

for images to fall on corresponding points of the retina for them to form a single image. Ideational content plays a very important part in this connection, and if, in one of those ideational-rivalry diagrams, you give two different percepts—one for each eye—and put them in such a position that it is impossible for them to form a unitary idea, they will not combine; but in figures of this kind it is not necessary for them to fall upon corresponding points of the retina to give an unitary idea. With regard to Dr. Jones's remarks about educating patients to understand their hallucinations, that is very difficult indeed; I have often tried. There was one patient especially whom I used to try to get to understand that experiment of Dr. Hack Tuke's that if, by pressing upon one eyeball, you can double an image it is not an hallucination. I tried it with this patient, who was very intelligent; and I tried to teach her that during the daytime images would be doubled by pressing on the eye. I told her to do so when an hallucination appeared. Whenever an hallucination appeared, however, she was too frightened. You cannot get patients to do it. As a matter of fact, a psychological experiment often comes in as a means of treating patients. I remember one lady who fell in love with some doctor at the Royal Ophthalmic Hospital, Moorfields. She never thought of him for about a year from the time she attended for her eyes, until indeed she began to go insane. Then she used to hear his voice and see him every morning when she woke up. I told her it would be permissible for her to listen to the voice with her fingers in her ears, and watch him with her eyes closed. She did this and the voice of the man went at once, and it never recurred. But some weeks later, she began to hear the voice of God, and I did not know how to get over that difficulty. I thank Dr. Yellowlees for his remarks. Cases have been pointed out to me which were said to have no sensation whatever; but on closer examination I have found that there is generally a little sensation in the feet and a little about the pelvis, just small areas. I have seen two or three cases of that kind. One I saw recently was an epileptic subject, in whom it was said that there was no place where he could feel. On investigation I found he had small sensitive spots. But the most interesting point about the case was that he had allocheiria; that is to say, on putting a pin into one of these spots he immediately put his hand to the opposite side. On putting a pin into one foot he put his hand on to the opposite foot. I should like to know if any member of the association has come across allocheiria associated with cerebral conditions. Of course in spinal conditions, such as tabes, it is extremely common, but this is the only patient I have had in whom allocheiria has been associated with a cerebral condition.

Histological Studies on the Localisation of Cerebral Function. (1) By ALFRED W. CAMPBELL, M.D.

AT the Annual Meeting of this Association held at Liverpool two years ago I had the pleasure of giving an account of the work which I was then doing, on the medullated nerve-fibres of the cortex cerebri, and I endeavoured to demonstrate that a comprehensive study of the form and arrangement of these constituents in the normal adult condition afforded a useful guide to precise localisation of function.

Since then the investigation has been extended in several directions. Other brains have been converted into serial

sections and territorial variations in cell lamination worked out as minutely and exhaustively as were those of the nerve-fibres ; points bearing on the localisation of function, suggested by the normal arrangement of cortical elements, have been amplified and confirmed by the histological inspection of a large amount of pathological material (the brains of cases of amyotrophic lateral sclerosis, of amputation of extremities and of deprivation of the special senses) ; and lastly, a comparative examination of the cortex of two members of the anthropoid ape family and of several of the lower animals has been effected. The gross assets of the research are the furtherment of the direct correlation existing between physiological function and histological structure, a clearer understanding of many cerebral homologies and a survey of the brain surface more complete than any which has been attempted hitherto, and one giving the exact distribution of various functional areas previously ill defined.

Viewed collectively, the human brain harbours two varieties of centres, controlling what we may call "primary" and "higher evolutionary" functions respectively ; the former are those common to all animals and essential to survival, *viz.* centres for movement and common and special sensation ; the latter are those complex psychic functions in the possession of which man rises superior to all other beings.

Now since it will be impossible in the time at my disposal to discuss all these centres satisfactorily, and knowing that any evidence which will throw light on the localisation of the higher functions will be of interest to the members of this association, I propose to devote most of my remarks to-day to the parts supposed to govern these functions, the frontal and parietal lobes, and only to touch lightly on the localisation of the primary centres.

We will start with the motor area, as this will lead us on to the frontal lobe. One has shown that this area is as easy to define on the histological bench as on the table of the experimenter, that it is mainly characterised by the giant cells of Betz, and that it is confined to the precentral and does not spread, as has been supposed, to the post-central gyrus. Proof, from the pathological side, of the correctness of this localisation has been supplied by an examination of the brains of cases of amyotrophic lateral sclerosis. Amyotrophic lateral sclerosis is a perfect example of a malady limited in its affection to the

muscles and the motor system of neurones; and on making serial sections of the central gyri in two typical instances, it was extremely instructive to find profound changes confined absolutely to our "precentral or motor area" and consisting essentially of a destruction of the cells of Betz.

Then the brains of individuals who have been disabled by amputation of one or other extremity have afforded material for further differentiation within the area. I have made serial sections of the central gyri in seven cases, and in all have discovered changes in the giant cells identical with those found by Marinesco in the spinal cord after experimental section of spinal motor nerves, and described by him under the name "réaction à distance."

In carnivoræ and other lower animals, cortex can be recognised almost identical in structure with the motor cortex of man and the man-like ape, and an analysis of its distribution sheds light on several debated fissural homologies. Perhaps one's most important finding is that the sulcus cruciatus of lower orders does not appear to be the homologue of the fissure of Rolando, and the chief objection to this commonly accepted homology is that the sulcus cruciatus invariably lies more or less in the midst of the motor area, whereas the fissure of Rolando is essentially a boundary. Searching for a sulcus which will correspond more with the fissure of Rolando (at any rate, the upper part), we find an isolated fissure on the posterior limb of the sigmoid gyrus, sometimes referred to as the "compensatory ansate" fissure; and as this is present in other orders besides Canidae and Felidae, and as, like Rolando, it forms a sharp histological limit between motor and what I take to be common sensory cortex, I prefer to regard it and not the sulcus cruciatus as the Rolandic homologue. In man, the chimpanzee, and the orang a fissure situated on the oval or paracentral lobule, immediately in front of the upper extremity of Rolando and invariably harbouring Betz cells in its walls, seems to be the equivalent of the sulcus cruciatus. (This fissure may be seen in the drawing of the mesial surface, lying within the precentral area.)

I have referred in loose terms to the field just described as the "motor area," but this question of function must be considered more carefully. From Dr. Hughlings Jackson we have the suggestion that movement is represented at three different

levels—firstly, in the anterior cornual cells of the spinal cord, these being simple movements ; secondly, in the giant cells of the precentral gyrus, these being more complex movements ; and thirdly, in other parts of the frontal lobe, these being most complex movements. This thesis histology seems to favour, and from a thorough study of the field in different animals and different conditions I am inclined to believe that the area of cortex we have just described, the motor area of Sherrington and Grünbaum, is designed for the execution of simple primary or automatic movements—for instance, the movements of progression. I cannot enter into this question fully here, but one most significant fact of histology is that in the human brain the supply of giant cells is far greater in the leg than in the arm area, while in quadrupeds, on the contrary, the supply seems to be approximately equal in the respective fields.

If, then, simple, primary, automatic movements are represented in our precentral area, where are those which we call skilled or higher evolutionary movements represented ? In an immediately adjoining zone on the frontal side, which I have called “intermediate precentral.” Looking carefully at the distribution of this area, it may be observed that it embraces two important centres for movements of essentially skilled type—the area of Broca for speech, and the cheirokinæsthetic centre for writing ; and a further conclusion I have formed is that this “intermediate precentral” strip of cortex harbours a sequence of centres for the control of skilled movements following the same order, deposited more or less on the same horizontal level, and connected by commissural fibres with the series of “primary” centres occupying the “precentral” area. And though it may appear to be against my contention that opposite the “primary” leg area the field in question is broad, while skilled movements of the leg are few, I would point out that those movements are only in abeyance ; they are potential and capable of development, and as witness of this take the case of “armless wonders,” whose toes and feet are educated to perform with as much skill as are our hands and fingers.

Other points of interest about this “intermediate precentral” area are that its anterior boundary coincides remarkably closely with that of the old “motor” area as defined by Ferrier, Beevor, and Horsley, etc. ; also, in regard to the same limit, it agrees almost precisely with Flechsig’s great central projection sphere.

Passing on to the remainder of the frontal lobe, structurally its investing cortex is divisible into two areas, which I have called "frontal" and "pre-frontal"; and although the line of demarcation between these is not abrupt, it may be found on proceeding from behind forwards that there occurs a step-like numerical and volumetrical reduction in the cells and fibres, and a reduction which reaches such a degree in the "pre-frontal" area that I am in the habit of referring to it as showing an extreme of fibre poverty and cell weakness.

As nothing is to be gained by discussing the numerous views put forward by workers in other departments on the functions of the frontal lobe, I shall just briefly mention the points suggested by the histology of the part.

In the first place, concerning the pre-frontal subdivision, I have just stated that it is extremely weak structurally; add to this the experience of the physiologist, that it is the only part of the whole brain which is absolutely irresponsive to electrical excitation, and likewise that of the clinician and experimenter, that its destruction is followed by no noticeable permanent effect, and I think it will be agreed that it cannot possess great functional importance. For my part I think that histology brings proof of what was previously only surmise—that it is the very last pallium to appear in the progress of phylogenesis. I would submit that it is a part with a future, but that at present its evolution is incomplete.

Histological investigation, of course, does not help us in determining whether or not the frontal lobe is the seat of higher psychic functions or their nature; however, the collateral examination of this lobe in man and the anthropoid ape reveals another significant point: it is that the cortex which I have labelled "frontal" is more extensive in the human being than in the ape.

One more point: it is argued in certain quarters in accordance with Flechsig's doctrine that the frontal lobe must be a higher association centre because it is a part which along with certain others shows most atrophy in cases of dementia, particularly the dementia of general paralysis; but this is evidence which we must accept with the greatest caution. On the validity of Flechsig's doctrine I would express no opinion, but I would indicate that there are simple physical reasons to explain why the cortex of the frontal lobes specially shows

changes to the naked eye in the course of cerebral wasting ; it is that it is built up on an extremely weak and collapsible framework of nerve-fibres. The central gyri, the occipital lobe, and other parts do not present this naked-eye change because they, on the contrary, are built on a stout framework.

Turning now to the cortex of the parietal lobe, let me repeat that I believe it is a mistake to suppose that the motor function is represented behind the fissure of Rolando, and judging from the profound structural differences between the ascending frontal and ascending parietal gyri, it is remarkable that the difference in function has not been previously advanced beyond the stage of suspicion. Even with the naked eye the cortex of the ascending frontal gyrus may be seen to be much deeper and the projection of white substance on which it rests plumper and more voluminous than that of the ascending parietal, and there are numerous microscopic distinctions which I am detailing elsewhere. And in regard to function I may state without wasting words that I have plumped for the view that the post-central or ascending parietal gyrus is the main terminus for common sensory impressions. These are my reasons : First, it is now being admitted by those who have studied the developing myelin that the fibres pertaining to this gyrus, like sensory fibres in the spinal cord, acquire their medullated sheath at a relatively early period ; secondly, some of those who have worked at secondary degenerations trace the "cortical lemniscus"—that is, the cerebral continuation of the main sensory system of fibres—to the gyrus in question ; and, thirdly, I myself have obtained some evidence from an examination of the brain in cases of tabes dorsalis, which, in my opinion, is more conclusive than any yet adduced. In pure cases of tabes we have an affection as closely restricted to the sensory neurones as amyotrophic lateral sclerosis is to the motor ; and in three cases I have succeeded in demonstrating profound changes, consisting chiefly of destruction of the large pyramidal elements accompanied by a general disturbance of the cell lamination ; and what is more important, these changes are limited in the most convincing manner to the ascending parietal cortex, particularly that on the rolandic wall.

Concerning that part of the parietal cortex which adjoins my "post-central" area, clinical evidence is gradually accumulating to the effect that lesions thereabouts give rise to isolated

disturbances of the higher components in common sensation—for instance, astereognosis and loss of the muscle sense ; and I incline to the belief that the area for common sensation, like the motor area, will ultimately be divided into different levels or centres. I would submit that the “ post-central area ” proper may be a primary centre, one serving for the recognition of the simplest components in common sensation ; such are impressions of heat and pain ; while parts behind, including the “ intermediate post-central area ” may constitute a higher centre and deal with more complex components, such as the recognition and orientation of cutaneous pressure and the appreciation of the position and condition of our muscles—components all of which involve a psychic process.

But between this “ sensory ” area in front and the visual area behind there still remains for consideration a large tract of cortex of which the structure is unspecialised and the function obscure. The field embraces the great posterior association area of Flechsig, and it is a matter for future settlement what part it plays in the conduct of higher psychic processes. Personally I am not prepared to argue on this question, and will merely indicate some points of interest which occur to the anatomist and histologist. As the act of consciousness is built up on the interpretation of sensory impressions, and we have classical illustrations of the fact that individuals deprived at birth of sensation are of necessity aments, it is significant that this great parieto-temporal area is placed in close anatomical connection with all the great sensory centres ; thus immediately in front we have common sensation ; immediately behind, vision ; immediately below, hearing ; and on the inner surface, by means of the limbic lobe and cingulum, it is brought into association with the sense of smell ; and this simple fact of anatomy seems to favour the idea that the field under consideration may serve for the further elaboration and interpretation of impressions primarily received by the various sensory areas.

In the second place, although Hitzig was perfectly right in saying that in the animal series the growth of the intellect proceeded *pari passu* with the development of the frontal lobe, it might just as truly be said that it bears a like ratio to the development of the parietal lobe. Thus, in the pig, an animal very low down in the series, there is practically no parietal

cortex ; the areas for vision and common sensation lie in close approximation ; in the dog, considerably higher in the series, and with a commencing fissure of Rolando, vision and sensation are separated by an appreciable interval, and in primates the gap widens still further.⁽²⁾ Therefore, whether our parietal lobes share with our frontal convolutions the conduct of high psychic processes or not, there is no doubt that both undergo equal expansion in the progress of phylogenic development.

Another point on which I think I can supply an illustration is that in the human being the parts most prone to suffer from non-development are precisely those which are the last to appear in the course of phylogenic growth. In our pathological museum at Rainhill Asylum we have three remarkable brains, all showing well-developed motor, common sensory, visual, olfactory, and auditory cortex ; but all the frontal gyri anterior to the precentral, and all the parietal behind the post-central, are in a state of microgyria ; the condition is bilateral and symmetrical, and the subjects from whom these brains came were all idiots. Now, I can see no other way of explaining this lesion than by regarding it as a true instance of developmental failure or agenesis affecting that pallium which is the last to form in the progress of cerebral expansion.

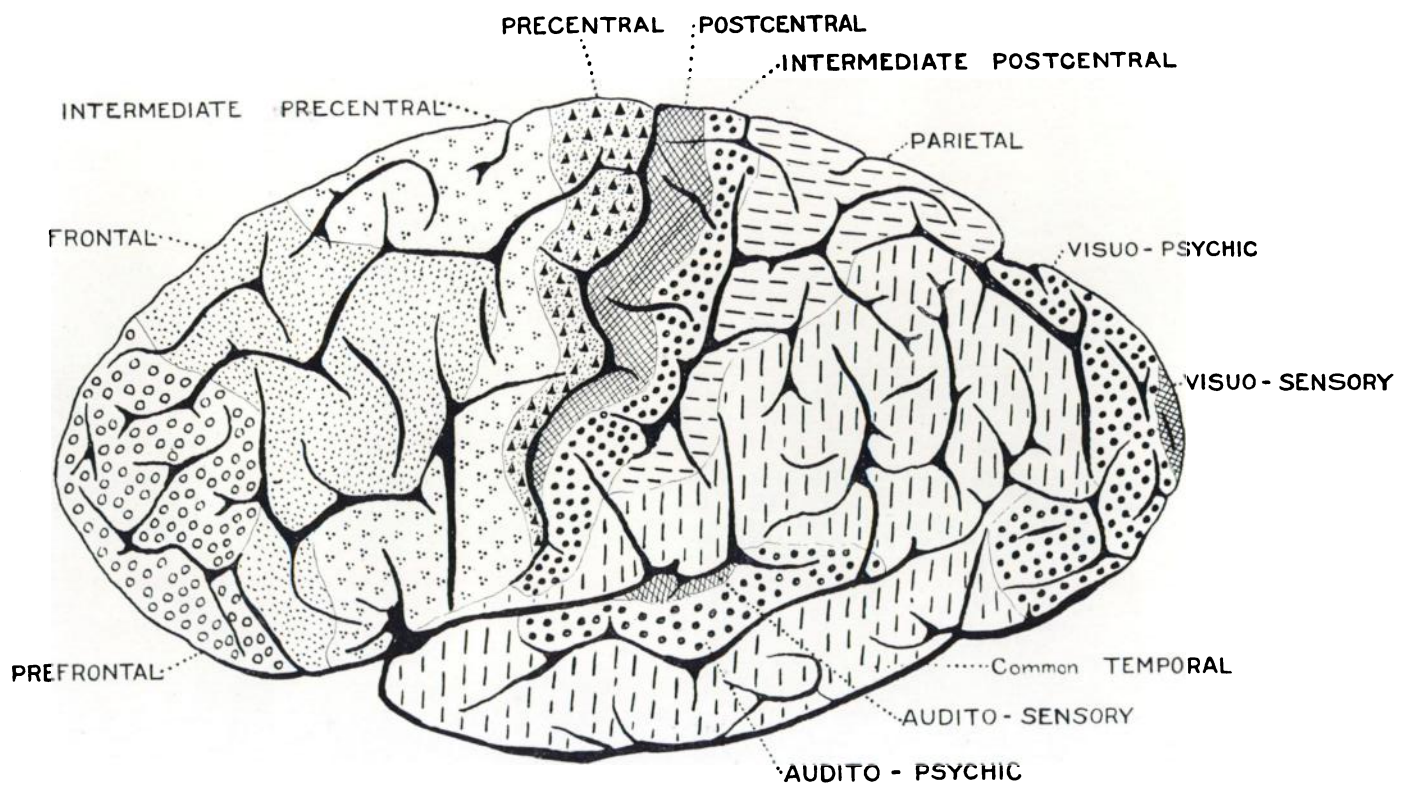
In conclusion, I will briefly indicate what I believe to be the exact distribution of other areas to which I have only made passing reference, and which are shown in the accompanying diagrams.

The visual cortex is histologically divisible into two areas. The first closely follows the calcarine fissure and is marked by the line of Gennari ; it is probably designed for the primary reception of visual impulses ; the second is an investing area which I have called visuo-psychic, and it may serve for the further elaboration of these impressions. In the anthropoid ape the same areas can be defined, but they extend more widely on the lateral surface, they are not specially related to the "Affenspalte," but follow the "external calcarine fissure" very closely.

The primary auditory area I locate on the transverse temporal gyri or gyri of Heschl, while the "audito-psychic" centre corresponds in distribution with the well-known "word-hearing" centre.

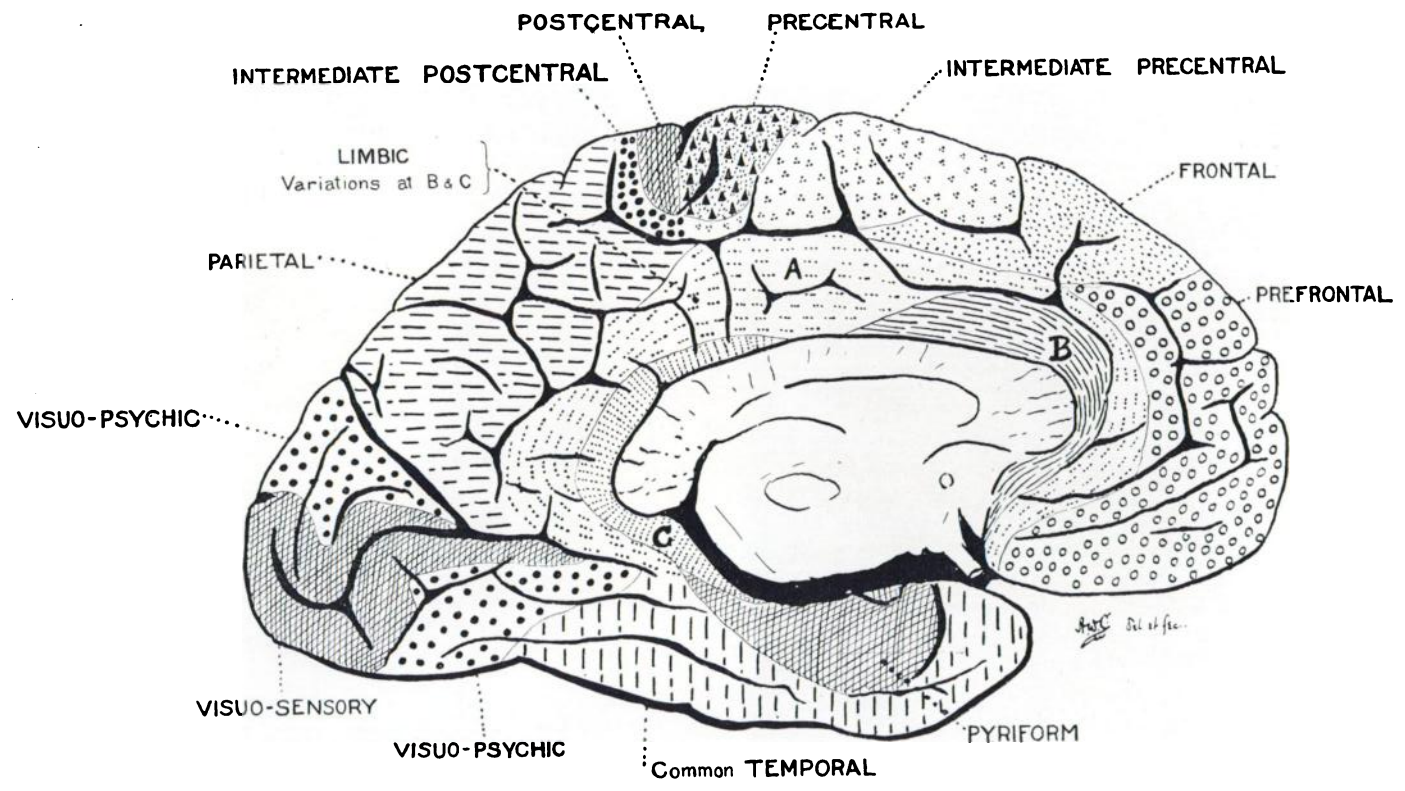
Part of the insula may deal with the recognition of taste impressions.

JOURNAL OF MENTAL SCIENCE, OCTOBER, 1904.



Bale and Danielsson, Ltd.

JOURNAL OF MENTAL SCIENCE, OCTOBER, 1904.



Bale and Danielsson, Ltd.

The olfactory cortex (pyriform) stands as it was. I would merely add that the gyrus fornicatus shows some points in common with it, and that histology gives no support to the view that the cortex of the former gyrus has to deal with common sensation. ⁽³⁾

⁽¹⁾ Read at the Annual General Meeting of the Association, held in London July, 1904.—⁽²⁾ Lantern slides were shown illustrating these points.—⁽³⁾ An account of this work *in extenso* is in course of publication by the Royal Society of London.

EXPLANATION OF DIAGRAMS.

Human brain. M—, æt. 41. Orthogonal tracings of the lateral and mesial surfaces (the former somewhat tilted to show the convexity) of the left cerebral hemisphere, with a composite representation of the distribution of the various areas defined from an examination in serial sections of the cortical nerve fibres and nerve cells in the normal brain and in various states of disease.

In a surface diagram it is impossible to give a true idea of the extent of these fields because cortex concealed within fissures cannot be indicated. Unfortunately, the figures are especially misleading in regard to some of the most important areas; thus the floor and not the lip of the Rolandic sulcus is the boundary between the precentral and postcentral fields, and the concealed portion of these areas is almost equivalent to that exposed. The same applies to the visuo-sensory field, while that marked "audito-sensory" is almost completely hidden away in the Sylvian fissure.

DISCUSSION

At the Annual Meeting in London, July 22nd, 1904.

The PRESIDENT.—Gentlemen, I am sure you will agree with me that our warmest thanks are due to Dr. Campbell for this most interesting demonstration; and of course there are many points which it may be beneficial to discuss. I do not myself feel competent to criticise his work, which is so histological and implies so much original investigation that it would be impossible for me to really seriously comment on it. There are two or three things which he seems to have very definitely settled—that is, the limit of the motor area and the importance of the relationship of the parietal lobe to consciousness. The question of the localisation of mental functions is, of course, one which we always think about and which no one has at all definitely settled; and Dr. Campbell has, I think, done extremely good service in impressing upon us the fact that it is not likely that consciousness is limited in any way to the pre-frontal or frontal areas. His showing of the concurrent development of the parietal lobe with the development of consciousness is most important. Another point is that, as he said, he plumps for the view that the anterior part of the parietal convolution is the arrival platform for common sensation. I shall be very glad to know if anybody will give us his views on this paper. There must be many histologists here who have worked at this subject.

Dr. URQUHART.—A good many of us have thought that there was reason to suppose that the frontal and pre-frontal lobes were in some way connected with the moral faculties, and that in cases of damage to these lobes there was a certain degeneration of the moral and higher psychological faculties. I think that has been rather set aside this morning, and I should like to know if Dr. Campbell rejects that opinion, which has been held for a long time. Another point is that some years ago I published the case of a man who was extremely musical and who died insane. For some time previous to his death the musical faculty had entirely disappeared; it was a sort of aphasia of the musical faculty. After death there was found to be an advanced degeneration of the tip of the temporal lobe, and I think that has been correlated with similar cases of the decadence of the musical faculty in

Germany by certain observers there. If Dr. Clapham were here this morning, he would be greatly indebted to Dr. Campbell for the help he has given him with regard to the theory he propounded so many years ago in placing the intellectual faculties at the back of the head. I need not add to what you have said, sir, as to the value of this paper.

Dr. ANDRIEZEN.—I am glad to have had this opportunity of hearing Dr. Campbell's excellent paper, with so much practical material in it, because what we want in discussing these problems of the brain are really exact and abundant data. And in this respect, as regards the human brain, he has brought forward a quantity of material, of which some at least is new. I was particularly struck with his photographs of brains showing agenesis, especially of the association areas of Flechsig. I have not seen anything like that before. I have certainly met, in *post mortems*, areas of agenesis due to epilepsy associated with arrest of development of nerve-cells microscopically, occurring perhaps as early as the fourth or fifth month of foetal life. Five or six specimens of that I have come across in recent years; and in 1897 I published an article in the *British Medical Journal* on the pathogenesis of epileptic idiocy and imbecility, in which these appearances were described as very common and constant. But they had not quite the localisation that Dr. Campbell describes. These areas which I found in idiots of congenital origin were of vascular distribution; they corresponded to certain vascular territories. So that we may have agenesis, a primary and purely nervous condition, with arrest of development of nerve-cells and areas irrespective of vascular distribution, and also agenesis of vascular origin, which may also give rise to idiocy and other forms of defective development. I have myself, like all who have worked in the comparative anatomy of the brains of mammals, found great difficulty, in my earlier studies, in making any homology between the crucial sulcus of the carnivora and the Rolandic fissure in man. They do not correspond, and the minute study of the histology behind and in front of the crucial sulcus shows that the differences do not correspond with what obtains in man. But I believe this was pointed out twenty-five or thirty years ago, by Bevan Lewis in one of his memoirs published in 1878 or 1879. This leads me to place some emphasis on this point. Bevan Lewis with remarkable insight mapped out in a strikingly accurate way the various areas of the brains in lower animals. But I will not linger on this, because you are all well acquainted with it. But since Flechsig definitely advanced his theory in 1895, our advance in this direction has been very great indeed. With most of the anatomical facts and histological details which Dr. Campbell has brought forward one can only express one's concurrence. But there are one or two points I would like to ask his opinion upon, as I feel inclined to differ. With regard to the destruction of the pre-frontal area, I believe Dr. Campbell said it produced no mental disabilities. I believe clinical evidence within the last five or six years, accumulated by such skilful observers as Bianchi, von Bruns, Höniger, and others, has shown clearly that small tumours not exceeding the size of a walnut, in the most anterior part of the brain, the pre-frontal lobe, are capable of producing dulness, apathy, and depressive mental symptoms; and that as these tumours grow larger and grow backwards, and thus come near the limits of the kinaesthetic area, kinaesthetic complications, such as slight movements of the hand or face, or excitation of the speech centre, with slight speech disturbance, are present. From a very careful study of the work on this subject, I have concluded that the extreme prefrontal area is part of the psychic area, and that tumours of it are associated with those distinct disabilities. It has been said that movement is not represented behind the fissure of Rolando. That is true of about 95 *per cent.* of the kinaesthesia; but I should like to ask whether Dr. Campbell has no evidence that slight oculo-motor representation is present in the calcarine area. I believe Munk was the first to call attention to this in the dog. Those of you who have examined histological specimens of the cortex of the cat or dog will remember that in the calcarine area there are collections or groups of large pyramidal cells, something like Betz cells. It is practically the only part of the brain, except the so-called motor area, in which they are present; and I believe Munk suggested that these cells are connected centrifugally (downwards) with the oculo-motor region in such a way that they act as cerebral adjusting centres for oculo-motor movements. With that exception, I agree with Dr. Campbell. I wish to add a few words about the question of phylogeneses of the brain. One of the best and most instructive ways—in fact, *the way*—of apprehending the

functions of the brain must be by tracing its phylogenesis. And that is just what Darwin has taught us. Take the amphibian brain. You will find it is a very lowly organ of representation: it is practically almost entirely an olfactory organ and nothing more. In some investigations which I made and published in *Brain* in 1894, I pointed this out, and others have done so too, that the olfactory fibres as they pass into the basal part of the brain of the frog extend and spread practically throughout its whole cortex, and that few, if any, other sensory fibres could be traced. So the cerebral hemispheres of the brain are practically an olfactory organ in the frog. Then as we rise higher in the scale we get the movements of the forelimbs especially, which are prominent in the mammalia, and especially the segments corresponding to the fingers, parallel with the higher development of the motor area; until you can, in a measure, trace a parallelism between the gradual increase in the kinæsthetic life of the animal and the development of the pentadactyle limb in grades of mammals, from the lower such as the rodentia, and the somewhat higher carnivora, to the highest, such as the monkey and man. I wished to emphasise the great importance of the comparative study of the brain, and I would express my great pleasure at having heard such an excellent paper.

Dr. ROBERT JONES.—Dr. Campbell is doubtless aware of a very interesting demonstration which took place at Claybury some time ago, before the Psychological Society. Dr. Bolton therein laid very particular stress on the prefrontal lobe. He had a large number of sections at the position of the transverse fissure of Wernicke in the anterior part of the frontal lobe, and I believe Dr. Bolton, in a subsequent paper, published some of these details, which went to show very much, as far as one could appreciate them, the relationship between dementia and the large pyramidal cells. Evidently, from what I have learned to-day, Dr. Campbell is inclined to be somewhat sceptical about the intellectual functions of the prefrontal and frontal lobes so far as the pyramidal cells are concerned, and prefers, at any rate as far as I can make out, to place greater importance upon the parietal lobe as the part of the brain first connected with consciousness, although he stated there were marked cell differences between the frontal and parietal lobes. I should like to know whether Dr. Campbell agrees that the large pyramidal cells are concerned in the main with intellection, as Dr. Bolton believes, and that the prefrontal lobe represents essentially this highest evolved mental area; I was also interested in what Dr. Urquhart said. It seems to me the moral sense is capable of further analysis. It is not an unanalysable faculty: it is the resultant of a number of simple mental factors, and cannot apparently be located in one special territory of the brain.

Dr. CAMPBELL.—I am delighted with the reception my demonstration has met with, and although there has not been a long discussion, I have the feeling that my work has been thoroughly appreciated by the members of this Association, and that, to me, is an ample reward for the time spent on it. Several important points have been raised by the gentlemen who have spoken, and I am specially obliged to them for mentioning these, because it affords me an opportunity of filling up one or two omissions. Dr. Urquhart's questions were particularly pertinent, and my answer to that concerning the function of the frontal lobe will also apply to one of Dr. Andriezen's questions. The point about the functional value of the frontal lobe which I do not seem to have made clear is, that the part which I am calling the "prefrontal area" is not of much importance. My meaning is, that it is probably a region with a future, but that at the present its evolution is imperfect. The area which I call "frontal," on the contrary, is of proved importance; there is a large amount of clinical evidence, almost incontrovertible, which I had not the opportunity of mentioning before, as I endeavoured to confine myself to histological evidence, which has been supplied by Leonora Welt and others, and emphasised by von Monakow, to the effect that destruction of what one may call the middle part of the frontal lobe—that corresponding to my "frontal area"—gives rise to various disturbances of the moral faculty. Then, on the other hand, there is as much clinical and experimental evidence proving that destruction of the tip of the frontal lobe—the "prefrontal area"—on both sides, gives rise to no effect at all. In this connection, I think Dr. Andriezen referred to Bianchi's experiments; with these I am familiar. Bianchi tried to remove the inexcitable part of the frontal lobe only, but it is doubtful whether he succeeded; he must surely have damaged the excitable region to some extent, and this would account

for his positive results. In reference to the cases of loss of the musical faculty mentioned by Dr. Urquhart, it is true that such cases stand recorded in the literature, and they aim at showing that this faculty is located at the tip of the temporal lobe, but this localisation is not finally proved; indeed, it is only by an analysis of a further accumulation of work, by earnest co-operation between the physiologist, the pathologist, the clinician, and the histologist, that this and many other difficult points can be definitely settled. I am glad to have heard Dr. Bevan Lewis' name mentioned, because there is no man for whom I have a greater admiration as a pioneer in cerebral histology. We would have been saved years of labour if his work had been duly recognised; personally I have found his descriptions of the "giant-cells" in man, the cat and the sheep so exact, that, after going over their area of location many times, I would not like to alter a single word he has written. I have been asked whether oculo-motor movements do not result from stimulation of the calcarine area; they certainly do, as Sherrington and Grünbaum have clearly shown; and I may further mention that there are several other parts of the brain special stimulation of which produces such movements. Thus, they have been obtained from the angular gyrus—and this is one of the points in Ferrer's argument that the same gyrus constitutes the "word-seeing" centre. But I think the most constant part from which eye movements have been elicited is one well in advance of the hand area. Horsley and Beavor first mapped out the field in the Orang, and their results have been confirmed by Sherrington and Grünbaum.

The Educational Treatment of Young Epileptics.⁽¹⁾ By
G. E. SHUTTLEWORTH, B.A., M.D., formerly Examiner of
Defective and Epileptic Children, School Board for London.

I HAVE thought that at the present time, when there is a prospect of systematic school provision being made for epileptic children in accordance with recent legislation, the attention of this Association might usefully be called to the necessities of the case.

I may just remind the meeting that legislation on the subject has been the outcome of much preliminary discussion. The Charity Organisation Society appointed a committee in 1890 to consider and report on the public and charitable provision made for the care and training of feeble-minded, *epileptic*, and crippled persons; and a book embodying the conclusions arrived at with regard to the two latter classes was published in 1893.⁽²⁾ Later the Government appointed a Departmental Committee to inquire and report (*inter alia*) as to the provision of suitable elementary education for epileptic children; and this committee reported to the Board of Education in 1898. The outcome was an Act of Parliament passed in the following year "to make a better provision for the elementary education of defective and epileptic children in England and Wales."