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PART 1.—ORIGINAL ARTICLES.

The Structure of the Cerebral Hemisphere. By W. H. BROADBENT, M. D. Lond., F.R.C.P., Lecturer on Physiology, St. Mary's Hospital Medical School, &c.

THE dissections on which the following account of the structure of the cerebral hemisphere is founded, have been described in detail in a communication to the Royal Society. The results will be here given, without regard to the order in which they are reached, and with a view simply to clearness and comprehensibility.

I.—The Crus Cerebri; its constitution and relations with the Central Ganglia and Convolutions.

The crus as it enters the hemisphere is seen to be embraced on its inferior aspect by the optic tract, and when this is removed, by a set of fibres having the same general direction, which may be called "*the Collar of the Crus*" (*l'anse du pédoncle* of Gratiolet). It then spreads out rapidly into a fan-like expansion, the edges of the fan being forwards and backwards, the surfaces inward and outward, but sloping outwards, so that the outer surface looks downward, and is concave; the inner looks upward, and is convex. The anterior edge of the fan runs forward just to the outer side of the anterior perforated space; the posterior curves backward round the commencement of the descending cornu of the lateral ventricle.

When divided just in front of the pons, it is found to consist of two layers of fibres separated by the "locus niger."

The superficial layer seen at the base of the brain is composed entirely of white fibres; it contains the continuation upwards of the anterior pyramid of the medulla, largely re-inforced by fibres arising in the grey matter of the medulla and pons, some of which connect the motor nerve nuclei in the floor of the fourth ventricle with the higher centres, others *apparently* turning upwards from the middle crus cerebelli. This layer is called the "*Crusta,*" and constitutes the motor tract of the crus. The deeper layer, called the "*Tegmentum,*" continues upwards the sensory tract of the cord, and while consisting mainly of fibres, has a greyish appearance; with it passes upwards the superior crus cerebelli. The tegmentary division of the crus does not diverge from its fellow of the opposite side so markedly as the crusta, the two separating only at the posterior edge of the third ventricle.

The crusta and tegmentum can be separated from each other for some distance upwards as they spread out to form the fan-like expansion spoken of; but before they emerge from the central ganglia, the fibres of one sink in between those of the other, and they become mixed together so as to be no longer distinguishable. Anteriorly, however, near the tuber cinereum, a considerable number of fibres from the anterior edge of the fan formed by the tegmentum turn round the anterior edge of the fan formed by the crust to reach the grey matter of the extra-ventricular C. striatum, in which they end.

The destination of the fibres of the crus is various. It can be easily demonstrated that many pass through, or by the central ganglia, to the convolutions of the hemisphere proper. It is clear also that many fibres of both crust and tegment end in the grey matter of the corpus striatum, but apparently no fibres of either division end in the thalamus.

II.—The Central Ganglia: Thalamus and C. Striatum.

The thalamus and corpus striatum may be said to sit astride the posterior and anterior edge respectively of the fan formed by the crus as it expands, each having an intra-ventricular and an extra-ventricular division. The thalamus is much the smaller of the two ganglia, and may be said to be embraced by the C. striatum, which is also on a rather higher level. Both in structure and in their relations with the crus on the one hand, and the convolutions of the hemisphere on the other, there is a remarkable contrast between the thalamus and C. striatum.

The thalamus is mainly intra-ventricular, the extra-ventricular portion consisting only of a prolongation from the body of the ganglion which bends round the posterior edge of the crus, and curves forward in the roof of the descending cornu of the lateral ventricle, becoming pointed anteriorly, and terminating in the optic tract and collar of the crus. The intra-ventricular mass of the thalamus rests upon the tegmentum of the crus, from which it can be raised from behind, forwards and upwards, the diverging fibres of this part of the crus appearing to pass onwards beneath the ganglion without ending in it. It is possible that communication, by means of cell processes, exists between the radiating fibres and the overlying ganglion, bringing them into a relation equivalent to the direct termination of fibres in cells. This is one of the points awaiting determination by the microscope.

The thalamus consists of an admixture of fibres and grey matter, and presents a laminated arrangement as described by Mayo, but this is not always distinguishable. The fibres radiate outwards and upwards towards the convolutions, accompanying strictly the diverging fibres of the tegment on which they rest, and becoming intermingled with them. They are readily displayed by pushing outward the tœnia semi-circularis and the edge of the intra-ventricular C. striatum, when they are seen to form large distinct, round, cord-like bundles, diverging rapidly from each other, and leaving distinct intervals, which anteriorly are occupied by the soft grey matter of the C. striatum, and into which posteriorly dip slender bands of fibres which pass backwards from the pointed end of this body. Most of the fibres from the thalamus are thus distributed to the convolutions with those of the crus, but posteriorly a considerable mass curves backwards round the commencement of the descending cornu, and along the outer side of the posterior cornu to the occipital extremity of the hemisphere, quite distinct from fibres of the crus taking the same general direction.

The fibres of the extra-ventricular portion are distributed to parts which are not reached by any fibres from the crus. The anterior pointed extremity of this division of the thalamus gives off forwards. 1.—The optic tract. 2.—The collar of the crus. 3.—Laminæ of fibres to the apex of the temporo-sphenoidal lobe and neighbouring convolutions. The optic tract need not be

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described here.* The collar of the crus, *l'anse du pédoncle* of Gratiolet, is exposed when the optic tract is removed, and consists of fibres having the same general direction with the tract, and forming a groove in which it rests, derived posteriorly from the thalamus, and passing forwards closely round the crust, the most internal to the tuber cinereum, or to parts in the third ventricle, others to the internal grey nucleus of the C. striatum to be described later. The fibres passing to the convolutions of the temporo-sphenoidal lobe form a succession of thin laminæ which run forwards and outwards in the roof of the descending cornu, the first layer proceeding forwards to the apex, the succeeding layers taking successively a more outward direction to the infra-marginal convolution of the fissure of Sylvius at its anterior end. From beneath the last of the thin laminæ, curving forwards, as seen from the inferior aspect, appears a large mass of fibres, passing backwards to the occipital extremity of the hemisphere from the thalamus, crus, and C. striatum.

The corpus striatum differs altogether from the thalamus; the latter, as has just been described, does not appear to be a terminus for any fibres of the crus, but is a starting point for a vast number of new fibres, which go on to the convolutions; the former can be clearly seen to have many fibres of both divisions of the crus ending in its grey matter, and other new fibres arise in it, which are distributed to the convolutions; these are, however, few in number, when compared to the mass of grey matter, and radiate from two small points in the periphery of the ganglion.

The C. striatum sits astride of the anterior edge of the

* The relations of the optic tract with the thalamus and other parts are sufficiently interesting to be worthy of a brief note. Following it from the commissure backwards, it is first found that the commissure is very closely adherent to the tuber cinereum, and cannot be detached without breach of structure. Usually the commissure raises fibres which belong to the tuber cinereum. As the tract is traced backwards, its outer edge is seen to be joined by fibres from the groove in which it is lodged. On reaching the anterior pointed extremity of the extra-ventricular part of the thalamus, it is not difficult to raise it with the tract, but if the tract is kept distinct from the fibres which do not strictly form part of it, it suddenly detaches itself from the thalamus, raising a small, solid, firm, grey nucleus about the size of a barley corn from a smooth bed, in which it was lodged, with scarcely any rupture of fibres. It is evident that the mass of the fibres of the tract end in this nucleus, but a distinct though slender tract of fibres is continued onwards to the corpora quadrigemina; others again pass to the C. geniculatum internum, which is seated on the posterior edge of the tegmentum of the crus, some of these dipping into the groove between the crust and tegment.

radiating crural fibres having an intra-ventricular and an extra-ventricular division. The intra-ventricular portion consists of a deposit or bed of soft grey matter, not intermixed with distinct fibres visible to the naked eye, thicker and wider anteriorly in the anterior cornu of the ventricle—narrowing to a point posteriorly. It rests upon the radiating fibres of the tegmentum and thalamus, which pass onwards beneath it to the hemisphere proper. Anteriorly, the soft grey matter of the C. striatum fills up the interstices between these radiating fibres; posteriorly, fibres arise near the inner edge which is in relation with the thalamus, and passing backwards, dip into the intervals between the cord-like bundles of fibres which issue from it. These can be followed through the fan of radiating fibres to the extra-ventricular C. striatum, with the fibres of which they are distributed. It cannot be determined with certainty by naked eye dissection whether fibres arise near the margin of the soft, grey matter which forms the intra-ventricular C. striatum to pass outward to the convolutions with the radiating fibres of crus and thalamus, nor can it be made out whether fibres begin or end in the grey matter lying in the interstices of the diverging bundles. These points are reserved for microscopic investigation now in progress.

The extra-ventricular C. striatum appears to be larger than the intra-ventricular division, and like it is larger anteriorly, where it is rounded like the large end of a pear, narrowing to a tail or stalk-like extremity posteriorly. The grey matter of the two portions can scarcely be said to be continuous round the edge of the crus; their line of junction is near the outer margin of the anterior perforated space; this space belongs, therefore, to the intra-ventricular division. The extra-ventricular C. striatum is exposed by the complete dissection of the temporo-sphenoidal lobe, and by the removal of the convolutions of the island of Reil. It consists of a layer of soft grey matter, resting upon the outer aspect of the fan of radiating fibres of the crusta, encased by a thin lamina of fibres which forms an inferior and external limiting wall for the ganglion. The inferior surface is flat, and presents longitudinal fibres, some of which belong to the great longitudinal commissural system of the hemisphere, and can be followed from the tip of the occipital lobe to the anterior edge of the frontal, but most arise from two exposed patches of the interior grey matter, which have been named the *internal* and *external grey nuclei*. The *internal grey nucleus* lies close to the optic tract and collar of the crus, and is in the same transverse line with the C. albicantia; it is exposed when the anterior clubbed extremity of the gyrus uncinatus is detached. It has been already mentioned that fibres from the thalamus, forming part of the collar of the crus, end in it; from it fibres can be followed backwards to the occipital extremity of the hemisphere, and backwards and outwards to the convolutions along the lower and outer edge of the occipital lobe, also to the sylvian infra-marginal gyrus and the parallel gyrus of the temporo-sphenoidal lobe, and to intervening angular and annectent gyri on the same level; on the other hand, it sends fibres forward with or beneath the fasciculus uncinatus to the anterior edge of the frontal lobe, forwards and outwards in considerable numbers to the apex of the temporo-sphenoidal lobe overhanging the fissure of Sylvius, and to adjacent parts. The internal grey nucleus is thus an important focus of distribution for the C. striatum. It should be added that fibres of the C. callosum are traceable to it, as will be described later. The *external grey nucleus* is in the same transverse line with the internal, and separated from it only by a narrow band of fibres belonging to the longitudinal commissural system of the hemisphere. It sends fibres backwards to the posterior extremity of the hemisphere, and forwards to the frontal lobe, but it is situated on the border formed by the junction of the inferior and external surfaces of the C. striatum, and its fibres radiate mainly over the external surface. Another point to be mentioned in the account of the inferior aspect, is that the anterior commissure emerges on this surface just in front of the internal grey nucleus from a canal running inwards between it and the anterior perforated space, to be distributed to the convolutions on the inferior aspect of the temporo-sphenoidal lobe.

The external surface of the extra-ventricular C. striatum underlies the convolutions of the island of Reil, and forms the inner side of the wide valley into which the Sylvian fissure is converted by the removal of these convolutions. From this aspect the ganglion may be compared to an elongated mound highest in the centre, sloping off towards each end; at the summit is the external grey nucleus from which, as a centre, the fibres radiate forwards, backwards, and outwards over this surface, forming a smooth limiting plane, which can be raised from the soft grey matter of the interior. The fibres passing forwards spread out, and are distributed mainly to the posterior part of the third frontal convolution; some, however, proceeding onwards with fibres of the crus to the other frontal gyri. Those passing backwards form part of a large mass proceeding to the extremity of the occipital lobe; those passing outwards instead of curving across the floor of the Sylvian valley to the supra-marginal convolution of this fissure, as at first sight they appear to do, for the most part penetrate between the fibres forming the floor to reach, probably, the first or superior frontal convolution. They are, however, followed with difficulty.

When the inner side of the extra-ventricular C. striatum, which is in contact with the radiating crust of the cerebral peduncle is examined, the ganglion can be separated from the crus for a short distance, but more deeply, numerous delicate fibres pass from the one to the other, giving to both a flocculent appearance. At the posterior edge of the crus, fibres of both crust and tegment turn forwards to end in the ganglion, but these are not numerous. Anteriorly, as has already been mentioned, a considerable body of fibres from the tegment turns round the edge of the crust to reach and end in the grey matter of this ganglion. As in the case of the intra-ventricular C. striatum, it cannot be determined by the naked eye whether fibres of the crus end, and fibres for the convolutions begin in the grey matter lying between the strands of diverging fibres, but careful examination leads to the conclusion that to whatever extent this may be the case, fibres of the crus in large numbers pass uninterruptedly through or by the central ganglia to the convolutions. In the case of the fibres of the posterior edge of the crus, there is scarcely room for error on this point, as they do not come at all into relation with grey matter on their way.

While speaking of the central ganglia, it may be well to mention the commissures by which they are connected with the corresponding ganglia of the opposite hemisphere. The thalami are associated by means of the posterior and the middle or soft commissures; the precise mode of termination of the former, however, has not been definitely ascertained. The corpora striata of the two sides have no special commissural connection; the anterior commissure which has sometimes been said to join them, passes on to the convolutions of the temporo-sphenoidal lobe, without giving any fibres to the central grey matter. Fibres of the C. callosum can be traced to the C. striatum, and it is possible that these may serve to associate the two C. striata.

III.—The Hemisphere proper, or Hemispherical Ganglion.

The grey matter of the hemisphere is spread over the surface of the convolutions, and the problem which presents itself for investigation comprises—

1. The course and distribution to the convolutions of the fibres issuing from the central ganglia, whether these have their origin in the thalamus or C. striatum, or have ascended to the hemisphere in the crus.
2. The course and distribution of the fibres which cross from one hemisphere to the other in the corpus callosum.
3. The course of any sets or systems of fibres which may pass from the grey matter of one part of the convoluted surface of the hemisphere to the grey matter of other parts.

There is a dissection, or rather section, so easily made and so instructive that it may be described here. When the great horizontal branch of the fissure of Sylvius is opened out the island of Reil is exposed, and the fissure, single at its two extremities, and apparently single along its whole length, before the lips are separated, is seen to have two divisions—a lower between the island and the temporo-sphenoidal lobe, an upper, much deeper, and more complex between the island and the different convolutions, orbital, frontal, and parietal, which contribute to form the antero-superior edge of the fissure. Now, the lower division of the fissure, along its entire length, runs close to and parallel with the descending cornu of the lateral ventricle, the two being separated only by a thin lamina of fibres, while the upper division of the fissure is parallel to the outer angle of the ventricle, being nowhere distant from it half an inch. If the temporo-sphenoidal lobe be partially detached by raising the apex and opening the point of the descending cornu, the section being carried backwards along the thin septum between the cornu and the lower division of the fissure of Sylvius, it will become evident, on reaching the end of the fissure and the entrance of the cornu into the ventricle, that the thin lamina divided must contain all the fibres which can reach the temporo-sphenoidal lobe from the crus, or central ganglia. It may be added that it contains many others. The temporo-sphenoidal lobe may either be completely separated by carrying the section backwards along the calcarine fissure, or be left attached to the rest of the hemisphere. The section should now be carried through the thicker septum between the outer border of the lateral ventricle and the upper division of the Sylvian fissure from behind forward, starting at the point where the former section terminated, and continued anteriorly round in front of the anterior perforated space externally, along the anterior cornu of the ventricle internally. In a recent brain this section is most conveniently accomplished by means of scissors, one point in the ventricle and the other in the fissure. The fibres last divided are those of the corona radiata, *i.e.*, the whole of the fibres entering the frontal, parietal, and occipital lobes from the crus and central ganglia,—plus numerous other fibres connecting the temporo-sphenoidal lobe and the island of Reil with these same lobes. The hemisphere will now be completely detached, like a hood, from the central ganglia.

A comparison of the sectional area of the fibres entering the temporo-sphenoidal lobe, with the mass of white matter in it, and of the sectional area of the fibres entering the upper part of the hemisphere, with its centrum ovale minus, will show that the radiating fibres must bear a small proportion to the fibres passing from one part of the surface to another. A comparison, again, of the sectional area of the fibres thus seen issuing from the central ganglia with the area of the crus as it emerges from under the pons, will show that the ascending fibres have been largely reinforced by additions from the ganglia.

The plan of construction of the hemisphere appears to be as follows:—

The central fibres, including under this term the fibres of both crus and central ganglia, spreading out are distributed to the convolutions only along certain main lines, or at certain points. They do not, as has usually been assumed, and as is expressly stated by Gratiolet, enter each convolution and form an axial plane connecting the summit of the convolution with the crus. On the contrary, there are extensive tracts of convolutions which receive no central fibres at all.

The fibres of the corpus callosum proceed for the most part to the very same parts of the surface in which the central fibres end. The intermediate convolutions which receive no central or callosal fibres are connected by fibres with the parts of the surface in immediate relation with the crus, central ganglia, and C. callosum, and in addition, the most distant parts of the hemisphere have connecting fibres, the general

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direction in both cases being longitudinal; the fibres do not, as a rule, pass transversely under the sulci from one gyrus to another, but usually run longitudinally in the convolutions from one part of the surface grey matter to another.

A.—The Frontal and Parietal Lobes.

Taking first the fronto-parietal lobes, limited behind by the parieto-occipital fissure, below by the great horizontal branch of the fissure of Sylvius, and comprising the three horizontal frontal gyri, the ascending parietal gyri,* with the postero-parietal lobule at the upper corner posteriorly, and the supra-marginal lobule at the lower corner. The arrangement of the fibres is as follows:—

The central fibres, on their way to the convolutions, reach the under surface of the C. callosum along the outer angle of the lateral ventricle and its anterior cornu, and an inter-crossing of fibres here takes place; they are, in fact, woven together so compactly that identification of the central and callosal strands after their passage, is very difficult, and their subsequent distribution is partly inferred, and not completely demonstrable.

The mingled central and callosal fibres, after this decussation, are distributed mainly along the two margins of the combined lobes; above along the margin of the great longitudinal fissure, below along the margin of the Sylvian fissure continued forward along the lower edge of the frontal lobe by the third frontal gyrus; the two lines of distribution meeting at the anterior extremity of the hemisphere, and curving back together for a short distance along the inner and lower edge of the frontal lobe towards the anterior perforated space, but not nearly reaching it. The greater part of the fibres of the C. callosum pass to the border of the longitudinal fissure, and apparently the central fibres preponderate in the sylvian and frontal convolutions along the lower margin. The proportion of central fibres to the mass of brain substance again increases from behind forwards, the direction of the radiating fibres being mostly towards the frontal lobe. This end of the

* It will be seen that the short ascending branch of the fissure of Sylvius is taken as the line of separation between the frontal and parietal lobes. The fissure of Rolando, though appearing early, is a mere sulcus, and the small contorted horizontal gyri, and the larger and simpler ascending gyri seem to fall naturally into distinct groups.

hemisphere also has a larger share of callosal fibres, in consequence of the reduplication of the C. callosum at the genu.

If we suppose the planes of fibres just described, proceeding from a common axis, one vertically upwards, the other nearly horizontally outwards, to the two borders of this part of the hemisphere, to represent its framework, they will enclose an angle which is filled up by the convolutions of the convex surface with the white substance subjacent to them; on the inner aspect of the ascending plane are the callosal and marginal gyri—on the lower aspect of the horizontal plane are some small secondary convolutions in the fissure of Sylvius, and the orbital convolutions. All these may be looked upon as super-added convolutions.

Deeply in the angle runs a mass of longitudinal fibres, entering the parietal lobe from the occipital and temporo-sphenoidal lobes, and extending forwards to the tip of the frontal lobe. Some fibres leave this longitudinal system to turn to the surface grey matter of the successive convolutions, others join it from these convolutions to proceed forwards in it to more anterior gyri. This may perhaps be provisionally called the *great axial longitudinal system.*

Superficial to it for the most part, but sometimes, and especially posteriorly, inter-crossing with it, are bands of fibres having a more or less transverse direction. The supra-marginal (sylvian) and postero-parietal lobules are thus connected by plates and bands of fibres having a most tortuous course. In the parietal ascending convolutions, they run more simply along the convolution. The second or great ascending parietal gyrus has complicated connections with the adjacent convolutions behind it, and receives large bands of fibres from the posterior part of the hemisphere, by means of the axial longitudinal system; it is also extensively connected with the anterior parietal convolution, and sends forward, deeply, fibres to all the three frontal convolutions. The second frontal, besides receiving fibres from the axial system and parietal convolutions, is connected with the first and third frontal gyri between which it lies by numerous large laminæ, which do not simply dip transversely under the intervening sulci, but run tortuously forwards or backwards, their intertwinings being too complicated to admit of either description or representation. Fibres, moreover, cross transversely under the second frontal gyrus from the first to the third. It will have been noted that no mention has been made of central or callosal fibres reaching these convolutions on the convex surface of this part of the hemisphere, and they receive few or none. It may be stated with tolerable certainty that behind the second parietal gyrus, the central and callosal fibres pass exclusively to the margins, and not at all to the intermediate parts; there is less certainty anterior to this convolution, and apparently the anterior parietal convolution, and the second frontal receive central fibres.

The callosal and marginal gyri on the flat internal surface of the hemisphere exhibit a similar plan of arrangement to that seen on the convex surface, but simplified and on a smaller scale—*i. e.*, fibres running longitudinally from the grey matter of one part to the grey matter of another, some lying deeply connecting the two extremities of the convolutions, others superjacent, having a shorter course. A small cord-like band of fibres curves upwards from the temporo-sphenoidal lobe closely round the splenium C. callosi, and runs forward deeply along the upper surface of this body, to be distributed to the grey matter quite at the anterior part of hemisphere. From the grey matter of the quadrilateral lobule (an expansion of the posterior end of the callosal gyrus), the fibres curve downwards and turn forwards in the callosal gyrus, some reaching the anterior pointed extremity close to the anterior perforated space, others curving upwards at various points beneath the marginal gyrus to the edge of the hemisphere. In the more superficial marginal gyrus the fibres have a shorter course, but the same general direction. The gyrus fornicatus was named by Mr. Solly the superior longitudinal commissure, but the term commissure conveys a very imperfect idea of the relations and probable uses of the complicated arrangement of fibres and cells, and the name is rendered still more inappropriate by the existence of the longitudinal system in the axis of the hemisphere.

The super-added gyri on the concealed surface of the convolutions forming the upper margin of the Sylvian fissure are connected by large masses of fibres with the convolutions of the island of Reil, as will be described more fully later. The convolutions of the orbital lobule, resting on the orbitar plate of the frontal bone, receive fibres from the apex of the temporo-sphenoidal lobe, and from the fasciculus uncinatus; their intrinsic fibres run divergently from behind forwards, and are superficial to the central fibres spreading out to the anterior margin of the frontal lobe.

B.—The Occipital Lobe.

In the occipital lobe the central fibres pass mainly to the posterior extremity, and it is worthy of note that the fibres from the thalamus and C. striatum predominate in number over those from the crus, and again that the central and callosal fibres do not interlace, but run side by side in distinct bands till they approach the surface grey matter in which they end. The cuneus, a small triangular lobule on the inner aspect, between the internal parieto-occipital and the calcarine fissures, consists mainly of super-added convolutions, which are carried away by fibres traced thereto from adjacent parts under the fissures named; the convolutions, again, on the inferior surface, resting on the tentorium, belong properly to the temporo-sphenoidal lobe. The occipital lobe is thus reduced to small dimensions, and its gyri, elsewhere than at the extremity and along the outer edge, receive few central or callosal fibres, but contribute to the axial longitudinal system of the fronto-parietal lobes, and receive fibres from the temporo-sphenoidal lobe.

C.—Temporo-Sphenoidal Lobe.

This lobe which extends on the inferior aspect of the hemisphere to the occipital extremity is remarkable from the fact that no fibres from the crus can be traced to any part of it. It has already been stated that the extra-ventricular thalamus sends forward in the roof of the descending cornu of the ventricle fibres to the apex of this lobe, and that fibres pass to the same part from the internal grey nucleus of the C. striatum. Fibres again of the rostrum C. callosi bend backwards in front of the anterior perforated space to this part. Posteriorly, this lobe may be considered to share with the occipital lobe the mass of central fibres passing to the posterior extremity of the hemisphere, and it is thus in direct connection with the central ganglia and C. callosum at the two ends. Fibres again from the internal grey nucleus of the C. striatum certainly, and probably also from the thalamus and C. callosum, are scantily distributed to the inframarginal sylvian and parallel gyri along its outer margin. The convolutions on the under aspect with the exception of the G. uncinatus, which will require a special description, belong to the class of super-added convolutions, not in direct relation with crus or central ganglia; they have, however, a special transverse commissure in the anterior commissure, which is distributed entirely to them, and the lobe has extensive commissural connections with the rest of the hemisphere. The superficial fibres on the inferior aspect run longitudinally in the convolutions from the two extremities of the lobe to a kind of lobule near the middle of this surface, which from its situation and relations may be called the *collateral lobule.* Beneath these is a set of fibres which, starting anteriorly in a compact bundle, spreads out as it proceeds backwards into a beautiful thin plane, which is in contact with the lining membrane of the floor of the descending cornu of the ventricle, where it is joined by the cornua of the ventricle itself, and of the posterior cornu. At the eminentia collateralis and in the posterior cornu the fibres of this plane are mingled with fibres of the C. callosum, but it may be said to form the floor of the inferior cornu. The fibres curve inwards in succession; those first given off crossing the floor of the descending cornu, and then ending in the grey matter of the uncinate gyrus, or more posteriorly reaching the upper wall of the calcarine fissure; those crossing the eminentia collateralis in the floor of the ventricle partly accompanying the set last described, partly entering and ending in the inferior wall of the calcarine fissure with the part of the plane in the floor of the posterior cornu. When this plane is removed a longitudinal system of fibres is exposed, which equals in interest any previously described. From its connection with the fasciculus uncinatus which crosses the inner end of the fissure of Sylvius, it may be named *the Longitudinal System of the Fasciculus Uncinatus.* As reached by dissection it presents itself posteriorly as a ridge along the outer side of the posterior cornu, beginning at the tip of the occipital lobe, continuing forwards by the side of the roof of the inferior cornu, here curving outwards slightly, subsiding opposite the internal grey nucleus of the C. striatum, but going on in the fasciculus uncinatus to the extremity of the frontal lobe. This *system of the fasciculus uncinatus* though largely commissural is not entirely so, but is composite in constitution. Any considerable bundle taken up from it opposite the crus traced backwards would pass mainly to the tip of the occipital lobe, but would also give fibres to various points of the outer edge of the hemisphere and might contain some from the C. callosum; traced forwards it would send fibres outwards to the edge of the temporo-sphenoidal lobe near the apex and to the apex, directly forwards to the anterior edge of the frontal lobe in the fasciculus uncinatus, inwards to the internal grey nucleus. This system is in contact with the inferior surface of the extra ventricular corpus striatum.

The commissural connections of the temporo-sphenoidal lobe with the parietal are remarkable. In the posterior part of the infra-marginal convolution of the fissure of Sylvius a considerable plane of fibres passes obliquely backwards under the termination of the fissure, and curving forwards spreads out in the supra-marginal convolution as far forwards as the third frontal gyrus. A still larger mass or plane of fibres passes backwards and inwards from the posterior part of the parallel gyrus, bends inwards above the fibres passing from the thalamus, &c. to the posterior extremity of the hemisphere, and then turns forward in the parietal lobe as part of the axial longitudinal system in which it can be distinctly recognised lying close to the ascending plane of central and callosal fibres. In close relation with this group is a large band of fibres from the angular gyrus, which takes a very similar course, as also do fibres from the lower annectent gyri.

It may perhaps be worthy of mention that between the infra-marginal sylvian and parallel gyri, separated by the deep parallel sulcus, there is the most extensive commissural connection to be found between adjacent convolutions in the entire brain.

In the preceding description many details, some of considerable importance, have been omitted for the sake of clearness, they will be partially supplied in the account, yet to be given of particular parts. As the fasciculus uncinatus has just been under consideration it will be taken first.

Fasciculus Uncinatus.

This is a mass of fibres crossing the entrance of the fissure of Sylvius from the temporo-sphenoidal to the frontal lobe. As has been seen, it receives contributions from the occipital extremity and from the convolutions along the lower and outer edge of the hemisphere (lower occipital and annectent, angular, parallel, and infra-marginal sylvian gyri); large bands again, not previously mentioned, enter it from the anterior end of the parallel and sylvian gyri, and in particular, a considerable group of fibres starting at the apex of the temporo-sphenoidal lobe which overhangs the fasciculus and fissure, after passing backwards to reach the fasciculus, bends sharply forward in it, forming its superficial layer; fibres also from the extremity of the gyrus uncinatus run forwards in it. Its distribution is as follows:—A superficial layer of fibres, mainly derived from the apex of the temporo-sphenoidal lobe, passes forwards and inwards in front of the anterior perforated space; some of these can be followed into the rostrum of the C. callosum, others to the callosal gyrus near the rostrum, others again obliquely under the olfactory sulcus to the margin of the hemisphere adjacent to it. A few fibres end in the grey matter of the convolutions at and near the posterior border of the orbitar lobule, but the greater proportion pass forwards beneath the convolutions resting on the orbital plate, spreading out as they proceed, and end along the anterior edge of the hemisphere, together with subjacent central fibres with which they become intermixed. By the plane of fibres they form, the orbitar convolutions are insulated, so to speak, from the central fibres. Still another destination of fibres from the fasciculus remains to be pointed out; this is the posterior part of the third frontal gyrus, to which a considerable number proceed, they spread out over the anterior and external part of the C. striatum, descending, so to speak, into the Sylvian valley, and after crossing it, curve into the convolution on its outer side. These fibres underlie the summit of the island of Reil, and are interposed between the grey matter of its convolutions and the C. striatum.

Island of Reil.—The Gyri Operti.

It has been already incidentally stated that the convolutions of the island belong to the class of super-added gyri, having no direct relation with crus, thalamus, or even with the C. striatum on which they rest. This is true with one possible slight qualification to be mentioned presently. The island of Reil may be described as having three pairs of convolutions—anterior, external, and posterior—radiating from a summit near the entrance of the fissure of Sylvius. A few fibres from the overhanging apex of the temporo-sphenoidal lobe end in the grey matter near the summit, but for the most part the fibres arising in the grey matter of the island curve across the bottom of the fissure of Sylvius, and carry away the grey matter of the surface of the convolutions along its upper margin, *i.e.*, the posterior border of the orbitar lobule, the third frontal, and the parietal gyri abutting upon the fissure. These fibres are very numerous, and form a thick layer; their course is not simply across the fissure, but when followed in detail extremely intricate. Fortunately the outer part of the fasciculus uncinatus runs beneath the summit and anterior convolutions, and forms a distinct layer between their fibres and the C. striatum, serving as a guide to the plane of separation between the island and the ganglion, so that the outer wall of the latter is laid bare as a smooth plane of radiating fibres. In the course of this dissection, however, the external grey nucleus is exposed, and it is possible that at this small point the grey matter of the ganglion and that of the island may come into relation. This seems the more likely, since fibres from the posterior part of the hemisphere apparently end in both.

Third Frontal Convolution.

This is mentioned on account of the interest attaching to it from the recent discussion on aphasia. Whatever view may be adopted it must be admitted that this is an important convolution. Besides central and callosal fibres it receives numerous fibres from the fasciculus uncinatus, very many from different convolutions of the island of Reil, and some from the adjacent convolutions along the upper edge of the fissure of Sylvius; then also it has a specially free communication with the external grey nucleus of the C. striatum. All these reach the posterior end of the convolution on its sylvian aspect. On the other side are the complicated commissural connections with the parietal and frontal gyri. No marked difference of structural relations has been found between the convolutions of the right and left side.

The Fornix.

This body has not been the subject of special investigation, and more particularly its anterior relations have not been minutely ascertained; but it may be stated that they are more complicated than is usually described. The anterior pillar does not pass entirely behind the anterior commissure in the third ventricle, but divides and encloses it, the fibres running in front of it passing forward with the septum lucidum, those descending behind it proceeding mainly to the corpus albicans, thalamus, and crus. Posteriorly fibres of the fornix pass with fibres of the C. callosum in the wall of the calcarine fissure to the occipital extremity of the hemisphere; but, for the most part, they run in the posterior pillar, or tœnia hippocampi, to end in the grey matter of the hippocampus major, and in the club-shaped extremity of the uncinate gyrus, sometimes called the uncinate lobule. It obviously conveys an inadequate idea of the relations of the fornix to call it a longitudinal commissure; at one extremity it is mainly connected with central parts, the crus and thalamus, by the other with the surface grey matter, so that, apparently, it is a peculiar method of distribution of central fibres.

Anterior Commissure.

This has sometimes been called the commissure of the corpora striata, appearing, as it does, to cross from one to the other across the third ventricle. It has, however, no connection with these ganglia; but on reaching the wall of the third ventricle enters a canal, in which it lies free, and is conducted to the inferior surface of the C. striatum, on which it emerges between the anterior perforated space and the internal grey nucleus, with an oblique direction backwards to be distributed to the convolutions on the under aspect of the temporo-sphenoidal lobe. It is, therefore, the commissure between this part of the two hemispheres. The canal in which it is lodged is formed superficially by fibres running forwards from the uncinate lobule and adjacent parts, deeply by the anterior edge of the radiating crus.

Corpus Callosum, Hippocampi Major and Minor, and Gyrus Uncinatus.

Various views have been entertained as to the course and destination of the fibres crossing between the two hemispheres in the C. callosum. Some have held—notably Foville—that this body arched over the ventricles and central ganglia from one crus to the other. Gratiolet states that in a transverse section of the brain he traced every fibre of the C. callosum from the crus of one side to the convolutions on the other. It is quite certain that the first of these views is erroneous, scarcely less certain that the second is so likewise, though not in the same degree, for some fibres can be traced from the corpus callosum into the radiating crus. The C. callosum is, however, mainly, but not exclusively, a transverse commissure between the convolutions of the two hemispheres. The course and distribution of its fibres has been already indicated in a general manner, but some additional details must be given. In the parieto-frontal lobes they pass with the central fibres to the sylvio-frontal and longitudinal margins, but in decidedly larger proportion to the edge of the longitudinal fissure, curving, for the most part, directly to this border without any obliquity. About the middle of the upper surface, however, a few fibres are seen passing forwards across the rest; these increase in number more anteriorly, till they begin to turn successively to the margin of the hemisphere above the genu, and the genu is thus encircled by a whorl of fibres radiating to the anterior and inferior part of this border. Beneath this thin layer the proper fibres of the genu and rostrum spread out—upwards, forwards, or downwards, respectively, to the nearest part of the same margin. It will be remembered, however, that near the point of the rostrum of the C. callosum its fibres pass to the apex of the temporo-sphenoidal lobe in the fasciculus uncinatus, running beneath the commencing callosal and marginal gyri, and detaching them from their assigned starting point, the anterior perforated space. While the fibres of the C. callosum are strictly transverse in direction the central fibres are mostly oblique, passing forwards and outwards anteriorly, backwards and outwards posteriorly; they consequently traverse the C. callosum obliquely, and give rise to the oblique fissures often seen in sections through it. This alone throws doubt on Gratiolet's observation, since a transverse section at the point named by him would necessarily divide the oblique radiating fibres of the crus as they reached the C. callosum. On careful examination, however, numerous fibres are distinctly to be seen bending down from the corpus callosum into the radiating fan of fibres from the crus and ganglia.

Posteriorly the C. callosum presents a thick rounded free edge, the splenium, which, when exposed and followed, is found to curve backwards to the tip of the occipital lobe above the level of the posterior cornu, not decussating with the central fibres passing to the same point. Some fibres are also distributed to the convolutions on the upper and outer part of the occipital lobe.

On the under surface of the splenium is a reflected process of the C. callosum, which may in some respects be compared to the rostrum at the anterior end, but it is smaller, and in the middle line is adherent to the body of the commissure. Its anterior margin is continuous with the body of the fornix, and its fibres, which are transverse in direction, when followed outwards, are found to bend downwards, leaving the corpus callosum proper, which forms the roof of the lateral ventricle, and crossing the floor of this cavity, taking subsequently different directions; forwards in the hippocampus major and gyrus uncinatus, backwards in the hippocampus minor, or calcar avis, transversely outwards in the eminentia collateralis, these last subsequently curving forwards in the longitudinal system of the temporo-sphenoidal lobe. Perhaps this process may be named the *Commissure of the Hippocampi.*

Another point remains to be noted in the distribution of the C. callosum. The fibres on the under surface of the body of the splenium, forming the roof of the posterior part of the ventricle and of the posterior cornu lying immediately beneath the lining membrane, take a curved direction forwards, across the mass of fibres arching backwards from the thalamus to the occipital extremity of the hemisphere. It is extremely difficult to trace these to their destination; but it has been definitively ascertained that a large proportion of them go into the internal grey nucleus of the C. striatum.

The hippocampus minor is a longitudinal projection in the posterior cornu corresponding very nearly to the bottom of the calcarine fissure. It has been mentioned that fibres of the recurved process of the C. callosum on the under aspect of the splenium run backwards in it. A full account of this hippocampus would involve a description of the complicated arrangement of fibres in the walls of the calcarine fissure, the details of which, though of some interest, are not apparently of any great importance.

The gyrus uncinatus and hippocampus major merit a fuller description. It will be found convenient to limit the name gyrus uncinatus to the anterior half of the long convolution usually so-called, to that part of it, namely, which encloses the hippocampus, extending from the club-shaped expansion, sometimes called the uncinate lobule anteriorly, to where the calcarine fissure cuts the *convolution de l'ourlet* (gyrus fornicatus) posteriorly. Two layers of fibres can be distinguished in this convolution, having different relations; a superficial stratum connected with the surface grey matter running longitudinally and passing to adjacent convolutions and to the calcarine end of the same gyrus, and a deeper stratum commencing anteriorly in the uncinate lobule, and forming here a thin plane of the width of the convolution. Passing backwards they approach the inner border, assuming a twisted arrangement, the outer fibres crossing over the inner and bending round the splenium into the callosal gyrus, while the inner fibres dip beneath the outer and end in the grey matter of the hippocampus, or proceed to the hippocampal commissure of the C. callosum.

The uncinate lobule has most varied connections, which can only be enumerated without any attempt at description. Fibres enter it anteriorly from parts within the third ventricle not distinctly made out, from the olfactory tract, the orbital convolutions, and the apex of the temporo-sphenoidal lobe, posteriorly from the tœnia semicircularis, the hippocampus, and the uncinate gyrus. It is, moreover, situate exactly over the internal grey nucleus of the C. striatum, which is exposed when it is detached.

The hippocampus major curves round the crus in the descending cornu of the lateral ventricle, and terminates in the expansion of the pes, which is attached to the uncinate lobule. Its convex outer border is rounded, and lies free in the cornu, as does also the upper surface; the lower surface is slightly adherent to the plane of fibres which forms the floor of the cornu, but is quite separable from it. The hippocampus may be described as a curved groove or gutter of fibres, the bottom of the gutter forming the convex outer border, the edges being found on the concave inner border. The upper edge is free, and is formed by the posterior pillar of the fornix; the lower is continuous with the internal margin of the gyrus uncinatus, and round this edge the surface grey matter of the hemisphere folds over into the groove and after reaching the bottom of it turns up the other side for a short distance, where the free border presents itself as the plicated corpus fimbriatum. The fibres forming the groove or case arise in the grey matter of the interior, pass obliquely upwards and backwards across the lower surface, and round the convex border to the upper surface, across which they run towards the edge of the groove formed by the pillar of the fornix; the pillar of the fornix is in fact made up of these fibres. Such of them as have not reached the margin when the hippocampus approaches the ventricle, assist to form the recurved part of the C. callosum, which has been named the commissure of the hippocampi. Besides the fibres which form the wall of the hippocampus the interior grey matter gives origin to fibres which turn over the lower edge to emerge on the surface of the hemisphere; these are most numerous posteriorly, and they pass backwards in the upper wall of the calcarine fissure. It will be understood that in this account of the hippocampus a free interpretation has been put upon the facts obtained by dissection.

Resuming very briefly the more important facts contained in the preceding account of the structures of the cerebral hemisphere, and adding a few simple inferences, it has been found that the fibres ascending in the crus do not all terminate in the central ganglia, but that many pass to the convolutions. In their passage through the central ganglia they are reinforced by numerous fibres arising both in C. striatum and thalamus, but mainly in the latter. On the other hand many fibres of both crust and tegment end in the C. striatum, while apparently this is not the case with the thalamus. No conclusions can be drawn as to the function of the thalamus and corpus striatum while it remains uncertain whether fibres of crus end in the thalamus, or indeed, until it is ascertained not only that fibres end in the C. striatum, but what fibres these are, whether from the cord or medulla, or arising in grey matter higher up. In the distribution to the convolutions of the fibres which emerge from the central mass they are for the most part intermingled, and pass to the same regions. Those of the crust and tegment are so mixed up as to be quite indistinguishable; in the fronto-parietal part of the hemisphere those of the thalamus pass with and cannot be distinguished from those of the crus, while the fibres of the C. striatum, though following an independent course, reach the same destination. Again, in the occipital lobe the fibres of the crus and ganglia, which here are not mingled together, run to the same convolutions, and in the temporo-sphenoidal lobe the thalamus and C. striatum give fibres to the same parts. Anatomical structure does not therefore lead us to expect that there will be a distinct sensory and motor region of convolutions. It is very remarkable again, that the fibres of the C. callosum are distributed to the same parts of the surface grey matter as the fibres issuing from the centres. Assuming that the C. callosum is not only the transverse commissure of the two hemispheres, but that the fibres in it connect corresponding parts (as can be demonstrated with regard to some parts of this commissure), this would imply that the points of the surface grey matter of the two hemispheres in which the central fibres ended were bilaterally associated.

It has further been found that throughout the hemisphere the distribution of the central and callosal fibres is to the margin of the respective lobes, leaving extensive intermediate tracts of convolutions, which receive no fibres from either crus, central ganglia, or C. callosum. It is at once obvious that these super-added convolutions will be the convolutions most characteristic of the human brain, and wi constitute the difference between one brain and another.* The sensations transmitted upwards from the several sense-centres must first impinge upon those parts of the surface grey matter in which the fibres from the sensory tract or ganglia end; so, again, wherever volitions may be originated, the downward starting point of the motor impulse must be in some convolutions connected by fibres with the motor ganglion or tract. These convolutions then which receive central fibres and are bilaterally associated by the C. callosum will constitute the perceptive centres of Dr. Bastian, and centres for the emission of volitional or ideo-motor impulses. But the perception of sensations and the emission of motor impulses are psychical operations of the simplest character, and are common to man and the lower animals. The higher and more complex operations of combining and comparing perceptions, the formation and elaboration of ideas, are thus almost by way of exclusion assigned to the super-added convolutions, and it can scarcely be considered fanciful to see in the withdrawal of the nerve-cells engaged in these intellectual operations from immediate relation with the external world, and in the intricate associations of different parts of the surface, conditions adapted to the function attributed to them. From this point of view it is interesting to compare the different super-added convolutions among each other as to the degree of complexity in their relations with other parts, as this may be an element in the estimation of their relative importance. The arrangement of fibres is perhaps most simple in the convolutions of the orbitar lobule, next in those on the inferior aspect of the temporo-sphenoidal lobe, and in

* Confirmation of this is readily found in a comparison of the hemisphere of the monkey tribe with that of man, material for which is furnished by Gratiolet's work on the cerebral convolutions in the primates and man. I have not had the opportunity of examining a monkey's brain, but by the kindness of Mr. Streeter I have before me a cast of one, which may be taken as a sample, the convolutions being very simple. The frontal lobe is represented by a superior and inferior gyrus, the second being rudimentary; the parietal has a simple ascending convolution on each side of the sulcus of Rolando, and a supra-marginal sylvian gyrus. No supra marginal or postero-parietal lobule. The occipital lobe is plain; the temporo-sphenoidal, large in proportion to the rest of the hemisphere, has infra-marginal, parallel and uncinate gyri, no superadded gyri, on the under surface. To bring this into the likeness of a human brain it would be necessary to interpose a second frontal gyrus between the first and third, to add supra-marginal and postero-parietal lobules, to replace the smooth surface of the occipital lobe by numerous and tortuous convolutions connected with the rest of the hemisphere by annectent convolutions, and to increase the complexity of the callosal and marginal gyri, and of the gyri on the orbitar lobule, and on the under surface of the temporo sphenoidal lobe.

the callosal and marginal gyri of the internal surface, or in the gyri operti of the island of Reil. At the occipital extremity of the hemisphere the convolutions have most tortuous communications with each other. The ascending parietal convolutions are characterised rather by varied relations with distant parts, while the frontal gyri have at the same time free and complicated inter-communications and numerous connections with other convolutions.

It is hoped that a fuller knowledge of the structure of the cerebral hemispheres, the instrument of thought, will give greater precision to our speculations on the physiology of thinking; it will certainly afford a firmer basis for the application of pathological facts to the elucidation of physiological problems.

The Medical Treatment of Insanity. By T. S. Clouston, M.D. Edin., Medical Superintendent of the Cumberland and Westmoreland Lunatic Asylum.

(Read at a Meeting of Members of the Medico-Psychological Association, held in Edinburgh, at the Royal College of Physicians, 25*th November,* 1869.)

Might it not be possible greatly to extend our knowledge of the effects of medicines in insanity by treating similar classes of cases in all asylums in a similar way for a certain time? Might we not in this way arrive at a much greater degree of scientific accuracy in our treatment of certain forms of insanity than we are able to practise at present?

I venture to bring forward those questions for discussion at this meeting because I think that we shall all agree that the medical treatment of insanity is a most important subject, and that at present the looseness and divergence of opinion in regard to this, the corner-stone of our specialty, is most unsatisfactory; nay, is almost scandalous. When I saw that there was nothing on our programme of business directly relating to this subject, but that all communications would be received, I informed our Secretary that I should bring forward this paper; not that I consider myself in any way specially qualified to treat the question as it deserves, but because I do not think that even our first meeting should pass over without our attention being directed to it. If any other consideration were needed to make us consider this