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read 43 to 54.

Part I

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"On the Phenomena resulting from ablation of the Grey matter in the Frontal Lobes"

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(From experiments made in the Physiological Institute of the Strassburg University).

I

In considering the Physiology of the Brain, one is struck by the want of harmony, amounting in many cases to positive contradiction, between the results obtained by numerous able investigators in this field of research.
Notwithstanding all the laborious researches and speculations, which have been directed towards the elucidation of this Subject, we seem still to be far from the much desired consummation of our wishes with regard to the subtle workings of the great organ of the mind.

Of the older observers, Flourens, the great pioneer in cerebral physiology, taught with regard to the question of localisation of function, that the whole mass of the cerebrum, in all its parts, was subservient to the same functions, and that after destruction of any portion of the same, its functions could be performed quite well by those parts which remained unimpaired. He even maintained that if the cerebrum of an animal were destroyed almost entirely, leaving only a small portion behind - this portion would still be able to carry on fully the functions formerly performed by the entire mass. According to Flourens then the functions of any portion of the cerebrum can be replaced by any other portion of the same organ. (Recherches Experimentales sur les propriétés et les fonctions du Système Nerveux. Seconde Edition. p. 99.)

His Conclusions were drawn from experiments on doves and other animals low in the Scale of development. The few observations made by him on mammals are very superficial in character, and consequently of little worth.

In Support of Flourens view, many cases may be cited, where extensive destruction of brain substance has coexisted with little or no apparent Symptoms during life, as it has been frequently observed, that after wounds of the Skull, large portions of the brains of men might be removed, wilout any marked effect on the physical Condition of the patients. Hitzig relates the Case of a Soldier, who was struck by a Splinter from a shell. (Granatsplitter) The piece entered the Glabella, where it made a triangular opening. For fourteen days brain substance continuously Escaped through this opening. Finally the

wound healed. Neither sensory nor motor disturbances made their appearance in this case (Untersuchungen über das Gehirn. p. 23).

Another case frequently quoted, is that known as the "American Crowbar Case". In blasting a rock a young man was hit by a bar of iron, which passed through the left frontal region, having traversed the anterior part of the left Hemisphere. Speedy recovery took place — and the man lived for thirteen years afterwards, without manifesting any special symptoms, that could be attributed to such a serious injury of the brain. (American Journal of the medical Sciences — July 1850).

Carville and Duret, in their admirable memoir ("Sur les Fonctions des Hémisphères" — Archives de Physiologie normale et pathologique) Containing a most elaborate Series of Experiments have given an able

Exposition of the Effects of destructive lesions of the motor centres in dogs. These observers are of opinion that - "un point quelconque (on the same side) des regions motrices corticales vient suppléer le centre detruit" - but deny the vicarious action of the same centre of the opposite Hemisphere - since they observed that after recovery from paralysis on the left side, due to an operation on the opposite Hemisphere, subsequent operation on the same portion of the other Hemisphere, produced the usual effect on the right side, but did not reinduce the paralysis on the left side. Their theory that when a centre was destroyed, other portions of the same Hemisphere took up its functions, is strongly opposed by Goltmann who considers it extremely unlikely, that one portion of the Cerebral Hemisphere can supply the place of another portion of the same half. The view

held by him is, that the functions lost through destruction of a portion of cerebral substance, in one Hemisphere, can only be replaced by the Symmetrical portion of the opposite side. ("Experimentelle Studien über die Functionen des Grosshirns der Neugeborenen" – p. 106 – Jahrbuch für Kinderheilkunde. N. F. IX).

In the hands of most Experimenters ordinary Stimuli applied to the Surface of the brain Convolutions of animals, failed to produce any clearly recognisable Effects. On the other hand clear Evidence has been deduced from clinical and pathological observations, that not only is delirium caused by disease of the Cortex Cerebri, as in Meningitis, but sometimes also Convulsions occur either of an Epileptic Character or localised to particular groups of muscles.

Hitzig and Fritsch were the first to demonstrate the effects produced by the application of the constant Galvanic current to the Cortex Cerebri of animals. They showed that its application to particular Convolutions and to particular parts of Convolutions gave rise to various coordinate movements of various Groups of muscles.
(Reichert and DuBois Raymond's Archiv: 1870 - p. 300).
Hitzig's Experiments led him to the following conclusion wif regard to the localisation of function - "Es geht ferner aus der Summe aller unserer Versuche hervor, das keineswegs wie Flourens und die meisten nach ihm meinden - die Seele eine Art Gesammtfunction der Gesammtheit des Gehirns ist, deren Ausdruck man wohl im ganzen, aber nicht in seinen Einzelnen Theilen durch mechanische mittel aufzuheben vermag —

Sondern das vielmehr sicher Einzelne
Seelische Functionen, wahrscheinlich
alle – zu ihrem Eintritt in die Materie,
oder zur Entstehung aus derselben
auf circumscripte Centra der Gross-
hirnrinde angewiesen sind." ("Unter-
suchungen über das Gehirn". p. 31. 1874)
According to this sharply circumscribed
localisation theory – he considers it
impossible that after destruction of
one portion of the cerebrum – its functions
can be carried on by another portion,
which has totally different functions
to perform. He maintains that those
cases, in which complete recovery has
taken place after loss of cerebral sub-
stance, can only be explained by
supposing that the Centres concerned
were not entirely destroyed, but only
partially – the portions left gradually
increasing in strength – till finally they
became strong enough to perform
their functions as well as the uninjured Centres.

In an interesting paper ("Über Electrische Reitzversuche an der Grosshirnrinde" pflügers Archiv: vol X. p. 77 – 84) Hermann strongly opposes the views entertained by Hitzig. He is of opinion, that the mere fact of certain movements following upon stimulation of certain areas, is no proof that these areas are to be considered as motor centres. Provided the anaesthesia be not too profound – the phenomena produced by stimulation continue when the animal is under the influence of Opium and Chloroform, and not only does mechanical and chemical stimulation prove inefficient to produce them, requiring for their development currents of considerable strength – but the results of stimulation are the same, when the convolution operated is highly congested – completely dried up – or after it has had strong

acid applied to it. Isolation of the area experimented upon, from the surrounding grey matter, produced the same results. He further contends that Hitzig's theoretical explanation regarding the rapid restitution of functions after destruction of portions of the Cortex Cerebri, is entirely untenable, and concludes his paper with the following sentence:- "Ich schliesse mit der Behauptung das die Versuche von Fritsch und Hitzig - so interessant und schätzbar sie sind, zu keinerlei Schlüssen hinsichtlich der Functionen des Grosshirnrinde berechtigen."

Among British Experimenters in this direction the name of Ferrier stands foremost. Though differences exist between him and Hitzig in regard to the extent of localisation, and with respect to the true character and significance of cerebral phenomena, yet a marked

similarity is observable in the deductions drawn by these two able investigators from their Experiments on the lower animals in this field of research. Ferrier, making use chiefly of the interrupted or Faradic current, repeated and extended the observations of Fritsch and Hitzig, and drew up topographical brain charts - mapping out the convolutions of the front and middle part of the ~~Brain~~ Hemisphere, in some of the lower animals, into a number of precisely limited areas, stimulation of each of which produced distinct and limited movements. The conclusion, arrived at by Ferrier, is, that the Brain is a complex system of centres of motion and centres of Sensation. (Ferrier on "The Functions of the Brain". p. 255)

The important results obtained by Goltz from his Experiments on dogs

furnish the most serious objections to the theory of superficial cerebral centres and deserve to take a prominent place in treating of this question.
Goltz removed large tracts of the Grey matter of the Cerebrum at different points, with the Exception of the frontal lobes, which have hitherto not been investigated by him.
He found that destruction of a portion of the Cortex Cerebri in one Hemisphere, was followed by diminished Sensation, and voluntary power on the opposite side of the body — imperfect sight or even blindness of the opposite Eye being also a Constant result — these phenomena varying according to the amount of Cortical destruction. These Symptoms he thinks are determined more by the extent than the locality of the lesion. Of the ancinal Survives, improvement takes place up to a certain degree — so much so, in many instances,

that the inexperienced eye would not be able to detect anything abnormal. The permanent disturbances are slight loss of tactile sensibility — a remarkable degree of visual derangement — and a varying degree of alteration in some of the animals movements. The theory advanced by Soltmann of Compensation by the motor centres of the opposite Hemisphere, is strongly opposed by this observer, and in this respect his experiments accord with those of Carville and Duret. If the Compensation were effected by the Cortical Centres of the opposite Hemisphere — it ought to follow that Extirpation of these also — after the animal had recovered, should reinduce the paralysis which at first resulted from unilateral destruction of the Cortex Cerebri. In several cases, after removal of a certain portion of grey matter, in one Cerebral Hemisphere, paralysis was induced on

the opposite side. After ten or fifteen days, when the animal had recovered from the paralysis, a similar portion of brain substance was removed from the other Hemisphere. This did not reinduce the paralysis which was brought on by the first operation, but produced similar symptoms on the opposite side. According to this observer, the Effects of destruction of the Cortex cerebri are of two kinds - transient and permanent. The former he attributes to irritative inhibition (Hemmungsvorgang) - the latter, (Ausvallerscheinungen) he regards, as the direct results of the lesion in question. He further argues - that after destruction of the Cortex Cerebri - the functions are performed by those parts of the brain, lying between the Cerebral Convolutions and the Spinal Cord ('das Kleinhirn - Mittelhirn und was dahinter liegt).

not that these parts have taken over new functions – but only resumed functions, which belonged to them as much before the operation – and which were only suspended for some time, in consequence of the operation. In other words – after destruction of the Cortex Cerebri, new Centres are not formed, but only the resumption of old functions by uninjured Centres, whose activity had been interrupted. The gross mechanical movements, such as walking – running &c – which are impaired, at first, after removal of a portion of the Grey matter, have their centres, not at all in the Cerebrum, but in the Cerebellum and its Connections (das Kleinhirn – Mittelhirn und das dahinter liegt).

Nevertheless – in spite of apparently complete recovery, careful

observation showed that for weeks after a considerable portion of the Cerebral Substance had been removed, certain things remained permanently lacking. Only after the unimpaired Centres have resumed their functions, can the permanent disturbances, which are the direct results of the lesion – be clearly differentiated. (Pflüger's Archiv: Vol. XIII – p. 39.).

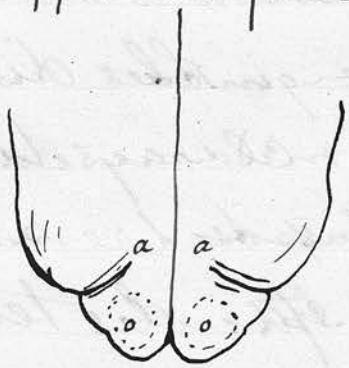
II

— Mode of Operation. —

The animal having been brought fully under the influence of Chloroform, I make an incision, in the median line, through the skin, three inches in length, beginning from a point midway between the Eyes.

The bone is Exposed and the skin reflected on one side, till the temporal muscle comes into view — a very small portion of which is reflected either wid a scalpel, or loosened with a periosteum scraper — till a sufficiently clear space is obtained, over the spot where I wish to apply the trephine. A medium sized trephine is now applied over the anterior wall of the frontal sinus. The piece of bone having been removed — and the frontal sinus Exposed — the opening is Enlarged with bone pliers. Having obtained sufficient room, a smaller trephine is applied to the

Upper Surface



Behind the lines a a lie the motor areas of Ferrier and Hitzig. The points o.o surrounded by dotted lines show the locality from which I removed the grey matter in the frontal lobes.

inner wall of the sinus, a little to one side of the median line. On account of the thinness of this plate of bone - great care is required. In this case also - the opening made by the trephine, is enlarged with small bone pliers. This part of the operation is difficult and tedious. Before opening the dura mater, the wound is thoroughly cleansed, by a stream of water - so as to remove all small fragments and spicules of bone. I next open the dura mater with small scissors and pincette - to the same extent as the opening in the bone - and wash away as much of the brain substance as I think desirable.

The method of washing away a portion of the Cortex Cerebri, was introduced by Professor Goltz of Strassburg. He removes the grey matter by means of a forcible jet of water directed against the surface - a process which he thinks preferable to excision or

Condensation – as being less likely to produce profuse haemorrhage, or subsequent inflammation. The water, brought up to about the temperature of the blood, is driven by a small force pump through a caoutchouc tube, to the end of which a Cannula is attached. The Cannula used by me was one curved and flattened at the extremity – so as to permit of it's being used somewhat after the manner of a Spoon. When the bone has been removed and the dura mater cut through, I take the Cannula in my hand, while an assistant works the pump. As soon as the water flows in a continuous stream the Cannula is introduced superficially into the grey substance of the Exposed brain. Employing the Cannula as a Spoon, I scrape away the grey matter from the portion of Brain on which I am operating, while the Stream of water flowing steadily through the end of

the canula washes away all the shred of brain substance thus loosened.
A certain amount of bleeding always takes place - it being almost impossible not to rupture the delicate coats of the veins. But the bleeding can always be controlled by suitable means.
The operation having been completed, the skin is brought back into position - so as to completely close the opening in the bone - against which it is firmly pressed - while a stream of cold water is directed for some time against the hairy outer surface. As soon as all bleeding has ceased, the edges of the wound are united by interrupted sutures. I close the wound completely, leaving no opening for drainage, which takes place through the nose.
The wound is cleansed daily with luke warm water - and attention paid that proper drainage takes place.
One of the chief dangers attending

the Operation, is sudden Stoppage of the heart and respiration. As a rule this can always be overcome by the induction of artificial respiration, made by interrupted pressure on the animals abdomen - upwards against the diaphragm. When death takes place, after the operation, the chief cause is extensive inflammation of the brain and its membranes.

Immediately after the operation, the dog is placed in a box, containing straw.

The temperature of the room, in which the animals are kept for observation, is maintained at a uniform degree, by means of fire. The animals utilised by me, for my Experiments, were generally kept running about in the room, for at least a week before I operated on them. Along with the Laboratory attendant I fed them daily, and spent some time in playing with them, teaching them to

follow me and respond to my caresses. This I consider of importance. It accustoms them to their new and altered surroundings, and gives time for the establishment of friendly relations, between them and those persons with whom they have to come in contact - from day to day - Further, - I think - that, having their minds at rest - and the feeling of strangeness removed, it helps them to bear up against - and tide over the severe effects immediately following upon the operation. And of greater importance, than this, is, that with this freindly relation existing between the operator and dog - we are better able to note the different phenomena, which make their appearance - than if the animal felt strange in his abode - afraid of those with whom it came in contact - and consequently irresponsive to all calls and caresses.

III.

— Experiments —

In connection with the following experiments — I must record my indebtedness to Professor Goltz, for the able assistance he so willingly rendered me, in all my operations — and for much kind — and useful advice, in carrying out my observations.

Case I.

First Day. At 12 noon, I operated on a medium sized — well nourished pointer bitch, of average canine intelligence, and superficially removed the grey matter in the Left Frontal Lobe. Haemorrhage was slight and soon ceased. Wound completely closed by means of sutures.
On visiting the animal at 3pm. I found

that it had recovered from the Chloroform narcosis – was lying on its right side, and curled up with head to left side.

5 p.m. Taken out of box, it made some efforts before it succeeded in gaining its feet – motor power much impaired on right side, the limbs doubling up under the animal in a powerless manner – Walked round constantly in a circle to left – the right limbs deviating and giving way so that the animal slips – stands on the dorsum of the right front foot – and plants it in various abnormal positions.

Second day. 9 a.m. Lies on right side and curled up with head to left. Taken out of the box – it exhibited the same appearances as to movements as on the previous day – Eyeballs turned slightly to left. A piece of raw meat held in front of the nose was taken. I then took another piece – and bringing it forward from behind – held it in front of the right eye – without producing any

Effect on the Animal. On moving it across to the other Eye, the head was immediately turned - and the meat eagerly snatched out of my hand. A burning match held in front of the Left Eye, caused wincing and retraction of the head - held in front of the right Eye, produced no impression whatever. This shows ~~that~~ that the Animal had lost the power of vision in the right Eye. (Both Eyes had been tested before the operation - a necessary precaution).

- Third Day. Status idem as to locomotion and sight. On testing sensibility by pinching the Ears with a pincette - pinching the skin on both sides of the body - pinching and treading on the toes - I found it diminished on the entire right side. In walking round - it brushed with its right side against surrounding objects, in a manner that is never observed in a sound dog. I further tested tactile sensibility in the following manner. On placing the

Left fore paw in cold water - it was immediately withdrawn. Repeating the experiment with the right - it was not withdrawn. Further on placing the left fore leg over the Edge of a table it was immediately withdrawn - the right on being similarly placed was allowed to hang down.

Fourth Day. Status idem. motor power increasing on right side.

Fifth Day. Status idem.

Sixth Day. Stronger and more lively. The right fore leg now rarely doubles up in walking. Wound healed by first intention.

Eighth Day. Blindness in right Eye and diminution of tactile sensibility on the right side continue. When left to itself the animal still walks round in a circle (a kind of circus movement) to the left; - but on having its attention specially directed - it can also walk straight forward & turn round to the right.

Thirteenth Day. To an inexperienced observer nothing will be noticeable now in the case. The animal runs about like a sound dog. All motor disturbances have disappeared. All that now remain are diminished sight and tactile sensibility on the Right side.

Seventeenth Day. Vision in right eye still bad. No alteration visible in tactile sensibility as shown by the cold water test - the edge of the table - and the "trap door" Experiment. This latter, is an extremely fine test - and is made in the following manner. A piece three inches by three is taken out of the centre of a table - the piece taken out fitting exactly into the hole thus made. To the under surface of this piece a handle is attached - so that it can be gradually lowered or entirely removed. The dog standing on the table, is placed with one of its feet on this piece, which is then slowly lowered from beneath. If sensibility is not diminished - the paw is instantly withdrawn

the moment the piece on which it is resting begins to sink — whereas if Sensibility be diminished, the limb is allowed to sink into the hole, sometimes for a considerable distance, before it becomes aware of the fact. In some instances I have seen the limb sink up to the shoulder, and remained hanging down without any attempt at withdrawal being made.

Twenty third day. Status idem as to sight and tactile Sensibility.

Thirty one days after the first operation a second operation was made on the corresponding opposite side. (Right). After this operation the Animal behaved in every respect similarly to one in which the removal of a portion of the Cortex cerebri had taken place further back — in the so called motor Zones. The gait was uncertain in all particulars but especially was there diminished motor power on the left side. A week after this second oper-

ation the animal died. Apparently not enough time had been allowed to elapse between the two operations.

The Autopsy revealed a somewhat more extensive destruction of the Grey matter in the right than in the left frontal lobe. The so called motor Zones were entirely uninjured.

It has been seen in this case that complete recovery took place, after the first operation as far as motor disturbances were concerned. What remained permanently were diminished power of vision and tactile sensibility on the opposite side. A slight alteration in intelligence was also noticeable - but to this I do not attach any special importance in connection with the frontal lobes - having observed the same alteration after destruction of a portion of the Cortex Cerebri in other parts of the Brain.

— Case II —

First Day.. At 12 noon, I removed from a village dog, the grey matter in the left frontal lobe superficially — not taking away quite so much as in Case I. During the operation the respiration stopped — as did also the heart beat. Restoration took place on the induction of artificial respiration made in the manner already described.

On recovery from the Chloroform narcosis, I took the animal out of its box. On trying to rise to his feet, it fell over on its right side, two or three times before it succeeded. Muscular weakness on right side is less than in Case I. occasional doubling up of right fore leg. Walks round in a circle to left. On testing sight with raw meat and fire — as in the preceding case — found blindness of the right Eye. On withdrawing a basin of milk, of which the animal was partaking — to the right — it

made a Complete revolution to the Left before finding it again. This, Repeated two or three times – with the same result. Tactile sensibility, tested in the same manner, as in Case I, also gave diminution on the entire right Side – though not quite so marked as in the previous case.

Second Day. Status idem.

Third Day. No defect noticeable in gait. Circus movement to left continues still – but is less marked. Is able to go straight forward – and even turn round to the right when its attention is attracted. The motor disturbances have passed off much more quickly than in Case I, where they lasted till the twelfth day.

Fourth Day – Sight still much impaired in right Eye. Tactile Sensibility tested by means of cold water – and placing

See also experiments of Brown Sequard
on Guinea pigs performed in 1870.

the paws over the Edge of a table – gave the same results, as in the former case. With the trap door – the right fore leg sank down for three fourths of its length, before it was withdrawn – the left was immediately removed from the spot, the moment it began to sink. The hind legs gave the same results.

Fifth Day. Status idem as to sight and tactile sensibility on right side.

Sixth Day. Died at one pm.

Necropsy. Cause of death – double pneumonia. Grey matter in in left frontal lobe entirely removed. Wound in Brain healthy – circumscribed and strictly confined to the frontal lobe. The wound in the skin had healed by first intention.

Whether in this case any connexion existed between the brain injury and the lung affection – I cannot tell.

It has been noticed by Rotnagel, that Haemorrhage into the lung followed upon stimulation of the Cerebral Surface in the Rabbit – (Centralblatt. med. Wissenschaft. 1874. p209)

— Case III —

First Day. Large dog — strong and well nourished — Removed in this case the grey matter superficially in both the frontal cerebral lobes (Right and Left). Considerable bleeding took place during the operation. After recovery from narcosis some attempts were made to stand. Lies on no particular side — as noticed in Cases I & II — but lies sometimes on the right and sometimes on the left side.

5 p.m. Wound much distended with blood clot. Removed all the sutures to relieve tension. Left the wound open.

Second Day. Extreme apathy — will not take any milk or other nourishment. Walks heavily and feebly. Does not go in a circle to right or left — but straight forward with head down. Sensibility impaired on both sides — apparently Equally.

On account of the animals apathetic condition - I was not able to test its sight.
Death ensued three days after the operation. The post mortem examination revealed no Encephalic inflammation, as I had anticipated. No cause could be detected to account for death. On mentioning the matter to Professor Goltz, he told me that he had entirely abandoned the plan of operating on both sides "a tempo". According to his experience death generally followed in such cases a few days after the operation. The portions removed on the two sides were well circumscribed and confined to the frontal lobes. The so called motor areas were uninjured -

Case IV

First Day. At 12 noon, I removed the Grey matter superficially - in the Right Frontal Lobe - in a medium sized - Stout Short legged terrier. In this case, I made use of a Small Spoon (Davids -) instead of the other method with water - removing less than in any of the preceding Cases.

5 pm. Lies on Left side - with body curled up to right. Taken out of the box - the animal showed no motor disturbances whatever.

Second Day. Runs about apparently quite well. Tested sight - and found diminution of vision in Left Eye. Tactile sensibility tested by the method already described showed a decided diminution in the Left Extremities.

Third Day. Status idem.

Fourth day. Status idem.

Tenth day. Again tested sight and tactile sensibility with the same result on the left side. Wound healed by first intention. In all other respects the animal appears quite well, and without making the above named experiments with regard to sight and tactile sensibility - might be held for normal.

Fifteenth day. Status idem.

Eighteenth day. Status idem. Sight of left eye and tactile sensibility on left side remained impaired.

Thirty fifth day. Status idem.

Thirty Sixth day. Operated again on the opposite side - removing with a spoon the grey matter in the left frontal lobe.

Forty seventh Day. The wound healed by first intention. The animal eats excellently and appears to be quite well. A considerable amount of motor disturbance was apparent after this second operation. Intelligence much affected. Does not concern itself about other dogs - walks about stupidly, but carefully avoids all obstacles. Often remains standing - for a long time in front of a wall vacantly staring at it. Tactile sensibility, which was impaired on the left side after the first operation on the right side - and as we have seen remained so - up to the date of the second operation on the left side - is now diminished in all the extremities, but especially on the right side - as shown by the cold water - edge of table - and trap door tests.

Case V

First Day — At 12 noon I operated on a strong, well nourished bull terrier — and removed the Grey matter in the left frontal lobe. Half an hour after the operation — on the animal's recovery from the Chloroform narcosis, I took it out its box, and observed the following phenomena.

After some attempts — during which it constantly fell over on its right side — it succeeded in gaining its legs — made unsteady circus movements to the left — and showed considerable muscular weakness on the right side — the limbs — especially the right fore leg, constantly doubling up, and slipping helplessly from underneath the animal; — brushed with right side against surrounding objects — and repeatedly struck its head against objects, purposely placed in front of the right eye.

5 pm. Lies on right side - curled up to left - Always uses the left front paw in applying it to the wounds - never once the right - Otherwise 'Status idem'.
Removed all the sutures from the wound, which was showing a certain amount of tension.

Second Day - will not take milk - Considerable twitchings of facial muscles. A bad sign - often observed in commencing meningitis.

Third Day. No twitching of muscles to-day. Very weak - Beginning to take milk.

Fourth day. Takes food well. Meat held in front of right eye is not seen - Otherwise 'Status idem'.

Ninth day - Still exhibits considerable loss of motor power on right

side - Walks in a circle to left. Vision in the right Eye very imperfect. Great diminution of tactile sensibility on right side.

Twelfth Day. Wound healing well. Is able to walk. Moves constantly in a circle to left. The right fore leg no longer doubles up - but occasionally slips outwards, especially when the animal shakes itself. The motor disturbances are passing off, having lasted about as long as in Case I. Tactile sensibility much impaired on right side - Does not see at all with the right eye -

Forty second day. The animal is not absolutely blind in the right Eye now as at first - but ~~still~~ sees very imperfectly with it - no ~~improving~~ improvement having taken place in it for nearly a month - Tactile sensibility much diminished on right side -

Case VI

First day — A strong and intelligent medium sized dog. I removed in this case, the grey matter superficially in the right frontal lobe. After recovery from the chloroform narcosis - the animal was taken out of its box - and the following phenomena observed: Fell over several times on left side, before gaining its feet. Lies on left side - with head curled up to right. Eye balls turned to right side.

5 pm. Shows no motor defect whatever - Runs about nimbly and jumps with ease into its box.

Second day — Tactile sensibility tested in a variety of ways, showed decided diminution on the left side. While professor Falk was attracting the animals attention by stroking its head - I brought a piece

of raw meat from behind forwards, in front of the left Eye. It appeared to become aware of an object - but did not recognise it. On passing it over the head to the opposite side - the head was immediately turned and the meat snatched away. In this case also then - the sight in the Eye, on the side opposite to that on which the operation was performed - is much diminished.

Fourth day - Status idem.

Eighth day - Wound healthy and healing. The animal seems perfectly well in all its movements - Sees worse with left than with right Eye - Tactile Sensibility remains impaired on left side -

Fortieth day - Sees pretty well out of the left Eye - but apparently not quite so well as with right Eye. Tactile Sensibility slightly impaired on left side - In all other respects - the animal is perfectly well -

— IV —

— Conclusion —

It has been seen from the above recorded cases, that the phenomena resulting from superficial ablation of the grey matter in the frontal lobes, were of two kinds - transient and permanent. To the former belong loss of motor power on the side opposite to that on which the operation took place - and certain circus movements: — while to the latter belong impairment of vision and diminution of tactile sensibility on the opposite side, accompanied by a varying amount of altered intelligence.

This transitory loss of motor power, I observed also in many cases, in which Professor Goltz had removed portions of the Cortex Cerebri at different points - further back and therefore

more in the neighbourhood of the motor areas of Hitzig and Ferrier.
That the same phenomena should have occurred when the ablation took place at such a distance from the so called motor areas, goes far I think to prove Goltz's theory that these phenomena are not to be considered as the direct result of the injury done to the Cortex Cerebri, but must be attributed to inhibitory influence extending further back, and acting on those parts lying between the cerebral convolutions and the Spinal Cord (das Kleinhirn - mittelhirn und was dahinter liegt) and that in these regions of the Encephalon the centre for motor acts must be located -

The Circus movements which occurred in most of my cases - and passed off after variable intervals of time in the different animals -

were also noticed by Brown-Sequard (Mémoires de la Soc: de Biologie Vol. V. p 117) and Schiff ("Lehrbuch der Physiologie des Menschen" - Lahr. 1858-9. p. 346). By these observers it was explained as due to paralysis of the muscles on the opposite side of the body - so that the animal is not able to walk ~~in a straight~~ forward or turn round in the opposite direction. If it were due to paralysis - how then does it happen, that these animals, as I observed in all my cases, in which circus movements occurred - are able sometimes to go in a straight line - and even turn round the opposite way, when their attention is specially directed - so as to cause greater effort of will? - Of the fact that they were able to move in different directions - I frequently convinced myself by attracting their attention with a piece of raw meat, and then leading them in any direction

I chose - Only when the animal was left alone - and walking about without any object - did it turn round, as a rule to one side. To me it appears highly probable, that these circular movements are caused by diminished muscular power on one side - the muscles acting more on one side than the other - and thus causing the animal involuntarily to turn to the side of the stronger muscles. If it were due to paralysis - it is impossible to believe, that the paralysis could be interrupted for a short time, so as to allow the animal to walk straight forward - or turn in the opposite direction, and then immediately relapse again into its former state -

One of the methods adopted by me for testing tactile sensibility, namely that of allowing the animals legs to hang over the edge of a table, with the result of causing immediate

retraction of the sound limb, while that in which there was impairment was not withdrawn - is also described by Hitzig. This was observed by him in an animal in which he had removed a portion of the Cortex Cerebri on the left side ("Oberflächliche Extirpation im lateralen Drittel des Gyrus" - DuBois Reymond's Archiv: Vol. X. p. 420). In Explanation of this phenomenon, he says that the dog had a "hochgradigen Störung des Muskelbewusstseins - hatte aber sein Sehvermögen durchaus nicht eingebüsst. Nichtsdestoweniger benahm sich mit seiner rechten Vorderpfote so als ob für dieses glied des Sehvermögen nicht existire - oder als ob die Gesichtseindrücke nicht zür Bildung von Vorstellungen für dasselbe verwerthet würden" - (Idem. p. 440). He goes on to say that had the animal not been prevented by him, it would have fallen headlong over the Edge of the table. This explanation is entirely erroneous.

Had he made the same experiment with a blind - but otherwise sound dog, he might have convinced himself of his error - and proved that it has nothing whatever to do with sight, but is entirely due to diminution of tactile sensibility. When a blind dog is put on a table and brought near the edge, it immediately withdraws any paw that is placed over the edge of the table - A much more delicate test for proving this, and one in which blindness is not requisite, is that made with the trap door in a table as already described.

Hitzig's absolutely negative results with regard to the frontal lobes, can only be explained by the fact that he removed far too little - substance less in amount than a pea. So fragmentary a portion I am convinced may be removed from any portion of the cortex cerebri - without producing any

appreciable results. Not that I think, that any portion of the Grey matter is superfluous, and serves no purpose, but whatever deviations from the normal standard, removal of such a portion may produce, we have no means of testing — our modes of observation and test appliances being as yet not sufficiently advanced. In Case IV where I removed a very small portion, though considerably more than a pea in size — no apparent motor disturbances followed — in fact the animal appeared perfectly normal — and had I not specially tested the sight and tactile sensibility, I may easily have arrived at a negative conclusion in this Case.

From Experiments on three monkeys by Ferrier, he arrived at the following Conclusion: — "Removal or destruction by the Cautery of the antero frontal lobes, is not followed by any definite physiological

results – the animals retain their appetites and instincts – and are capable of Exhibiting Emotional feeling – the Sensory faculties sight hearing – touch – taste – and Smell remain unimpaired – the powers of Voluntary motion are retained in their integrity – and there is little to indicate the presence of such an Extensive lesion or removal of so large a portion of the brain" – ("Functions of the Brain". p. 231).

He states further, that although he was unable to observe any physiological Symptoms, still these animals had undergone a decided alteration in character and behaviour – this alteration being of a psychological nature. From this he deduces that it is difficult to say what the physiological functions of the frontal lobes may be – but leans strongly to the view that they are the seat of Intelligence. With regard to Intelligence, I partially agree with Ferrier. After the operation my dogs were not what they were before it –

They often had a somewhat stupid and vacant look appearing not to be able to fix their eyes properly on any object. They frequently appeared to walk about automatically, and if another dog stood in the way, rather than go round - they would often creep through under the belly of the other - or walk over another dog that lay in the way. This alteration in character and behaviour, I noticed not only in the dogs - from which I had removed portions of the frontal lobes, but also in many other cases, where different portions of the Cortex Cerebri had been removed by Professor Goltz, this altered intelligence varying with the amount of destruction and having no apparent relation to the locality.

Munk, in a recently published

paper on localisation of function observed, after removal of the left frontal lobe in a dog, circus movements to the left and deminished sensibility along the back on the opposite side. As to condition of the sight in the right eye, he does not make mention, and with regard to tactile sensibility in the right extremities - which is much more easily tested than that in the back - he says nothing. From this observation, he has located the centre for sensation along the back, in the frontal lobes. ("Verhandlungen der Physiologischen Gesellschaft zu Berlin". Sitzung IV am. 29 November 1878. p. 17.).

With Ferrier and Munk - the former holding that the frontal lobes are the seat of Intelligence - the latter that they contain the Centre for sensation

along the back — I agree as to the phenomena observed — so far as they go, but cannot admit their deductions entirely.
As already shown the permanent phenomena in all my cases were diminution of Tactile Sensibility and impairment of vision on the opposite side, accompanied by a certain amount of reduction in Intelligence. The same results were obtained by Goltz after removal of portions of the Cortex Cerebri further back — the degree of deviation from the normal depending more upon the amount of Cortical destruction, than the locality of the lesion.

With these facts before me, I am of opinion that Tactile Sensibility — Sight and Intelligence are intimately connected with the Entire Cortex Cerebri — and cannot have their Centres localised in any

particular Spot –