XXI. *On the Functions of some parts of the Brain, and on the relations between the Brain and Nerves of Motion and Sensation.* *By Sir* CHARLES BELL, *F.R.S.*

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THE difficulties which attend the investigation of the structure and functions of the brain are shown by the ineffective labours of two thousand years; and the first endeavour of the author is to remove the idea of presumption that attaches to the very title of this paper. Perhaps the enumeration of some of the sources of error which have retarded discovery may be the best introduction and apology.

The first impediment to success is in the nature of the inquiry, since extraordinary and contradictory results must be expected from experimenting on an organ so fine as that must be which ministers to sensibility and motion, and which is subject to change on every impression conveyed through the senses. This remarkable susceptibility is exemplified in what we often witness; extraordinary results, such as violent convulsions and excruciating pain, from causes which appear quite inadequate. For example, the presence of a minute spicula of bone which has penetrated to the brain, will at one time be attended with no consequence at all; at another it will occasion a deep coma, or loss both of sensibility and motion. Nay, symptoms apparently as formidable will be produced by slight irritation on remote nerves. Seeing these contradictory effects, is it reasonable to expect constant and satisfactory results from experiments in which deep wounds are inflicted on the brain of animals, or portions of it torn away?

Other circumstances evince the slight varieties in the causes which produce the most extraordinary effects. Water in the brain, which has free access to all the cavities of the brain, and which to all appearance both presses equally, and if it irritate must irritate equally, will have the effect of rendering one side of the body paralytic and of convulsing the other with incessant motion.

Another source of error, especially to the experimenter on the brain, is the disturbance of its circulation; for the brain depends more directly than any other organ on the condition of the circulation within it. We may see this in the provisions for the free and equable supply of the blood within the head, as well as for its unimpeded exit. Now by raising the skull, a necessary preliminary to most experiments on the substance of the brain, there is an immediate disturbance of the circulation, which of itself may be attended with insensibility or convulsions.

The most frequent source of error, perhaps, is the obscurity which hangs over the

whole subject; for although the brain be divided naturally into distinct masses, not one of these grand divisions has yet been distinguished by its function. There is not even an opinion as to their relative importance. Hence it has followed that the experimenter has not known what to seek, or how to plan his experiment; and hence have been derived the weakest fancies that have ever obscured any science. Another difficulty meets the inquirer at every step if he be not critically guarded. Whole masses of the brain may be destroyed by disease, or actually removed with impunity; that is to say, without any immediate influence on the mind, or on the power of motion or of sensibility; yet the very slightest general impression on the brain will in the instant deprive the individual both of sense and motion.

It will not be denied that the most unequivocal proof of the little success which has attended the efforts made to improve this part of physiology, is the failure of all attempts to explain the phenomena which attend injury of the brain; it is neither said why in disease of the brain sensation and motion should be lost together, nor why one faculty should sometimes be imperfect and the other entire. There is no satisfactory reason given for the most common occurrence in practice, the loss of motion and sensation on the side of the body opposite to that side of the brain which has received the injury; nor has the condition of the face as associated with that of the body been accounted for. When circumstances so remarkable present themselves daily, consequent upon accident or disease affecting the brain, without our teachers succeeding in offering a satisfactory reason for them, it is obvious that we are in a state of profound ignorance of the most interesting functions of the animal body, notwithstanding the innumerable experiments which have been made upon the brains of animals.

These are probably the reasons why ingenious men have failed to make us acquainted with the distinct functions of the divisions of the brain, and countenance us in advancing to the inquiry in a manner altogether different. If the real intricacy of the brain, and the disappointments met with, have inclined many to consider it as an inextricable labyrinth, we may well doubt whether the thread which is to lead us through has been properly selected. This term is not altogether metaphorical, since it is our design to follow the course of the natural filaments discernible in the nervous matter of the brain. The investigation into the substance of the brain must be made in a manner different from common dissection; there is a new element to conquer. Every part of the brain is closely united and pent up within the skull, for the protection of its delicate substance. This compactness of structure guards the brain against impulse from within as well as from external injury; but whether the whole of this structure be essential and of primary importance, or whether some part may not perform the merely accessory office of packing and joining together the more delicate parts, and so securing the finer filaments which run through it, is even up to the present time matter of conjecture. However, it is to the filamentous and striated texture that we attach importance, as leading in the right path, and as marking the

relations which exist between the parts of the brain, and the connexions of these with the nerves distributed over the body. The advantage with which we now enter on this inquiry is obvious, for instead of seeking, by injuring the substance of the brain, to discover the effects on remote parts of the nervous system, we commence the inquiry with a knowledge of that system.

It being now universally allowed that nerves have distinct functions, and not a common quality, and that the sensitive and motor roots of the nerves spring from different sources, it must appear a very natural mode of inquiry to follow these nerves into the brain, and to observe the tracts of nervous matter from which they take their origin. It is surely an easy, as well as a natural proceeding, to follow these tracts, and to mark the portions of the brain to which they ultimately tend; finally, to inquire what is the effect of the diseases of these parts, what the accompanying symptoms, and to compare the symptoms with the anatomical details.

On this plan I now propose to demonstrate that sensibility and motion belong to the cerebrum,—that two columns descend from each hemisphere,—that one of these, the anterior, gives origin to the anterior roots of the spinal nerves, and is dedicated to voluntary motion,—and that the other (which from its internal position is less known) gives origin to the posterior roots of the spinal nerves, and to the sensitive root of the fifth nerve, and is the column for sensation.

Further, I propose to show that the columns of motion which come from different sides of the cerebrum join and decussate in the medulla oblongata,—that the columns of sensation also join and decussate in the medulla oblongata. Finally, that these anterior and posterior columns bear in every circumstance a very close resemblance to one another,—that is to say, the sensorial expansions of both are widely extended in the hemispheres: they pass through similar bodies towards the base of the brain, and both concentrate and decussate in the same manner, thus agreeing in every respect, except in the nervous filaments, to which they give origin.

Of the striated Septa in the Medulla Oblongata and Pons Varolii.

We can have no hesitation in giving superior importance to those tracts of striated matter which descend from the brain to the spinal marrow, since they are obviously the lines of communication between the organ of the mind and the frame of the body. But these longitudinal tracts are separated by certain plates of fibrous matter which go directly transverse, are very regular, very easily demonstrated, and although no doubt important in themselves, are particularly useful to us in our present view, as establishing the natural distinctions or boundaries between the columns which descending from the encephalon constitute the medulla oblongata and the spinal marrow.

I shall first name parts that are familiar, as being noticed in systematic works, and proceed to others which I conceive have been overlooked. Of the former class are

the superficial transverse fibres of the pons or nodus cerebri, which passing across terminate in the crura cerebelli. When this part of the pons Varolii is raised, and with it the longitudinal striated matter which passes from the crus cerebri and is prolonged to the corpus pyramidale, a very distinct layer or septum of transverse fibres is seen crossing from the one hemisphere of the cerebellum to the other. This septum is best seen from behind, when the tracts which descend from the cerebrum and from the corpora quadrigemina are taken away, for then its appearance (as in Plate XX. fig. 1. A. A.) much resembles the plates now to be described.

As to those septa which I conceive have hitherto been neglected, the most remarkable is that which forms a plane in the median line, resting with its edge upon the last-named transverse septum, and extending its fibres directly backwards, so as to form a striated leaf, separating the two great longitudinal tracts which pass between the medulla oblongata and the thalami nervorum opticorum (Plate XX. fig. 1. B.).

If we separate the corpus restiforme (meaning by that term the mass which passes between the cerebellum and the medulla oblongata,) from the corpus olivare, we shall find a layer of delicate fibres which constitute a pellicle much resembling the fibrous layer, which might be peeled from the bark of the birch-tree, and this is a septum (fig. 1. c. c.).

Another septum of the same kind intervenes between the two anterior corpora pyramidalia. So accurately are the extreme anterior fibres of this septum attached to the corpora pyramidalia, that if we separate these bodies the fibres will alternately adhere to the right and left column, so as to present an appearance as if there was an actual commissure between them; and authors have mistaken this, describing that, which truly is a septum of separation, as a bond of union. And so on the back part of the medulla oblongata, when we push aside the restiform bodies, or those columns which have sometimes been called the posterior pyramidal bodies, and open the central slit, we have the same appearance of minute commissures, which, however, is only the separation of the fibres of the plate or septum; and these fibres, instead of running in a direction to be a lateral bond of union or commissure, run from before backwards, and intervene between the longitudinal columns.

These layers not only distinguish in a natural way the columns which are descending from the cerebrum to form the spinal marrow, but they are necessary as leading us to the true points of union between the longitudinal columns, where their fibres actually decussate, and where these septa are deficient to permit the union.

The Pons Varolii, or nodus cerebri, is undoubtedly an intricate part of the brain; but until this intricacy be explained, we can have no hope of making a correct arrangement of the course of the filaments in the brain, and which pass through this body. We shall therefore take it as a key to the composition of the brain.

The pons has with seeming correctness been considered as the commissure of the cerebellum. In this, its capacity of joining opposite parts, we have to notice its two

transverse laminæ of fibres above alluded to, one superficial and the other deep-seated. We observe also an oblique lateral process which passes from the cerebellum to the crus cerebri. These septa intersect and distinguish the grand fasciculi or tracts of nervous matter, which, coming down from the cerebrum, seem to flow under the bridge and converge in the medulla oblongata*.

We commence our investigation with parts that are familiar. We trace the corpora pyramidalia of the medulla oblongata upwards from the point of their decussation towards the brain. They enter the pons by two distinct arches. The superficial layer of transverse fibres stretching from the crura cerebelli is over them, and the deeper septum is under them. On raising the superficial layer of the pons, we see the fibres of the corpora pyramidalia passing quite through to the crus cerebri; and now in one view we see a great portion of the grand tract which furnishes the nerves of motion (Plate XIX. A. B. C.).

Let us divide these tracts by a transverse incision where the corpora pyramidalia enter the pons, and lift them up. We keep close to the deeper transverse septum, which we shall find as distinct and smooth as a floor, and now directed by this septum we distinguish the portion of fibrous matter which is anterior to it; and if we follow this up into the crus cerebri, we shall come upon the corpus nigrum, and find that the crus is not a simple texture of filaments, but that it is compound, and that we are lifting that anterior division of it which belongs to motion, and which we shall find spreads over the tract of nervous matter which comes up behind the deeper-seated septum.

We may complete our view of this motor tract, by making sections of the cerebrum, and pursuing the diverging fibres, first into the corpus striatum, and thence, as they proceed onwards, spreading into the hemisphere of the cerebrum and diverging to the cineritious convolutions.

Thus we have already found, that the crus cerebri is not simple, but consists of parts easily and naturally divided. Returning then to the pons as furnishing us with the means of making the natural distinctions of these tracts, we take the deep septum or posterior set of transverse fibres again as our guide, and trace

The posterior Tract.

To obtain a distinct view of the whole extent of the posterior tract, we require to have the parts carefully prepared †. It will be very convenient to have the crura, pons,

* The terms pons and nodus are sufficiently intelligible and harmless, as implying no theory; I retain the old names unless the new ones be countenanced by the just eminence of the authors who have invented them. This is the proper check against the mutiplication of terms in anatomy. In describing the course of the fibres, the expressions I employ are used in their anatomical sense, as implying the direction in which the hand and eye are following the line, and not in reference to the course in which I may suppose the energy to pass in the performance of their functions.

† It will be in vain for the anatomist to attempt demonstrating these facts in the recent brain; but he will find it easy if he take some old preparation of the brain, which has been for some years in spirits.

and medulla oblongata detached from the great masses of the cerebrum and cerebellum, so that they may lie before us. We should first mark out and trace the columns of the spinal marrow; observing the corpora restiformia as they come down from the cerebellum, we may split them at the posterior fissure and fold them aside.

We now survey the extent of the fourth ventricle. On each side of the calamus scriptorius are two pyramidal columns*. To trace these upwards we must cut into the iter ad tertiam ventriculam, by dividing the corpora quadrigemina, and then we can trace them up into the thalami nervorum opticorum. By a section we may trace them through that body, and then diverging into the hemispheres of the cerebrum.

Having followed these columns upwards, we next trace them downwards, and find that they join, intermingle, and decussate, and again separate, and proceed down the spinal marrow (Plate XX. fig. 2. B. C.).

From no part of this column does any nerve of motion take its origin; its relations to the sensitive nerves will be seen on further dissection.

The corpus striatum and the thalamus lie very curiously together: the thalamus forms a nucleus round which the corpus striatum bends, and when their respective layers of striæ make their exit beyond these bodies to form the great fan- or solar-like expansion into the hemisphere of the cerebrum, their rays mingle together. A rude representation of these two tracts of the cerebrum, as we have traced them, may be made with the hands. If I place my wrists together, parallel, and closing one hand, embrace it with the other, I represent the two portions of one crus. The closed fist is the thalamus, and the other is the corpus striatum. If I then extend my fingers, interlacing their points, I represent the final distribution of the portions of the nervous matter which are dedicated to sensation and volition.

But before proceeding further, we must distinguish a certain portion of the great tract of fibrous matter that lies behind the septum of the pons, which does not belong to sensibility, but to a different order of parts. If we dissect round the corpus olivare, we find it easy to separate this body from the column of motion on the fore part, and the column of sensation behind. Following then the fibrous portion of matter which ascends from it, we find that it runs close upon the back of the septum of the pons, and that a part of it goes off to the corpora quadrigemina, whilst a part runs directly into the crus cerebri.

On tracing the column which descends from the corpus olivare, we find that it is very soon attached to the columns both of motion and of sensation, and becomes incorporated with them as it passes downwards (Plate XXI. G.).

We have now traced three great tracts or courses of fibres into the crus cerebri;

* In fact all the columns which form the medulla oblongata converge downwards and are pyramidal. We have the anterior pyramidal bodies, the posterior pyramidal bodies or corpora restiformia, and those deeper columns, whose form might authorize the term, as they are more especially counterparts of the true anterior pyramidal bodies.

an anterior one for motion, a posterior one for sensation, and a middle one, which for the present we may call the tract of the corpus olivare.

After these dissections, it is impossible for us to consider the medulla oblongata as the mere commencement of the spinal marrow: it has a peculiar structure and distinct functions; it is the body formed by the convergence of the great tracts of the cerebrum, where these tracts respectively meet and decussate; in it the tract of the corpus olivare is joined to those of motion and sensation.

Below the medulla oblongata the spinal marrow commences, or rather is prolonged from it, but it is constituted with a distinct arrangement of its columns. On each side it receives three columns from the cerebrum, besides those which come down from the cerebellum, under the name of corpora restiformia, to form its posterior part, and these columns enter into relations which do not exist above.

Decussation of the Posterior or Sensitive Part.

We have noticed a fact of more than ordinary importance as reconciling the occurrence of symptoms, with our knowledge of anatomy. Where the posterior tract, descending from the cerebrum, has reached the point of the medulla oblongata, just opposite to the decussation of the corpora pyramidalia on the fore part, we described a coalescence. We have already stated, that when we proceed to separate the columns on the sides of the slit called calamus scriptorius, we see small, neat, and regular filaments, as it were, interlacing and joining the two columns. But when we examine further, we perceive that these filaments belong to a plate of fibrous texture which passes in the central plane from before backwards (Plate XX. fig. B.). This striated septum stops or is interrupted by the union of the columns of sensation; and now attending to the fibres of these two columns, we find them to decussate with an interweaving as distinct as that of the corpora pyramidalia or anterior columns (Plate XX. fig. 2. c.). After this union and decussation has taken place we may trace the nervous matter downwards in the two lateral portions of the spinal marrow, covered by the columns, which are the most posterior of all, and which descend from the cerebellum under the name of corpora restiformia.

Before tracing the origin of the sensitive roots of the spinal nerves, and that of the fifth nerve, in their relations to these tracts, we may review their course. We cannot fail to observe the remarkable correspondence in the structure and course of the two grand tracts or divisions of the crus cerebri, which descending, form so large a portion of the spinal marrow. Tracing them from the brain, we find both converging from the periphery of the hemisphere; both entering masses of cineritious matter, emerging alike, and approaching, but not absolutely joining; both contracting into narrow pyramidal columns; both having corresponding decussations, and only distinguishable at last by one of them giving origin to the motor nerves, and the other to the sensitive.

The origin of the posterior roots of the Spinal Nerves, and their relation to the decussation of the Posterior Column.

The brain being before us so as to present its posterior aspect, and the back part of the spinal marrow, we raise the cerebellum and tear the pia mater, so as to expose the fourth ventricle. We may divide the processes of the cerebellum and take that body away. Having the parts thus prepared, we attend more particularly to the posterior series of roots of nerves which run towards the uppermost spinal nerve.

If we trace the line where the posterior roots of the spinal nerves arise, we find that the posterior columns of the spinal marrow are behind these roots; and if we trace these posterior columns upwards, we see them diverging under the name of corpora restiformia to the cerebellum. We strike a level by following the posterior roots of the spinal nerves into the spinal marrow. In doing this we shall find it necessary to lift the posterior column, and then, being able to trace the roots of the nerves, we shall find them connected with a course of longitudinal filaments; and these, on further investigation, will be found to be continued from the point immediately below the decussation of the posterior column of sensation, which I have described above (Plate XX. fig. 2. c.).

Thus it will be found, that the posterior roots of the first, and consequently of all the spinal nerves, are derived from that posterior column which descended from the posterior division of the crus cerebri, and that they are thus placed in the same relation as the anterior roots with respect to the decussation of the prolonged medullary matter of the cerebrum.

The origin of the sensitive root of the Fifth Nerve, and its relation to the Spinal Marrow.

In former papers I have proved the fifth nerve of the head, according to the arrangement of Willis, to be the nerve of sensation to the head and face, thus distinguishing it from the nine nerves of the encephalon, and from the appropriate nerves of the senses to the nose, and eye, and ear.

I gave my reasons, at the same time, for distinguishing it as the nerve of mastication, and showed, in short, that it had all the characteristics of a spinal nerve. It becomes now a subject of interest to observe in what respect it further resembles the spinal nerves, and to inquire how its relations with the brain are formed. It is a happiness in this inquiry, that although it be difficult to trace the motor roots of nerves, owing to the delicacy of their connexions with the brain, the sensitive root is followed with ease into the brain or spinal marrow.

We commence the dissection of the fifth nerve by distinguishing its grand divisions as they emerge from the side of the pons, separated by a transverse band of fibres (Plate XX. fig. 6, 7.).

Leaving, for the present, the scattered roots of the motor portion which pass between the transverse cords of the pons, we shall proceed to follow the other in a retrograde

direction towards its origin. For this purpose, with a small and fine knife, we cut into the substance which surrounds the sensitive root, to the depth of a twelfth of an inch, and then lay aside the knife and take the curette, and perhaps the ivory handle of the knife *. With these we push aside the substance of the brain, in doing which there is no difficulty in distinguishing the smooth, flat, and ribbon-like white nerve. Continuing to press aside the matter of the pons, and, when separated, to cut it away, we find the nerve taking a course backwards and downwards into the medulla oblongata, making a considerable angle. Here we are interrupted by the crossing of the portio mollis of the seventh nerve. We observe in passing, that the portio mollis has two roots; that besides that usually described passing round the processus ad cerebellum to the anterior part of the fourth ventricle, it has a round root, which enters anteriorly to that process. But by attention and much neat dissection we may preserve these roots of the seventh nerve, and, recovering the tract of the fifth nerve below, trace it downwards. We are again interrupted by the origins of the eighth pair of nerves; and here, too, it will be found, on careful dissection, that this nerve does not correspond with the description in systematic works. But to proceed with our proper subject. Some part of the root of the fifth may be seen to deviate in a direction towards the calamus scriptorius; but the main tract descends behind the fasciculus of the corpus olivare, by the side of the great fasciculus of fibres which we have already traced down from the cerebrum. Disregarding this association, and following still the root of the fifth nerve, we find it continued to the roots of the superior spinal nerves; and in tracing it thus far, we must conclude that its relations are with the spinal marrow rather than directly with the brain, and that it joins the posterior column below the decussation of that sensitive tract or column. It remains a proper subject of inquiry to determine how far the deviation of a part of the sensitive tract of this nerve corresponds with its complex function in being the source of taste as well as of common sensibility.

It has been observed by diligent anatomists from time to time, that the nerves of the encephalon come off in a direction ascending from the spinal marrow. There can be no doubt that the sensitive root of the fifth ascends, and that it has its origin in the spinal marrow rather than in the brain. Without at present inquiring into the minute anatomy of the other nerves, we may draw very important conclusions from what is before us.

It is rather surprising, that from what was known of the anatomy of the brain, pathologists should have so agreed in their explanation of the phenomenon of injury of one side of the brain producing its effects on the opposite side of the body. Their opinion was founded on the decussation of the anterior columns, or pyramidal bodies, and those only; but great misconception must have prevailed as to the anatomy, when such an explanation could be satisfactory; and, at all events, it must

* If we order dissecting instruments, there is no end to the trouble of procuring them fine enough. The operating case of the oculist, however, furnishes at once all that is necessary for delicate anatomy.

have been believed that the posterior roots of the spinal nerves were the same, in function, with the anterior roots. When, however, it is understood that the anterior column of the medulla oblongata gives off only filaments of motion, the rationale of decussating fibres fails, or rather is imperfect; for in injury of the brain, both motion and sensation are lost on the opposite side of the body. We perceive how important it was, in order to understand this symptom, that the posterior or sensitive part of this column should be shown to descend from the cerebrum, and decussate at a point, corresponding to that at which the decussation of the pyramidal bodies takes place.

I have observed, that the corpus striatum is the part in which most frequently rupture of the cerebral vessels occurs; and the observations of authors correspond with this opinion. In such cases we can readily believe that the power of motion will be most injured; whilst such derangement in the hemisphere must, at the same time, more or less affect the sensibility.

Certain circumstances essential to the study of the pathology of the brain are explained through this part of anatomy; first, that motion and sensation should, in by far the greater number of cases, be lost together, in disease of the brain; because the sensorial extremities of both columns are in the hemisphere of the cerebrum; secondly, it is seen why it is that the sensibility, as well as the power of motion, is injured on the opposite side of the body when the hemisphere of the cerebrum is hurt or diseased, for both columns decussate; in the third place, the anatomy of the origin or root of the fifth nerve explains very satisfactorily why, in palsy, the privation of sensibility of the side of the face corresponds with that of the body.

My paper should perhaps have terminated here, with these demonstrable facts, but I am tempted to reach a little further.

Further examination of the relation between the Brain and Spinal Marrow.

Other questions will be suggested in reference to the symptoms of disease in the brain. When the side of the body is paralytic, how far are the nerves affected which appear to have their origin above the decussations? Does the ninth or lingual, or the portio dura of the seventh nerve, correspond with the spinal nerves? Do the third nerve and the muscles of the eye partake of the condition of the body?

As there is no decussation above the apparent origin of these nerves, and as the commissures of the brain do not serve to explain this phenomenon, we are directed in our inquiries to the spinal marrow.

The spinal marrow has much resemblance to the brain, in the composition of its cineritious and medullary matter, and in the union of its parts. In short, its structure declares it to be more than a nerve, that is, to possess properties independently of the brain. Another consideration presses upon us. Where are the many relations existing between the different parts of the frame, and necessary to their combined actions, established? There must be a relation between the four quarters of an animal. If the muscles of the arm or of the lower extremities are combined through the plexus of

nerves in the axilla, and in the loins, what combines the muscles of the trunk, and more especially what joins the extremities together in sympathy? That these combined motions and relations are not established in the brain, the phenomena exhibited on stimulating the nervous system of the decapitated animal sufficiently evince. They must therefore depend on an arrangement of fibres somewhere in the spinal marrow. Comparative anatomy countenances this idea, since the motions of the lower animals are concatenated independently of a brain, and independently of the anterior ganglion, which in some respects gives direction to the volition of these animals.

It comes next to be inquired what use there can be in a decussation, by which one side of the brain is made to serve the opposite side of the body. Ingenuity can offer no reason for such an arrangement; the object must surely be an interchange of fibres, and consequently a correspondence in the movements of the sides of the body and of the extremities. And on this subject it must be admitted, that although in nine out of ten cases the side of the body opposite to that which is diseased in the brain is affected with paralysis, it is not always so, and very often a certain debility is perceptible in the side which is least affected. Again, when a man is seized with paralysis, he is sometimes at the instant affected with pain in the other side. These irregularities tend to countenance the belief that the decussations of the sensitive and motor spinal columns are rather intended to effect combination and sympathy between every part of the frame, than that one half of the brain should belong to the opposite half of the body, for no apparent object, and without producing any harmony of action.

Such arguments induce me to believe that the brain does not operate directly on the frame of the body, but through the intervention of a system of nerves whose proper roots are in the spinal marrow, and that the decussation, or rather the arrangement of the fibres, takes place at the point where the columns descending from the brain join the spinal marrow, and consequently in effect above the origin of all the nerves, excepting those of the four senses. This supposition would furnish an explanation of the whole of one side of the body, limbs, face, and head, being similarly affected in paralysis. It would also explain the appearance, which all the nerves of motion and sensibility have, of coming in a direction upwards from the spinal marrow, rather than directly outwards from the brain, as the nerves of the proper organs of sense do.

In reflecting on the origins of the nerves of the encephalon, it appears that neither nerves of sense nor of motion arise from the cerebellum or its processes. It further appears that the restiform bodies or processes form no union or decussation similar to those which we have described in the columns of motion and sensation which descend from the cerebrum.

Those descending processes of the cerebellum, however, form a large portion of the spinal marrow; and we must thence infer that the cerebellum operates through the system of the spinal marrow.

The symptoms attributed to disease of the cerebellum do not remove the obscurity which invests this part of anatomy. We know that sometimes the whole hemisphere of the cerebellum is destroyed by suppuration, without loss either of sense or of motion. Moreover, when symptoms do attend disease of the cerebellum, its juxtaposition to the medulla oblongata inclines us to suspect that the effects are produced through the latter body. The substance of the cerebellum is not of diameter sufficient to have a large clot of blood in it, or a large abscess, without blood or matter communicating with either the fourth ventricle, or bursting out upon the surface. The influence thus becomes general on the nervous system, and a confusion in the symptoms is the necessary result. We have no distinct and well-marked cases of disease in the substance of the cerebellum, such as we possess of disease in the cerebrum; and on the whole it does not appear to stand in direct relation to the motions of the frame, or to the common sensibility.

Explanation of the PLATES.

PLATE XIX.

The figure in this Plate represents the great anterior column which gives off the nerves of motion.

A, A. The fibrous texture of the hemisphere, concentrating to form the anterior portion of the crus cerebri.

B. The anterior column where it is passing the pons Varolii.

C. The right pyramidal body; a little further down is the point of decussation.

D. The remaining part of the pons Varolii, a portion having been dissected off to expose B.

1. The olfactory nerve in outline.
2. The union of the optic nerves.

3, 3. The third nerve.

4, 4. The fourth nerve.

5, 5. The fifth nerve, trigeminus.

6, 6. The muscular division of the fifth nerve.

7. The sensitive root of the fifth nerve.
8. The sensitive root rising from the posterior part of the medulla oblongata.
9. The sixth nerve.
10. The portio mollis of the seventh nerve, or auditory nerve.
11. The portio dura of the seventh nerve, or facial nerve.
12. The eighth nerve, viz. par vagum, glosso-pharyngeal nerve, and spinal accessory nerve.
13. The ninth nerve, or lingual nerve.
14. Spinal nerves.
15. Spinal accessory nerve of the right side.

Drawn by Sir Cha.s Bell.

Engraved by H. Basire.

Fig. 1.

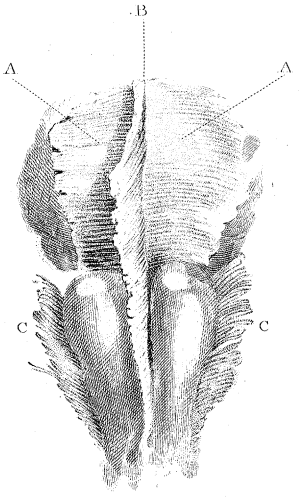
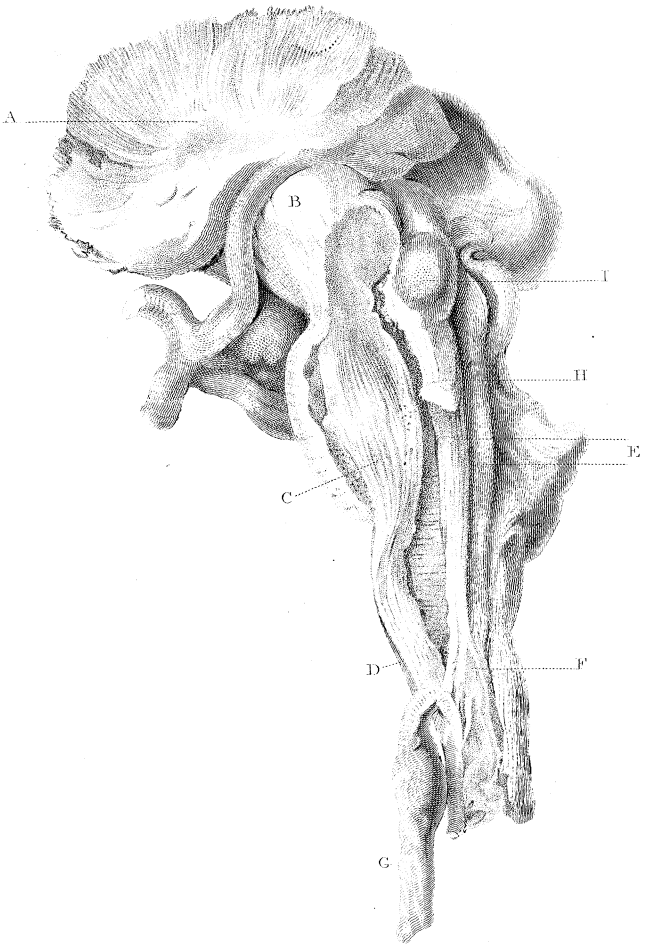


Fig. 2.

Drawn by Sir Cha.s Bell.

Engraved by T. Bonnor.



Drawn by Sir Chas. Bell.

Engraved by F. Bauer.

Plate XX.

Fig. 1. Represents the plates of fibres which pass across the pons and medulla oblongata, and which divide those great columns of medullary matter which we trace down from the cerebrum into the spinal marrow.

A, A. The posterior transverse septum of the pons, seen from the back part.

B. The septum, which rising perpendicularly from the septum of the pons, divides the great tracts of nervous matter which descend from the cerebrum, viz. the posterior divisions of the crura cerebri.

C, C. The lateral septum of the medulla oblongata, which separates the corpus olivare from the anterior or muscular tract.

Fig. 2. In this figure the posterior or sensitive tract is shown. They are separated so as to exhibit the posterior transverse septum of the pons.

A. The pons Varolii, with the transverse fibres of the septum (fig. 1. A, A.).

B, B. The sensitive tract dissected and separated.

C. The union and decussation of the posterior tract.

D, D. The posterior root of the spinal nerve continued with the posterior tract below the decussation.

E, E. The sensitive roots and tracts of the fifth pair of nerves.

Plate XXI.

This figure presents a lateral view (slightly oblique) of the two columns, with a section of the pons and crus cerebri.

A. Fibrous texture of the anterior tract as it converges from the left hemisphere of the cerebrum.

B. A section of the left crus cerebri.

C. The motor tract in its course through the pons Varolii.

D. The corpus pyramidale of the left side.

E, E. The posterior or sensible tracts.

F. Their union and decussation.

G. The corpus olivare, hanging by the tract or column, where it is united to the anterior column D and the posterior column E.

H. The superior part of the tract of the corpus olivare, running up into the corpora quadrigemina.

I. Corpora quadrigemina.

Note.—These views of the brain have been taken from dissections made of the parts after they have been preserved a long time in proof spirits.