

chard found the urine in diarrhoeal conditions much more toxic than when the faeces were normal.

**Eclampsia Infantum.**—That a close relation exists between many of the convulsions of childhood and gastro-intestinal disturbances cannot be denied. These disturbances, to be sure, may be of the most varied nature and in some of the cases seem to depend upon the presence of intestinal parasites. In the explanation of these convulsions is seen again the struggle for precedence between the reflex and the auto-intoxication theories, and again the latter seems more satisfactorily to answer the requirements. Even in those cases depending upon the presence of intestinal worms the symptoms are attributed by several of the most recent writers to the absorption of the toxic products formed by the living or dead parasites.

Much attention has recently been given to the association of acetonuria with many cases of eclampsia infantum. Aceton is without doubt frequently found in the urine in these cases, and von Jaksch claims for it a convulsive effect, and goes so far as to describe a particular clinical picture which he terms *epilepsia acetonica*. Baginsky also has found aceton in the urine of many cases of infantile convulsions, but he has never found it in the vomitus or faeces. Moreover, acetonuria is frequently seen in febrile conditions not associated with convulsions, and he regards the presence of aceton in the urine as a symptom rather than as a cause of infantile eclampsia.

**Nervous and Mental Diseases.**—As might be expected, a great number of functional nervous diseases have been attributed with greater or less plausibility to auto-intoxication.

In the case of tetany, uræmia, eclampsia, and eclampsia infantum there are substantial grounds for such belief. In many cases, however, there is, up to the present time, little that can be offered in support of this theory.

The relation of *epilepsy* to auto-intoxication is by no means settled. Griffith has isolated in large quantities from the urine of epileptics an alkaloidal body to which he ascribes causal attributes, but his findings have hitherto not been verified.

There remain to be mentioned three very rare nervous affections which may with considerable probability be attributed to auto-intoxication.

1. A periodic paralysis of the extremities, first described by Hartwig, in which there is the periodical appearance of extensive paralysis associated with sudden loss of electrical irritability. These symptoms last for hours or days and then disappear. The affection has been seen to develop after attacks of malaria, after infectious diseases, and even after the ingestion of certain foods.

2. **Myasthenia Gravis Pseudo-Paralytica** (Jolly).—This recently described condition consists essentially in the periodical development of extreme muscular weakness of the whole body. It resembles clinically the results of the action of proto-veratrin upon the muscle and nerve endings and those of extreme muscular fatigue.

3. **Myotonia Congenita, or Thomsen's Disease.** There is ground for believing that certain psychoses, especially those of a more acute nature, may be the manifestations of an auto-intoxication. Several investigators have found an increased toxicity in urine from cases of melancholia and from other psychoses. It is still too early, however, to formulate definite views upon the subject.

**Gastric and Intestinal Vertigo. Asthma Dyspepticum.**—A close relationship has for a long time been recognized between gastro-intestinal derangements and certain forms of vertigo and asthma; and while proofs are still lacking, there are many reasons for believing that these conditions may sometimes depend upon the absorption from the gastro-intestinal canal of certain toxic substances.

**Skin Diseases.**—From the importance of the skin as an organ of excretion it may be fairly assumed that the disturbances of the skin in many diseases are to be taken as evidence of an attempt on the part of the skin to excrete certain poisons, e.g., in uræmia, diabetes, the exanthemata, etc.

Such disturbances may manifest themselves in the form of almost any known eruption, the erythematous and urticarial types, however, being those most frequently seen. These skin affections seem especially frequent with gastro-intestinal auto-intoxications. Singer has found almost regularly in the skin diseases associated with digestive disturbances, an augmentation of the putrefactive products as shown by the increased amount of ethereal sulphates in the urine.

**Diseases of Muscles.**—In 1889 Wagner described under the name of *polymyositis acuta* an inflammatory disease of the muscles throughout the body, associated with gastric and constitutional symptoms, for which Senator has suggested, with some plausibility, an origin in auto-intoxication. There is as yet, however, no proof of this.

**Coma Carcinomatousum.**—In cancerous conditions of the gastro-intestinal tract, and in various cachectic conditions due to such unlike diseases as the severe anæmias, chronic nephritis, miliary tuberculosis, and cirrhosis of the liver, there sometimes develops a peculiar form of coma which is closely allied to diabetic coma and which is known as carcinomatous or dyscrasic coma. This has a close clinical resemblance to the coma of diabetes, but differs somewhat in a few of its symptoms and especially in its prognosis. In the urine of these cases as well as of those of diabetic coma are found aceton, diacetic acid, and  $\beta$ -oxybutyric acid. These bodies seem to be products of the destructive metabolism of the albumins which is brought about by the action of toxins present in diabetes, cancer, and the other cachexias. It seems probable that both the coma and the acids found in the urine are the expressions of the action of these toxins, rather than that the coma is the result of the poisoning of the body by the acids themselves. The condition common to all these diseases is that of grave disturbance of nutrition, which means excessive albumin destruction. Klemperer found that the blood serum of a cancerous patient, when injected into a dog, caused a much greater increase in the albumin conversion than did the serum of a healthy person.

The nature of this coma-inducing poison is as yet quite unknown. It is interesting that the carcinomatous coma has thus far been observed only in cancers associated with the gastro-intestinal tract.

**Chlorosis. Pernicious Anæmia. Leucæmia.**—Among the various theories regarding the cause and origin of chlorosis, that one which ascribes it to a chronic intestinal auto-intoxication or copræmia has been warmly advocated by Sir Andrew Clark, Bouchard, Ducloux, Notnagel, Hüllmann, and, more recently, by Garrod and Forchheimer. The last-named investigator concludes that the origin of chlorosis lies in a disturbance of the hæmatopoëtic function of the intestinal mucous membrane. He believes this membrane to be the laboratory of hæmoglobin, since in rabbits he found the blood in the mesenteric vein to be much (eighteen per cent.) richer in hæmoglobin than that of the mesenteric artery, and in human blood that after each meal there was a considerable increase in the hæmoglobin content. Moreover, he obtained from the urine of chlorotic patients an alcoholic precipitate which proved poisonous to rabbits. This was evidently a nitrogenous substance, and was regarded by him as an intermediate body between albumin and peptone.

On the other hand, Rethers has failed to find in the urine of chlorotics that evidence of excessive intestinal putrefaction which is based upon an increase in the ethereal sulphates.

Although in many clinical aspects chlorosis corresponds closely to other known intoxications, and although there are many theoretical grounds for accepting such a view, there is still lacking sufficient evidence to justify the definite acceptance of the theory of auto-intoxication.

The same may be said concerning the primary pernicious anæmias and the leucæmias. A support for the auto-intoxication theory in these diseases is furnished by the fact that very marked changes from the normal metabolic processes are found in all forms of pernicious anæmia and leucæmia. A number of investigators have found in these a much-increased excretion of nitrogen,

and this albumin destruction does not occur in the simple anæmias. Anæmia of itself causes no increase of destructive metabolism, and when this occurs then some other agents must be at work. These agents can hardly be conceived as other than poisons acting through the blood upon the cell activity of the organism. Again, a marked diminution of blood alkalinity is found only in the severe forms of anæmia, and never in chlorosis and the simple anæmias.

Köttnitz regards leucæmia as a chronic peptonæmia and offers an ingenious theory based upon this to explain the great increase in leucocytes. His views have not yet been substantiated by others.

**Hydrothionæmia.**—This condition is of especial interest because it furnished the first positive demonstration of gastro-intestinal auto-intoxication. In 1864 Betz, a German, in two cases with peculiar and violent gastro-intestinal symptoms, demonstrated the presence of  $H_2S$  in both urine and faeces, and regarded it as an evidence of intestinal putrefaction.

The name hydrothionæmia is applied to the  $H_2S$  poisoning which develops in the course of an acute gastro-intestinal derangement, and is associated with symptoms similar to those of  $H_2S$  poisoning in certain occupations. The condition is a rare one.

Lately Boas and others have found  $H_2S$  in some quantity in dilated stomachs, but never in the urine.

It is doubtful if the nervous and psychical disturbances associated with chronic constipation are to be referred to the toxic effects of the  $H_2S$  which is sometimes present.

**Acetonuria. Diæturia.**—The interesting condition of acetonuria is discussed in detail elsewhere under its own title.

The presence of aceton in the urine has been demonstrated in a great number of different conditions which seem to have no relation to each other, and it has now become evident that acetonuria, in most cases at least, is rather to be regarded as a symptom than as a cause of disease. Even upon the origin of aceton there is not yet full accord. The weight of opinion, however, at this time, attributes its formation to abnormal metabolism of the albuminoids in the gastro-intestinal tract.

The presence of diacetic acid in the urine is usually of more serious import to the organism than is that of aceton, but here also there is much doubt as to whether it is to be regarded merely as evidence of abnormal metabolism or whether it itself is the source of an intoxication. It seems, in its origin, to be closely related to both aceton and  $\beta$ -oxybutyric acid.

**Cystinuria. Diaminuria.**—Cystinuria is a rare condition, the interest in which was greatly augmented by the discovery by Baumann and Udransky that in patients whose urine contained cystin there were also to be found in the urine bodies of definite chemical composition called diamins. From these could be separated two substances, penta- and tetra-methylendiamin, which were identical respectively with cadaverin and putrescin—bodies isolated by Brieger from putrid meat. These diamins, moreover, could be found as well in the faeces of these patients. Here, then, is an illustration of the actual excretion by the urine of toxic substances formed in the intestine. Since, as Brieger showed, the diamins develop only in certain definite putrefactive processes, it follows that in those suffering from cystinuria certain specific decomposition processes must occur to give rise to the diamins.

Diaminuria is found only in connection with cystinuria, but the cystin in these cases has not been found in the intestines. Whether or not the diamins have a toxic action upon the organism is not known. Cystinuric patients suffer from various symptoms, and it is possible that some of these may be dependent upon the formation and absorption of the diamins.

**Oxaluria.**—There is still some doubt concerning the origin of oxalic acid in the body, but it is probably an intermediate product of carbohydrate metabolism which, under normal conditions, is promptly further changed into  $CO_2$  and water, but which under pathological con-

ditions may be formed in excess or may not be properly transformed. Under these circumstances it will appear in the urine. Cantani believes oxalæmia to arise from excessive starch or sugar decomposition, and from this a distinct clinical picture to result which is characterized by emaciation, furuncles, abscesses, etc. He regards oxaluria as analogous to glycosuria and as having originated in the same way. There is, without doubt, some relation between diabetes and oxaluria, for not only are they frequently associated, but glycosuria and oxaluria have been known to alternate in the same individual.

The appearance of small quantities of the oxalates in urine does not indicate an anomaly of metabolism. When large amounts are present regularly, however, there must be some serious derangement of the processes of nutrition, and the oxaluria may perhaps then be the expression of a definite auto-intoxication.

**The Poisons of the Urine.**—Normal urine, which for a long time was believed to be not toxic, is now known to be distinctly poisonous, and this toxicity is ascribed in large part to the salts of potassium. These salts alone, however, do not make up the entire toxicity, since the urine itself is found to be more poisonous than the urine ash, and urine rendered free from potassium is still toxic. This unknown, organic "urotoxin" has been earnestly sought for. Bouchard gave to this search fresh impetus by the introduction of his method of measuring the toxicity of urine. This consisted in the intravenous injection of urine into animals and the determining of the amount necessary to produce death. The amount needed to kill 1 kgm. of animal was made the unit of toxicity or "urotoxy." In this way he could study and compare the different "urotoxic coefficients"—that is, the number of urotoxies which 1 kgm. of man can form in twenty-four hours. This coefficient in normal individuals averaged 0.464, and in pathological conditions varied between 0.1 and 2.0.

Bouchard found in urine at least seven distinct poisons, including a narcotic, a sialogenous, a convulsive, and a myotic one. He found the urine toxicity to be independent of its concentration, and found that in pathological states the toxicity was usually but not always increased. These methods of Bouchard, which have been very extensively employed in France, are far from being wholly satisfactory, and the reliability of his results and conclusions have been questioned, especially in Germany, where much more exact methods have been employed.

Recently much attention has been paid to the organic poisons of the urine, and a number of alkaloid-like bodies have been isolated whose source Bouchard believes to lie in the putrefactive products of the intestines. It seems probable that these toxins are to be regarded not as the products of specific diseases, but rather as the cleavage products of albumin which appear in the urine when for any reason there is an excess of nitrogen excretion. It seems doubtful if the organic disease poisons themselves often appear in the urine. Their composition is so complex and unstable and they take such an active part in metabolism that they are likely to be broken up before reaching the kidneys.

It must be admitted that up to the present time the poisons of the urine have furnished little positive proof in support of the theory of auto-intoxication.

The subject of uræmia will be dealt with under its own title.

**AUTO-INTOXICATIONS OF HEPATIC ORIGIN.**—In spite of the many advances that physiology has made in the elucidation of the many functions of the liver, not all these are yet clearly understood.

As to the derangements of the biliary function, we must distinguish sharply between a cessation of bile formation (acholia), and the obstruction and the retention in the liver of the already formed bile (hypercholia).

The effects of the latter condition upon the organism are well understood, and depend—

1. Upon the failure of action of the bile as a digestive secretion, and
2. Upon the reabsorption of the bile into the blood



through the lymph vessels of the liver. Contrary to the view of Bouchard, it is now generally believed that the bile pigments are comparatively harmless and that the bile salts are the more actively toxic agents.

The group of severe nervous symptoms seen in grave disease of the liver and known as cholemia depend, in all probability, however, not upon a poisoning by bile salts from hypercholia, but rather upon the serious metabolic changes caused by cessation of the bile-forming function, and probably at the same time cessation of the other functions.

That part of the urea formation of the body which takes place in the liver (the so-called "Schroeder's portion") is formed from ammonium carbamide, which is a destructive product of the albumins and the amido acids. In severe disease of the liver this "Schroeder's portion" of urea is usually lacking, and the unused ammonium carbamide is in part changed to ammonium carbonate.

The introduction of ammonium carbamide into the blood of an animal produces symptoms very closely corresponding to those which follow total extirpation of the liver.

The liver seems to prevent the entrance into the systemic blood of these toxic substances which are intermediate steps between albumin and urea, *i. e.*, leucin, glycocoll, the amido acids, and especially ammonium carbamide.

Insufficiency of the liver function, then, always favors the development of auto-intoxications from the gastrointestinal tract.

**Acute Yellow Atrophy. Cholemia.**—The ultimate cause of acute yellow atrophy, except in cases of phosphorus poisoning, is still entirely unknown. Whatever it may be, there can be little doubt that the symptoms depend upon the failure of the liver to exercise its functions in converting or rejecting the many toxic products of digestion carried to it by the portal vein. We therefore have a typical example of auto-intoxication occasioned by the failure of function in a particular, and in this case a most vital, organ of defence. As a result of the failure of liver functions, the blood is flooded with substances which normally are not found there. Among these, leucin and tyrosin are the best known. It is probably no single substance, but the sum of all the foreign substances circulating in the blood, which gives to the disease its clinical picture.

The appearance in the urine of leucin, tyrosin, and other foreign bodies, and the great diminution in the excretion of urea, are exactly what might be expected from cessation of liver activity. The irritation of the kidneys by these foreign bodies may well render their excretion less complete, and so complicate still further the situation. Moreover, since urea is an active diuretic, its great decrease may have the effect of still further impairing renal activity.

**Diabetes.**—Not the least important function of the liver is to arrest the sugar carried to it and to convert this into glycogen. The liver is not a perfect filter, however, and even under normal conditions a small quantity of sugar gets past the barriers and so reaches the blood. When sugar is formed in the intestine in amounts greater than normal, more of it is apt to escape the liver filter, and when this sugar in the blood reaches a certain amount it makes its appearance in the urine and thus is produced an "alimentary" glycosuria. Sugar in the blood possesses marked toxic properties, and seems especially to be a "protoplasm poison," leading in all severe forms of diabetes to vastly increased tissue destruction, to excessive albuminous metabolism, and to high nitrogen excretion. Whatever its cause, therefore, diabetes is still a typical example of an auto-intoxication.

Since destruction or extirpation of the pancreas is so regularly associated with severe diabetes, it is evident that the pancreas must have for one of its functions the regulation of normal metabolism much as has the thyroid gland.

With the failure of this sugar-controlling function of the pancreas the liver is quite unable to arrest all of the

excess sugar carried to it, and the filter becomes altogether inadequate. The nature of this regulating function is entirely unknown. It may possibly depend upon a ferment.

**Addison's Disease.**—The modern theory, which regards Addison's disease as an auto-intoxication caused by failure of the specific function of the adrenals, while still lacking in direct proofs, has yet some interesting facts to support it and is gaining general acceptance. This view holds that the adrenals exercise some control upon the processes of metabolism whereby the action of certain toxic substances is neutralized or the bodies are converted into harmless ones. Just as the thyroid seems to have a regulating effect upon the mucin formation of the body and the pancreas upon sugar formation, so the adrenals have a specific influence upon the conversion of one of the most widely distributed nitrogenous, organic substances in the body, namely neurin.

**AUTO-INTOXICATIONS OF THYROID ORIGIN.**—The recognition of the relation between myxœdema and cretinism and the atrophy or destruction of the thyroid gland; the discovery that total extirpation of the thyroid was regularly followed by those cretinoid manifestations known as cachexia strumipriva, and the results of the treatment of myxœdematous conditions by thyroid extract, have served to throw much light upon the hitherto little understood functions of this ductless gland. It can now scarcely be doubted that the thyroid exerts some form of controlling action upon the products of digestion whereby complete assimilation is brought about. It completes the conversion of the absorbed foods and destroys certain unfinished toxic products of metabolism, in particular the mucin. The exact method of its action is not clear. It may be that by its cell activity the thyroid transforms into harmless bodies certain toxic ones brought to it by the blood, or that it generates a particular product which upon entering the circulation neutralizes the effects of certain poisons. It is possible that it may combine both of these functions. In any case, cretinism, myxœdema, and cachexia strumipriva must be regarded as auto-intoxications due to failure of function of a particular organ of defence.

In **exophthalmic goitre** we have a clinical picture which in many respects is the direct antithesis of that of myxœdema; furthermore, as Greenfield has suggested, the histological appearances are those of an organ in active evolution; finally, the poisonous symptoms produced by too large doses of thyroid extract bear a striking similarity to those of exophthalmic goitre.

These facts have naturally led many to the belief that Graves' disease is the result of a morbid activity of the thyroid gland; and although there are some contradictory facts still to be explained, this theory is the one now very generally accepted. Regarding the nature of the auto-intoxication, two views are held: one, that by some anomaly of function an abnormal and toxic secretion is formed; the other, that the symptoms depend upon the production of the normal secretion *in excessive amount*. The latter view seems at present to be the more plausible one.

It must be added that another hypothesis which has recently gained some adherents attributes the condition to an auto-intoxication of gastro-intestinal origin. One experimental fact seems to offer support to this view. Hürthle has found that by inducing jaundice through ligation of the gall duct in animals, a change in the activity of the thyroid was regularly produced whereby an excessive development of colloid resulted.

**THE AUTO-INTOXICATIONS OF PREGNANCY.**—The hypothesis which sees in many of the disorders of pregnancy the manifestations of a poisoning of the organism by the products of its own metabolic processes has much that is attractive and plausible in it, and in the case of certain affections, especially in that of eclampsia, can summon to its support a considerable number of very significant facts.

It has been clearly shown that during normal pregnancy an increased amount of work is put upon the

various organs of the body, and especially upon those concerned in the processes of metabolism and elimination.

The increased demand upon the organs can under perfectly normal conditions be met satisfactorily, and we see women go through their period of gestation with scarcely a single departure from the state of perfect health. These increased demands, however, are prone to bring to light any inherent weakness in an organ which in the non-pregnant state may perhaps be capable of performing its functions most satisfactorily.

Among the organs of defence which are likely in pregnancy to manifest evidences of insufficiency, the liver and kidneys stand alone in point of importance. The liver in particular seems especially liable to fail in the performance of some of its manifold functions.

In the symptoms which, with greater or less reason, have been ascribed to auto-intoxications, are included the obstinate vomiting, salivation, insomnia, peripheral neuritis, the psychoses of pregnancy, bronzing of the skin, pruritus, jaundice, eclampsia, and acute yellow atrophy. In connection with salivation it is interesting to recall that one of the poisons found by Bouchard in normal urine was a powerful sialogogue.

**Eclampsia Gravidarum.**—The urine of eclamptic patients has been found to be much less toxic than that of other pregnant women, while the blood serum, on the other hand, is distinctly more poisonous than that in normal pregnancy. There can be no doubt, therefore, that in the blood of eclamptic patients there is an accumulation of poisonous substances. These in all probability are not the end products of destructive metabolism, but rather the intermediate products which have gained the circulation because of failure on the part of some organ to convert them into useful, or at least harmless, bodies. In other words, eclampsia presents every evidence of being a severe auto-intoxication.

While certain cases of eclampsia may be identical in nature with uræmia, there is much evidence to show that in many, and perhaps in most cases, the two conditions are quite distinct.

Within the past few years many investigators have called attention to the association of severe hepatic lesions with the manifestations of eclampsia, and it cannot be doubted that some at least of the severe anomalies of metabolism found in this condition are due to derangement of the liver functions. In some cases the liver has shown post mortem the typical appearances of acute yellow atrophy; in others those of hemorrhagic hepatitis; in others still, many necrotic areas have been found. Schmorl reports a series of seventeen cases, in every one of which serious changes in the liver parenchyma were found post mortem. These consisted usually in necrotic areas of hemorrhagic or anemic character. Macroscopically the livers presented somewhat the appearance of acute yellow atrophy.

Stumpf suggests that the liver disturbances are of secondary nature, and that the origin of the poison may lie in the fetal organism. Under the influence of this unknown poison there is, he believes, an interference with the formation of urea. As a result of this, abnormal products of metabolism reach the blood and furnish a source of irritation to the kidneys, which, in turn, become insufficient and fail properly to eliminate these noxious bodies. The resulting abnormal condition of the blood acts also as a poison to the liver cells, and the failure of function of these precipitates the eclamptic attack through action upon the central nervous system.

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In an article such as the present one it is impracticable to give specific references for all the many assertions made therein. While numerous sources of information have been utilized, most of the statements contained are based upon those found in the following publications:  
Bouchard: Lectures on Auto-Intoxication in Disease. English edition, 1894. F. A. Davis Co., Philadelphia.  
Albu: Ueber die Autointoxicationen des Intestinaltractus, 1895. Hirschwald, Berlin.  
Vaughan and Novy: Ptomains and Leucomains. Third edition, 1896. Lea Bros. & Co., Philadelphia.

G. Bouffe de Saint-Blaise: Les auto-intoxications de la grossesse, 1899. Baillière et Fils, Paris.  
Bickel: Die Pathogenese der Cholemie, 1900. Bergmann, Wiesbaden.  
Of these, the work of Albu has proved especially valuable, and to it those readers who desire more detailed information are referred.

**AUTOMATIC ACTIONS.**—By the term automatic actions, as applied to living bodies, we mean those movements which go on without any outside stimulus, the causes being in the body itself. For the sake of understanding them more clearly it is necessary to divide them into certain classes, which, so far as the higher animals are concerned, are as follows:

1. **THE AUTOMATIC ACTIONS OF VEGETATIVE LIFE.**—Under this head we have: (a) those of the respiratory neuro-mechanism; (b) those of the cardiac neuro-mechanism; (c) those of the vaso-motor neuro-mechanism; (d) the rhythmical movements of the stomach, intestines, spleen, and bladder.

The automatic actions in these classes may be modified by voluntary or other extrinsic influences, but they are, nevertheless, essentially independent of them. Thus the respiratory movements may be modified by volitional impulses, but they in the main go on rhythmically and independently. The mechanism of this process of automatism is well illustrated in the cardiac movements. The pulsations of the heart depend upon the stimuli rhythmically sent out by the intrinsic ganglia. The cells which originate these stimuli receive no excitation themselves except that furnished by the aliment from the blood. This aliment is constantly building up these motor cells into a more and more unstable condition. When the instability reaches a certain limit, the cell decomposes or explodes with a discharge of its force, after which it immediately begins to build up into instability again; and so the process goes on. This explanation applies to all the rhythmical automatic movements of vegetative life. The movements are performed by unstriated muscles, or the muscles of internal relation.

2. **THE AUTOMATIC ACTIONS OF VOLUNTARY LIFE.**—A second and much more striking class of automatic activities includes those involving voluntary muscles and the mind. They appear in various forms and in varying complexity according to the part of the nervous system which they involve. They may be divided as follows:

(a) **The Motor Automatism.**—The harmonious movements of the eyes, the muscular adjustments called forth in the use of the voice, and of the jaws, mouth, and throat in suckling, are illustrations of motor automatism. The movements of the body and limbs in standing, sitting, walking, and in the various acquired dexterities, such as those of dancers, players, jugglers, acrobats, and skilled artisans, all are done automatically. Being, in man, acquired by practice, they may be spoken of as secondary automatic actions. They have for their anatomical substratum certain arrangements of nerve fibres and cells in the cerebellum, basal ganglia, and spinal cord. The conscious mind, though taking no active share, first fathered them, and stands in ready connection with them. It starts or stops the machinery, just as by touching the pendulum we start or stop a clock that has been wound. Physiology teaches also that all voluntary acts tend by repetition to become automatic. For voluntary movements, by repetition, are more and more easily and quickly performed, until at last they no longer possess the elements, such as duration and intensity, necessary to arouse consciousness, and they are then done automatically.

(b) **Psychical Automatism.**—There is another class of automatic activities closely related with the foregoing. Here volition and normal consciousness have no share at all, and the whole psychical life, so far as it appears at all, is automatic. The mind becomes a real machine, working in certain established grooves, unmodified by any volition or by any external or internal stimulus except such as gives it the start; just as the boy trims the sails and fastens the rudder of his toy boat, then launches it to sail as its mechanism directs.

This psychical automatism is represented in lower ani-