

THE TRANSMISSION OF CULTURE.

A GREAT prophet of science has arisen, in the person of Professor August Weismann, of Freiburg, who has essayed * to prove that what biologists call an "acquired character" is not hereditary. An acquired character is one that is not congenital, but has arisen, no matter how, since the birth of the organism possessing it. Professor Weismann naturally confines himself chiefly to animals and to modifications that take place in their physical structure, and he maintains that wherever such modifications descend to the offspring of such animals they cannot have been acquired by the animals during their lives, but must have previously existed in a latent state in their reproductive germs, and have been handed down from ancestors more or less remote. Mr. Francis Galton had anticipated Weismann in the expression of similar views, but he made them less absolute, and did not insist upon them with so great emphasis. He applied them, too, chiefly to man, and dealt with mental as well as with physical qualities. With the mental qualities of the human race, we are just now exclusively concerned, and we must leave the biologists to settle the question as regards animals and plants.

Weismann could not, of course, wholly ignore mental qualities, and the following passage from his book will serve to show that he does not exempt them from his law. At the same time, it may be taken as a sample of his reasoning and as a sort of text for what is to follow. He says:

"The children of accomplished pianists do not inherit the art of playing the piano; they have to learn it in the same laborious manner as their parents acquired it; they do not inherit anything except that which their parents also possessed when children, viz., manual dexterity and a good ear. . . . The pianist may by practice develop the muscles of his fingers so as to insure the highest dexterity and power; but such an effort would be entirely transient, for it depends upon a modification of local nutrition

* "Essays upon Heredity and Kindred Biological Problems." Authorized translation (Oxford, 1889).

which would be unable to cause any change in the molecular structure of the germ cells, and could not therefore produce any effect upon the offspring."

It may be observed that this passage contains two very distinct statements, which are confounded by Weismann, and have been generally confounded by writers on heredity. It is perfectly true that "the children of accomplished pianists do not inherit the art of playing the piano." But "the art of playing the piano" is really a form of knowledge, and no one has ever maintained that knowledge can be transmitted. It is necessary to distinguish sharply between knowledge and the capacity for acquiring knowledge. It is this latter only that has been generally believed to be hereditary.

Knowledge is of two kinds, subjective and objective—knowing how and knowing what. The former is the knowledge of handicraft, or art; the latter is the knowledge of facts and their relations, or science. Neither can be acquired except through the senses, and both have to be learned by repetition and memory. It is as absurd to say that a knowledge of piano execution can be inherited as it would be to say that a knowledge of the multiplication-table can be inherited. Both require a prolonged mnemonic drill of the appropriate faculties. To learn to play the piano it is necessary to learn what a piano is, how its keys are arranged, and how its tones are adjusted. It is also usually necessary to acquire the rudiments of European music, to which the piano is adapted, to learn to read written music, and to understand the relations of the musical characters on a sheet of music to the corresponding keys of the instrument. This does not differ from learning to read print, and certainly no one claims that the ability to read can be inherited. I have dwelt somewhat upon this point, because, simple as it may seem, no one has touched upon it in the prolonged discussion of Weismann's theories, and statements such as this have been allowed to weigh against the transmission of acquired characters. Being so obviously true, they have been supposed to have a peculiar force, when in fact they have no force at all, because they are wholly irrelevant.

The remainder of the passage quoted is to the point, and in

view of the state of popular opinion on such subjects, would doubtless be generally rejected as contrary to common observation. But we live in an age when popular beliefs are being constantly put to the test of exact science. Mere prevalence of opinion is no longer a legitimate ground for accepting any proposition. The most universal and long-standing dogmas have proved untrue, while the unpopular heresies opposed to them have often been found to correspond much more nearly to the reality. Is the doctrine of the transmissibility of mental aptitudes acquired through education—using that word in its widest sense—to be relegated to the limbo of exploded beliefs? And is the opposite proposition the true one—that acquired talents cannot be passed on to a future generation?

Such is the problem before us, and its immense importance must be obvious at a glance. Its settlement, supposing that it can be settled, must profoundly influence the action of every class of men who are sincerely working for the good of the race, and the side of this question which each individual espouses cannot but determine his course in everything that he undertakes. The educationalist must be governed by it in all his plans for human culture. The social reformer will be guided by it in all schemes for the improvement of society. Even the statesman and the legislator cannot fail to be affected by it, and will shape the policy of the state in a very different way for a race that is to develop through its own exertions, from the way in which they would shape it for a race that is completely at the mercy of the little-known processes of "natural inheritance."

Nor is the question now, viewed from the standpoint of scientific authority, any longer a one-sided one. In England, aside from Mr. Galton, there are to be counted among the followers of Weismann such eminent scientific specialists as Mr. W. T. Thistleton Dyer, Director of Kew, Prof. E. Ray Lankester, and, so far at least as animals are concerned, Dr. Alfred Russel Wallace. Led by such lights as these, perhaps one half of the biologists of England have subscribed, with or without qualification, to the Weismannian doctrine.

So long as the question is confined to the lower forms of life, it must be confessed that the defenders of the transmissibility of

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acquired characters are placed at a disadvantage, on account of the difficulty of proving that the facts to which they point are not capable of a different interpretation, and that they may not be equally well explained by the all-embracing law of natural selection. But when the human species is to be treated, the tables are, in a manner, turned. Dr. Wallace, co-discoverer with Darwin of the law of natural selection, has denied from the first that that law applies without qualification to man. His defense, therefore, of Weismann's views constitutes a singular anomaly. But the fact that, in attempting to account for the development of the human faculties, he abandons the scientific method and, in the language of Prof. E. Ray Lankester, "has recourse to a metaphysical assumption," does not invalidate his early claim. That claim was that such development cannot be due to the action of natural selection, since this can operate only where the quality to be developed possesses such a direct advantage in the struggle for existence as to increase the chances of reproduction and to insure the survival of those individuals endowed with it.

So far as the development of brain mass and consequent brain power is concerned, it must be conceded that no "character" could possibly be more directly the subject of natural selection, since the primal quality of brain is cunning, and this is more important in fitting a creature to survive than any other attribute. It is, therefore, only in the cases of certain derivative faculties that have little or nothing to do with the fitness to survive, many of them rendering man unfit and almost helpless in the struggle for existence, that we find the really strong claims of those who advocate the doctrine of the inheritance of acquired mental qualities, or post-natal increments to faculties already existing. What are these qualities? Dr. Wallace believes them to consist chiefly of the mathematical, the esthetic (sculpture, painting, etc.), and the musical; but he also very properly mentions the power of abstract reasoning, the metaphysical faculty, or talent for abstruse speculation, that which gives rise to wit and humor, and the moral or ethical attributes. Others might be enumerated, such as the talents for scientific observation, for laboratory experimentation, for mechanical invention, and for literary research; and, in general, all the powers of mental appli-

cation, abstraction, and attention, of study, and of investigation, by which knowledge has been increased. On the side of art might be added also the faculty of diction, both written and spoken, poetry, oratory, and style in writing.

It is certainly not necessary to explain that these biologically non-advantageous attributes, though highly derivative and without any place in the great scheme of organic development, have become to civilized and enlightened man not only the most advantageous of all his mental possessions, but the chief marks by which he is distinguished from the animal world below him. More than any and all physical distinctions, these constitute him man. Yet all derivative faculties do not belong to this class, for that of money-getting, whether in legitimate business ways or by sharp speculation, that of political and social intriguing to better one's condition, and many others, are but so many refined modifications of the primitive animal cunning, calculated to evade the protective institutions of society, and to secure by still greater indirection the personal advantages no longer attainable by brute force or sagacity. These have, therefore, developed through the survival of the fittest, and belong to the normal competitive class characteristic of the lower animals.

It is quite otherwise with those higher intellectual, esthetic, and ethical faculties first enumerated, and this is admitted by Weismann when he says that "predispositions which we call talents cannot have arisen through natural selection, because life is in no way dependent upon their presence." But he denies that they are due to the inheritance of what is gained by individual effort, and asserts with emphasis that "there is absolutely no trustworthy proof that talents have been improved by their exercise through the course of a long series of generations." He reminds us that men who have displayed special talents have most commonly been the only persons in their lines who have possessed such; that others are known to have inherited them, not from their parents directly, but from more or less remote ancestors; that quite varied talents have often cropped out in the same family; that highly-gifted men frequently emerge from the masses; and that great events are certain to evolve appropriate leaders of any popular movement. Therefore, he argues,

such powers of mind must be due to certain subtle influences at work through heredity in society; and the commingling of innumerable and widely-different ancestral germs, co-operating with favorable conditions for their manifestation, must suffice to explain the observed facts. Dr. Wallace offers a very different explanation, and holds that the facts "clearly point to the existence in man of something which he has not derived from his animal progenitors—something which we may best refer to as being of a spiritual essence or nature, capable of progressive development under favorable conditions."

On the other hand, Mr. Galton, although leaning strongly against the doctrine of the transmission of acquired qualities, has, in his "Hereditary Genius" and other works, ably shown from concrete examples that high qualities of mind tend to run in particular families, and has done much to disprove the popular notion, relied on by Weismann, that they are spasmodic products of the *Zeitgeist*. In the same line with Galton, M. Alphonse de Candolle, himself a notable example of "hereditary genius," has collected an additional mass of facts in support of the view that talents tend to persist in certain families or lines of descent. There are, it is true, many apparent exceptions to this rule, but most of them could probably be explained if all the facts were known. It is not to be supposed that there will be in every case a series of direct descendants, all displaying the same mental powers in a progressively increasing degree. Aside from the now well-understood law of atavism, which often makes long breaks in such series, a multitude of other influences tend to modify and distort the effects, and finally wholly to destroy them. The most important of these influences is, of course, the commingling of different strains in the two parents. The single fact that, as a rule, the sexes prefer their opposites would rather make us wonder that any one class of mental qualities can be perpetuated through two generations. And it is the recognition of this fact that has led some to propose an abandonment of the rule of personal choice, and to recommend the selection by parents and guardians of similar natures, instead of opposite ones, to be the parents of the race. But such persons forget that in the union of opposites nothing is lost of the qualities of either,

but only the tendency to extremes is checked. And, assuming the qualities thus neutralized to be worthy, many maintain that this leavening of the whole mass of society is more to be desired than the exaggeration of a few of even the noblest attributes.

Weismann and his followers do not generally deny that the faculties above enumerated have increased, and greatly increased. The chief explanation seems to be that this is effected by the fortunate union of varied ancestral qualities in the developing germ. Prof. E. Ray Lankester argues that they may have arisen more or less suddenly, as in the case of what are called "sports," and that this may be brought about by external influences acting abruptly and spasmodically upon the reproductive elements of the parents. He denies that the nature of the effect can have any qualitative relation to the cause, and compares this relation to that which the shaking of a kaleidoscope sustains to the change produced in the images exhibited. To the average mind this certainly seems far less reasonable than to suppose that the prolonged exercises and intense activity of a particular faculty has the effect, in some unexplained way, of producing in the parental germ a corresponding alteration which is capable of perpetuating itself in the offspring, and thus of transmitting to descendants the increment acquired by the parent through cultivation and personal exertion.

But aside entirely from all abstruse theories as to how heredity takes place, we have at least the following general facts, which can best be explained by the theory of the transmission of acquired qualities: Correlated with the general process of cephalization, which is admitted to be due to other causes, a large number of highly derivative and greatly specialized mental attributes that offer no advantage in the struggle for existence have made their appearance in man. These have arisen, so far as we know, only under the protection of such social institutions as are calculated to exempt a portion of the race, for longer or shorter periods, from the necessity of devoting its energies exclusively to the maintenance of physical existence; that is to say, they are the products of leisure, and represent the surplus mental energy insured by civilization. With the satisfaction of physical wants these intellectual, esthetic, and ethical wants have arisen, grown

powerful, and been attended with intense emulation. This has led to the incessant and vigorous exercise of these derivative faculties. Although not advantageous in the biological sense, these faculties have, nevertheless, been strengthened and increased *pari passu* with their exercise. They are most highly developed in those persons who have most strenuously cultivated them, as witness the ethical cast of the Hebrew mind, the talent for sculpture among the Italians, and the musical genius of the Germans. The faculties themselves are clearly hereditary and, notwithstanding parental crossing and other distributive influences, tend perceptibly to persist for a longer or shorter period in particular families.

The whole point at issue is whether there is a causal relation between the cultivation of these faculties and their development; in other words, whether the increment gained by their exercise is transmitted to posterity. Professor Weismann and most of his followers, constituting what is now generally known as the school of Neo-Darwinians, deny such transmission. If they are right, education has no value for the future of mankind, and its benefits are confined exclusively to the generation receiving it. So far as the inculcation of knowledge is concerned, this has always been admitted to be the case, and the fact that each new individual must begin at the beginning and acquire all knowledge over again for himself is sufficiently discouraging, and has often been deplored. But the belief, though vague, has been somewhat general that a part at least of what is gained in the direction of developing and strengthening the faculties of the mind, through their life-long exercise in special fields, is permanently preserved to the race by hereditary transmission to posterity of the acquired increment. We have seen that all the facts of history and of personal observation sustain this comforting popular belief, and until the doctors of science shall cease to differ on this point and shall reduce the laws of heredity to a degree of exactness which shall amount to something more like a demonstration than the current speculations, it may perhaps be as well to continue for a time to hug the delusion.

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CHEMISTRY TO-DAY AND ITS PROBLEMS.

IF we compare the chemistry of the present day with that existing in the earlier half of the century, we certainly see no epoch-making, far-reaching discovery such as that which has marked the sister science, biology. There is nothing which warrants us in speaking of the "new" or of the "old" chemistry. Nevertheless we have witnessed a most important advance. Our science is gaining a more complete organic and internal cohesion, and is entering into closer federal relations with the other sciences, giving and receiving fresh light. Chemistry, in conjunction with physics, furnishes astronomy with a new and most powerful method of research, and with a new body of facts and generalizations. But to these results we have no occasion to refer, as they have been ably explained by Professor C. A. Young.*

At the same time, chemistry is deriving new light from the very opposite direction. Not many years ago few persons, if any, surmised that certain microscopic living beings—microbia, or micro-organisms—could be powerful agents of combination and decomposition, not merely in living plants and animals, and not alone in dead organic matter, but even in the mineral kingdom. Some time ago the researches of Schloesing and Muntz, of Marcagno, of P. F. Frankland, and of others showed that the decomposition of dead organisms into their components depends mainly on the action of microbia which break up blood, flesh, leaves, and even wood, into carbonic acid and ammonia. Living organisms further convert the ammonia into nitric acid, which, if potash is present, forms saltpetre. By a due selection of different ferments—all of them living organisms—we can produce, in a solution of sugar or a decoction of malt, alcoholic liquors having the actual aroma and flavor of the choicest wines. More remarkable still, it is now proved that the green rust on antique bronzes is a product of microscopic plant life.

* The FORUM, September, 1890.