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HEREDITY, A FACTOR IN THE ETIOLOGY OF INSANITY.

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HEREDITY, A FACTOR IN THE ETIOLOGY OF INSANITY.[1]

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Du Bois Raymond says that "the hereditary transmission of acquired characters remains an unintelligible hypothesis which is only deduced from the facts which it attempts to explain."[2]

Weismann says,[3] "It is impossible to imagine any way in which the transmission of changes produced by the direct action of external forces upon the somatic cells can be brought about."

The views implied in these statements appear to differ from those which physicians have long entertained. Indeed, it would not be easy to quote an authority in medicine who does not refer in some form to the transmission of characters which have resulted from external accidental influences upon the organism. Clouston[4] traces a hereditary influence in insanity in from 30 to 40 per cent. of cases in hospital, and adds that there is a probability of a much higher per cent. He says: "Certainly the tendency to suicide is very hereditary." Mr. J. F. Briscoe,[5] in a paper read before the Medico-Psychological Association, London, 1896, gave as his opinion, after a careful study of the subject, that 90 per cent. of the insane have a heredity of insanity.

All are familiar with the fact that Darwin made liberal use of the doctrine of hereditary transmission of acquired characters in his work on the Evolution of Species.

In view of such an apparent difference of opinion, it may be of interest to examine the subject from the standpoint of the physician with special reference to that change in the character of the brain activities which is the basis of insanity, and as

[1] Read before the British Medical Association in Montreal, 1897.
[2] Ueber die Uebung, 1881. [3] Essays on Heredity, vol. I.
[4] Lectures on Mental Diseases.
[5] The Journal of Mental Disease, New Series, 143.

Weismann appears as one of the foremost representatives of the more recent views, I venture to present, in a brief way, some points of his argument so far as they relate directly to the question at issue.

Heredity, he argues, is a great biological law. Its action covers all forms of life, and its roots reach down into the elements of all living structures. Its effects are, therefore, coeval with the growth of organisms, and should be studied in conjunction with the laws of growth.

All organisms are either unicellular or multicellular. Those embraced in the first class grow to a condition of maturity, and are propagated by a division into two parts. The child cell inherits the characters of the parent cell so perfectly that it cannot be determined which is the older, and this process of division may continue indefinitely. Each organism is a full and completed body, and is endowed with the powers of assimilation, growth, and, in turn, of propagation. Such organisms attain to a degree of immortality. Heredity becomes absolute through the method of formation and growth, and its mode of action is not difficult to understand.

But when we pass into the study of multicellular organisms the problem of heredity becomes more complicated. This is especially the case in the different classes and orders of the vertebrates, where the individual organs and parts have become numerous, highly organized, and the cells of which they are composed have attained great diversity of character. Simple cell division becomes inadequate to even suggest any explanation of the process of hereditary transmission in such organisms; and nature has provided other means through which its laws can operate. This is in nearly all cases by sexual reproduction.

Such an arrangement necessitates the provision of a special order of cell, and also the assumption that at some period in the process of evolution there occurred a division of cells into two varieties: the reproductive, or germ cell, and the somatic cell. The first form of cell is concerned with the preservation of the species, and the second with the preservation of the organism and the discharge of its functions.

The nature of its function would seem to indicate that it is through the germ cell that the force of heredity operates.

Besides, this is the primordial cell, and from it the others originated; it therefore contains the potentiality of a development, under certain conditions, into a complete organism with parental and inherited characters. That is to say, it contains an almost infinite number of infinitesimal elements, each one of which contains a capacity of becoming one of the various kinds of cells, or colonies of cells, which, by multiplication, become members or organs of a complicated organism.

These views do not appear to be unreasonable, and may be accepted in a general way without argument; but an assumption is further made, about which there may be room for doubt. This is, that while the germ cell thus primarily determines the character of the various colonies of the somatic cells by means of its potentiality and continuity of character, the somatic cell has very little influence over the germ cell, and, therefore, that such changes of character as may occur in the latter from the effects of its environment and experiences, cannot be transmitted by the germ cell to a future organism. Weismann says: "Nothing can arise in an organism unless the predisposition to it is pre-existent."[6] That is, the germ cell is independent in its formation and continuous character of those influences which may produce changes and modify the characters of the somatic cells, except, possibly, in a "very slight" degree.

In trying to test the value of this assumption it becomes necessary to inquire in what way characters of the somatic cells may become modified and changed by influences acting upon them from without the organism.

Acquired characters represent two forms: first, those that depend upon an increase in the normal function of an organ or colony of cells; and, second, those which result from a diminution of function, or a modification in its form of activity. The function itself depends upon and has its representative in an original or inherited organ or member of the general system, and both the quality and quantity of the function will depend upon the character of this physical basis. But with a given quantity of physical basis, the quality of it will determine both the amount and perfectness of the functional product.

For example, a man of very great intellectual capacity, such

[6] Essays on Heredity, vol. I, p. 172.

as a Shakspeare or a Napoleon, may not have a brain of greater weight than the average man, but the inference that certain parts of it are more highly developed; that the cells are more sensitive to impressions and the recording of them; that the connection between the different groups of cells throughout the cortex is more perfect in functioning, thereby giving rise to wider generalizations, would be legitimate. In a great painter and musician those portions of the brain which are the centres of vision and hearing would be composed of a more highly organized structure than the corresponding parts in the average man. In an inverse order, the feeble-minded and idiotic have imperfectly developed physical representatives of their mental faculties, either in quantity or quality, or in both.

Increase in size and in the amount of function of any part or organ of the system arises from the transmission to it of larger measures of organic energy than have before been supplied, and which act upon its elements in the form of stimuli. The effects of such stimuli may become so continuous and powerful in some cases as to result in the development of a greater capacity of function, or in other words, an acquired character.

On the other hand, when the measure of such stimulus to any organ or part is lessened from the effects of exhaustion or from any other cause, there must of necessity result a diminution in the physical elements and also in the function of that organ. In process of time a secondary character may result from such physiological or pathological changes.

The scope of this paper restricts us mainly to a consideration of that form of acquired character which arises from a diminution or modification of normal mental function.

It is not possible accurately to determine how perfectly the elements of the cortex, in the fronto-parietal segment of the brain, recover from the effects of the impairing and destructive processes which occur during an attack of acute insanity. It doubtless varies to some extent in different cases, and depends upon the original recuperative capacity of the brain tissue and the severity and length of time during which the disorder exists. It is, however, a well-established fact, that after the brain has once experienced the continued excitement or depression incident to acute mania or melancholia, there ever afterwards remains, at least, a

tendency which may, from the experiences of trouble, worry and grief, result in one or more additional attacks of disease. Habit of action in a normal condition of the brain becomes a sort of "second nature" with most persons; and much more does a habit in the character of activity, which has become established in a disordered state of the brain, tend to become permanent. In some cases, under a favorable environment, this tendency may not become converted into a reality; in others it does so at the grand climacteric or in old age. In others still there is a frequently changing character in the mental functions characterized by attacks of excitement which may continue for longer or shorter periods, alternating with states of depression. Such persons may live many years with the functions of the general system not greatly impaired.

In the first class of cases the cells of the cortex may have regained their normal anatomical condition to a large extent, and yet still retain a memory or echo of the morbid experience which will impair to some extent their stability of function, and which will never wholly pass away.

In the second class of cases the impairment is more pronounced, and the normal relation of cell to cell has become so far destroyed that the regenerative process never becomes complete. In other words, a secondary and permanent character of functioning has become engrafted on certain elements of the cortex as the result of external accidental causes which may continue indefinitely.

In such cases the cortical function may become partially restored by means of an increase in the anatomy and capacity of those cells which have remained unimpaired. The process may be compared to that which occurs in the circulation of a limb when one of the larger arteries has been ligated or otherwise destroyed. The circulation becomes re-established and is carried on through other anastomosing arteries, the calibre of which becomes larger in process of time from the continued increase of pressure from the general circulation. The original anatomical character of the cortex, however, so far as it relates to the cells, never becomes restored, and its functions remain more or less impaired.

Now, the assumption of Weismann implies that this secondary or acquired character of activity of the cells of the cortex will

have no appreciable influence upon the ovaries, because these have been so thoroughly isolated during both embryonic and the mature life of the organism during innumerable generations, and are so far removed from the direct influence of the somatic cells. In the present supposed case, this means that they are so far removed from the cells of the cortex which have become impaired from the effects of external causes, that they will continue to functionate independently of such influence, so far as relates to the product of their function; or, if influenced at all, the effects must be, to use his own words, "very slight."

Now, if we regard heredity as equivalent to organic memory, and take into consideration the fact that the ovary has been discharging its function from generation to generation during long ages, it seems not unreasonable to conclude that its character of activity and that of its product are not likely to become greatly changed by those influences which may act upon it temporarily from accidental causes. In other words, those tendencies which have become incorporated in its texture during indefinitely long periods of time must be much more potent than any which may arise from such causes as continue in operation only during the single life of an organism. This may undoubtedly be true so far as concerns the general character of the function of the ovary, but the statement does not cover all the physiological factors or activities which properly relate to it.

The error appears to consist in the assumption that the stored up organic energy of the ovary is the only form of energy which can influence the product of its function, but while this does determine the general character of the function, it is not the only form of energy which is essential to the complete and perfect elaboration of the product. This is true in relation to all functioning organs of the general system.

From the physician's standpoint it is hardly necessary to recall the fact of the very intimate anatomical connection existing between the brain centres and all the organs of the body, nor that other no less important fact, that these organs are absolutely dependent on such connection in discharging their function. The efferent system of nerves presents continuous lines of communication along which stimuli of an organic and functional character may be radiated from the brain.

Cope[7] suggests that it is not necessary to assume, as Darwin did, that there exist throughout the body infinitesimal lines or threads, by means of which gemmules are conveyed from the different colonies of somatic cells to the germ plasm, in order to produce such representative modifications as may have occurred from external causes acting on themselves. Such modifications can be produced by currents or waves of nerve force or energy which are constantly passing to the ovaries from the brain centres.

As illustrating this point I may refer to the fact that all physicians of long experience have had more or less opportunity to observe cases in which certain functional disorders, and even profound emotional experiences existing for short periods only, arrest the progress of menstruation, and it may not again appear for some months. An attack of acute insanity produces such an effect in the majority of cases after the first one or two months, and the functional activities of the ovaries may become partially arrested from other less pronounced disturbances of the nervous system.

Now, if the functions of these organs can be thus affected by influences such as cold, shock, overwork, long continued exhaustion, imperfect nutrition, etc., which have their effects primarily and directly upon certain elements of the brain, why may we not argue, from the greater to the less, that there is still more reason to anticipate some effect upon the product of that function? The assumption which provides the basis of heredity, and which seems to be a reasonable one in the light furnished by microscopical studies, is that the germ plasm contains in its highly organized structure a vast number of elements which constitute the representatives of the future organism, not only in its physical parts, such as the contour of the face, the size and color of the eye, etc., but also some of the characteristics of its organic movements, as well as the qualities of the mind. The considerations above formulated seem to indicate an arrangement by means of which the influence of external causes acting upon the brain may be radiated to these elements of the germ plasm and modify their character. But there are some others of an anatomical character which tend to confirm the view that these potential elements of

[7] Primary Factors in Organic Evolution, p. 450.

the germ plasm not only may, but must, be influenced by such causes.

1. It may be affirmed that all acquired characters and changes in the physiological activities of the system, whether physical or mental, are affected primarily and essentially through influences acting on the nervous system. This is the medium through which the personality comes into relation with the external world. Irritations and influences from the environment act primarily upon it; and this, in turn, reacts upon the different organs and members of the general system. But the nervous system, comprising the brain, spinal cord, and nerves, is essentially a unit. The functions of its different parts, however, are of diverse character, and it is accordingly arranged with special reference to the functions to be performed.

Flechsig calls attention to a distinction between that part of the sensory system of nerves which receives impressions from the external world, and that which is concerned with the functional operations of the body. It is by means of the first kind of sensations, that is, those which come through the special organs of sense and general sensation, that we first become conscious of that which is not ourselves and enter into relations with the world without. The second group of sensory nerves comprises those whose function relates to the physical instincts, such as hunger, thirst, and sexual desire. The fibres of the latter group are found to be the first to become medullated, having connections with the nerves of the cord, medulla, and probably with the internal capsule.

Whether this view is correct, and will be verified in detail in the future, is immaterial. The particular point to which I desire to call attention is that that portion of the sensory system of nerves which has a distinct relation to the ovaries and their product is among the earliest in development, and is related to the primary instincts and profoundest activities of the organism. Provision is, therefore, early made in embryonic life for the future conveyance of radiations of organic energy from the brain to influence them.

2. In the line of this thought Hering, as quoted by Cope, observes: "We notice further on that the process of development of the germs which are destined to attain an independent

existence, exercises a powerful reaction, both on the conscious and unconscious life of the organism. And this is a hint that the organ of germination is in closer and more momentous relations to the other parts, especially to the nervous system, than any other organ. In an inverse ratio the conscious destinies of the whole organism, it is most probable, find a stronger echo in the germinal vesicles than elsewhere."

3. I have, in another connection,[8] called attention to the fact that the anatomy and physiological activities of the cortical cells differ from those of other somatic cells. Each one arises in an independent, isolated form, and not from another cell, in the ordinary manner of somatic cell-multiplication. "The cortical cell has an individual character and anatomy of its own; that its renewals do not occur by accretion or absorption from the surrounding tissues or blood-vessels directly, but from the influence of forces which act from within the cell itself; that the protoplasmic material of the interior of the cell is constantly elaborating nucleoli which in turn become nuclei, and these afterwards become cells proper, so that the cell never dies except from the effects of disease. Its characteristic form, its angles, projections and dendrites appear to be renewed from time to time, while its individual anatomy remains unchanged."

These are the cells upon which the influences of experience and environment, of whatever nature they may be, act primarily and directly, and no secondary character can arise in connection with any part or organ of the system, except from such influences as have first affected them, and have also been radiated by them to such part or organ.

It follows that when the energizing capacity of these cells has become much impaired from the effects of any cause whatever, there must result some corresponding effects in those organs and the product of their function, which are under their influence and are also dependent upon it when in a normal state of activity. But Weismann claims that this influence must be "very slight." "Very slight" is a very indefinite expression when used in such a connection. Be it little or much, however, it is sufficient, when the cortex is in certain conditions, to arrest the progress of menstruation, and to hold this

[8] The Physical Basis of Thought (Lectures on Mental Diseases).

function in a state of suspension continuously for months. If sufficient to effect this it certainly must be sufficient to modify the infinitesimal elements of the germ plasm, which are the representatives of the characters of the future organism.

That this organic connection between the cortex and the ovaries should be more perfect in some persons, families, and races than in others is highly probable; and, if this is the case, the fact would explain why some persons and families appear to be endowed with unusual ability in transmitting characteristics of family and race.

It may also furnish an explanation of the way in which the tendency towards disease and other undesirable acquired characters, and also characters of an opposite nature, which may pertain to one of the parents, may become eliminated or partially overcome. From the microscopical studies of Weismann and others, it appears to be certain that some portion of the elements of the two forms of germ plasm coalesce in the formation of the future organism, and this would insure the larger measure of influence from the more vigorous element.

Possibly it may be inferred that if the effects of a diminution in the function of the cortex may in a negative way have an effect on the ovaries and their product, the same may be true in a positive way in relation to an increase in the function of it.

There certainly exist some reasons for such an inference. Use and a favorable environment tend to attract larger measures of organic and functional energy to the brain. We constantly witness improvement in the quality of mental function from use and discipline, and if the product of function is improved, the inference is legitimate that the physical basis of it has become more highly developed and more finely organized. Indeed, we can judge of the quality of the structure only by the character of its product.

It is true that such acquired characters do not always appear in offspring; and with reason. Both parents rarely possess like acquired characters, and those of one parent may often wholly neutralize those of the other. Again, every one represents characters of the nervous system which are of diverse tendencies, which reach back through many generations in two families. The influence of atavistic tendencies is always operative, and leads to variety, and not uniformity, of characters.