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MEMOIRS.

MATERNAL IMPRESSIONS.*

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THE history of every science reveals a progress from supernatural to natural explanations of phenomena and in no department of science is this so clearly evident as in medicine, since this science above all others directly concerns mankind, and even the most primitive peoples are wont to regard themselves as the especial concern of supernatural beings, powerful to aid and powerful to wreak vengeance upon or even wantonly torment their protégés. And it seems probable that it is this very belief in supernatural influences which brings it about that ancient superstitions concerning things medical are more resistant than those which other sciences have to combat. The vitality of medical superstitions has undoubtedly been brought some time or other to the attention of every practicing physician for they are widespread and, unfortunately, are not confined to those, who, by common consent, are classed among the less educated members of the community. The belief that men have one rib less than women has not yet completely disappeared and how many are the believers in some of the superstitions concerning twins, in the good fortune which pertains to a caul and in many others of the more or less vain imaginings which have been handed down to us from early times. Indeed, it may almost be stated as a general principle, that any of the old beliefs which are still in vogue among the multitude are to be

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regarded with suspicion and should be accepted only after direct experimental confirmation.

This, it seems to me, is the proper standpoint to occupy with regard to the very prevalent belief in the influence of maternal emotions upon the offspring *in utero* and it is proposed to discuss in this paper the evidence upon which this belief is founded and the bearings of our modern ideas of development upon it; to enquire, in other words, whether it fulfils the requirements which we demand of scientific theories.

The belief is of wide prevalence both in time and space, dating at least from the time of the writing of the thirtieth chapter of the book of Genesis and occurring not only throughout European countries, but also, according to Ploss, in most diverse portions of the world. As Förster sharply remarks, "medical literature is full of it, but still more so the heads of midwives and other old women of both sexes." It appears under various garbs and receives, one may believe, almost universal acceptance among the laity, being generally associated with the belief that the mother mark, which is so certain to follow a violent emotion, will occur on that portion of the body of the child which the mother has touched upon her own person at the time she experienced the emotion. Indeed, so general is this belief that several cases may be found in the literature of the subject in which the mother-to-be has had sufficient presence of mind to touch a portion of her body, which, under ordinary circumstances, is concealed from view, so that the expected disfigurement of the child may be as unobtrusive as possible. As regards the prevalence of the belief among members of the medical profession it is interesting to note that it seems to be especially prevalent in this country, since out of ninety-one references given by Ballantyne for the decade 1886-1896, no less than two-thirds are to papers by American authors, the great majority of these papers being records of cases supposed to favor the belief.

In looking over the literature one readily perceives family likenesses, so to speak, between many of the recorded cases and one may classify them as (1) cases due to intense longings or cravings on the part of the mother; (2) cases resulting from more or less severe frights; and (3) cases following pronounced mental impressions other than fright. To these may be added a small fourth group of cases in which the impression supposed to have affected the child came from the father instead of from the mother. Concerning these cases of paternal impressions I shall not speak; the ideas which I shall endeavor to present regarding maternal impressions will apply with even greater force to those supposed to emanate from the father.

To the first group belong all cases of which the following may be taken as a type. The first child of Mrs. W., a girl, was marked upon the left buttock by a bunch of blackberries, because the mother during the seventh month of pregnancy had a "hankering" for blackberries, then out of season. The mark "always became quite black when these

berries were in season and dark brown at other times."[1] Very numerous are the variants of this story, cherries, strawberries and other fruits, oysters, lobsters, fish and even a much longed-for switch of hair taking the place of the blackberries.

More serious in many instances are the disfigurements shown by cases belonging to the second group, one or two examples of which may be quoted. (1) Mrs. A. was frightened by a mouse which ran across her arm when she thrust it into the flour-bin and the child subsequently born had the mark of a mouse upon its arm.[2] (2) Mrs. X. when in the fifth month of pregnancy had an encounter with a vicious ram; the child born was a monster, having a head like a sheep, a stump of a tail, and was covered with black wool and had a bleating cry just like that of a young lamb. It is to be noted that in this case the mother had given no particular thought to her tussel with the ram after it was over.[3] (3) Mrs. A. after the birth of her first child contracted syphilis; her second child was born with spina bifida and was held by the parents, but not, it must be said, by the reporter of the case, to be a "catfish birth," because the mother during her pregnancy had been frightened by a cat fish.[4]

Finally in the third group are cases such as the following: The husband, who was a physician, witnessed the ceremony of circumcision at a Jewish neighbor's and on his return home described the proceedings in detail to his wife, who, at the time, was in the second month of her pregnancy. The account made a great impression upon the mother who talked of it for several days. When the child was born the attendant physician remarked to the father that the child had hypospadias, but the father replied instantly, "No! you don't mean hypospadias, but circumcision," and on closer examination it was found that the glans was completely exposed and the retracted prepuce showed the "yet granulating cicatrix of what looked like a recent circumcision."[5] Even more remarkable is the "Dundreary case" vouched for by Fordyce Barker,[6] which presents the extraordinary peculiarity that the impression was made four years before the child was born and, indeed, while the mother was yet unmarried. To this group also belongs the device of the patriarch Jacob for obtaining "ringstraked, speckled and spotted" cattle, and many more may be culled from the literature.

It would be of the greatest interest to discuss in detail the history of the belief, but this would be superfluous since it has already been fully treated by Tartuffi[7] and by Ballantyne.[8] For the proper understanding of its present status a brief historical sketch is almost a nec-

[1] MILLER: *Philadelphia Medical and Surgical Reporter*, XLV, 1881.
[2] CLAPPERTON: *British Medical Journal*, I, 1875.
[3] DOTY: *Philadelphia Medical and Surgical Reporter*, XLV 1881.
[4] SHIVERS: *Philadelphia Medical and Surgical Reporter*, XLV, 1881.
[5] GASKELL: *American Journal of Obstetrics*, IV, 1871.
[6] BARKER: *American Journal of Obstetrics*, IV, 1871.
[7] TARTUFFI: *Storia della Teratologia*, Bologna, 1881–1894.
[8] BALLANTYNE: "Transactions of the Edinburgh Obstetrical Society," XXI, 1896.

essity; what I shall say on this side of the subject is drawn mainly from Tartuffi. And first, it may be stated that the belief in maternal impressions is intimately associated with the necessity for finding an explanation for monstrous births and is, indeed, a survival of one of these explanations. The occurrence of such births was a phenomenon which naturally evoked interest even in earliest times and just as naturally it was regarded as of supernatural origin, either a sign of the displeasure of a god or a portent of catastrophe to come. But along with such ideas were others ascribing more material causes, such as bestial and demoniacal connections, examples of belief in both these agencies being found in the writings of the classical authors, as well as in those of the middle ages and, indeed, into the renaissance, for one Fromann, a physician of Saxe-Coburg, taught in 1675 that although every monster was not a diabolical birth, every diabolical birth was a monster, and Licetus in 1616 admitted the possibility of monsters being produced as the result of a bestial connection.

With the revival of learning there were developed, however, more natural theories as to the causation of monsters, largely as the result of the observations of Fabricius and Harvey upon the development of the chick, and the discovery of the human ovum by de Graaf (1672) and of spermatozoa by Leeuwenhoek (1679). But while the theories mentioned had practically disappeared by the beginning of the eighteenth century, the theory of maternal impression, which, as we have seen, was contemporary with the others, remained unimpaired in its vigor and still persists, though now shorn to some slight degree of its former importance, for no upholder of the theory today will venture to maintain that pregnancy itself may be produced by the imagination. And yet Bartholin refers to an act of the parliament of Grenoble passed in 1637 by which an adulterous woman was pardoned on the ground that the pregnancy had been brought about by the imagination of the husband who had been absent for four years, and a similar possibility was maintained by one Hartenfels in 1671 and by Grass in 1691.

The first serious blow dealt the theory came from an English author, Blondel, who, in 1727, criticized the known cases on the ground of the incompleteness of the observations. His book was translated into several languages and gained many converts both in England and the continent, leading such men as Haller in Germany and Morgagni in Italy to reject as unsatisfactory the majority of the recorded cases, while admitting in some instances the activity of a force which they could not understand.

With the nineteenth century there came a more thorough study of the entire subject of teratology, based upon the more perfect knowledge of the facts of mammalian embryology furnished by von Baer (1826) and resulting in the publication of several monographs in which not only a classification and description of the various kinds of monstrosities were attempted, but also discussions of the causes which

produced them. Among these treatises may be mentioned more especially the "Traité de Tératologie" of Isidor Geoffroy Saint Hilaire published in 1836, Vrolik's "Handboek," published in 1840, Förster's "Missbildungen der Menschen," published in 1865, and Tartuffi's "Storia della Teratologia," published in 1881, and the opinion concerning mental impressions to which each of these arrives may be stated in the words of Saint Hilaire. After admitting that emotions of great intensity and duration may indirectly give rise to monstrosities and especially to cases of anencephalism and pseudencephalism, he goes on to say: "But although a mental emotion, sudden and violent, or even moderate or feeble but long continued, exercises upon the product of pregnancy a marked influence, there is no reason for believing that the same may be true of an emotion which is feeble and only momentary. It is contrary to all results of science and reason to believe that an object seen, feared, or desired by the mother can, so to speak, depict itself upon the body of the child which she carries in her womb; and a healthy physiology can see in this ancient belief merely a prejudice, as absurd and sometimes as dangerous as it is ancient."

This, I believe, is a fair statement of the opinion regarding maternal impressions held by all those of the present day who have made a study of the question from all its sides and I shall now endeavor to state as concisely as possible the grounds upon which the opinion is founded. It is to be noted, however, that the opinion is a negative one and it is admittedly a difficult task to prove a negative; yet this is the task which the teratologists must face. I shall not venture to maintain that they have accomplished this task, but I do hope to show that with the assistance of modern embryology they have rendered the position of the impressionists so insecure that with them rests the burden of proof that their position is tenable.

And first let me consider the relative frequency of the supposed cause and effect. Of course no one will maintain that a violent emotion necessarily affects the child, yet if the emotions are to be regarded as a *causa efficiens* in the production of anomalies or monstrosities it might be expected that there would be a fair proportion of effects compared with the frequency of the cause. Accurate statistics are, naturally, lacking, but there are some data which bear upon the matter. It is hardly necessary to refer to the general emotional condition of pregnant women, indeed, the word *hysteria* has its origin in a reference to the association of the reproductive organs with this highly emotional condition, and as one author upon the subject of maternal impressions has forcefully, if not elegantly, expressed it, "Every pregnant woman is on the watch, like a shying horse, for something to get frightened at; and such a something generally comes along, which, of course, she never forgets." It may be assumed, I believe, that the great majority of women during their pregnancies are subject to ardent longings or to severe frights, and yet how comparatively rare are maternal impressions which can be definitely referred to the emotion. Of course all

possible cases are not recorded, but, on the other hand, so many of the recorded cases are so manifestly incorrectly referred to the cause under consideration that we are necessarily left with the general impression that the number of cases showing the effect is out of all proportion small compared with the occurrence of the cause.

And even if all cases of births with abnormalities be considered the proportion yet remains small. The statistics on the relation of normal to abnormal births vary considerably, it is true, Adam giving the percentage of defective births as 0.29 per cent for Vienna and 0.56 for Paris, while Förster in the records of eight thousand three hundred eighty-six found sixty cases of malformation, a percentage of 0.71 and Puech in one hundred thousand births found four hundred fifty-four anomalies, sixty-one single monstrosities and two double monstrosities, a total of five hundred seventeen or about 0.5 per cent. Such abnormalities as naevi are of course neglected in such statistics, but these do not form the majority of the recorded cases of maternal impressions.

In this connection the observations of Johannes Müller and William Hunter are of interest as approaching the matter from a somewhat different standpoint. Hunter interrogated two thousand pregnant women *before* the births of their children as to whether they had experienced any vivid emotion or had had violent longings so that they were in dread that the child would show some corresponding marks. The results were throughout negative so far as the marking of the child was concerned. The same result followed Müller's similar inquiries and Doctor G. J. Fisher[9] obtained absolutely negative results from inquiries in one thousand two hundred cases.

So far, then, as far as our information goes, there seems to be a marked discrepancy between the occurrences of the cause and of the effect, a fact not in itself an important argument, but nevertheless of interest in connection with other considerations to be brought forward. And here a word may be said as to the evidence upon which many of the cases are founded, and that is that it is *post facto* evidence. A mark or a malformation is noticed upon a new-born child and the physician, nurse, relatives, or interested friends in the fullness of their belief in maternal impressions promptly make inquiries of the mother, more or less leading in their character, and she, out of the multitude of her experiences of the preceding months need not find it difficult to discover one which fits the case sufficiently accurately. Through faith mountains may be removed and to the eye of faith it is not difficult, Polonius-like, to discover in an anencephalic monster the counterfeit presentment of a toad, and in a naevus a resemblance to a strawberry, a bunch of blackberries or almost anything else. And so the wonder grows, and it is recorded that the strawberry or raspberry mark takes on a deeper hue in the strawberry or raspberry season!

"Das Wunder ist des Glaubens liebstes Kind."

Incidentally it may be mentioned that a case is recorded of the

[9] FISHER: *American Journal of Insanity*, XXVI, 1870.

birth during the French Revolution of a female child which had a dark spot on the arm. This was interpreted as a representation of the Liberty Cap and, the fact being reported to the government, the mother was the recipient of a premium for having given birth to a child with a revolutionary emblem on its arm.

Embryology has shown beyond cavil that abnormalities, including under this term all malformations from anomalies to monstrosities, are, in the large majority of cases, inhibitions of the normal developmental history. The theory of maternal impressions, so far as they concern abnormalities other than naevi, must therefore maintain that the imagination of the mother has the power to inhibit the development of the fetus, and not only so, it must have the power of inhibiting the development of a definite portion of the fetus.

To this latter point, which is of the greatest importance in the study of the question, I shall return shortly. In the meantime let me call attention to another impairment of the value of many of the cases reported as supporting the theory, namely, that quite frequently the supposed emotional cause has acted some time after the period at which the normal development of the affected part should have been completed. In other words the true cause of the malformation has in many cases already accomplished its work before the supposed cause had become effective. Thus, to take an example, it is well known that the condition of hare-lip is the result of a failure of the maxillary process to unite with the processus globularis of the fronto-nasal process, a union which is normally accomplished early in the second month of fetal development. Cases of hare-lip are therefore to be regarded as due to an inhibition of the normal development of the upper jaw during the first six weeks or so of embryonic life and yet one finds recorded such cases as that of a hare-lip produced by a dentist roughly lifting the upper lip of the mother at a time when she was in the sixth month of her pregnancy, a case which the recorder states he has "no doubt occurred from maternal impression conveyed to the foetus;" or as those cases in which the cause was assigned to the mother having been startled by a rabbit or having been shocked by the sight of a hare-lip while in the fourth month of her pregnancy. Examples of cases showing other abnormalities to which a similar criticism would apply might easily be cited.

Embryologists are accustomed to distinguish between the embryo and the fetus, the latter term denoting an embryo which has acquired the general form characteristic of the human species and has all its organs differentiated, though not in all cases histogenetically completed. The transition from embryo to fetus occurs at the close of the second lunar month, and it is evident, then, that the great majority of abnormalities due to inhibition must have their origin during the early weeks of development, many of them, indeed, at a time when the mother may be uncertain or even ignorant of her condition. On the other hand, the majority of supposed maternal impressions are assigned

to the later periods of gestation, and if really the effective causes of abnormalities, can only act by producing in the fetus a retracing of the developmental path already followed, an involution, if we may so call it, the occurrence of which we have no reason for postulating for the human fetus.

The theory of maternal impressions owes whatever vogue it possesses to the transmission from ancient times of a belief in it and to the accumulation in recent times of cases supposed to illustrate it, and I have shown that there are reasons which demand the rejection of a large percentage of reported cases as valid instances of its effects. But I would now go a little farther and inquire into the mode of action of the emotions upon the fetus, granting that such action exists. A theory of causation can never be completely accepted until a plausible explanation of its *modus operandi* has been discovered, and this has not yet been done for the theory under discussion. On the contrary the deeper we have penetrated into the mysteries of development the more reasons we have found for doubting the efficiency of emotional disturbances as causes for definite malformations. Several explanations of their mode of action have been propounded, and, dismissing from consideration hypotheses which call in the aid of such forces as animal magnetism, we will find that two have been received with greatest favor. One of these demands a direct nervous connection between the fetus and the parent, while the other regards the blood as the medium by which the emotion is transmitted.

As regards the first of these it may be said that no continuity of nerve tissue between the parent and fetus has been demonstrated by the most refined methods of histological technique. And not only so, but these are good reasons for doubting its existence. We are too apt to let our attention linger upon the union of the fetal and the maternal tissues in the placenta and to regard the fetus as anatomically and physiologically a part of the mother. On the contrary, the embryo is a parasite and is quite distinct from the parent, as distinct as is any parasite from its host. The study of the nutrition of the embryo from the comparative standpoint furnishes ample grounds for such a view, and all gradations from such a condition as is found in the oviparous monotremes to that occurring in the viviparous placental human species can be found within the group of the mammalia. Without going into the details of this I may merely point out that the ovum is set free from the Graafian follicle and normally traverses the entire length of the Fallopian tube perfectly independent of the parent, and only later establishes a connection with the uterine walls. It is for a time, therefore, a free-living independent organism and only secondarily becomes a parasite. And this being true, what grounds have we for believing that there is likely to be any continuity of the nervous tissue of the fetus with that of the parent? We do not expect such a condition in other parasites and why should we do so in the case of this one?

As to the blood forming the medium for the transmission of the impression, a little thought will convince one of the improbability of its possessing any such function. It has no properties which would lead us to regard it as a conducting tissue. But apart from this it is well known that there is no direct continuity between the maternal and fetal bloods in the placenta. The two fluids are completely separated by a membrane through which all interchange of gases or dissolved material must take place, and furthermore this membrane exercises a selection in the substances which it will allow to pass. It may be that it does not exert a judicious exclusion of mental impressions, but even so it is difficult to understand why one of two twins should be affected, while the other goes unscathed, as occasionally happens. This fact by itself is sufficient to awaken strong suspicion as to the blood playing any such rôle as that which we are discussing, and if we exclude all idea of the continuity of the nervous system we are left without any explanation for the supposed effect of the maternal emotions, unless it be assumed that some intangible mental force exists of which at present we have no knowledge.

But are we driven in our ignorance to assume the existence of such a force? Have we progressed no farther in the understanding of the causes of abnormalities than our remote forefathers, who were continually driven to appeal to some force lying beyond the pale of experience for the explanation of what seemed to them marvels? I believe that we have progressed greatly, and that teratological phenomena have been brought down from the realms of the supernatural to take their place in the ranks of scientific facts. Within recent years the effect of modified external conditions upon the development of organisms has been the subject of many experimental studies and it has been found at the same time to be very largely a study of the production of abnormalities. True, from the nature of things it has not been possible to carry on any very extensive experiments upon mammalian ova and still less upon the human ovum, but the results obtained with the ova of invertebrates, to say nothing of those observed in the case of the frog and the chick, have been so striking that we are warranted in assuming that in a general way they will equally apply to the human ovum.

Omitting as unlikely to affect the human ovum the effect upon the developing embryo of modifications of temperature, light, or electrical conditions, it may be said that alterations in the partial pressures of the surrounding gases or in the chemical composition or osmotic pressure of the surrounding media play very important parts in producing disturbances in the development and frequently result in the production of monsters. Thus, to mention only a few experimental results, Dareste and Roux found that an interference with the normal access of oxygen, produced by varnishing the shell of a chick egg or by excluding air from developing frogs' eggs, produced numerous inhibitions of development and so gave rise to abnormalities; Pouchet and Chabry found

that by diminishing the calcium-content of sea-water by only one-tenth of its normal amount the development of sea-urchin ova was materially altered, and by increasing the diminishment of the content highly abnormal embryo resulted. Similar results were obtained by Herbst by the addition of small quantities of potassium salts to sea-water, and especially striking were the results obtained by the same author by adding 0.1 per cent of lithium salts. Oskar Hertwig found that the exposure of frogs' eggs to a 0.5-1.0 per cent solution of sodium chloride for half an hour after fertilization produced striking abnormalities in the development, a failure of the anterior portion of the medullary groove to close being especially interesting as producing conditions which in human teratology are known as anencephaly and hemicrania.

When we consider the complicated nature of the metabolic processes proceeding with so great rapidity in the human ovum that in the first eight weeks of development it increases its weight over six thousand times, when we consider how important relatively slight changes in the environment, as shown in the experiments just referred to, may be in modifying the metabolic processes, and, finally, when we recall how minute quantities of certain substances, notably the iodine-content of the thyreoid body, play such important rôles in the metabolism, it seems that we have at hand a sufficiency of explanations for abnormalities, without calling in the aid of some indefinite and intangible force. And this, too, without referring to the mechanical causes of abnormalities, whether of the nature of direct mechanical insults or resulting from amniotic bands or adhesions; they are unquestionably effective in the production of abnormalities and evidence of their action is plentiful both on the clinical and the experimental side. Nor has reference been made to causes innate in the constitution of the ovum or in that of the fertilizing spermatozoon. Either one or the other of these cells may undoubtedly be at times the seat of pathological conditions either inherited or acquired, and these may eventuate in the development of a monstrosity or abnormality. Cases of maternal impressions, however, referred back to the ovum are, in the very nature of things, unlikely; one is reported, however, namely, the Dundreary case of Fordyce Baker already referred to. It is unnecessary to discuss this case in detail; it will stand or fall with the other supposed cases of maternal impression, for if the embryo may be affected in this way there is no reason why the ovum should not be also affected. I shall, accordingly, pass on to a consideration of a point to which, it seems to me, attention has not been sufficiently directed.

It may be urged that the parent forms the environment of the fetus and that any change in the environment must be a change in the parent and especially a change in the quality of the maternal blood. Why, then, may not severe emotion on the part of the mother be capable of altering the environment sufficiently to produce fetal

abnormalities? The reasoninig is in part quite correct and the conclusion likewise. But granting the power of the maternal emotions to produce abnormalities is not admitting that the abnormalities so produced will be definite ones and that is the *crux* of the theory of maternal impressions. It holds that the impression will bear more or less resemblance to the cause of the maternal emotion.

Consider what this demands. It requires not only that the emotion shall affect the development of the embryo, but also that it shall affect in some cases merely a small group of the myriads of cells of which even an early embryo is composed and that it shall furthermore affect this group in a definite and determinate manner. This, everyone will surely admit, is quite an extensive series of requirements and one which cannot readily be made to fit in with the views which have resulted from our increase of knowledge as to the mode of differentiation of the ovum during development. So long as the ancient doctrine of preformation existed, a doctrine which maintained that the organism in all its parts existed fully formed in miniature in the ovum and that the process of development was merely an unfolding as it were of the germ, so long was there a plausible explanation for maternal impressions. Long ago, however, in the middle of the eighteenth century, this theory was brought into disrepute by Caspar Frederick Wolff, who, in his "Theoria generationis," showed by actual observation that development consisted in the differentiation of new structures out of a non-differentiated preëxisting material, a process to which he applied the term epigenesis. As the result of increased facilities for observation and the active study of the process of embryonic differentiation the old doctrine of preformation was entirely given up and a search for the cause of epigenesis begun. And in one of the most important of the earlier theories we find a tendency to return toward preformation. For His in his studies of the development of the chick noted the definiteness with which each organ appears in a certain area of the germinal disk of the embryo, and propounded the view that while we could not regard the various organs as existing as such in the germinal disk, yet, nevertheless, we must regard the disk as composed of definite organ-forming areas. And if such areas occur in the disk they must manifestly continue back through the segmentation stages to the unsegmented ovum, which must consequently be regarded as differentiated to the extent that any given area of it is destined to give rise to a definite organ or group of organs.

Such a view was open to confirmation or disproval by experimentation, and the first experiment conducted by Roux appeared to confirm it. Roux destroyed one of the segmentation spheres of the two-celled stage of the frog's egg and found that the remaining sphere went on developing as if the other were present, a half-embryo resulting, as if all the organ-forming areas of one-half of the body had been located in one of the first two segmentation spheres and all of those of the other side in the other. Further observation, however,

served to modify this conclusion, for, in the first place, it was found that if development was allowed to proceed the half-embryo regenerated the missing structures and a whole embryo resulted; and, in the second place, it was observed that in other ova, such as those of Amphioxus or a jelly-fish, each of the two first spheres possessed the power, from the moment of its separation from its fellow, of developing as a whole ovum, and gave rise to a whole embryo of half the normal size. And not only so, but each of the first four cells, or even of the first eight cells, or, in the jelly-fish, of the first sixteen cells, possessed the same power, the resulting embryos being whole embryos, but of only one-quarter, one-eighth or one-sixteenth the normal size. Evidently then the doctrine of organ-forming germinal areas could not be maintained, at least in its original form.

It would take too long to even briefly describe the various results which have led to the position at present occupied by the majority of embryologists, and the nature of this position must be stated as briefly as possible. A certain amount of differentiation is recognizable in some ova and little in others and the line along which any given spherule differentiates is dependent upon its surroundings. Under normal conditions any given cell in the developing ovum of any species will differentiate along the same lines in every individual of the species, but if the conditions be modified, if the position of the cell with reference to its fellows be changed, if the environment be altered the line of differentiation will also be altered. In other words, it would seem that there is an interaction, physical or chemical, between all the cells composing the embryo, and that as development proceeds, by the multiplication of the cells the interactions become more complex and varied, leading to the differentiation of one cell along one line and another along another. Chemical or physical changes in the environment may affect all the interactions or they may affect only those taking place between certain cells, and so all gradations of abnormalities may occur.

If this view be correct, then it is surely difficult to perceive how a maternal emotion can affect a given group of cells so as to produce a definite result. Can we imagine the emotion experienced at the sight of a rabbit producing just the exact change in the environment that is necessary to affect the interactions between the cells composing the maxillary process and the *processus globularis* so as to prevent their union? Or can we imagine a longing for cherries so affecting the interactions between the vasifactive cells and those of the dermis and epidermis as to produce a naevus the exact counterpart in form and color of the coveted fruit, to say nothing of this disturbance of the interactions taking place only in a part of the body corresponding to that touched by the parent while experiencing the emotion? Putting the matter in this way is it not almost a *reductio ad absurdum?*

The position that we have reached then, is that while a belief in the view that emotional disturbances of the mother may affect the embryo

is justifiable, the theory of maternal impressions, to the effect that the maternal emotions may produce a definite and determinate abnormality corresponding to the emotion, is, to say the least, improbable. And the grounds for this opinion which I have endeavored to set forth are, briefly stated, as follows:

(1) There is no definite relation between the occurrence of the cause and the effect.

(2) The evidence of the theory is very largely *post facto,* and all attempts to obtain *ante factum* evidence have resulted negatively.

(3) The supposed cause has acted in many cases at a time long subsequent to that at which the abnormality could have arisen.

(4) No plausible means for the transmission of the cause to the embryo have as yet been discovered.

(5) All abnormalities can be explained on the basis of known physical forces inhibiting or modifying the normal processes of development, and there is no reason for calling into existence an unknown psychical force.

(6) The fact that the theory demands a definite and determinate response to the stimulus puts it quite out of harmony with the results of modern investigation into the causes of embryonic differentiation.

It cannot be maintained that the theory has been absolutely disproved. The question at present must be largely a question of the balance of evidence. But this balance seems to be largely in favor of the anti-impressionists and it rests with the impressionists to make good their case. And this cannot be accomplished by the mere heaping up of data similar to those with which we are at present burdened. Not only do many of the reports of cases present a painful lack of appreciation of what constitutes scientific evidence, but practically throughout there is an absolute failure to properly correlate the facts of embryology with the observed phenomena. Indeed, one is tempted to say that the final solution of the question rests with the embryologists, for they alone have opportunity for delving sufficiently deeply into the mysteries of embryonic differentiation to have hopes of discovering its ultimate causation.