

DEFECTIVE DEVELOPMENT OF THE CENTRAL NERVOUS SYSTEM IN A CAT.

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Introductory Remarks.

I AM induced to place this case of defective development of the central nervous system in a cat on record, because it appears to me to be of more than ordinary interest.

My grateful acknowledgments are due to Professor Victor Horsley for enabling me to carry out the examination of this animal at the Pathological Laboratory of University College. I am also indebted to Professor Boyce for his kindness in bringing to my aid his large experience of the topographical anatomy of the central nervous system of the cat.

It is impossible for me to express too cordially my thanks to Dr. S. W. Carruthers, to whose generosity I am indebted for the valuable animal on which these observations have been made. The symptoms presented by the cat, during life, reminded Dr. Carruthers of some dogs which I had shown at a meeting of the Neurological Society, and on whom I had practised ablation of one lateral lobe of the cerebellum; he therefore showed the cat at a meeting of the same Society, and afterwards gave it to me, to make use of as I thought fit.

On examining the animal, I found that there was evidence of paresis of both posterior extremities and of the

right anterior extremity, which condition corresponded to that met with in dogs after ablation of the right lateral lobe of the cerebellum. It therefore seemed probable that in this cat there must be some lesion, or defect, of the right lateral lobe of the cerebellum. And as will be seen subsequently, the condition found at the autopsy amply confirmed the surmise.

The cat was placed under the influence of chloroform, and killed by an over dose of this anæsthetic. On *post-mortem* examination the skull presented no abnormal features, and, as far as could be ascertained, there was no asymmetry. The membranes were normal, and not unduly adherent to the skull or to the brain. The right cerebral hemisphere appeared to be generally a little smaller than the left, but there was no special defect in any one part of it. The whole brain was below the average size; but there was no evidence of special atrophy or defective development of any part in particular, with the exception of the right hemisphere being a little smaller than the left, as has already been said.

The feature which attracted most attention was the condition of the cerebellum; the whole organ was smaller than normal, and also proportionally, as compared with the cerebrum; but most striking of all was the fact that the right lobe was scarcely a third the size of the left (see fig. 1) The right lobe was diminished in all its dimensions; and the corresponding right half of the pons and medulla shared in its defect, though not to such a marked extent. There was apparently a complete absence of the transverse fibres of the pons on the right side, and the whole of the right side of the pons and medulla were markedly smaller than the left. As far as could be ascertained, this asymmetry was not shared by the spinal cord, the two lateral halves of which appeared to be quite equal.

The cranial nerves were smaller on the right side than on the left; but the spinal ones did not present any detectable difference.

The whole central nervous system was preserved in Müller's fluid for subsequent microscopical examination; the result of which will now be detailed.

Microscopical Examination.

The stain that was chiefly employed in this investigation was Weigert's hæmatoxylin method as modified by Pal, and as further modified by Schäfer. This was variously supplemented by carmine, nigrosin, Delafield's hæmatoxylin, eosine, &c.

After describing the condition of the cerebrum and cerebellum, it will, I think, be best to describe the other defects in the rest of the central nervous system, as they are met with at certain typical levels of the pons and medulla, and then to give a short summary of all the defects which were found in this animal, before discussing the significance of these defects, and the deductions to be drawn from them.

The Cerebellum.

The defective development of the right lateral lobe of this organ, as compared with its left, was even more strikingly brought out on vertical transverse sections being made. The right half of the middle lobe did not appear to share in this defective development of the lateral lobe. Contrary to what might have been expected, the proportion between the different layers of cells of the cortex of this rudimentary right lobe was not altered, and the normal proportion of grey to the immediately subjacent white matter was preserved. The cells of Purkinje were normal in appearance, and in their arrangement, as were the cells of the granular and molecular layers of this rudimentary portion of the cerebellum. Whereas the corpus dentatum was well marked on the left side, its only representatives, on the right side, were a few irregularly scattered cells in the region where it ought to have been, which region was of course also greatly deficient in the amount of white matter. The total quantity of fibres passing to and from the cortex of the right lateral lobe was of course much below the normal, a fact in keeping with the small amount of cerebellar cortex which existed on this side.

The Cerebrum..

Vertical transverse sections through the hemispheres at different points showed less asymmetry than appeared to exist when the brain was viewed as a whole. The grey and white matter were normally arranged, the normal proportion between the two appeared to be preserved, and there was certainly no evidence of gross structural general or local change in either hemisphere. The cortical cells of the left hemisphere showed no evidence of atrophy, and those of the right side were also free from any such defect.

The basal ganglia appeared to be equally and normally developed on the two sides, and there was only a very slight difference in the size of the internal capsule on the two sides, that on the right appearing to be a little smaller than that on the left. But sections through the crura cerebri presented a very different state of things, for there could be no question that the right crus was considerably smaller than the left (see fig. 2). While this striking difference was seen in the size of the crura, the optic tracts appeared to be normally and equally developed on the two sides, and made the asymmetry in the crura the more evident (see fig. 2).

The Region of the Posterior Corpora Quadrigemina.

The asymmetry at this level is exceedingly marked, many of the structures on the right side being almost completely absent. The most striking differences are to be seen in the fillets, superior cerebellar peduncles, pyramids, and corpora quadrigemina; but in addition to these, certain minor differences on the two sides are evident.

The right corpus quadrigeminum is about a third the size of the left (see fig. 3); and the same proportion exists in the sizes of the right and left fourth nerves, as they are seen decussating in the roof of the aqueduct of Sylvius (see fig. 4). While the superior cerebellar peduncle is well marked on the left side, scarcely any trace of this structure can be made out on the right (see fig. 3). The difference in the size of the

descending root of the fifth cranial nerve on the two sides is not so striking, for although that on the right is smaller than that on the left, and its fibres are less regularly arranged (see fig. 3), there is not that pronounced difference which has been noted in connection with other structures already described at this level. Scarcely any trace of fillet fibres exists on the right side, while the left fillet is well developed and stands out prominently (see fig. 3). The pyramid on the right side is extremely diminutive, and contrasts markedly with the well developed left pyramid (see fig. 3).

The Region of Exit of the Sixth and Seventh Cranial Nerves.

Many points call for comment at this level (see fig. 5), and foremost amongst them is the complete absence of the pyramid on the right side, there being no trace of this structure to be seen; while on the left side the pyramid is normal.

The enormous difference in the size of the restiform body on the right side as compared with that on the left is striking, for while the latter is of normal size and appearance, the former is represented by an insignificant bundle of fibres, seen cut transversely and situated just internal to the superficial root of the eighth nerve as it makes its exit. The fibres which represent the right restiform body appear to be normal and are not obviously smaller than those of the left restiform body; but they are more crowded together, there being a marked deficiency in the amount of interstitial tissue. The contrast between the two restiform bodies is better seen at a lower level (as represented in fig. 6), at which level the relative sizes of the ascending root of the fifth nerve and the restiform body, on the two sides, is striking.

To revert to fig. 5, however, in addition to the points already mentioned, we see that the posterior longitudinal bundle is smaller on the right side than on the left. The seventh nerve, seen divided transversely as it lies internally to the sixth nucleus, is distinctly smaller on the right side,

its fibres appear smaller and do not stain as well as do those of the left nerve.

The sixth nucleus on the right side is a little smaller than that on the left, though the cells appear to be about the same size in both. Fewer fibres pass from the right sixth nucleus to the opposite posterior longitudinal bundle, than from the left nucleus.

The sixth nerve is slightly smaller on the right side than on the left; but the difference in size is not nearly so striking as is that between the two seventh nerves, the right seventh being notably smaller than the left. A still greater difference in size exists between the eighth nerves; and the accessory nucleus of the eighth is a trifle smaller on the right side.

Practically no difference in the size of the ascending root of the fifth exists on the two sides (see figs. 5 and 6), but the substantia gelatinosa is a little less on the right side as compared with the left. There is a difference in the size of the two superior olives, that on the right side being considerably smaller than that on the left, though its cells do not appear to be small or shrunken.

There is almost a complete absence of any connections between the right side of the pons and the cerebellum.

The Region of the Inferior Olive.

A section through the medulla at this level presents a curious picture (see fig. 7). The pyramid on the left side is well developed and occupies its normal position, whereas on the right side, where the pyramid ought to be, the inferior olive is situated, with the anterior external arcuate fibres, and in addition, what appear to be a few pyramidal fibres forming its inner and anterior boundary. The inferior olive on the left side is exceedingly poorly developed, and represents about a twelfth part of that on the right side in size.

The lateral medullary tract on the right side is almost completely absent, a distinct concavity existing in the periphery of the medulla in this region, instead of the normal convexity which exists on the left side. The nucleus lateralis

is also almost completely absent on the right side at this level. No trace of Boyce's direct tract,¹ which degenerates downwards after ablation of the cerebral hemisphere on the same side, is to be seen; while on the left side this tract is so prominent as to suggest the possibility of its being hypertrophied.

The ascending root of the fifth is equally well developed on the two sides; and the substantia gelatinosa is almost equal also, though possibly it is slightly less on the right side. There is not much to choose between the funiculus gracilis on the two sides; but with regard to the funiculus cuneatus, there is a marked difference, that on the left being about half the size of that on the right.

In addition to these differences, there is a general deficiency in the formatio reticularis on the right side.

The Region of the Decussation of the Anterior Pyramids.

The first and most important point to be noted at this level is with regard to the anterior pyramids. Whereas that on the left side, in accordance with what we have seen at higher levels, is well developed, there is only the merest trace of a pyramid on the right side, an insignificant bundle of fibres alone representing this structure at this level. But the point of extreme interest and importance lies in the fact that instead of the whole of the fibres in the well developed left pyramid passing across the middle line to the region of the right crossed pyramidal tract, the pyramid bifurcates, and while the majority of its fibres pass to the region of the opposite crossed pyramidal tract, about a fifth of their number pass to the region of the crossed pyramidal tract of the same side, that is, to the left crossed pyramidal tract (see fig. 8). The few fibres occupying the position of the anterior pyramid on the right side are distributed as follows: some decussate and pass to the opposite crossed pyramidal tract, some pass with the bulk of the fibres from the opposite

¹ Boyce, *Proc. Roy. Soc.*, 1894.

anterior pyramid to the region of the crossed pyramidal tract of its own side, while some turn forward into the grey matter of the anterior horn (see fig. 9). The next point worthy of note is the fact that there is a distinct deficiency in the region of the direct cerebellar tract on the right side, owing evidently to absence of this tract. Instead of the contour of the cord being preserved, there is a distinct concavity in the periphery at this region, which contrasts obviously with the normal convexity in the same region on the left side.

The defective development of the funiculus gracilis and funiculus cuneatus, with their nuclei, on the left side, is better seen at this level than in any that have been examined higher up. The funiculus gracilis is a little more than half the size of that on the right side, while its nucleus is only a third the size of that of the other. It is not so easy to judge of the exact amount of diminution in size of the funiculus cuneatus, but its nucleus is a little more than half the size of the nucleus of the right funiculus cuneatus (see fig. 8).

The Spinal Cord.

It is most surprising that, in spite of the complete absence of the right pyramid at certain levels in the pons and medulla, and the evident defective development of the direct cerebellar tract noted at the level of the decussation of the pyramids, there should be next to no asymmetry of the spinal cord. As may be seen even from fig. 10, which represents the upper cervical part of the cord, it is difficult to say that there is any difference on the two sides, and the same holds good in the dorsal region; but in the lumbar there is possibly some evidence of slight deficiency on the left side, chiefly in the region of the left crossed pyramidal tract. Nowhere, throughout the length of the cord, is there that difference on the two sides, which might have been expected, in view of the defects of those systems at higher levels which we know contribute to the formation of the cord.

No minute microscopic differences can be detected in the nerve fibres on the two sides of the cord, and the grey matter

is normal in amount, as compared with the white, and in arrangement. The minute structure of the grey matter is also normal on both sides, the cells being apparently perfectly natural and showing no structural alterations.

The anterior and posterior nerve roots present no differences on the two sides.

Summary.

It will be profitable for us to review briefly the salient abnormal features presented by this animal, before attempting to discuss the possible significance of certain of these.

First we have the fact that the cerebellum is smaller than normal, as a whole; and that its right lateral lobe is very much smaller than its left.

As to the cerebrum we have seen that only slight differences exist on the two sides in which the right is the slightly defective one, that this slight difference is also apparent in the internal capsule, and that when we come to examine the crura cerebri the right is very distinctly smaller than the left.

The pyramids present many features of great interest. The right pyramid is completely absent throughout the medulla, until the lowest part is reached; but at the level of the decussation a few fibres indistinguishable from pyramid fibres are seen occupying the region of the anterior pyramid on the right side. At the decussation, the normal left pyramid bifurcates, and while the greater number of fibres pass across to the opposite crossed pyramidal tract, a considerable number pass to the crossed pyramidal tract of their own side. Compensation is so complete that, with the exception of possibly a slight difference in the lumbar region of the spinal cord, the crossed pyramidal tract does not appear to be smaller on the left side than on the right.

Practically no trace of fillet fibres can be found on the right side.

All the peduncles of the cerebellum are very deficient, there is practically complete absence of the superior and

middle cerebellar peduncles on the right side, and the restiform body, or inferior cerebellar peduncle, is exceedingly diminutive on the same side.

The cranial nerves are all smaller on the right side than on the left, though they are not all equally so.

The superior olive is slightly smaller on the right side; but the inferior olive is exceedingly well developed on this side, while that on the left side is extremely poorly developed.

The nucleus of the funiculus gracilis and that of the funiculus cuneatus are smaller on the left side than on the right.

It is thus clear that in a pretty universal defect of development of the right side of the pons and medulla there are certain notable structures which do not share to any extent in this defect; they are the ascending root of the fifth nerve, the substantia gelatinosa, the inferior olive, and the nuclei of the posterior columns. Of these structures, two are not defective on the left side either, viz.: the ascending root of the fifth and the substantia gelatinosa; while the inferior olive is markedly defective on the left side, as are the nuclei of the posterior columns, though to a much smaller extent.

Deductions.

That the diminutive right lateral lobe of the cerebellum is a primary condition the result of defective development, and not one due to atrophy secondary to any other lesion of the central nervous system, is evident from the fact that the portion of cerebellar tissue present is normal in structure, neither the cells nor fibres composing it showing any sign of atrophy or other abnormality. It is as if a small portion of normal cerebellar tissue had been left, and the whole of the remainder of the lobe had been cut away. In this respect this case contrasts markedly with two cases of atrophy of the cerebellum in cats recorded by Herringham and Andrewes.¹ The condition of the cerebellum in their cases was apparently primary also, but instead of the cerebellar tissue present

¹ Herringham & Andrewes, *St. Bartholomew's Hospital Reports*, vol. xxiv.

being of normal structure, there was great atrophy of the granular and molecular layers of the cerebellar cortex. Their cases also differed from mine in that the whole cerebellum participated in the atrophy, and not one lateral lobe more than the rest of the organ.

The defective condition of the cerebellar peduncles on the right side calls for no comment, for that the superior peduncle, the transverse fibres of the pons or middle peduncle, and the restiform body or inferior peduncle should be thus defective is only in keeping with the diminutive size of the right lateral lobe of the cerebellum itself.

With so little cerebellar tissue representing the right lateral lobe, it is quite in accordance with our knowledge of the relationship between one lateral lobe of the cerebellum and the opposite inferior olive that the latter should be so defectively developed. The relationship is one which has been well established by pathological observations, and which has been put beyond question by the results of experiment, for it has been found that after ablation of one lateral lobe of the cerebellum the opposite inferior olive atrophies. In the present case it would appear to be not so much a secondary atrophy of the left inferior olive as a defective development of it in association with the defective development of the right lateral lobe of the cerebellum. The fact that the whole of the left side of the pons and medulla is perfectly normal, with the exception of the inferior olive and posterior column nuclei is a most significant one, and points unquestionably to their defectiveness being related in some way to defect of certain structures on the right side. We shall see presently what the probable significance of the defect of the posterior column nuclei on the left side is, and as to the defect of the inferior olive there can, I think, be no reasonable doubt that it is associated with the defective development of the right lateral lobe of the cerebellum. Similarly the well developed inferior olive on the right side, which is otherwise full of abnormalities, is no doubt consequent on the left lateral lobe of the cerebellum being fairly well developed, when compared to the right; a remark

especially applicable to the state of development of the corpus dentatum on the two sides.

This case points to the crossed relationship between one lateral lobe of the cerebellum and the opposite cerebral hemisphere as not being one in which the opposite cerebral hemisphere atrophies, or is defectively developed, in consequence of the abnormality of the lateral lobe of the cerebellum. Congenital cases of atrophy of one lateral lobe of the cerebellum and of the opposite cerebral hemisphere are always open to question as to which is the primary condition and which is the secondary. In thirteen cases, collected by him, Turner¹ concluded that the cerebellar atrophy was secondary to the cerebral. That one lateral lobe of the cerebellum may atrophy in consequence of damage to the opposite cerebral hemisphere is strikingly proved by a case published by Ferrier,² in which the one cerebral hemisphere had been converted practically into a cyst, by a hæmorrhage, and in which there was well-marked secondary atrophy of the opposite lateral lobe of the cerebellum. But I know of no similar proof that one cerebral hemisphere ever atrophies in consequence of destruction of the opposite lateral lobe of the cerebellum. A few cases, however, have been recorded in which with well-marked atrophy of one lateral lobe of the cerebellum there has been slight atrophy of the opposite cerebral hemisphere,³ and Wagner⁴ states that he found atrophy of the cerebrum after removal of the cerebellum in pigeons; but this result stands alone, and is open to question. No other observer has recorded atrophy of the cerebrum consequent on ablation of the cerebellum, so far as I am aware; and my own results of extirpation of parts of the cerebellum in dogs forbids my concluding that one hemisphere of the cerebrum atrophies in consequence of destruction of the opposite lateral lobe of the cerebellum. That the one half of the cerebellum exercises a very marked

¹ Turner, *Schmidt's Jahrb.*, 1856, vol. xc., p. 32.

² Ferrier, *BRAIN*, April, 1882.

³ Cf. Weber, Cramer, &c.

⁴ Wagner, *Journ. de Physiol.*, 1861, vol. iv., p. 394.

PLATE TO ILLUSTRATE DEFECTIVE DEVELOPMENT OF
THE CENTRAL NERVOUS SYSTEM IN A CAT.

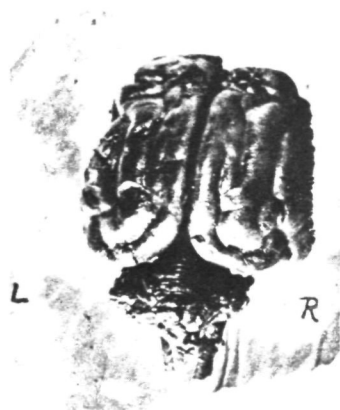


FIG. 1.



FIG. 2.



FIG. 3.

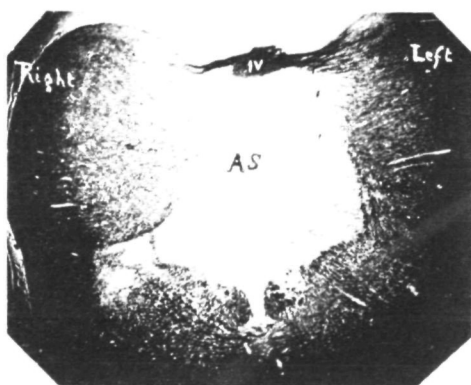


FIG. 4.

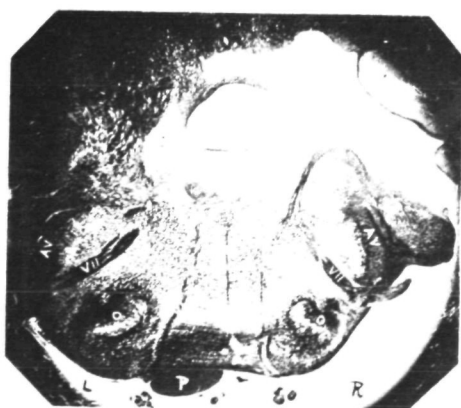


FIG. 5.



FIG. 6.

PLATE TO ILLUSTRATE DEFECTIVE DEVELOPMENT OF
THE CENTRAL NERVOUS SYSTEM IN A CAT.

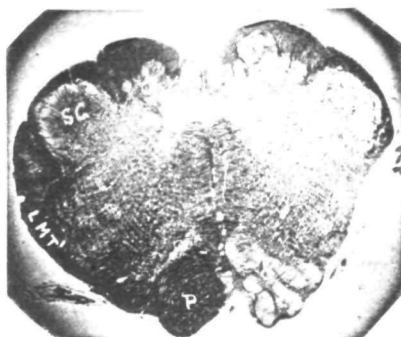


FIG. 7.

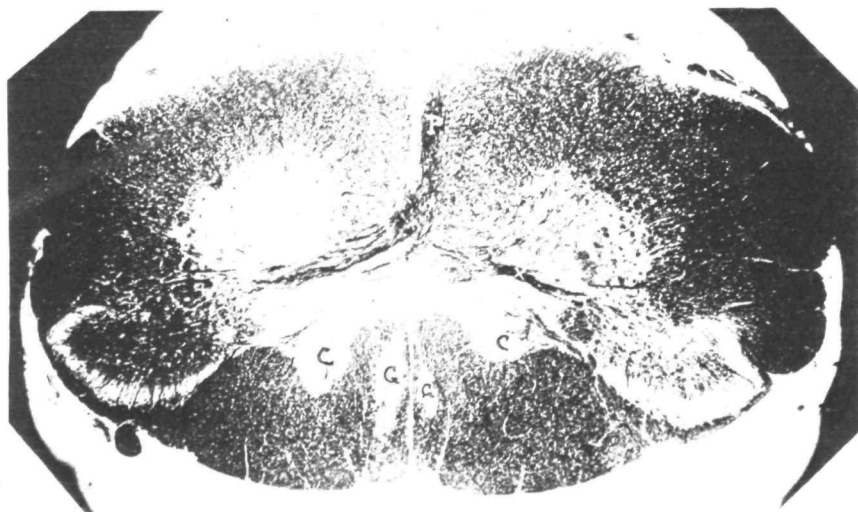


FIG. 8.

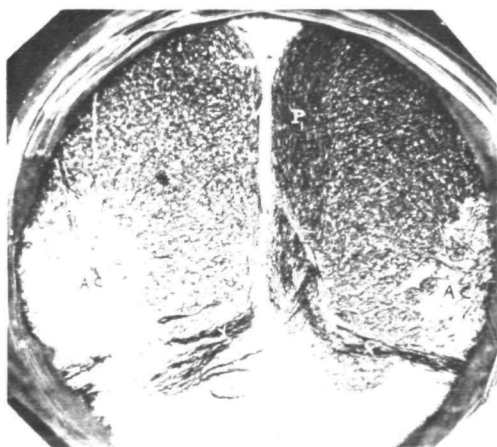


FIG. 9.

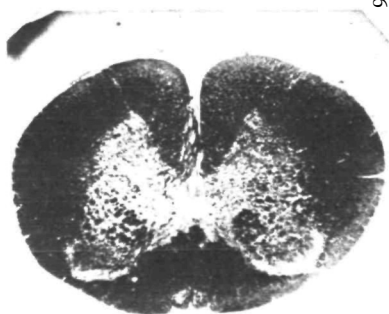


FIG. 10.

influence on the opposite half of the cerebrum has been strikingly demonstrated by certain of my experiments,¹ which leave little doubt that one lateral half of the cerebellum exercises a control on the cortical cells of the opposite cerebral hemisphere.

In the case we are at present considering, although there is very great deficiency of the right lateral lobe of the cerebellum, there is no sign of atrophy or other defect of the left cerebral hemisphere. On the contrary, it is the right cerebral hemisphere which is slightly smaller than its fellow, a condition which is probably part of the general defect on the right side of the central nervous system, and consequent on some common cause, with these other defects, and not in any way specially associated with, or secondary to, the defective development of the right lateral lobe of the cerebellum.

As we are considering the question of crossed relationships, it will be as well for us to inquire into the probable significance of the fact that the posterior column nuclei are smaller on the left side, which, with the exception of the inferior olive, is otherwise quite normal. That these nuclei should be smaller on the left side is only what we are led to expect from the complete absence of the fillet on the right side, for the relations of the fillet to the opposite posterior column nuclei is well recognised. Indeed, it is a matter for surprise that with apparently so complete an absence of fillet fibres on the right side the nuclei of the funiculus gracilis and funiculus cuneatus should not have been considerably smaller than they are; especially when we remember that nothing abnormal could be detected in the basal ganglia.

It only remains for us to consider the defects met with in the pyramidal system, and their probable significance. The internal capsule being a little smaller on the right side than on the left is of course in keeping with the fact that the right hemisphere generally is a little smaller than the left. The size of the right crus cerebri is also in keeping with this;

¹ *Phil. Trans. Roy. Soc.*, 1894.

but neither the size of the capsule nor of the crus prepares us for the complete absence of the right pyramid at a lower level. With such a complete absence of the pyramid on the right side, one would have been justified in looking for a greater diminution in the size of the crus and internal capsule, and certainly also in the cortex of the right cerebral hemisphere.

It is customary to designate those fibres which occupy the ventral aspect of the mesencephalon, in the region of the posterior corpora quadrigemina, pyramidal fibres; but that this is probably not strictly correct is rendered likely from the condition met with in this animal. We have seen that in the region of the corpora quadrigemina there is a distinct bundle of fibres occupying the region of what is generally looked on as pyramid, on the right side, though the bundle is very much smaller than the corresponding one on the left side. It is difficult to see how, if this bundle of fibres on the right side is wholly made up of pyramidal fibres, there should not be a trace of them to be found in the region of the pyramid at a slightly lower level. Boyce¹ has shown that pyramidal fibres leave the pyramids at all levels in their course, but the number of fibres which thus leave the pyramids under normal conditions are not sufficient to account for the entire disappearance of so considerable a bundle in so short a vertical space. It seems to me far more reasonable to suppose that the fibres forming the bundle in question in the posterior quadrigeminal region are not pyramidal fibres at all, but are of a totally different nature. If this be so, then it appears to me that it would be far more correct to call the bundle at present called pyramid, in the region of the posterior corpora quadrigemina, crural fibres, for as in the crus, so here, there are other fibres in addition to the pyramidal ones. I am thus inclined to believe that under normal circumstances there are certain other fibres contained in the bundle in question together with the pyramidal fibres, and that in this animal these fibres alone exist, while there are no pyramidal fibres contained in the bundle.

¹ Boyce, *Proc. Roy. Soc.*, 1894.

At the level where the anterior pyramids decussate there are two points which call for our consideration. In the first place we have seen that although the pyramid is completely absent on the right side at certain higher levels we have in this region certain fibres occupying the position of pyramidal fibres, indistinguishable from such fibres, and behaving like pyramidal fibres in many respects, for while some go to the anterior horns, others pass to the crossed pyramidal tract of the same side, and some to this tract on the opposite side. It is useless to speculate on the possible source from which these fibres are derived, but their presence points to the probability that just as fibres leave the pyramidal system at different levels, so fibres are added to it at certain levels. I see no other way of explaining the existence of these fibres. If this be the true explanation of their presence, it is clear that the generally accepted belief that all the pyramidal fibres are derived from the cerebral cortex, would require modification. The other point of interest with regard to the pyramidal fibres at the decussation is the fact that while the bulk of the fibres contained in the left or normal pyramid cross to the opposite crossed pyramidal tract, a considerable number pass to the crossed pyramidal tract of its own side. This state of affairs entirely conforms with the results obtained by Mellus¹ and Sherrington² who on extirpation of limited foci of the cortex of one cerebral hemisphere of monkeys found that at the decussation of the anterior pyramids the majority of the degenerated fibres passed across to the region of the opposite crossed pyramidal tract, but that a few degenerated fibres passed to the crossed pyramidal tract of the same side as the hemisphere from which the portion of cortex was removed. In my animal the proportion of fibres passing to the crossed pyramidal tract on the same side, that is, on the side of the normal pyramid, were considerably in excess of the proportion met with by Mellus³ in monkeys. Possibly this is an attempt to com-

¹ Mellus, *Proc. Roy. Soc.*, 1894.

² Sherrington, *Lancet*, 1894.

³ *Loc. cit.*

pensate for the absence of the pyramid on the right side at a higher level and the consequent meagre supply of pyramidal fibres to the left crossed pyramidal tract. This effort at compensation on the part of the normal pyramid accounts in great measure, no doubt, for the comparative symmetry of the spinal cord in the region of the crossed pyramidal tract ; but whether it wholly accounts for it may be open to question.

DESCRIPTION OF FIGURES.

FIG. 1.—Represents the cerebrum and cerebellum of a cat, and is intended to show that the whole cerebellum is smaller than normal but that the right lateral lobe is much smaller than the left.

R. = Right. L. = Left.

FIG. 2.—Is from a transverse section in the mesencephalon, and demonstrates that while the optic tracts are comparatively equal in size the right crus cerebri is considerably smaller than the left.

C = Crura cerebri. O. T. = Optic tracts.

FIG. 3.—Indicates the appearances met with on transverse section through the region of the posterior corpora quadrigemina. The right corpus quadrigeminum is obviously much smaller than the left, and there are far fewer crural fibres on the right side, on which side there is almost a complete absence of the fillet and superior cerebellar peduncle.

C. = Crural fibres.
F. = Left fillet.
S. = Left superior cerebellar peduncle.
D. V. = Descending root of fifth nerve.
R. = Right. L. = Left.

FIG. 4.—A section through the decussation of the fourth nerves in the roof of the aqueduct of Sylvius, and shows that the right nerve is much smaller than the left.

A. S. = Aqueduct of Sylvius. IV. = Fourth nerves.

FIG. 5.—Represents a transverse section through the lower part of the pons ; the most marked feature at which level is the entire absence of the pyramid on the right side.

P. = Left pyramid.
A. V. = Ascending root of fifth nerve.
O. = Superior olive.
VI. = Sixth nerve.
VII. = Seventh nerves, longitudinally and transversely divided.
R. = Right. L. = Left.

FIG. 6.—Is from a transverse section a little below the level from which fig. 5 was taken, and in addition to the absence of the right pyramid, it is intended to show the insignificance of the right restiform body as compared with the left.

- R. = Restiform bodies.
- V. = Ascending root of fifth nerves.
- O. = Superior olives.
- P. = Left pyramid.
- R' = Right. L. = Left.

FIG. 7.—Is a section of the medulla oblongata, made transversely through the level of the inferior olive, which is well marked on the right side and extremely diminutive on the left side. The pyramid and lateral medullary tract are absent on the right side.

- G. = Funiculus gracilis.
- C. = Funiculus cuneatus.
- S. G. = Substantia gelatinosa.
- L. M. T. = Lateral medullary tract.
- P. = Pyramid.
- O. = Inferior olive.

FIG. 8.—Is from a transverse section through the decussation of the pyramids, and shows that while the bulk of fibres from the intact pyramid pass to the opposite crossed pyramidal tract, some pass to the crossed pyramidal tract of the same side.

- P. = Left pyramid.
- X. = Fibres going from the left pyramid to the crossed pyramidal tract on the same side.
- G. = Funiculus gracilis.
- C. = Funiculus cuneatus.

FIG. 9.—Is from the same level as the last, but more highly magnified.

- P. = Left pyramid.
- A. C. = Anterior horn.
- X. = Fibres from pyramid to left crossed pyramidal tract.
- T. = Fibres from pyramid to right crossed pyramidal tract.
- Z. = Fibres in position of right pyramid.

FIG. 10.—Represents a transverse section through the upper part of the cervical cord and shows that the two lateral halves of the cord are as nearly as possible equal.