THE JOURNAL OF MENTAL SCIENCE.

[*Published by Authority of the Medico-Psychological Association of Great Britain and Ireland.*]

No. 184. NEW SERIES, No. 148. JANUARY, 1898. VOL. XLIV.

PART I.—ORIGINAL ARTICLES.

Flechsig on the Localisation of Mental Processes in the Brain.

By W. W. IRELAND, M.D.Edin.

Two Treatises* recently published contain the views of Professor Flechsig, of Leipzig, upon the present state of our knowledge of brain function. The first is in the form of an oration delivered in 1894 in the University Church of Leipzig, of which a new edition appeared last year. The second is a shorter pamphlet, which contains an account of the most recent researches in the structure of the brain. In the oration the notes occupy three times the space of the text; in the other treatise the notes are not so long. In both these notes are important, and form in some passages the most interesting part of the work. He holds that the time has now come when the old introspective psychology must turn for guidance to anatomy and physiology. It is only within the last few years that such claims could be entertained. The localisation of mental operations in the brain was made by Hippocrates from observations of the loss of function caused by diseases or wounds of the head. Polybos, the son-in-law of the great Greek physician, held that the brain was the centre of the nerves and the central organ of the thinking soul; and Erasistratos, of Alexandria, first taught that the superior intelligence of man depended upon the greater size of the human brain, and the more complicated structure of the convolutions. A new era began with the experiments of Fritsch and Hitzig in our own day. Since then experimental physiology and clinical observations,

* *Gehirn und Seele*, von Dr. Paul Flechsig, Professor der Psychiatrie an der Universität, Leipzig. Verlag von Veit und Comp, 1896. Octavo, pp. 112.—*Die Localisation der Geistigen Vorgänge insbesondere der Sinnesempfindungen des Menschen*, von Dr. Paul Flechsig. Leipzig, 1896. Post octavo, pp. 88.

going hand in hand together, have led to the accumulation of a large fund of knowledge about the several functions of the nervous centres. Another path of discovery was opened by Golgi through his new method of differentiating the finer structure of the grey masses of the brain by his silver colourings; and also by Kölliker, who, working with low powers, was able to demonstrate the course of the motor and sensory nerve paths and of the association system in the brain.

Dr. Flechsig gives to Gall the credit of an incomparable advance in brain physiology, as he showed that the convolutions of the brain formed the most important substratum of mental activity. In my opinion this praise is little deserved. What Gall did was to make a pretty comprehensive list of the mental faculties and to locate them on all those portions of the hemispheres under the outer surface of the skull, wholly leaving out of consideration the gyri opposing one another in the great longitudinal fissure, and also those lying on the floor of the cranium. Gall, Spurzheim, the Combes, and other preachers of phrenology kept up a noisy and futile controversy which lasted for two generations, and led many away from the truth. The only one of Gall's guesses which survived was the localisation of the orbital part of the anterior lobe for the faculty of language, which was put upon a scientific footing by Dax and Broca. Dr. Flechsig observes that Goltz's vivisection upon dogs went to show that the extirpation of the cerebrum was followed by the loss of all mental manifestations. The dogs which survived removal of the hemispheres lost all memory and judgment, and were incapable of seeking out objects to gratify their wants; but they could still run about and hold themselves upright. Under the stimulus of pressure, very bright light, and loud noises, they executed movements which we are accustomed to associate with discomfort and pain. A dog thus mutilated bites and howls when lifted up in the air, and when kept without food the whole body appears in unmistakable disquiet. After being fed he falls into a state of rest and apparent satisfaction, continuing in what appears to be a dreamless sleep till aroused by new stimulation. These observations show clearly the power and independence of the bodily impulses; they teach us that many actions have absolutely nothing to do with the mind. Many of such observations hold good for the human species. Take the case of the new-born child; he comes into the world with a brain quite immature. The axis-cylinders of the nerve

fibres have scarcely formed, and the chemical structure of his brain is different from that of the adult, yet the animal impulses show themselves with the first breath, and through his cries he seeks the gratification of his wants which are those needful to sustain life. When such wants are appeased, and he is left undisturbed, the outward manifestations of consciousness are suspended. The feelings of hunger and thirst in the infant do not appear to differ much from the need of respiration excited by chemical alterations in the blood acting upon the medulla oblongata. Dr. Flechsig observes that only one-third of the human brain stands in direct relation with the nerve-tracts which convey the excitations of the periphery of the body to the grey matter, the seat of consciousness, or which conducts the returning impulses to the muscles, enabling the mind to direct voluntary movements. The other portions of the brain have to do with the operations of the intelligence and will. In the study of the histological development of the infant's brain Dr. Flechsig finds the key to the evolution of the mental faculties. He assumes that the nerve-tracts do not exercise their functions until the axis-bands are formed, and these are developed independently in different parts of the nerve centres. These tracts, known to be the paths of conduction of the senses, first show the axis-band. To make this plain we must translate several of Dr. Flechsig's pages, principally from the smaller and newer treatise upon cerebral localisation. The author remarks that he is unable to make his views clear without illustrations, of which there are several beautiful coloured lithographs at the end of the Oration. Of these the first three plates show sections of the brains of new-born and young children. The next two plates give a diagrammatic representation of the sensory and motor areas of the brain, the paths of conduction and the association centres. We reproduce all the engravings in the smaller treatise, only altering the German names for their Latin or English equivalents, and must refer our readers to the original works for the coloured plates.

One of the chief achievements in working out the anatomy of localisation of the brain functions is the complete demonstration of the paths of sensory conduction from their entry into the encephalon to their termination in the cortex. These paths of sensory conduction of all the fibres in the white substance of the brain are the first to appear in a matured condition, that is showing axis-bands. In the brain of the fœtus and

of the new-born child these tracts appear quite isolated. One can easily distinguish their course and the areas of the cortex with which they come into connection. These observations derive confirmation from Türk's methods of observation, which consist in tracing downwards the secondary degenerations following upon local inflammation of the central area of the brain. We here give a sketch of what is known of the spinal paths of sensory conduction.

1. *The Posterior Roots of the Spinal Cord.*—The first sensory paths of conduction appear in the posterior roots of the spinal cords and the oblongata. In the white substance of the brain the first mature nerve fibres are exclusively prolongations of these posterior roots.

The posterior roots are the conductors of those organic sensations which do not depend upon the sympathetic, and also of the impressions transmitted from the skin, those of touch and temperature. For a long time clinical medicine was not able to make out from the study of inflammations in the cortex what areas were connected with sensory and organic sensations. There is an important observation mentioned in all the text-books of the connection of the inner capsule with derangements of sensibility, which goes by the title of Türk's hemianæsthesia. This form of disease occurs in two principal forms, a simple, and a complicated one. In the simple form there is a suspension of the sensibility and the organic feelings connected with the motor approaches, the so-called muscular sense and the feeling of pain in all outer parts of one half of the whole body, including the cavity of the mouth and the sexual organs. The sensibility of the abdominal viscera to pressure is generally maintained, because these organs, reaching into the middle line, have relations with both sides of the brain. As Türk observed, and Charcot particularly investigated, these symptoms are frequently accompanied by anæsthesias of the higher senses, deafness or difficulty of hearing in one ear, hemiopia, loss of taste and smell on one side. The simple form of Türk's hemianæsthesia, in which only the functions of the posterior of the spinal cord are suspended, is observed to follow lesions of the posterior portion of the inner capsule, or the neighbouring foot of the corona radiator. This forms a part of the *carrefour sensitif* of Charcot. It is worthy of note that from injury to no other region of the cortex does there follow so lasting and so deep a hemianæsthesia of the posterior roots as from injury to

the said part of the inner capsule. Well, in studying the history of the development of the nervous system we find that the inner capsule is precisely the portion of the brain in which we first recognise fibres with axis cylinders in the fœtal brain. This can be very clearly demonstrated. In the course of development the strand of conduction separates into three systems of fibres of the inner capsule. I have named these No. 1, No. 2, and No. 3 (compare Figures 1-3).

A. The Sensory System, No. 1.—This occupies the upper half of the inner capsule close behind the area of the pyramidal path. It contains fibres with axis-cylinders developed about the beginning of the ninth month of fœtal life. Taking with it the bulk of the fibres of the basal portions of the lateral nucleus of the thalamus as well as fibres from the shell-like corpuscle, corpus testaceum, and from the fillet, this sensory tract runs into the grey matter of the median gyri which thus of all the cortex first receives excitations from the periphery of the body. This tract forms a flat strand of nerve fibres; its cross section through the medullary substance of the temporal lobe is indicated by a line running from before backward (1 1′ 1″ Fig. 1.3). A small bundle appears to go to the under part of the radiating optic fibres (1 ×). Whether this offshoot of System No. 1 goes to the visual sphere cannot be certainly made out; in any case we do not find fibres with the axis-band in any part of the temporal lobe at this stage of development, whilst in the optic tract single bundles containing axis-bands may be found in the basal part of the posterior brain (externally to and below the posterior cornu). These fibres may be followed nearly to the hinder portion of the lateral nucleus (L. K. × Fig. 1).

B. System, No. 2.—About a month later than in No. 1 there is observed in the inner capsule a second tract of nerve fibres which also grows out of the lateral nucleus of the optic thalamus, but more behind (compare Fig. 2) than No. 1, which last issues out of the basal part of the optic thalamus. This second tract of fibres passes into the centrum ovale to the same regions of the cortex as No. 1., *i.e.*, the lobulus paracentralis and the foot of the first frontal convolution; another portion of this tract takes a sharp turn (2, 2, 2,) inwards and comes into connection with nearly the whole length of the gyrus fornicatus. The posterior bundles (2, Fig. 1) enter the cingulum and run

towards the hippocampus major. About the time of maturity these said fibres, which issue from the upper and anterior rim of the inner capsule, are accompanied by another band which issues from the basal side, enters the gyrus circinatus (2‴) and finally reaches the pes hippocampi so that the whole lobus limbicus is connected with the lateral nucleus of the optic thalamus. The bundles of fibres which pass to the first frontal gyrus seem to come from the median centre (Luys) of the thalamus.

C. System, No. 3.—At a period varying from one to several months after birth there is to be found in the inner capsule a third system of fibres with axis-bands, which comes into connection with the lateral nucleus of the thalamus. This band of fibres passes from the anterior part of the lateral nucleus in the middle of the capsule; one portion of it goes directly to the foot of the third convolution; another portion takes sharp curves to reach the cortex. Some hundreds of these last mentioned fibres run forward from the neighbourhood of the pyramidal path into the fasciculus subcallosus, and mount at the anterior rim of the corpus striatum to the third frontal gyrus (3′); a second group runs through the anterior part of the inner capsule into the frontal lobe almost mounting to the vortex; it then wheels round so that some of the fibres reach the middle of the gyrus fornicatus (3); others reach the anterior half of the first frontal (3″), and others reach the foot of the second frontal gyrus.

All the ascending paths of nerve conduction which are continuations of the posterior roots of the spinal cord pass into the lateral nucleus of the optic thalamus, namely the chief part of the fillet strand (compare Table 2), the upper peduncle of the cerebellum (compare Table, Fig. 2 B), the posterior and lateral columns, and the longitudinal bundle of the formatio reticulares (compare Table, Fig. 2).

The fillet strand enters the ventral and posterior portion of the lateral nucleus, especially the posterior half of the ventral group of nuclei of Monakow; the basal bundles go direct into the inner capsule. The lateral nucleus of the thalamus, in my opinion, is also a gathering point in the course of the posterior to the cortex cerebri. Here lies everything together which goes from the thalamus to the cortex as well as the strands which do not end here. What remains over passes into the area which I have named the corpus testaceum (Schalenförmiger Körper), and the median

centre of Luys. The rest of the thalamus has nothing to do with the sensory paths of the posterior roots.

These results, gained from a study of development, are confirmed by pathological anatomy. In a case, which had lasted fifty years, of softening of both central convolutions, especially the posterior one, which had completely disappeared, there was found secondary degeneration of the upper crus cerebelli, the fillet strand, and the formatio reticularis. Besides the corpus testaceum, the lateral nucleus of the thalamus was visible, and especially at the places from which the fœtal System No. 1 arises. There was degeneration of the whole ganglion cells, so that pathology and the history of development agree in showing that the central gyri are related in part directly, but mainly indirectly, with the sensory nuclei of the posterior and lateral columns of the spinal cord. Destruction of the central gyri is often accompanied by loss of the kinæsthetic perceptions, so that the sense of situation and of the accomplished movements for the extremities and the mouth are deficient or entirely wanting.

In the skin, especially after small localised inflammations, there is a loss of the feeling of lighter contact and of the knowledge of the locality touched. As a result of injury of the arm region of the cortex, the middle of the central gyri, there is an incapacity to recognise the form of outward objects by touch.

Wernicke has shown that injury to the third frontal gyrus is followed by an incapacity to execute, or rather to recognise, the situation of the organs used in speech. The System No. 3, already described as leading to the third, and perhaps also to the first frontal gyrus, is distinguished from the sensory paths of the median convolutions not by a connection with the cutaneous sensories, but with the deeper parts of the body. The new-born child makes use of his limbs, lips, and tongue before he can co-ordinate the muscles of the trunk and the apparatus of voice. Accordingly we find that the sensory and motor nerve paths to the extremities are more early developed than those for the trunk and the special organs of speech.

The gyrus hippo-campi has been regarded as the terminal station for the muscular sense; but a careful study of the clinical cases has shown that this convolution has never been affected without the inner capsule and thalamus also showing lesions; besides Couty, an excellent observer, has

shown that in lesions of the deeper part of the inner capsule (in which System No. 1 comes in), disturbances of the kinæsthetic feelings have been observed.

No pure case of disease of the whole gyrus limbicus (gyrus fornicatus and hippo-campi) has been published. In a case reported by Saville there was total loss of sensibility on the opposite side, which soon passed away. Ferrier, Horsley, and Schäffer are all agreed that destruction of the gyrus limbicus in monkeys is followed by marked and persistent anæsthesia to the stimuli of touch and pain; thus the gyrus limbicus would be the terminal station of the conducting path for the impression of touch and temperature and common sensation, not for the whole conducting fibres, but for a considerable part of them which end in the central and frontal convolutions. To this region of the cortex, to which we trace the termination of the posterior roots of the spinal cord, Munk has given the name of sphere of bodily feeling (Körpersfühlsphäre). This area, no doubt, contains a number of sensory centres of different kinds, among which the touch sphere is of special importance; but we must hold in mind that the perception of touch demands the simultaneous exercise of different qualities of sensations. This sphere of bodily feeling is not exclusively connected with sensory conducting tracts; it forms the starting-point of numerous motor paths which lead in a centrifugal direction. One group of these issues from the brain by the crus cerebri; another is connected with the lower centres through the thalamus and the tegmentum. The nerve tracts belonging to this sphere of bodily sensation form about four-fifths of the diameter of the crus cerebri, including millions of nerve fibres. In their development they show an arrangement similar to that of the sensory system in the inner capsule. The pyramidal path in System No. 1 is the only direct conducting tract from the cortex to the cells of origin of the motor nerves coming from the bulb and spinal cord.

Whether there is a motor tract corresponding with System No. 2 our knowledge of anatomy and development does not yet enable us to say.

Most of the paths which lead from the sphere of bodily sensation pass into a region which cannot be shown to stand in a relation to the posterior roots of the cord. These are known in the older nomenclature as the inner nucleus and the pulvinar. Dr. Flechsig, in conjunction with

Tschisch, named this the chief nucleus (Hauptkern); he now proposes as a more handy term the dorso-median nuclear group (dorso-medial Kern-gruppe). This group occupies the whole thalamus with the exception of the lateral nucleus, the corpus testaceum, and the median centre, as well as that structure which the learned professor has designated as the ventro-lateral nucleus group. It seems probable that cortico-petal fibres lead into this ventro-lateral group while centrifugal fibres pass into the dorso-median group; however, it is difficult to separate those two groups of nuclei in dorsal and fore region of the thalamus. Each part of the dorso-median groups of nuclei is connected with one particular region of the cortex; the anterior nucleus with the lobus limbicus with the cornu ammonis through the fornix with the corpus mammilare and the bundle of Vicq d'Azyr; the inner nucleus in its outer dorsal part is connected with the median gyri, and on the inner part with the foot of the collective frontal gyri and the corpus striatum. The pulvinar has nothing to do with the spheres of bodily sensation: it is exclusively connected with the visual area and perhaps with the auditory one.

The significance of these anatomical details would be clearer if we could fully demonstrate all the peripheral connections of the dorso-median nucleus group of the thalamus. Within the sphere of bodily feeling are included the motor regions of the cortex.

It would appear from the experiments of Horsley and Beevor on the cortex and internal capsule of the orang-outang that only those tracts answer to electric stimulation which lead to the crus cerebri, the paths of voluntary motion. This sphere of bodily feeling has also relations with the respiratory muscles, including those of the abdomen and to the circulating system comprising the pulse beat, the dilatation and contraction of the vessels, and the regulation of the bodily temperature. It is to be presumed that in the cortico-petal path of the sphere of sensation there are paths of conduction which convey to the reach of consciousness organic sensations from every part of the body, feelings of thirst and of well-being, and changes in the respiration and circulation as well as the state of contraction of all the voluntary muscles. Dr. Flechsig considers it likely that this sphere of sensation has to do with the increase or diminution of muscular motions attending the expression of the affections and passions, but he feels unable to indicate

by what paths these muscular innervations are conveyed from the cortex to the optic thalamus.

2. *The Olfactory Nerve.*—According to Edinger the sense of smell is first manifested in the vertebrate animals. This does not answer the expected correspondence between the ontogeny and phylogeny of man, for in man the nerves of common sensation become developed before the nerves of smell, and the nerves of smell before those of vision. The olfactory tract contains axis-bands about the end of the ninth month. The frontal part is developed more easily than the posterior part. The olfactory tract is directly connected from all parts with the cornu ammonis, which has, no doubt, something to do with the perception of smell. Besides this the olfactory sphere has connections with the globus pallidus of the nucleus lenticularis, and with the thalamus. Perhaps they furnish cortifugal reflex paths.

The author is unable to indicate the locality of the sphere of taste; he thinks it should be sought for at the edge of the sphere of bodily sensation or of the olfactory sphere.

3. *The Optic Nerve* shows fibres with the axis-cylinder in the middle of the tenth month. At this period fibres may be traced directly from the outer corpus geniculatum externum, and thence to the anterior corpus quadrigeminum. From the corpus geniculatum externum a large bundle goes to the pulvinar of the thalamus, which might appear to be a direct continuation of the optic tract. This bundle reaches the cortex of the calcarine fissure; it can be very easily shown in the brain of the new-born child as a strand, with axis-cylinders passing into the occipital lobe.

In the fœtus the axis-bands are first developed in connection with the macula lutea. In the child born at eight months the axis-band fibres are not complete, but at nine months the eye is mature for vision. From observations upon a fœtal brain the professor is inclined to think that it is only the fibres of the macula lutea which are in direct connection with the outer geniculate body, and that it is the peripheral fibres of the retina which go directly to the anterior corpus quadrigeminum and to the thalamus.

Gratiolet's optic tract contains within its circuit many fibres which have other functions than those of vision. Dr. Flechsig holds that the visual sphere embraces the whole inner mesial surface of the occipital lobe and a narrow zone on its convex aspect in the region of the first occipital gyrus up to the parieto-occipital fissure. It is even ques-

tionable whether all parts in this area subserve visual perception. These anatomical data, gained through the study of development, are confirmed by the critical examination of secondary degenerations. Softening which exclusively affects the region of the calcarine fissure is followed by degeneration of the fibres of the occipital lobe and of the thalamus to the anterior corpus quadrigeminum. The corpus geniculatum externum can be found degenerated in all its parts. The pulvinar shows a partial degeneration. The degeneration is more extensive the more the primary lesion affects the part of the visual sphere behind the calcarine fissure. Dr. Flechsig holds that the gyrus angularis has nothing to do with vision.

4. *The Auditory Nerve.*—The fibres of the auditory tract are developed last of all the sensory nerves, though they afterwards take the highest place in the intellectual and emotional life of man. The nervus cochlearis through the lateral fillet and a few fibres of the fornatio reticularis connects itself with the lower corpus quadrigeminum and the inner corpus geniculatum to reach the temporal lobe. The path of the auditory nerve from the cochlea to the cortex has now been clearly made out. Clinical observation has shown that a defined region of the temporal lobe is in intimate relation with hearing. Sensory aphasia, or the perceptive form of word deafness, is dependent upon the lesions of the first temporal gyrus coming from before backwards. Naunyn has more strictly defined this auditory area as embracing the third and fourth fifth of the superior temporal gyrus counting from before backwards. Monakow has recently shown that destruction of this part is followed by degeneration of the inner corpus geniculatum through its whole extent. It has been found in the two months' child that the fibres appear in the inner corpus geniculatum sooner than in any other parts of the occipital lobe, from which it is inferred that it is those two hitherto neglected cross gyri of the temporal lobe which form the auditory sphere, especially the anterior cross convolution (see Plate, Fig. I.). Both these cross convolutions lie hid in the depth of the Sylvian fossa, but they are connected with the first temporo-sphenoidal, of which they indeed form the roots. They lie between the posterior rim of the insula and the free outward part of the first temporal. In all observed cases of complete deafness following destruction of the cortex in both sides, the area of these cross convolutions

was found injured on both sides, and also in cases of one-sided deafness or difficulty of hearing there were found abscesses on one side or injury to the nerve fibres radiating from the same region. Dr. Flechsig also describes a special motor system of nerve fibres connected with the auditory sphere which passes down to the outer bundle of the crus cerebri.

The nervus vestibularis does not appear to be connected with the auditory sphere of the temporal lobe. It can be traced to the posterior roots of the oblongata, so that its terminal station may be looked for in the sphere of bodily sensation.

Feelings Not Localised.

Besides these definite sensory perceptions there are vague feelings, such as general unrest, following on the over-charging of the blood with carbonic acid, changes in the calibre of the vessels, the sexual impulses, and feelings of tension, and general distress, which cannot be localised in precise areas of the nervous centres. Dr. Flechsig observes that the axis-bands are found developed in the motor regions of the spinal cord, the antero-lateral columns, at a period of fœtal life when the posterior roots are still in an embryonic condition. In this respect there is a remarkable difference between the cortex cerebri and the medulla oblongata. In the grey matter of the brain the motor areas come to mature development, without exception, after the sensory areas. But though the motor columns of the cord are ready to take on their function, it does not appear what function they could perform while beyond the reach of outward excitation and central impulse. From observation on monstrosities, born without the higher portions of the brain, and from extirpations in animals, we may infer that some dull feelings are manifested in the lower ganglia and bulb; but for the waking consciousness and the arrangement of our sensations in space and time we are dependent upon the grey matter of the brain.

Dr. Flechsig holds that the exercise of the senses is absolutely dependent upon these defined areas of the cortex. Patients in whom the visual areas are destroyed are absolutely blind; patients after destruction of the auditory sphere on both sides are absolutely deaf. There is no functional substitution of these sensory perceptions to any other portion of the brain. The specific energies of the

special senses are only realised through the centres in the grey matter of the brain. Here it may be asked, with so decided a difference of function, can there be recognised any difference in structure? Dr. Flechsig replies that in the sensory spheres there is a characteristic difference both in the form and arrangement of the nervous elements. A practised observer, he says, can distinguish between a microscopic section, from the gyrus fornicatus from the visual area, the visual auditory and other sensory spheres, as well as between a piece of the liver and the kidney. In the gyrus fornicatus there is a special form of cell (the large spindle cell of Branca), which he has never found in any other part of the cortex. The sensory spheres are also distinguished by greater richness in the tangential cortical associating fibres to such an extent that on the surface of the gyrus circinatus in the sphere of bodily sensation the tangential fibre layer, and deeper down, a layer of white nervous fibres is observable to the naked eye. Dr. Flechsig observes that the optic tract, in the outer geniculate body, has a peculiar structure. It has granular layers, which are similar to those of the retina. Indeed the layers of the whole cortex have a resemblance to the structure of the layers in the retina. This supports the view, which I have suggested, that the retina is really a portion of the brain in which visual images may be realised. This view is strengthened by the history of its development. In the grey matter of the brain the visual sphere is the most complicated in structure; here Meynert counts eight layers, while the olfactory area has the fewest layers.

In support of these striking statements Dr. Flechsig has to combat the remark of Kölliker that the differences observed in the size, number, and situation of the pyramidal cells and the abundance and distribution of the nerve fibres with and without axis bands, are of little significance. He insists that this judgment is not borne out even by Kölliker's own book. He also blames Golgi for asserting that parts of the cortex having different functions show throughout the same structure. The Professor observes that the Italian histologist lays too much stress upon his method of staining preparations, and that if he had used aniline dyes he would not have denied the distinctive character of the giant cells of the central convolutions. It may be here observed that Dr. Flechsig uses his notes not only to explain his text by farther details, but to keep up a fusillade of controversy

against other neurologists. To reproduce these disputes would take up too much space on this occasion. Only about a third of the human brain stands in direct relation to the conducting paths which bring the impressions of the senses within consciousness and carry motor impulses to the muscles. Two-thirds of the brain have nothing directly to do with those operations; they have a higher office to perform. They are the regions of intellectual activity, the Think-Organs (Denkorgane). This region of the brain comprises the whole frontal lobe except a part of the third gyrus, the insula, the first and second parietal, the second and third temporal convolutions, except the inner polus temporalis, the occipito-temporal gyri, the second or third occipital, and almost the whole precuneus (see Plate, Fig. 1 and 2, the areas not dotted). All these convolutions mature later than the sensory spheres. A month after birth the Think-organs are immature, their fibres without the axis-cylinder, while the tissues of the sensory areas have fully developed quite independently of one another. Even in the third month these areas show such a poverty in the axis-cylinders that they can be easily distinguished from the other areas. Soon appear numberless associated fibres running from the other centres and connecting all parts of the brain together. Dr. Flechsig thinks that the ganglion cells of this mental region are the central organs for the association of ideas. The sphere of bodily sensation is much richer in association systems than the other sensory regions. The auditory and visual areas are only directly connected with the adjoining convolutions, but do not send any association paths, at least these are few. Thus each of these sensory spheres has a border zone of connection. In addition to this the sphere of bodily sensation sends numerous long bands of nerve fibres into the middle of the great association centres, especially a large one to the posterior one (see Fig. 1), that is to the outer surface and base of the temporal lobe. This band is distinguished from all others by its late development. It has probably to do with the voluntary or affective impulses of the mental conceptions. It is partly covered in by the fasciculus arcuatus, as Meynert has represented. The central convolutions are connected before with the frontal region, below with the insula, and sends association fibres into the sensation sphere, so that the central neurone of the association centres is closely connected with the border zones of the sensory spheres (see Plate, Fig. 1). The posterior and frontal mental centres

seem mainly to keep up connection one with another through the sensation sphere. Indeed, when we think of it, the realisation of impressions from all parts of the body is of supreme importance. It is the necessary prelude for the formation of the conception of the Ego, and is the only wholly indispensable condition for mental development, to which the other senses contribute without being absolutely requisite for the formation of a personality.

Man owes his mental superiority not only to the larger mass and surface of his brain, but also to his great posterior association centres, which enable him to associate all his conceptions with words, and then to clothe them in words. His capacity to utter these words rests upon the larger development of his third temporal gyrus, and also of a part of the sensation sphere, which last is not nearly so well developed even in the highest apes. How far the strong development of the frontal association centre contributes to the mental superiority of man will be appreciated when we better succeed in tracing the connections of this portion of the brain. It is to be noted that the capacity to combine the attention with personal motives for the regulation of conduct is generally lost in double-sided disease of the frontal lobes.* In disease of the association system lies the special cause of insanity. We find the association fibres altered in those mental derangements, the nature of which is clearest to us because the microscope, cell by cell, fibre by fibre, displays clearly the underlying alterations, and thus we can show what are the consequences for mental life when these tissues are more or less disorganised. The thoughts whirl through one another, the mind fashions strange images when stirred by the irritation of disease, and when morbid processes go farther the person loses the capacity to make use of the past and to foresee the consequences of his actions. These tissues are the chief bearers of what we call apprehension, knowledge, and experience, of what we call principles and the higher feelings, and in part also of speech, and all these capacities are swept away with one stroke, if through some intoxicating agent, the mental centres are deprived of their excitability.

* Flechsig observes that the height of the forehead depends partly upon the size of the sensation sphere, and this in its turn upon the size of the body. Thus the height of the forehead is no direct measure of the mental powers. The most important part of the brain for great mental performance seems to lie in the posterior regions.

It was Tuczek who in his monograph on Dementia Paralytica first showed the importance of the alterations in the nerve fibres in this disease. Of all forms of mental derangement general paralysis is the most instructive in showing the dependence of morbid mental manifestations upon brain lesions. In some cases the derangement is purely intellectual; another patient has the most senseless delusions of grandeur, with maniacal excitement; another is troubled by deep melancholia or hypochondria; another is the victim of fixed systematised delusions of persecution; other patients are visited by hallucinations, or circular insanity, or are simply affected by progressive indolence and want of judgment. These varying symptoms are no doubt partly dependent upon born constitutional proclivities, and also upon the exciting causes which have brought the disease to a head, syphilis, or mental excitement, or drunkenness; for the most part, however, these variations in the clinical symptoms depend upon a lesser or greater power of resistance in different parts of the brain, so that the disappearance or dissolution of numerous nerve fibres, and occasionally, too, of nerve cells, is greater or less in different regions of the brain. Sometimes the dissolution of the nerve fibres affects the association centres of the fore brain, of the insula, or of the hind brain. Professor Flechsig thinks that the variations in the mental symptoms may thus be explained. He regards the disappearance of the association fibres as the essential lesion of general paralysis. Other lesions, such as the inflammation of the membranes, the extension of the inflammation of the substance of the brain to the medulla and the hydrocephalus internus and externus he regards as more or less incidental.

In some cases Professor Flechsig thinks that he has succeeded in separating the simple affection of the association fibres from these complications, and has thus been able to observe a group of symptoms which may be regarded as the result of the deranged activity of the frontal lobes. The patient loses a proper sense of his own personality; confounds me and thee, mine and thine; cannot distinguish the false from the true, and is prone to yield to his affections and passions. In the end dementia supervenes, when he loses the sense of what he has been, and of what he is.

The preceding *résumé* does not exhaust the interesting observations made by Professor Flechsig. With great

diligence and much ability he has sought to show how recent researches in the structure and development of the brain go to explain its high functions. In fact, after going through his demonstrations we do see more clearly how the mechanism of the brain renders it fit to be an instrument of feeling and thought. Nevertheless, through the dead brain we cannot understand the living mind in all its wonderful powers, capacities, and receptivities. Of the internal vital processes accompanying the working of the mind we know scarcely anything. Professor Flechsig, indeed, remarks, that as consciousness will not persist for a moment when the supply of arterial blood-bearing oxygen to the brain is interrupted, we may infer that a process of oxidation goes on between the blood and the nerve cells.

The controversy which has already arisen in consequence of the publication of these opinions is still in progress, and Professor Flechsig has lately replied to his critics. Early this year he intends to publish the further results of his researches and reflections, and we await his communication with great interest.

Atypical and unusual Brain-Forms, especially in relation to Mental Status: A Study on Brain-Surface Morphology. By W. JULIUS MICKLE, M.D., F.R.C.P. (London).

(*Concluded from page 803, October, 1897.*)

CHAPTER XIII.

Continuing the *recapitulation,* begun in the last chapter (which dealt thus with the *more general* morphological states), we next resume in brief the several Chapters, III to VIII, on

UNUSUAL OR ABERRANT MORPHOLOGICAL CONDITIONS OF INDIVIDUAL LOBES, GYRES, AND FURROWS.

Taking first the MESIAL SURFACE,

Sub-frontal fissure. Superorbital, and mesial frontal intragyral, sulci.

The sub-frontal fissure may present many deviations from more usual form. It may end, behind, at different points of the antero-posterior diameter in the two hemispheres. Its posterior upturn may be further forward or further backward than usual, relatively to the established landmarks;