OF SPOTTED NEGROES

FIG. 20.--The piebald factor sometimes shows itself as nothing more than a blaze in the hair (see preceding figure); but it may take a much more extreme form, as illustrated by the above photograph from Q. I. Simpson and W. E. Castle. Mrs. S. A., a spotted mutant, founded a family which now comprises, in several generations, 17 spotted and 16 normal offspring. The white spotting factor behaves as a Mendelian dominant, and the expectation would be equal numbers of normal and affected children. Similar white factors are known in other animals. It is worth noting that all the well attested Mendelian characters in man are abnormalities, no normal character having yet been proved to be inherited in this manner.

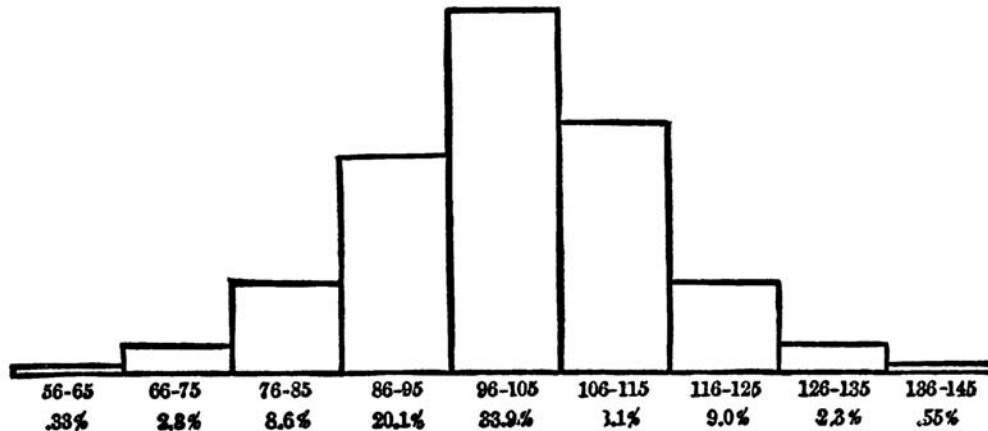
N. Collins says,[49] "still many gross characters that stand as simple Mendelian units, but few, if any, of these occur in plants or animals that have been subjected to extensive investigation. There is now such a large number of characters which at first behaved as units, but which have since been broken up by crossing with suitable selected material, that it seems not unreasonable to believe that the remaining cases await only the discovery of the right strains with which to hybridize them to bring about corresponding results."

In spite of the fact that there is a real segregation between factors as has been shown, it must not be supposed that factors and their determiners are absolutely invariable. This has been too frequently assumed without adequate evidence by many geneticists. It is probable that just as the multiplicity and interrelation and minuteness of many factors have been the principal discoveries of genetics in recent years that the next few years will see a great deal of evidence following the important lead of Castle and Jennings, as to variation in factors.

Knowing that all the characters of an individual are due to the interaction of numerous factors, one must be particularly slow in assuming that such complex characters as man's mental traits are units, in any proper genetic sense of the word. It will, for instance, require very strong evidence to establish feeble-mindedness as a unit character. No one who examines the collected pedigrees of families marked by feeble-mindedness, can deny that it does appear at first sight to behave as a unit character, inherited in the typical Mendelian fashion. The psychologist H. H. Goddard, who started out with a strong bias against believing that such a complex trait could even *behave* as a unit character, thought himself forced by the tabulation of his cases to adopt the conclusion that it does behave as a unit character. And other eugenists have not hesitated to affirm, mainly on the strength of Dr. Goddard's researches, that this unit character is due to a single determiner in the germ-plasm, which either is or is not present,--no halfway business about it.

[49] "The Nature of Mendelian Units." By G. N. Collins, *Journal of Heredity*, V: 425 ff., Oct., 1914.

How were these cases of feeble-mindedness defined? The definition is purely arbitrary. Ordinarily, any adult who tests much below 12 years by the Binet-Simon scale is held to be feeble-minded; and the results of this test vary a little with the skill of the person applying it and with the edition of the scale used. Furthermore, most of the feeble-minded cases in institutions, where the Mendelian studies have usually been made, come from families which are themselves of a low grade of mentality. If the whole lot of those examined were measured, it would be difficult to draw the line between the normals and the affected; there is not nearly so much difference between the two classes, as one would suppose who only looks at a Mendelian chart.



DISTRIBUTION OF I Q'S OF 905 UNSELECTED CHILDREN, 5-14 YEARS OF AGE

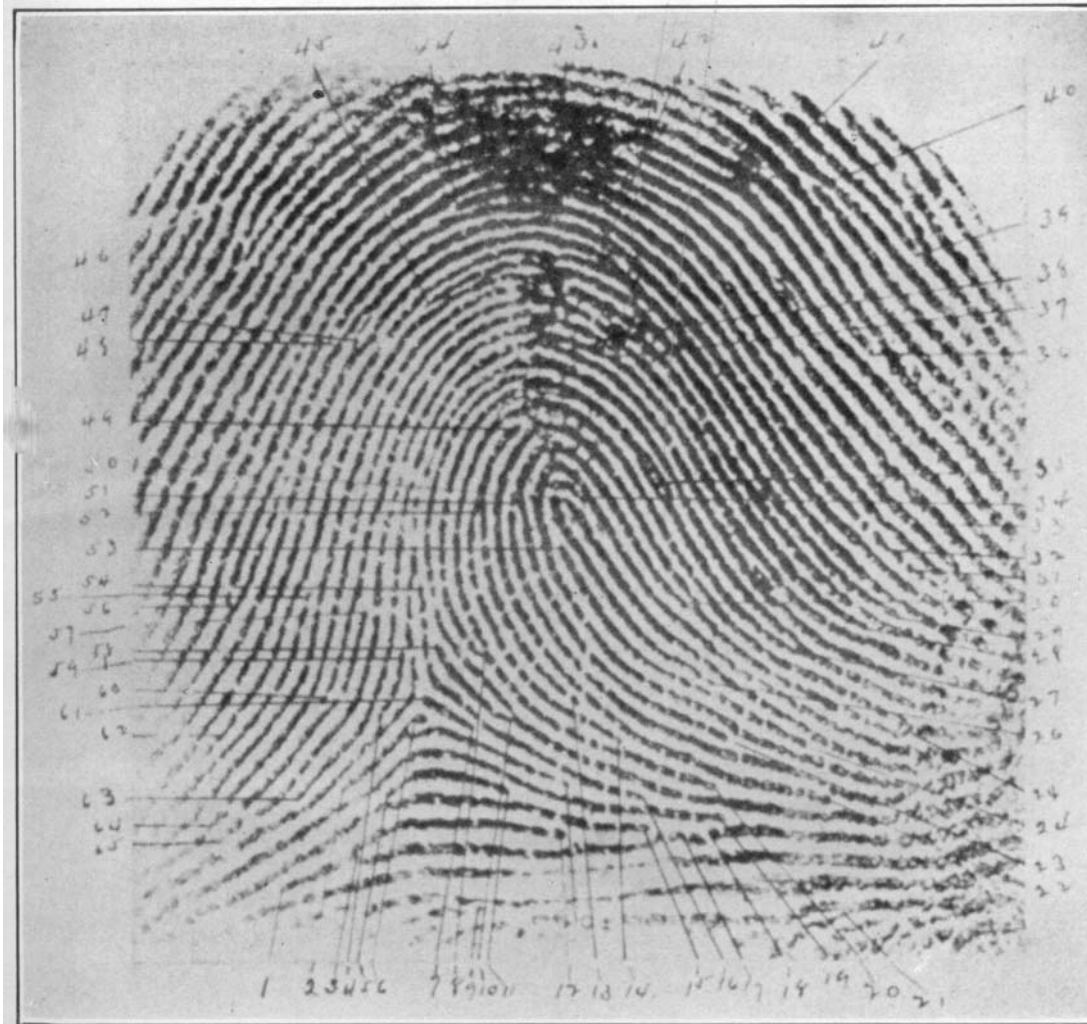
THE DISTRIBUTION OF INTELLIGENCE

FIG. 23.--Diagram showing the mentality of 905 unselected children, 5 to 14 years of age, who may probably be taken as representative of the whole population. The median or tallest column, about one-third of the whole number, represents those who were normal or, as a statistician would say, mediocre. Their mental ages and chronological ages were practically identical. To the left of these the diminishing columns show the number whose mental ages fell short of their chronological ages. They are the mentally retarded, ranging all the way down to the lowest one-third of one per cent who represent a very low grade of feeble-mindedness. On the other side the mentally superior show a similar distribution. A curve drawn over the tops of the columns makes a good normal curve. "Since the frequency of the various grades of intelligence decreases *gradually* and at no point abruptly on each side of the median, it is evident that there is no definite dividing line between normality and feeble-mindedness, or between normality and genius. Psychologically, the mentally defective child does not belong to a distinct type, nor does the genius.... The common opinion that extreme deviations below the median are vastly more frequent than extreme deviations above the median seems to have no foundation in fact. Among unselected school children, at least, for every child of any given degree of deficiency there is roughly another child as far above the average as the former is below." Lewis M. Terman, *The Measurement of Intelligence*, pp. 66-67.



A HUMAN FINGER-TIP

FIG. 21.--The palms of the hands and soles of the feet are covered with little ridges or corrugations, which are supposed to be useful in preventing the grasp from slipping; whence the name of friction-skin has been given to these surfaces. The ridges are developed into various patterns; the one above is a loop on the left forefinger. The ridges are studded with the openings of the sweat glands, the elevated position of which is supposed to prevent them from being clogged up; further, the moisture which they secrete perhaps adds to the friction of the skin. Friction-skin patterns are inherited in some degree. Photograph by John Howard Payne.



THE LIMITS OF HEREDITARY CONTROL

FIG. 22.--Print of a finger-tip showing a loop-pattern, enlarged about eight times. This is a common type of pattern, and at first glance the reader may think it could be mistaken for one of his own. There are, however, at least sixty-five "ridge characteristics" on the above print, which an expert would recognize and would use for the purpose of identification. If it were found that the first two or three of them noted corresponded to similar characteristics on another print, the expert would have no doubt that the two prints were made by the same finger. In police bureaus, finger-prints are filed for reference with a classification based on the type of pattern, number of ridges between two given points, etc.; and a simple formula results which makes it easy to find all prints which bear a general resemblance to each other. The exact identity or lack of it is then determined by a comparison of such *minutiæ* as the sixty-five above enumerated. While the general outline of a pattern is inherited, these small characters do not seem to be, but are apparently rather due to the stretching of the skin as it grows. Illustration from J. H. Taylor.



It would be well to extend our view by measuring a whole population with one of the standard tests. If the intelligence of a thousand children

picked at random from the population to be measured, it will prove (as outlined in Chapter III) that some of them are feeble-minded, some are precocious or highly intelligent; and that there is every possible degree of intelligence between the two extremes. If a great number of children, all 10 years old, were tested for intelligence, it would reveal a few absolute idiots whose intelligence was no more than that of the ordinary infant, a few more who were as bright as the ordinary kindergarten child, and so up to the great bulk of normal 10-year-olds, and farther to a few prize eugenic specimens who had as much intelligence as the average college freshman. In other words, this trait of general intelligence would be found distributed through the population in accordance with that same curve of chance, which was discussed and illustrated when we were talking about the differences between individuals.

Now what has become of the unit character, feeble-mindedness? How can one speak of a unit character, when the "unit" has an infinite number of values? Is a *continuous quantity* a *unit*?

If intelligence is due to the inheritance of a vast, but indeterminate, number of factors of various kinds, each of which is independent, knowledge of heredity would lead one to expect that some children would get more of these factors than others and that, broadly speaking, no two would get the same number. All degrees of intelligence between the idiot and the genius would thus exist; and yet we can not doubt that a few of these factors are more important than the others, and the presence of even one or two of them may markedly affect the level of intelligence.

It may make the matter clearer if we return for a moment to the physical. Height, bodily stature, offers a very good analogy for the case we have just been discussing, because it is obvious that it must depend on a large number of different factors, a man's size being due to the sum total of the sizes of a great number of bones, ligaments, tissues, etc. It is obvious that one can be long in the trunk and short in the legs, or vice versa, and so on through a great number of

possible combinations. Here is a perfectly measurable character (no one has ever claimed that it is a genetic "unit character" *in man* although it behaves as such in some plants) as to the complex basis of which all will agree. And it is known, from common observation as well as from pedigree studies, that it is not inherited as a unit: children are never born in two discontinuous classes, "tall" and "short," as they are with color blindness or normal color vision, for example. Is it not a fair assumption that the difference between the apparent unit character of feeble-mindedness, and the obvious non-unit character of height, is a matter of difference in the number of factors involved, difference in the degree to which they hang together in transmission, variation in the factors, and certainly difference in the method of measurement? Add that the line between normal and feeble-minded individuals is wholly arbitrary, and it seems that there is little reason to talk about feeble-mindedness as a unit character. It may be true that there is some sort of an inhibiting factor inherited as a unit, but it seems more likely that feeble-mindedness may be due to numerous different causes; that its presence in one child is due to one factor or group of factors, and in another child to a different one.[50]

It does not fall wholly into the class of blending inheritance, for it does segregate to a considerable extent, yet some of the factors may show blending. Much more psychological analysis must be done before the question of the inheritance of feeble-mindedness can be considered solved. But at present one can say with confidence of this, as of other mental traits, that like tends to produce like; that low grades of mentality usually come from an ancestry of low mentality, and that bright children are usually produced in a stock that is marked by intelligence.

Most mental traits are even more complex in appearance than feeble-mindedness. None has yet been proved to be due to a single

[50] Dr. Castle, reviewing Dr. Goddard's work (*Journal of Abnormal Psychology*, Aug.-Sept., 1915) concludes that feeble-mindedness is to be explained as a case of multiple allelomorphs. The evidence is inadequate to prove this, and proof would be, in fact, almost impossible, because of the difficulty of determining just what the segregation ratios are.

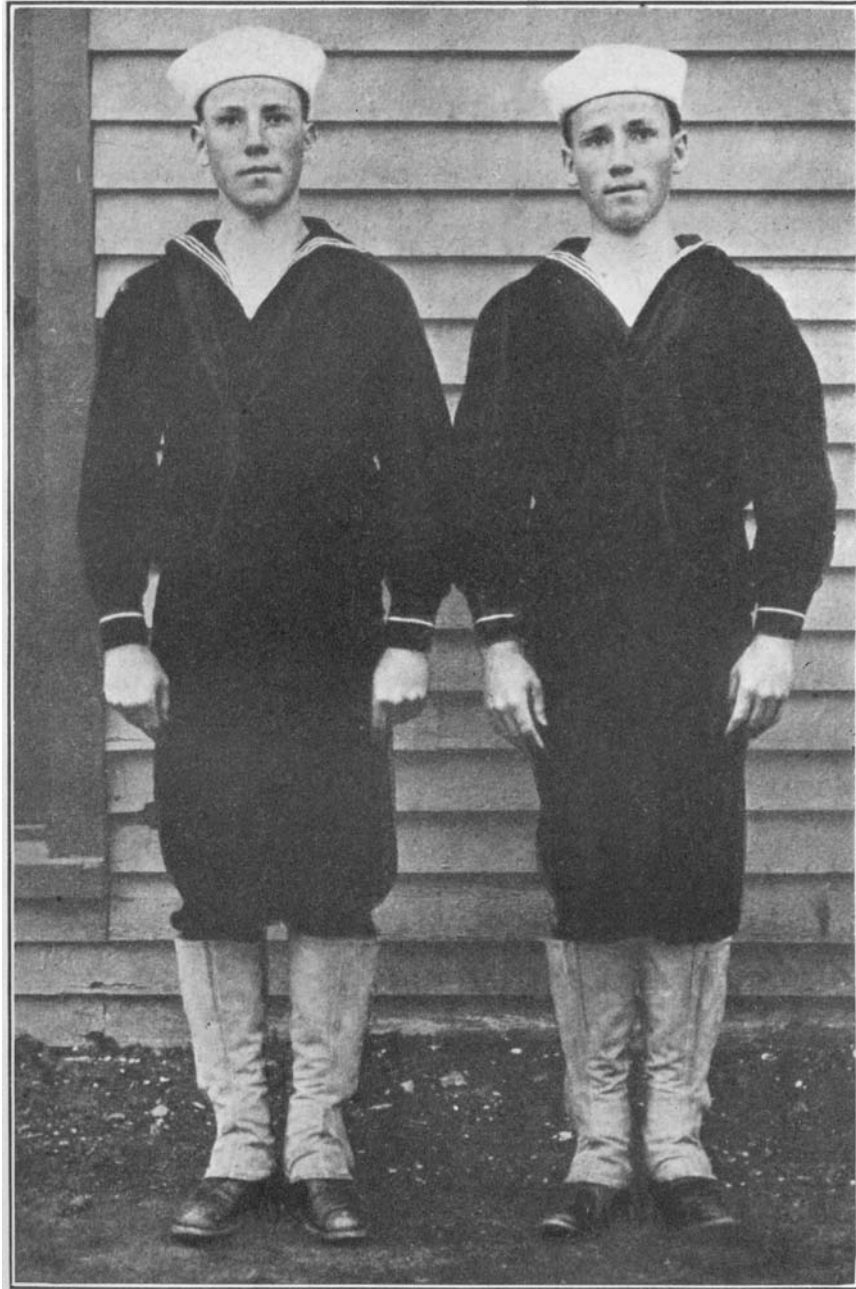


FIG. 24.--The twins whose finger-prints are shown in Fig. 25.

germinal difference, and it is possible that none will ever be so demonstrated.

Intensive genetic research in lower animals and plants has shown that a visible character may be due to

1. Independent multiple factors in the germ-plasm, as in the case of wheat mentioned a few pages back.
2. Multiple allelomorphs, that is, a series of different grades of a single factor.
3. One distinct Mendelian factor (or several such factors), with modifying factors which may cause either (a) intensification, (b) inhibition, or (c) dilution.
4. Variation of a factor.
5. Or several or all of the above explanations may apply to one case.

Moreover, the characters of which the origin has been most completely worked out are mostly color characters, whose physiological development seems to be relatively simple. It is probable that the development of a mental character is much more complicated, and therefore there is more likelihood of additional factors being involved.

To say, then, that any mental trait is a unit character, or that it is due to a single germinal difference, is to go beyond both the evidence and the probabilities.

And if mental traits are, in their germinal foundations, not simple but highly complex, it follows that any advice given as to how human matings should be arranged to produce any precise result in the progeny, should be viewed with distrust. Such advice can be given only in the case of a few pathological characters such as color-blindness, night-blindness, or Huntington's Chorea. It is well that the man or woman interested in one of these abnormalities can get definite information on the subject; and Huntington's Chorea, in particular, is a dysgenic trait which can and should be stamped out. But it can not be pretended that any of man's traits, as to whose inheritance prediction can be made with confidence, is of great importance to national eugenics.

In short, a knowledge of heredity shows that attempts to predict the mode of inheritance of the important human traits (particularly mental traits) are still uncertain in their results. The characters involved are too complex to offer any simple sequences. If two parents have brown eyes, it can not be said that all their children will have brown eyes; still less can it be said that all the children of two musically gifted parents are certain to be endowed with musical talent in any given degree.

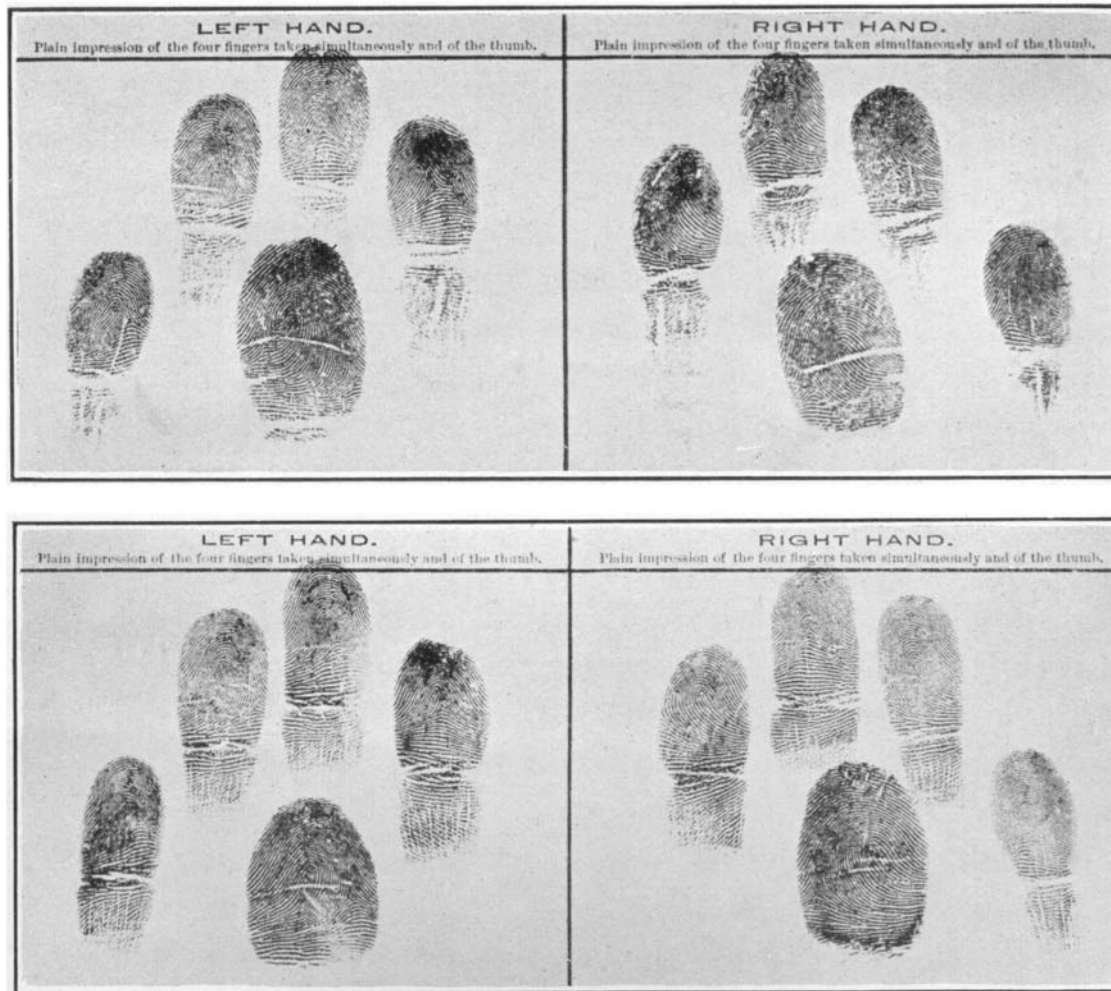
Prediction is possible only when uniform sequences are found. How are such sequences to be found in heredity, if they do not appear when a parent and his offspring are examined? Obviously it is necessary to examine a *large number* of parents and their offspring,--to treat the problem by statistical methods.

But, it may be objected, a uniformity gained by such methods is spurious. It is merely shutting the eyes to the mass of contradictions which are concealed by an apparent statistical uniformity.

This objection would be valid, if the statistical results were used for prediction *in individual cases*. The statistician, however, expressly warns that his conclusions must not be used for such prediction. They are intended to predict only general trends, only average results; and for this purpose they are wholly legitimate. Moreover, evolution itself is a problem of statistics, and therefore the statistical method of studying heredity may offer results of great value to eugenics, even though it can not furnish in individual cases the prediction which would be desirable.

From this standpoint, we return to attack the problem of the relation between parent and offspring. We noted that there is no uniform sequence in a single family, and illustrated this by the case of brown eyes. But if a thousand parents and their offspring be selected and some trait, such as eye-color, or stature, or general intelligence, be measured, a uniformity at once appears in the fact of regression. Its discoverer, Sir Francis Galton, gives this account of it:

"If the word 'peculiarity' be used to signify the difference between the amount of any faculty possessed by a man, and the average of that possessed by the population at large, then the law of regression may



### FINGER-PRINTS OF TWINS

FIG. 25.--Above are the finger-prints, supplied by J. H. Taylor of the Navy Department, of the two young sailors shown in Fig. 24. The reader might examine them once or twice without seeing any differences. Systematic comparison reveals that the thumbs of the left hands and the middle fingers of the right hands particularly are distinguishable. Finger-prints as a means of identification were popularized by Sir Francis Galton, the founder of eugenics, and their superiority to all other methods is now generally admitted. In addition to this practical usefulness, they also furnish material for study of the geneticist and zoölogist. The extent to which heredity is responsible for the patterns is indicated by the resemblance in pattern in spite of the great variability in this tract.

be described as follows: each peculiarity in a man is shared by his kinsmen, but on the average in a less degree. It is reduced to a definite fraction of its amount, quite independently of what its amount might be. The fraction differs in different orders of kinship, becoming smaller as they are more remote. When the kinship is so distant that its effects are not worth taking into account, the peculiarity of the man, however remarkable it may have been, is reduced to zero in his kinsmen. This apparent paradox is fundamentally due to the greater frequency of mediocre deviations than of extreme ones, occurring between limits separated by equal widths."

As to the application of this law, let Galton himself speak: "The Law of Regression tells heavily against the full hereditary transmission of any gift. Only a few out of many children would be likely to differ from mediocrity so widely as their Mid-Parent [i. e., the average of their two parents], allowing for sexual differences, and still fewer would differ as widely as the more exceptional of the two parents. The more bountifully the parent is gifted by nature, the more rare will be his good fortune if he begets a son who is as richly endowed as himself, and still more so if he has a son who is endowed yet more largely. But the law is evenhanded; it levies an equal succession-tax on the transmission of badness as of goodness. If it discourages the extravagant hopes of a gifted parent that his children on the average will inherit all his powers, it not less discourages extravagant fears that they will inherit all his weakness and disease.

"It must be clearly understood that there is nothing in these statements to invalidate the general doctrine that the children of a gifted pair are much more likely to be gifted than the children of a mediocre pair." To this it should be added that progeny of very great ability will arise more frequently in proportion to the quality of their parents.

It must be reiterated that this is a statistical, not a biological, law; and that even Galton probably goes a little too far in applying it to individuals. It will hold good for a whole population, but not necessarily for only one family. Further, we can afford to reemphasize

the fact that it in no way prevents the improvement of a race by selection and assortative mating.

Stature is the character which Dr. Galton used to get an exact measurement of the amount of regression. More recent studies have changed the value he found, without invalidating his method. When large numbers are taken it is now abundantly proved that if parents exceed the average stature of their race by a certain amount their offspring will, in general, exceed the racial average by only one-half as much as their parents did. This is due, as Galton said, to the "drag" of the more remote ancestry, which when considered as a whole must represent very nearly mediocrity, statistically speaking.

The general amount of regression in heredity, then, is one-half. If it be expressed as a decimal, .5, the reader will at once note its identity with the coefficient of correlation which we have so often cited in this book as a measure of heredity. In fact, the coefficient of correlation is nothing more than a measure of the regression, and it is probably simpler to think of it as correlation than it is to speak of a Law of Regression, as Sir Francis did.

This correlation or regression can, of course, be measured for other ancestors as well as for the immediate parents. From studies of eye-color in man and coat-color in horses, Karl Pearson worked out the necessary correlations, which are usually referred to as the law of Ancestral Inheritance. Dr. Galton had pointed out, years before, that the contributions of the several generations of individuals probably formed a geometrical series, and Professor Pearson calculated this series, for the two cases mentioned, as:

Parents	Grandparents	G-Grandparents	G-G-Grandparents	
.6244	.1988	.0630	.0202	... etc.

In other words, the two parents, together, will on the average of a great many cases be found to have contributed a little more than three-fifths of the hereditary peculiarities of any given individual; the four grandparents will be found responsible for a little less than one-fifth, and the eight great-grandparents for about six hundredths, and so on, the contribution of each generation becoming smaller with



ascent, but each one having, in the average of many cases, a certain definite though small influence, until infinity.

It can not be too strongly emphasized that this is a statistical law, not a biological law. It must not be applied to predict the character of the offspring of any one particular mating, for it might be highly misleading. It would be wholly unjustified, for example, to suppose that a certain man got three-tenths of his nature from his father, because the Law of Ancestral Heredity required it: in point of fact, he might get one-tenth or nine-tenths, none or all of a given trait. But, when dealing with a large population, the errors on one side balance the errors on the other, and the law is found, in the cases to which it has been applied, to express the facts.[51]

While, therefore, this Galton-Pearson law gives no advice in regard to individual marriages, it is yet of great value to applied eugenics. In the first place, it crystallizes the vague realization that remote ancestry is of much less importance than immediate ancestry, to an individual, while showing that every generation has a part in making a man what he is. In the second place, it is found, by mathematical reasoning which need not here be repeated, that the type of a population may be quickly changed by the mating of like with like; and that this newly established type may be maintained when not capable of further progress. Regression is not inevitable, for it may be overcome by selection.

To put the matter in a more concrete form, there is reason to think that if for a few generations superior people would marry only people on the average superior in like degree (superior in ancestry as well as individuality), a point would be reached where all the offspring would

[51] In strict accuracy, the law of ancestral inheritance must be described as giving means of determining the probable deviation of any individual from the mean of his own generation, when the deviations of some or all of his ancestry from the types of their respective generations are known. It presupposes (1) no assortative mating, (2) no inbreeding and (3) no selection. Galton's own formula, which supposed that the parents contributed  $1/2$ , the grandparents  $1/4$ , the great-grandparents  $1/8$ , the next generation  $1/16$ , and so on, is of value now only historically, or to illustrate to a layman the fact that he inherits from his whole ancestry, not from his parents alone.

tend to be superior, mediocrities of the former type being eliminated; and this superiority could be maintained as long as care was taken to avoid mating with inferior. In other words, the Galton-Pearson Law gives statistical support for a belief that eugenic marriages will create an improved breed of men. And this, it seems to us, is the most important implication of that law for eugenics, although it is an implication that is generally ignored.

We do not propose to discuss further the laws of heredity; but it is likely that the reader who has made no other study of the subject may by this time find himself somewhat bewildered. "Can we talk only in generalities?" he may well ask; "Does eugenics know no laws of heredity that will guide me in the choice of a wife? I thought that was the purpose of eugenics!"

We reply: (1) The laws of heredity are vastly complicated in man by the complex nature of most of his characters. The definite way in which some abnormalities are inherited is known; but it has not been thought necessary to include an account of such facts in this work. They are set forth in other books, especially Davenport's *Heredity in Relation to Eugenics*. The knowledge of how such a trait as color-blindness is inherited may be of importance to one man out of a thousand in choosing a wife; but we are taking a broader view of eugenics than this. As far as the great mass of human characters go, they are, in our opinion, due to so many separately inheritable factors that it is not safe to dogmatize about exactly how they will behave in heredity. Such knowledge, desirable as it may be, is not necessary for race progress.

(2) But it is possible, with present knowledge, to say that human traits, mental as well as physical, are inherited, in a high degree. Even before the final details as to the inheritance of all traits are worked out--a task that is never likely to be accomplished--there is ample material on which to base action for eugenics. The basal differences in the mental traits of man (and the physical as well, of course) are known to be due to heredity, and little modified by training. It is therefore possible to raise the level of the human race--the task of eugenics--by getting that half of the race which is,

on the whole, superior in the traits that make for human progress and happiness, to contribute a larger proportion to the next generation than does the half which is on the whole inferior in that respect. Eugenics need know nothing more, and the smoke of controversy over the exact way in which some trait or other is inherited must not be allowed for an instant to obscure the known fact that the level can be raised.

CHAPTER VI

**NATURAL SELECTION**

Man has risen from the ape chiefly through the action of natural selection. Any scheme of conscious race betterment, then, should carefully examine nature's method, to learn to what extent it is still acting, and to what extent it may better be supplanted or assisted by methods of man's own invention.

Natural selection operates in two ways: (1) through a selective death-rate and (2) through a selective birth-rate. The first of these forms has often been considered the whole of natural selection, but wrongly. The second steadily gains in importance as an organism rises in the scale of evolution; until in man it is likely soon to dwarf the lethal factor into insignificance. For it is evident that the appalling slaughter of all but a few of the individuals born, which one usually associates with the idea of natural selection, will take place only when the number of individuals born is very large. As the reproductive rate decreases, so does the death-rate, for a larger proportion of those born are able to find food and to escape enemies.

When considering man, one realizes at once that relatively few babies or adults starve to death. The selective death-rate therefore must include only those who are unable to escape their enemies; and while these enemies of the species, particularly certain microorganisms, still take a heavy toll from the race, the progress of science is likely to make it much smaller in the future.

The different aspects of natural selection may be classified as follows:

Natural selection	{	Lethal	{	Sustentative
	{		{	Non-sustentative
	{	Reproductive	{	Sexual
	{		{	Fecundal

The lethal factor is the one which Darwin himself most emphasized. Obviously a race will be steadily improved, if the worst stock in it is cut off before it has a chance to reproduce, and if the best stock survives to perpetuate its kind. "This preservation of favourable individual differences and variations, and the destruction of those which are injurious, I have called natural selection, or the survival of the fittest," Darwin wrote; and he went on to show that the principal checks on increase were overcrowding, the difficulty of obtaining food, destruction by enemies, and the lethal effects of climate. These causes may be conveniently divided as in the above diagram, into sustentative and non-sustentative. The sustentative factor has acquired particular prominence in the human species, since Malthus wrote his essay on population--that essay which both Darwin and Wallace confess was the starting point of their discovery of natural selection.

There is a "constant tendency in all animated life to increase beyond the nourishment prepared for it," Malthus declared. "It is incontrovertibly true that there is no bound to the prolific plants and animals, but what is made by their crowding and interfering with each others' means of subsistence." His deduction is well known: that as man tends to increase in geometrical ratio, and can not hope to increase his food-supply more rapidly than in arithmetical ratio, the human race must eventually face starvation, unless the birth-rate be reduced.

Darwin was much impressed by this argument and ever since his time it has usually been the foundation for any discussion of natural selection. Nevertheless it is partly false for all animals, as one of the authors showed[52] some years ago, since a species which regularly eats up all the food in sight is rare indeed; and it is of very little racial importance in the present-day evolution of man. Scarcity of food may put sufficient pressure on him to cause emigration, but rarely death. The importance of Malthus' argument to eugenics is too slight to warrant further discussion.

[52] Johnson, Roswell H., "The Malthusian Principle and Natural Selection," *American Naturalist*, XLVI (1912), pp. 372-376.

When the non-sustentative forms of lethal selection are considered, it is seen very clearly that man is not exempt from the workings of this law. A non-sustentative form of natural selection takes place through the destruction of the individual by some adverse feature of the environment, such as excessive cold, or bacteria; or by bodily deficiency; and it is independent of mere food-supply. W. F. R. Weldon showed by a long series of measurements, for example, that as the harbor of Plymouth, England, kept getting muddier, the crabs which lived in it kept getting narrower; those with the greatest frontal breadth filtered the water entering their gills least effectively, and died.

But, it was objected, man is above all this. He has gained the control of his own environment. The bloody hand of natural selection may fall on crabs: but surely you would not have us think that Man, the Lord of Creation, shares the same fate?

Biologists could hardly think otherwise. Statisticians were able to supply the needed proof. A selective death-rate in man can not only be demonstrated but it can be actually measured.

"The measure of the selective death-rate." says[53] Karl Pearson, to whom this achievement is due, "is extraordinarily simple. It consists in the fact that the inheritance of the length of life between parent and offspring is found statistically to be about one-third of the average inheritance of physical characters in man. This can only be due to the fact that the death of parent or of offspring in a certain number of cases is due to random and not to constitutional causes." He arrived at the conclusion[54] that 60% of the deaths were selective, in the Quaker families which he was then studying. The exact proportion must vary in accordance with the nature of the material and the environment, but as A. Ploetz found at least 60% of the deaths to be selective in the European royal families and nobility, where the environment is

[53] Karl Pearson, *The Groundwork of Eugenics*, p. 25, London, 1912.

[54] "Let  $p$  be the chance of death from a random, not a constitutional source, then  $1-p$  is the chance of a selective death in a parent and  $1-p$  again of a selective death in the case of an offspring, then

$(1-p)^2$  must equal about  $1/3$ , = .36, more exactly 'therefore'  $1-p = .6$  and  $p = .40$ . In other words, 60% of the deaths are *selective*."

uniformly good, there is no reason to think that Professor Pearson's conclusion is invalid.

Dr. Ploetz[55] investigated the relation between length of life in parents, and infant mortality, in about 1,000 families including 5,500 children; half of these were from the nobility and half from the peasantry. The results were of the same order in each case, indicating that environment is a much less important factor than many have been wont to suppose. After discussing Professor Pearson's work, he continued:

It seems to me that a simpler result can be reached from our material in the following way. Since the greater child-mortality of each of our classes of children (divided according to the ages at death of their parents) indicates a higher mortality throughout the rest of their lives, the offspring of parents who die young will therefore be eliminated in a higher degree, that is, removed from the composition of the race, than will those whose parents died late. Now the elimination can be non-selective, falling on all sorts of constitutions with the same frequency and degree. In that case it will of course have no connection with selection inside the race. Or it may be of a selective nature, falling on its victims because they differ from those who are not selected, in a way that makes them less capable of resisting the pressure of the environment, and avoiding its dangers. Then we speak of a selective process, of the elimination of the weaker and the survival of the stronger. Since in our examination of the various causes of the difference in infant mortality, in the various age-classes of parents, we found no sufficient cause in the effects of the environment, which necessarily contains all the non-selective perils, but found the cause to be in the different constitutions inherited by the children, we can not escape the conclusion that the differences in infant mortality which we observe indicate a strong process of natural selection.

Our tables also permit us to get an approximate idea of the extent of selection by death among children in the first five years of life. The minimum of infant mortality is reached among those children whose parents have attained 85 years of age. Since these represent the strongest constitutions, the mortality of their children would appear to represent an absolute minimum, made up almost wholly of chance, non-selective, unavoidable deaths. As the

[55] *Archiv f. Rassen-u. Gesellschafts Biologie*, VI (1909), pp. 33-43.

number of children from marriages, both parties to which reached 85 years of age, is so small as to render any safe conclusions impossible, our only recourse is to take the children of the 85-year-old fathers and the children of the 85-year-old mothers, add them together, and strike an average. But we must recognize that the minimum so obtained is nevertheless still too large, because among the consorts of the long-lived fathers and mothers, some died early with the result of increasing the infant mortality. The infant mortality with the 85-year-old fathers and mothers is found to be 11.2%-15.4%, average about 13%. The total child-mortality reaches 31-32%, of which the 13% make about 40%. Accordingly at least 60%, and considering the above mentioned sources of error we may say two-thirds, of the child mortality is selective in character. That accords reasonably well with the 55-74% which Pearson found for the extent of selective deaths in his study.

In general, then, one may believe that more than a half of the persons who die nowadays, die because they were not fit by nature (i. e., heredity) to survive under the conditions into which they were born. They are the victims of lethal natural selection, nearly always of the non-sustentative type. As Karl Pearson says, "Every man who has lived through a hard winter, every man who has examined a mortality table, every man who has studied the history of nations has probably seen natural selection at work."

There is still another graphic way of seeing natural selection at work, by an examination of the infant mortality alone. Imagine a thousand babies coming into the world on a given day. It is known that under average American conditions more than one-tenth of them will die during the first year of life. Now if those who die at this time are the inherently weaker, then the death-rate among survivors ought to be correspondingly less during succeeding years, for many will have been cut down at once, who might otherwise have lingered for several years, although doomed to die before maturity. On the other hand, if only a few die during the first year, one might expect a proportionately greater number to die in succeeding years. If it is actually found that a high death-rate in the first year of life is associated with a low



death-rate in succeeding years, then there will be grounds for believing that natural selection is really cutting off the weaker and allowing the stronger to survive.

E. C. Snow[56] analyzed the infant mortality registration of parts of England and Prussia to determine whether any such conclusion was justified. His investigation met with many difficulties, and his results are not as clear-cut as could be desired, but he felt justified in concluding from them that "the general result can not be questioned. Natural selection, in the form of a selective death-rate, is strongly operative in man in the early years of life. We assert with great confidence that a high mortality in infancy (the first two years of life) is followed by a correspondingly low mortality in childhood, and vice-versa.... Our work has led us to the conclusion that infant mortality *does* effect a 'weeding out' of the unfit."

"Unfitness" in this connection must not be interpreted too narrowly. A child may be "unfit" to survive in its environment, merely because its parents are ignorant and careless. Such unfitness makes more probable an inheritance of low intelligence.

Evidence of natural selection was gathered by Karl Pearson from another source and published in 1912. He dealt with material analogous to that of Dr. Snow and showed "that when allowance was made for change of environment in the course of 50 years, a very high association existed between the deaths in the first year of life and the deaths in childhood (1 to 5 years). This association was such that if the infantile death-rate *increased* by 10% the child death rate *decreased* by 5.3% in males, while in females the *fall* in the child death-rate was almost 1% for every 1% *rise* in the infantile death-rate."

To put the matter in the form of a truism, part of the children born in any district in a given year are doomed by heredity to a premature death; and if they die in one year they will not be alive to die in some succeeding year.

Lately a new mathematical method, which is termed the Variate Difference Correlation method, has been invented and gives more accurate results,

[56] Snow, E. C., *On the Intensity of Natural Selection in Man*, London, 1911.

in such an investigation as that of natural selection, than any hitherto used. With this instrument Professor Pearson and Miss Elderton have confirmed the previous work. Applying it to the registered births in England and Wales between 1850 and 1912, and the deaths during the first five years of life in the same period, they have again found[57] that "for both sexes a heavy death-rate in one year of life means a markedly lower death-rate in the same group in the following year of life." This lessened death-rate extends in a lessened degree to the year following that, but is not by the present method easy to trace further.

"It is difficult," as they conclude, "to believe that this important fact can be due to any other source than natural selection, i. e., a heavy mortality leaves behind it a stronger population."

To avoid misunderstandings, it may be well to add to this review the closing words of the Elderton-Pearson memoir. "Nature is not concerned with the moral or the immoral, which are standards of human conduct, and the duty of the naturalist is to point out what goes on in Nature. There can now be scarcely a doubt that even in highly organized human communities the death-rate is selective, and physical fitness is the criterion for survival. To assert the existence of this selection and measure its intensity must be distinguished from an advocacy of high infant mortality as a factor of racial efficiency. This reminder is the more needful as there are not wanting those who assert that demonstrating the existence of natural selection in man is identical with decrying all efforts to reduce the infantile death-rate." A further discussion of this point will be found in a later chapter.

The conclusion that, of the infants who die, a large number do so through inherent weakness--because they are not "fit" to survive--is also suggested by a study of the causes of death. From a third to a half of the deaths during the first year of life, and particularly during the first month, are due to what may be termed uterine causes, such as debility, atrophy, inanition, or premature birth. Although in many

[57] *Biometrika*, Vol. X, pp. 488-506, London, May, 1915.

cases such a death is the result of lack of prenatal care, in still more it must be ascribed to a defect in the parental stock.

In connection with infant mortality, it may be of interest to point out that the intensity of natural selection is probably greater among boys than among girls. There is a steady preponderance of boys over girls at birth (about 105 to 100, in the United States), while among the stillborn the proportion is 158 to 100, if the Massachusetts figures for 1891-1900 may be taken as general in application. Evidently a large number of weak males have been eliminated before birth. This elimination continues for a number of years to be greater among boys than among girls, until in the period of adolescence the death-rates of the two sexes are equal. In adult life the death-rate among men is nearly always higher than that among women, but this is due largely to the fact that men pursue occupations where they are more exposed to death. In such cases, and particularly where deaths are due to accident, the mortality may not only be non-selective, but is sometimes contra-selective, for the strongest and most active men will often be those who expose themselves most to some danger. Such a reversal of the action of natural selection is seen on a large scale in the case of war, where the strongest go to the fray and are killed, while the weaklings stay at home to perpetuate *their* type of the race.

A curious aspect of the kind of natural selection under consideration,--that which operates by death without reference to the food-supply,--is seen in the evolution of a wide pelvis in women. Before the days of modern obstetrics, the woman born with an unusually narrow pelvis was likely to die during parturition, and the inheritance of a narrower type of pelvis was thus stopped. With the introduction and improvement of instrumental and induced deliveries, many of these women are enabled to survive, with the necessary consequence that their daughters will in many cases have a similarly narrow pelvis, and experience similar difficulty in childbirth. The percentage of deliveries in which instrumental aid is necessary is thus increasing from generation to generation, and is likely to continue to increase

for some time. In other words, natural selection, because of man's interference, can no longer maintain the width of woman's pelvis, as it formerly did, and a certain amount of reversion in this respect is probably taking place--a reversion which, if unchecked, would necessarily lead after a long time to a reduction in the average size of skull of that part of the human race which frequently uses forceps at childbirth. The time would be long because the forceps permit the survival of some large-headed infants who otherwise would die.

But it must not be supposed that lethal, non-sustentative selection works only through forms of infant mortality. That aspect was first discussed because it is most obvious, but the relation of natural selection to microbic disease is equally widespread and far more striking.

As to the inheritance of disease as such there is little room for misunderstanding: no biologist now believes a disease is actually handed down from parent to child in the germ-plasm. But what the doctors call a diathesis, a predisposition to some given disease, is most certainly heritable--a fact which Karl Pearson and others have proved by statistics that can not be given here.[58] And any individual who has inherited this diathesis, this lack of resistance to a given disease, is marked as a possible victim of natural selection. The extent to which and the manner in which it operates may be more readily understood by the study of a concrete case. Tuberculosis is, as everyone knows, a disease caused directly by a bacillus; and a disease to which immunity can not be acquired by any process of vaccination or inoculation yet known. It is a disease which is not directly inherited as such. Yet every city-dweller in the United States is almost constantly exposed to infection by this bacillus, and autopsies show that most persons have

[58] Pearson, Karl, *Tuberculosis, Heredity and Environment*, London, 1912. Among the most careful contributions to the problem of tuberculosis are those of Charles Goring (*On the Inheritance of the Diathesis of Phthisis and Insanity*, London, 1910), Ernest G. Pope (*A Second Study of the Statistics of Pulmonary Tuberculosis*, London, Dulau & Co.), and W. P. Elderton and S. J. Perry (*A Third Study of the Statistics of Pulmonary Tuberculosis. The Mortality of the Tuberculous and Sanatorium Treatment*), London, 1909. See also our discussion in Chapter I.

actually been infected at some period of life, but have resisted further encroachment. Perhaps a fraction of them will eventually die of consumption; the rest will die of some other disease, and will probably never even know that they have carried the bacilli of tuberculosis in their lungs.

Of a group of men picked at random from the population, why will some eventually die of tuberculosis and the others resist infection? Is it a matter of environment?--are open-air schools, sanitary tenements, proper hygiene, the kind of measures that will change this condition? Such is the doctrine widely preached at the present day. It is alleged that the white plague may be stamped out, if the open cases of tuberculosis are isolated and the rest of the population is taught how to live properly. The problem is almost universally declared to be a problem of infection.

Infection certainly is the immediate problem, but the biologist sees a greater one a little farther back. It is the problem of natural selection.

To prove this, it is necessary to prove (1) that some people are born with less resistance to tuberculosis than others and (2) that it is these people with weak natural resistance who die of phthisis, while their neighbors with stronger resistance survive. The proof of these propositions has been abundantly given by Karl Pearson, G. Archdall Reid and others. Their main points may be indicated. In the first place it must be shown that the morbidity from tuberculosis is largely due to heredity--a point on which most medical men are still uninformed. Measurement of the direct correlation between phthisis in parent and child shows it to be about .5, i. e., what one expects if it is a matter of heredity. This is the coefficient for most physical and mental characters: it is the coefficient for such pathological traits as deafness and insanity, which are obviously due in most cases to inheritance rather than infection.

But, one objects, this high correlation between parent and child does not prove inheritance,--it obviously proves infection. The family relations are so intimate that it is folly to overlook this factor in the spread of the disease.

Very well, Professor Pearson replied, if the relations between parent and child are so intimate that they lead to infection, they are certainly not less intimate between husband and wife, and there ought to be just as much infection in this relationship as in the former. The correlation was measured in thousands of cases and was found to lie around .25, being lowest in the poorer classes and highest in the well-to-do classes.

At first glance this seems partly to confirm the objection--it looks as if there must be a considerable amount of tubercular infection between husband and wife. But when it is found that the resemblance between husband and wife in the matter of insanity is also .25, the objection becomes less formidable. Certainly it will hardly be argued that one of the partners infects the other with this disability.

As a fact, a correlation of .25 between husband and wife, for tuberculosis, is only partly due to infection. What it does mean is that like tends to mate with like--called assortative mating. This coefficient of resemblance between husband and wife in regard to phthisis is about the same as the correlation of resemblance between husband and wife for eye color, stature, longevity, general health, truthfulness, tone of voice, and many other characters. No one will suppose that life partners "infect" each other in these respects. Certainly no one will claim that a man deliberately selects a wife on the basis of resemblance to himself in these points; but he most certainly does so to some extent unconsciously, as will be described at greater length in Chapter XI. Assortative mating is a well-established fact, and there is every reason to believe that much of the resemblance between husband and wife as regards tuberculosis is due to this fact, and not to infection.[59]

[59] While most physicians lay too great stress on the factor of infection, this mistake is by no means universal. Maurice Fishberg, for example (quoted in the *Medical Review of Reviews*, XXII, 8, August, 1916) states: "For many years the writer was physician to a charitable society, having under his care annually 800 to 1,000 consumptives who lived in poverty and want, in overcrowded tenements, having all opportunities to infect their consorts; in fact most of the consumptives shared their bed with their healthy consorts. Still, very few cases were met with in which tuberculosis was found in both the husband and wife. Widows, whose husbands died from phthisis, were only rarely seen to develop the disease."

Again, it is objected that the infection of children is not a family matter, but due to tuberculous cows' milk: how then does it appear equally among the Japanese, where cows are not tuberculous and cow's milk rarely used as an infant food: or among such people as the Esquimaux and Polynesians, who have never seen a cow?

But, it is argued, at any rate bad housing and unsanitary conditions of life will make infection easier and lower the resistance of the individual. Perhaps such conditions may make infection easier, but that is of little importance considering how easy it is for all city dwellers--for the population as a whole. The question remains, will not bad housing cause a greater liability to fatal phthisis? Will not destitution and its attendant conditions increase the probability that a given individual will succumb to the white plague?

Most physicians think this to be the case, but they have not taken the pains to measure the respective rôles, by the exact methods of modern science. S. Adolphus Knopf of New York, an authority on tuberculosis, recognizes the importance of the heredity factor, but says that after this, the most important predisposing conditions are of the nature of unsanitary schools, unsanitary tenements, unsanitary factories and workshops. This may be very true; these conditions may follow after heredity in importance--but how near do they follow? That is a matter capable of fairly accurate measurement, and should be discussed with figures, not generalities.

Taking the case of destitution, which includes, necessarily, most of the other evils specified, Professor Pearson measured the correlation with liability to phthisis and found it to be .02. The correlation for direct heredity--that is, the resemblance between parent and offspring--it will be remembered, is .50. As compared with this, the environmental factor of .02 is utterly insignificant. It seems evident that whether or not one dies from tuberculosis, under present-day urban conditions, depends mainly on the kind of constitution one has inherited.

There is no escape, then, from the conclusion that in any individual, death from tuberculosis is largely a matter of natural selection. But

by taking a longer view, one can actually see the change to which natural selection is one of the contributors. The following table shows the deaths from consumption in Massachusetts, per 10,000 population:

1851-60	39.9
1861-70	34.9
1871-80	32.7
1881-90	29.2
1891-1900	21.4
1901	17.5
1902	15.9

F. L. Hoffman further points out[60] that in Massachusetts, Rhode Island, and Connecticut, 1872-1911, the decline in the death-rate from tuberculosis has been about 50%. "The evidence is absolutely conclusive that actually as well as relatively, the mortality from tuberculosis in what is the most intensely industrial area of America has progressively diminished during the last 40 years."

It will be noted that the great increase in death from consumption in this area began in the decade following 1840, when the large Irish immigration began. The Irish are commonly believed to be particularly susceptible to phthisis. Crowded together in industrial conditions, they rapidly underwent infection, and their weak racial resistance led to a high death-rate. The weak lines of heredity were rapidly cut off; in other words, the intensity of natural selection was great, for a while. The result was to leave the population of these New England states much more resistant, on the average, than it was before; and as the Irish immigration soon slowed down, and no new stocks with great weakness arrived, tuberculosis naturally tended to "burn itself out." This seems to be a partial explanation of the decline in the death-rate from phthisis in New England during the last half century, although it is not suggested that it represents the complete explanation: improved methods of treatment and sanitation doubtless played their part. But that they

[60] In 9th Trans. of *American Association for the Study and Prevention of Tuberculosis*, p. 117.



are the sole cause of the decline is made highly improbable by the low correlation between phthisis and environmental factors, which was mentioned above, and by all the other biometric study of tuberculosis, which has proved that the results ascribed to hygiene, including sanatorium treatment, are to some degree illusory.

That tuberculosis is particularly fatal to the Negro race is well known. Even to-day, after several centuries of natural selection in the United States, the annual death-rate from consumption among Negroes in the registration area is 431.9 per 100,000 population (census of 1900) as compared with 170.5 for the whites; in the cities alone it is 471.0. That overcrowding and climate can not be the sole factors is indicated by the fact that the Negro race has been decimated, wherever it has met tuberculosis. "In the years 1803 and 1810 the British government imported three or four thousand Negroes from Mozambique into Ceylon to form into regiments, and of these in December, 1820, there were left just 440, including the male descendants. All the rest had perished mainly from tuberculosis, and in a country where the disease is not nearly so prevalent as in England." [61] Archdall Reid has pointed out [62] that the American, Polynesian and Australian aborigines, to whom tuberculosis was unknown before the advent of Europeans, and who had therefore never been selected against it, could not survive its advent: they were killed by much smaller infections than would have injured a European, whose stock has been purged by centuries of natural selection.

These racial histories are the most important evidence available to the student of natural selection in man. The conclusion to be drawn from them seems plain. Natural selection, which has in the past never had an opportunity to act upon the Negro race through tuberculosis, is now engaged in hastening, at a relatively rapid rate, the evolution of this race toward immunity from death by tuberculosis. The evolution of the white race on this line is, as the figures show, going on

[61] *Geographical and Historical Pathology* (New Sydenham Society, 1883), Vol. III, p. 266.

[62] Reid, G. Archdall, *The Present Evolution of Man*, and *The Laws of Heredity*.

simultaneously, but having begun centuries earlier, it is not now so rapid. The weakest white stocks were cut off hundreds of years ago, in Great Britain or Europe; those of the black race are only now going. Despite all the efforts of medicine and sanitation, it is likely that the Negro death-rate from phthisis will continue high for some years, until what is left of the race will possess a degree of resistance, or immunity, not much inferior to that of the whites among whom they live. The blacks in North America now must be already more resistant than their ancestors; the mulattoes descended of normal healthy unions should be more resistant than the pure Negroes, although no statistics are available on the point; but were a new immigration to take place from Africa to-day, and the immigrants to be put into villages with their Americanized brethren, the high death-rate would result.

While the Negroes were thus undergoing the radical surgery of natural selection, what was happening to the aborigines of America? The answer of history is unmistakable; they were meeting the same fate, in an even more violent form. Not tuberculosis alone, but small-pox, measles, alcohol and a dozen other importations of the conquerors, found in the aborigines of the New World a stock which had never been selected against these diseases.

It is the custom of sentimentalists sometimes to talk as if the North American Indian had been killed off by the white man. So he was,--but not directly: he was killed off by natural selection, acting through the white man's diseases and narcotics. In 1841 Catlin wrote, "Thirty millions of white men are now scuffling for the goods and luxuries of life over the bones of twelve millions of red men, six millions of whom have fallen victims to small-pox." Small-pox is an old story to the white race, and the death of the least resistant strains in each generation has left a population that is fairly resistant. It was new to the natives of America, and history shows the result. Alcohol, too, counted its victims by the thousand, for the same reason. The process of natural selection among the North American Indians has not yet stopped; if there are a century from now any Indians left, they will of

necessity belong to stocks which are relatively resistant to alcohol and tuberculosis and the other widespread and fatal diseases which were unknown upon this continent before Columbus.

The decrease of natives following the Spanish conquest of tropical America has long been one of the most striking events of history. Popular historians sometimes speak as if most of the native population had been killed off by the cruelty of the conquistadores. Surely such talk could not proceed from those who are familiar with the action of natural selection. It is obvious that when the Spaniard brought the natives together, making them work in mines and assemble in churches, he brought them under conditions especially favorable for infection by the new diseases which he had brought. The aborigines of the New World, up to the time the Spaniards came, had undergone no evolution whatever against these diseases; consequently the evolution began at so rapid a rate that in a few centuries only those who lived in out-of-the-way places remain unscathed.

The same story is repeated, in a survey of the history of the Pacific Islands. Even such a disease as whooping-cough carried off adults by the hundred. Robert Louis Stevenson has left a graphic picture[63] of natural selection at work:

"The tribe of Hapaa," he writes, "is said to have numbered some four hundred when the small-pox came and reduced them by one-fourth. Six months later a woman developed tubercular consumption; the disease spread like fire about the valley, and in less than a year two survivors, a man and a woman, fled from the newly-created solitude.... Early in the year of my visit, for example, or late the year before, the first case of phthisis appeared in a household of 17 persons, and by the end of August, when the tale was told me, one soul survived, a boy who had been absent at his schooling."

In Tasmania is another good illustration of the evolution of a race proceeding so rapidly as to be fatal to the race. When the first

[63] *In the South Seas*, p. 27; quoted by G. Archdall Reid, *The Principles of Heredity* (New York, 1905), p. 183. Dr. Reid has discussed the rôle of disease and alcohol on the modern evolution of man more fully than any other writer.

English settled on the island, in 1803, the native population consisted of several thousand. Tuberculosis and many other new diseases, and, most of all, alcohol, began to operate on the aborigines, who were attracted to the settlements of the whites. In a quarter of a century there were only a few hundred left. Many, of course, had met violent deaths, but an enlightened perusal of any history of the period,[64] will leave no doubt that natural selection by disease was responsible for most of the mortality. By 1847 the number of native Tasmanians was reduced to 44, who were already unmistakably doomed by alcohol and bacteria. When the last full-blood Tasmanian died in 1876, a new chapter was written in the story of the modern evolution of the human race.

No such stories are told about the white settlements on this continent, even before the days of quarantine and scientific medicine. There is no other adequate explanation of the difference, than that the two races have evolved to a different degree in their resistance to these diseases. It is easily seen, then, that man's evolution is going on, at varying rates of speed, in probably all parts of the human race at the present time.

We do not mean, of course, to suggest that all the natives who have died in the New World since the landing of Columbus, have died because the evolution of their race had not proceeded so far in certain directions as had that of their conquerors. But the proportion of them who were eliminated for that reason is certainly very large. In the more remote parts of South America the process is still going on. Recent press dispatches have carried the account of the University of Pennsylvania's Amazon Expedition, under the direction of William C. Farrabee. In a letter dated March 16, 1916, the leader told of the discovery of the remains of the tribe of Pikipitanges, a once populous tribe of which a chief, six women and two boys alone are left. The tribe had been almost wiped out, Dr. Farabee reported, by an epidemic of *influenza*!

If the aborigines of the New World succumb to the diseases of the European, it is not less true that the European succumbs to diseases

[64] See, for example, John West's *History of Tasmania*, Vol. II, Launceston, Tasmania, 1852.

against which his race has not been selected. The deadliness of yellow fever to Americans in the tropics, and the relative immunity of Negroes, is familiar; so too is the frequently fatal result of the African tropical fevers on the white man, while the natives suffer from them much less, having been made more resistant by centuries of natural selection.

This long discussion may now be summarized. We dealt with lethal selection, that form of natural selection which operates by prematurely killing off the less fit and leaving the more fit to survive and reproduce their kind. It is of course understood that the word "fit" in this connection does not necessarily mean morally or mentally superior, but merely fit for the particular environment. In a community of rascals, the greatest rascal might be the fittest to survive. In the slums of a modern city the Jewish type, stringently selected through centuries of ghetto life, is particularly fit to survive, although it may not be the physical ideal of an anthropologist.

Two forms of lethal selection were distinguished, one depending on starvation and the other on causes not connected with the food supply. Direct starvation is not a factor of importance in the survival of most races during most of the time at the present day so far as the civilized portion of the world is concerned. But disease and the other lethal factors not connected with the food-supply, through which natural selection acts, are still of great importance. From a half to two-thirds of all deaths are of a selective character, even under favorable conditions.

It is also to be noted, however, that with the progress of medicine, and the diminution of unfit material, this kind of natural selection will tend to become less and less widespread. For a long time, natural selection in man has probably done little to cause marked change in his physical or mental characteristics. Man's interference has prevented. In recent centuries natural selection has probably done no more on the whole than keep the race where it was: it is to be feared that it has not even done that. It is doubtful if there is any race to-day which attains the physical and mental average of the Athenians of 2,500 years ago.

Lethal natural selection, then, has been and still is a factor of great importance in the evolution of the race, but at present it is doing little or nothing that promises to further the ideal of eugenics--race betterment.

But lethal natural selection is only half the story. It is obvious that if the constitution of a race can be altered by excess of deaths in a certain class, it can equally be altered by excess of births in a certain class. This is reproductive selection, which may appear in either one of two forms. If the individual leaves few or no progeny because of his failure to mate at the proper time, it is called sexual selection; if, however, he mates, yet leaves few or no progeny (as compared with other individuals), it is called fecundal selection.

Even in man, the importance of the rôle of reproductive selection is insufficiently understood; in the lower animals scientists have tended still more to undervalue it. As a fact, no species ordinarily multiplies in such numbers as to exhaust all the food available, despite the teaching of Malthus and Darwin to the contrary. The rate of reproduction is the crux of natural selection; each species normally has such a reproduction rate as will suffice to withstand the premature deaths and sterility of some individuals, and yet not so large as to press unduly upon the food supply. The problem of natural selection is a problem of the adjustment between reproductive rate and death-rate, and the struggle for subsistence is only one of several factors.

While the reproductive rate must be looked upon as a characteristic which has its adaptations like other characteristics, it has one peculiarity--its increase is always opposed by lethal selection. The chances of life are reduced by reproducing, inasmuch as more danger is entailed by the extra activities of courtship, and later, in bearing and caring for the young, since these duties reduce the normal wariness of individual life. The reproductive rate, therefore, always remains at the lowest point which will suffice for the reproductive needs of the species. For this reason alone the non-sustentative form of selection might be expected to be the predominant kind.

J. T. Gulick and Karl Pearson have pointed out that there is a normal conflict between natural selection and fecundal selection. Fecundal selection is said by them to be constantly tending to increase the reproductive rate, because fecundity is partly a matter of heredity, and the fecund parents leave more offspring with the same characteristic. Lethal selection, on the contrary, constantly asserts its power to reduce the reproductive rate, because the reproductive demands on the parents reduce their chances of life by interference with their natural ability of self-protection. This is quite true, but the analysis is incomplete, for an increased number of progeny not only decreases the life chances of the parents, but also of the young, by reducing the amount of care they receive.

In short, lethal selection and reproductive selection accomplish the same end--a change in the constitution of the species--by different means; but they are so closely linked together and balanced that any change in the operation of one is likely to cause a change in the operation of the other. This will be clearer when the effect of reproductive selection is studied in man.

Recalling the truism that most human characters have a hereditary basis, it is evident that the constitution of society will remain stable from generation to generation, only if each section of society is reproducing at the same rate as every other (and assuming, for the moment, that the death-rate remains constant). Then if the birth-rate of one part of the population is altered, if it is decreased, for example, the next generation will contain proportionately fewer representatives of this class, the succeeding generation fewer still, and so on indefinitely--unless a selective death-rate is operating at the same time. It is well known not only that the death-rate varies widely in different parts of the population, as was pointed out in the earlier part of this chapter, but that the birth-rate is rarely the same in any two sections of the population. Evidently, therefore, the make-up of society must necessarily be changing from generation to generation. It will be the object of the rest of this chapter to investigate the ways in which it is changing, while in the latter half of the book we shall point out some of the ways in which it might be changed to better advantage than it is at present.

Sexual selection, or differential success in marrying, will be discussed at some length in Chapter XI; here it may be pointed out that the number who fail to marry is very much greater than one often realizes. It has already been noted that a large part of the population dies before it reaches the age of marriage. Of 1,000 babies born in the United States, only 750 will reach the average age of marriage; in some countries half of the thousand will have fallen by that time. These dead certainly will leave no descendants; but even of the survivors, part will fail to marry. The returns of the thirteenth U. S. census showed that of the males 45-64 years of age, 10% were single, while 11% of the females, 35-44 years old, were single. Few marriages will take place after those ages. Add the number who died unmarried previous to those ages, but after the age of 20, and it is safe to say that at least one-third of the persons born in the United States die (early or late) without having married.

The consideration of those who died before the age of marriage properly comes under the head of lethal selection, but if attention is confined to those who, though reaching the age of marriage, fail to marry, sexual selection still has importance. For instance, it is generally known (and some statistical proof will be given in Chapter XI) that beauty is directly associated with the chance of marriage. The pretty girls in general marry earlier as well in larger percentage; many of the ugly ones will never find mates. Herbert Spencer argued ingeniously that beauty is associated with general mental and moral superiority, and the more exact studies of recent years have tended to confirm his generalization. A recent, but not conclusive, investigation[65] showed beauty to be correlated with intelligence to the extent of .34. If this is confirmed, it offers a good illustration of the action of sexual selection in furthering the progressive evolution of the race. Miss Gilmore, studying a group of normal school graduates, found a direct correlation between intelligence (as judged by class marks) and early marriage after graduation. Anyone who would take the trouble could

[65] See Hollingworth, H. L., *Vocational Psychology*, p. 170, New York, 1916.



easily investigate numerous cases of this sort, which would show the effect of sexual selection in perpetuating desirable qualities.

But sexual selection no longer has the importance that it once had, for nowadays the mere fact of marriage is not a measure of fecundity, to the extent that it once was. In the old days of unlimited fecundity, the early marriage of a beautiful, or intelligent, woman meant a probable perpetuation of her endowments; but at present, when artificial restraint of fertility is so widespread, the result does not follow as a matter of course: and it is evident that the race is little or not at all helped by the early marriage of an attractive woman, if she has too few or no children.

Fecundal selection, then, is becoming the important phase of reproductive selection, in the evolution of civilized races. The differential birth-rate is, as we have often insisted, the all-important factor of eugenics, and it merits careful consideration from all sides.

Such consideration is made difficult by the inadequate vital statistics of the United States (which ranks with Turkey and China in this respect); but there is no doubt that the birth-rate as a whole is low, as compared with that of other countries; although as a whole it is not dangerously low and there is, of course, no necessary evil in a low birth-rate, of itself, if the quality be satisfactory. The U. S. Census tabulation for 1915 gives the following comparison of the number of babies born alive each year, per 1,000 population, in various countries:

Russia in Europe (1909)	44.0
Japan (1911)	34.1
Italy (1913)	31.7
Austria (1912)	31.3
Spain (1913)	30.4
Austria (1913)	28.3
German Empire (1912)	28.3
Holland (1913)	28.1
Denmark (1913)	25.6
Norway (1913)	25.3
United States (registration area only, 1915)	24.9

England and Wales (1913)	24.1
Sweden (1912)	23.8
Switzerland (1913)	23.1
Belgium (1912)	22.6
France (1912)	19.0

The United States birth-rate may, on its face, appear high enough; but its face does not show that this height is due largely to the fecundity of immigrant women. Statistics to prove this are given in Chapter XIII, but may be supplemented here by some figures from Pittsburgh.

Ward 7, in that city, contains the homes of many well-to-do, and contains more representatives of the old American stock than any other ward in the city, having 56.4% of residents who are native born of native parents while the majority of the residents in nearly all the other wards in the city are either themselves foreign-born, or the offspring of foreign-born parents.

Ward 7 has the lowest birth-rate and the lowest rate of net increase of any ward in the city.

With this may be contrasted the sixth ward, which runs along the south bank of the Allegheny river. It is one of the great factory districts of the city, but also contains a large number of homes. Nearly 3,000 of its 14,817 males of voting age are illiterate. Its death-rate is the highest in the city. Almost nine-tenths of its residents are either foreigners or the children of foreigners. Its birth-rate is three times that of the seventh ward.

Taking into account all the wards of the city, it is found that the birth-rate *rises* as one considers the wards which are marked by a large foreign population, illiteracy, poverty and a high death-rate. On the other hand, the birth-rate falls as one passes to the wards that have most native-born residents, most education, most prosperity--and, to some extent, education and prosperity denote efficiency and eugenic value. For 27 wards there is a high negative correlation (-.673), between birth-rate and percentage of native-born of native parents in the population. The correlation between illiteracy and net increase[66] is +.731.

[66] Net increase here refers only to the first year of life, and was computed by deducting the deaths under one year, in a ward, from the number of births in the same ward for the same year. For details of this study of the Pittsburgh vital statistics, see the *Journal of Heredity*, Vol. VIII, pp. 178-183 (April, 1917).

The net increase of Pittsburgh's population, therefore, is greatest where the percentage of foreign-born and of illiterates is greatest.

The significance of such figures in natural selection must be evident. Pittsburgh, like probably all large cities in civilized countries, breeds from the bottom. The lower a class is in the scale of intelligence, the greater is its reproductive contribution. Recalling that intelligence is inherited, that like begets like in this respect, one can hardly feel encouraged over the quality of the population of Pittsburgh, a few generations hence.

Of course these illiterate foreign laborers are, from a eugenic point of view, not wholly bad. The picture should not be painted any blacker than the original. Some of these ignorant stocks, in another generation and with decent surroundings, will furnish excellent citizens.

But taken as a whole, it can hardly be supposed that the fecund stocks of Pittsburgh, with their illiteracy, squalor and tuberculosis, their high death-rates, their economic straits, are as good eugenic material as the families that are dying out in the more substantial residence section which their fathers created in the eastern part of the city.

And it can hardly be supposed that the city, and the nation, of the future, would not benefit by a change in the distribution of births, whereby more would come from the seventh ward and its like, and fewer from the sixth and its like.

Evidently, there is no difficulty about seeing this form of natural selection at work, and at work in such a way as greatly to change the character of one section of the species. For comparison, some figures are presented from European sources. In the French war budget of 1911 it appears that from 1,000 women between the ages of 15 and 50, in different districts of Paris, the number of yearly births was as follows:

Very poor	108
Poor	99
Well-to-do	72
Very prosperous	65
Rich	53
Very rich	35

Disregarding the last class altogether, it is yet evident that while the mother in a wealthy home bears two children, the mother in the slums bears four. It is evident then that in Paris at the present time reproductive selection is changing the mental and moral composition of the population at a rapid rate, which can not be very materially reduced even if it is found that the death-rate in the poorer districts is considerably greater than it is on the more fashionable boulevards.

J. Bertillon has brought together[67] in a similar way data from a number of cities, showing the following birth-rates:

	<i>Berlin</i>	<i>Vienna</i>	<i>London</i>
Very poor quarters	157	200	147
Poor quarters	129	164	140
Comfortable quarters	114	155	107
Very comfortable	96	153	107
Rich	63	107	87
Very rich	47	81	63
	---	---	---
Average	102	153	109

Obviously, in all these cases reproductive selection will soon bring about such a change in the character of the population, that a much larger part of it than at present will have the hereditary characteristics of the poorer classes and a much smaller part of it than at present the hereditary characteristics of the well-to-do classes.

David Heron and others have recently studied[68] the relation which the birth-rate in different boroughs of London bears to their social and economic conditions. Using the correlation method, they found "that in London the birth-rate per 1,000 married women, aged 15 to 54, is

[67] Quoted from Newsholme and Stevenson, *The Decline of Human Fertility*, London, 1906.

[68] Heron, David, *On the Relation of Fertility in Man to Social Status*, London, 1906. The account is quoted from Schuster, Edgar, *Eugenics*, pp. 220-221, London, 1913.

highest where the conditions show the greatest poverty--namely, in quarters where pawnbrokers abound, where unskilled labor is the principal source of income, where consumption is most common and most deadly, where pauperism is most rife, and, finally, where the greatest proportion of the children born die in infancy. The correlation coefficients show that the association of these evil conditions with the relative number of children born is a very close one; and if the question is put in another way, and the calculations are based on measures of prosperity instead of on measures of poverty, a high degree of correlation is found between prosperity and a low birth-rate.

"It must not be supposed that a high rate of infant mortality, which almost invariably accompanies a high birth-rate, either in London or elsewhere, goes far toward counteracting the effects of the differential birth-rate. Where infant mortality is highest the average number of children above the age of two for each married woman is highest also, and although the chances of death at all ages are greater among the inhabitants of the poorer quarters, their rate of natural increase remains considerably higher than that of the inhabitants of the richer.

"From the detailed study of the figures made by Newsholme and Stevenson, conclusions essentially the same as those of Heron can be drawn.... Their first step was to divide the London boroughs into six groups according to the average number of domestic servants for 100 families in each. This is probably as good a measure of prosperity as any other. They then determined the total birth-rate of the population in each group, and arrived at the following figures:

*Group*

I.	10 domestic servants for 100 families	34.97
II.	10-20	38.32
III.	20-30	25.99
IV.	30-40	25.83
V.	40-60	25.11
VI.	Over 60	18.24

"In order to find out how far the differences shown by these figures are due to differences in the percentage of women who marry in each group

and the age at which they marry, they corrected the figures in such a way as to make them represent what the birth-rates would be in each group, if the proportion of wives of each age to the whole population comprising the group was the same as it is in the whole of England and Wales. The corrected birth-rates thus obtained were as follows:

*Group*

I	31.56
II	25.82
III	25.63
IV	25.50
V	25.56
VI	20.45

"It will readily be seen that the effect of the correction has been to reduce the difference between the two extreme groups by about one-third, showing that to this extent it is due to the way in which they differ as to the average age and number of the women who marry. Further, Groups II, III, IV and V have all been brought to about the same level, with a corrected birth-rate about halfway between the highest and the lowest. This shows that there is no gradual decrease in fertility associated with a gradually increasing grade of prosperity, but that three sharply divided classes may be distinguished: a very poor class with a high degree of fertility, to which about a quarter of the population of London belong, a rich class with a low degree of fertility, and a class intermediate in both respects."

"Eugenics is less directly concerned with this side of the question than with the relative rate of increase of the different classes. This may be found for the six groups in the usual way by deducting the death-rate from the birth-rate. The following figures for the rate of natural increase are then obtained:

*Group*

I	16.56
II	13.89
III	11.43
IV	13.81
V	10.29
VI	5.79

"The figures show in a manner which hardly admits of any doubt that in London at any rate the inhabitants of the poorest quarters--over a million in number--are reproducing themselves at a much greater rate than the more well-to-do."

A research on similar lines by S. R. Steinmetz[69] in Holland shows that the average number of children in the lowest class families is 5.44. People in industry or small trade, skilled mechanics and professors of theology have five children to the family; in other classes the number is as follows:

Artists	4.30
Well-to-do Commercial Classes	4.27
High Officials	4.00
University Professors (excluding theological)	3.50
23 Scholars and Artists of the first rank	2.60

It is not hard to see that the next generation in Holland is likely to have proportionately fewer gifted individuals than has the present one.

Fortunately, it is very probable that the differential birth-rate is not of such ominous import in rural districts as it is in cities, although some of the tribes of degenerates which live in the country show birth-rates of four to six children per wife.[70] But in the more highly civilized nations now, something like a half of the population lives in urban districts, and the startling extent to which these urban populations breed from the bottom involves a disastrous change in the balance of population within a few generations, unless it is in some way checked.

Just how great the change may be, statistically, has been emphasized by Karl Pearson, who points out that "50% of the married population provide 75% of the next generation," owing to the number of deaths before maturity, the number of celibates and the number of childless

[69] *Ztschft. f. Sozialwissenschaft*, VII (1904), pp. 1 ff.

[70] Two of the best known of these tribes are the "Jukes" and "Nams." "An analysis of the figures of the Jukes in regard to the birth-rate shows that of a total of 403 married Juke women, 330 reproduced one or more children and 73 were barren. The average fecundity, counting those who are barren, is 3.526 children per female. The 330 women having children have an average fecundity of 4.306 as compared with that of 4.025, based on 120 reproducing women in the Nam family."--Estabrook, A. H., *The Jukes in 1915*, p. 51, Washington, Carnegie Institution, 1916.

marriages. "The same rule may be expressed in another way: 50% of the next generation is produced by 25% of the married population." At this rate in a few generations the less efficient and socially valuable, with their large families, will overwhelm the more efficient and socially valuable, and their small families.

Fecundal selection is at work to-day on a large scale, changing the character of the population, and from a eugenic point of view changing it for the worse. Fortunately, it is not impossible to arrest this change.

But, it may be objected, is not this change merely "the survival of the fittest?" In a sense, yes; and it is necessary that the more intelligent classes should make themselves "fitter" to survive, by a change of attitude toward reproduction. But the dying-out of the intellectually superior part of the population is a pathological condition, not a part of normal evolution; for barring artificial interference with the birth-rate, fertility has been found to go hand in hand with general superiority. This demonstration is due to F. A. Woods' study[71] of 608 members of the royal families of Europe, among whom, for reasons of state, large families are desired, and among whom there has probably been little restraint on the birth-rate. Averaging the ratings of his individuals from grade 1, the mentally and physically very inferior, to grade 10, the mentally and physically very superior, he found that the number of children produced and brought to maturity increased in a fairly direct ratio. His figures are as follows:

BOTH SEXES (AVERAGED)									
Grades for virtues	1	2	3	4	5	6	7	8	9
10									
Average number of adult children.	1.66	2.86	2.99	2.41	3.44	3.49	3.05	3.03	3.93
3.83									

Investigations of Karl Pearson and Alexander Graham Bell[72] show that fecundity and longevity are associated. It follows that the mentally

[71] Woods, Frederick Adams, *Heredity in Royalty*, New York, 1906.

[72] Beeton, Miss M., Yule, G.U., and Pearson, Karl, *On the Correlation between Duration of Life and the Number of Offspring*, Proc. R. S. London, 67 (1900), pp. 159-171. The material consisted of English and American Quaker families. Dr. Bell's work is based on old American families, and has not yet been published.



and morally superior, who are the most fecund, are also the longest-lived; and as this longevity is largely due to inheritance it follows that, under natural conditions, the standard of the stratum of society under consideration would gradually rise, in respect to longevity, in each generation.

Such is probably one of the methods by which the human race has gradually increased its level of desirable characters in each generation. The desirable characters were associated with each other, and also with fecundity. The desirable characters are still associated with each other, but their association with fecundity is now negative. It is in this change that eugenics finds justification for its existence as a propaganda. Its object is to restore the positive correlation between desirable characters and fecundity, on which the progressive evolution of the race depends.

The bearing of natural selection on the present-day evolution of the human race, particularly in the United States of America, must be reviewed in a few closing paragraphs.

Selection by death may result either from inadequate food supply, or from some other lethal factor. The former type, although something of a bugaboo ever since the time of Malthus, has in reality relatively little effect on the human race at present. Non-sustentative lethal selection in man is operating chiefly through zymotic diseases and the bad hygiene of the mentally inferior.

Reproductive selection is increasingly effective and its action is such as to cause grave alarm both through the failure of some to marry properly (sexual selection) and the failure of some to bear enough children, while others bear too many (fecundal selection). It is obvious that the racial result of this process will depend on what kind of people bear and rear the most children; and it has been shown that in general the larger families are in the section of the population that makes fewer contributions to human prosperity and happiness, while those endowed with great gifts, who ought to be transmitting them to their children, are in many cases not even reproducing their own number.

Natural selection raised man from apehood to his present estate. It is still operating on him on a large scale, in several ways, but in none of these ways is it now doing much actually to improve the race, and in some ways, owing to man's own interference, it is rapidly hastening race degeneracy.