DISEASES OF THE BRAIN, ETC. ETC.

PART II.

GENERAL OBSERVATIONS ON THE STUDY OF THE STRUCTURE AND FUNCTIONS OF THE BRAIN.

The obvious though mysterious connection between the brain and the mind — between the large mass of matter within the skull and our spiritual nature, has given rise to much investigation and controversy.

But many of the investigations and controversies relating to this subject, have not, I apprehend, been conducted in a right spirit, with the sole desire of ascertaining the exact truth, but oftener with a wish to establish, or to overthrow, some preconceived and frequently prejudiced opinion.

I hope the reader of these observations will endeavor to divest himself of all prejudices upon the subject, and examine, one by one, and with rigid impartiality the various methods which have been recommended by writers, to determine what are the functions of the brain. Such an examination seems to be necessary at the outset, that we may ascertain satisfactorily to ourselves,
which of the methods proposed will be most profitable for us to pursue.

We should also call to mind that but little is now known upon this subject; that all physiologists of reputation and candor admit, that though no other subject is more deserving of thorough investigation, yet there has been but a small amount of evidence furnished, to enable us to determine with accuracy the office, or use, of the various parts of the brain of man. It therefore devolves upon the anatomists, physiologists and pathologists of the present generation, to make investigations upon this important subject to a far greater extent than have hitherto been made, in order to dispel the darkness, in which it is at present involved.

And it is gratifying to perceive that the functions of the brain and nerves are now attracting the attention of medical inquirers, much more than at any former period. Many of the most industrious and distinguished members of the medical profession, and such as from official station and other advantages have the best opportunities for investigating such subjects, are prosecuting inquiries with great earnestness respecting the growth, structure, and diseased appearance of the brain and nerves, with a view of ascertaining their functions and remedying their diseases. We may therefore reasonably expect within a short period valuable additions to our knowledge of the nervous system. We are encouraged in this belief from the important facts which have been made known within a few years by the labors of Gall, Reil, Spurzheim, Flourens, Bell, Magendie, Foville, Lallemand, Abercrombie, Andral, Serres, Tenneman, Muller, Hall, Solly, Grainger, &c., who, with many others, have cultivated this department of medical inquiry. These distinguished men have not pursued the same methods of investigation; some have had recourse to experiments upon the living nervous system; others have chiefly devoted their attention to its diseased condition and to noticing the symptoms produced by this condition; while others have watched its growth and development, and marked the manifestation of function at different periods; and from these dissimilar methods of investigation, we have within a few years been put in possession of more knowledge respecting the nervous system, than had come down to us from all previous time.

The study of the human brain yields in utility and dignity to none other. It is the study of the most important part of our organization, of that portion for which all the others seem to be created. It is also of the highest philosophical interest, from the connection of the nervous system with the manifestation of mental phenomena. I am fully convinced that this system plays a more important part in the human organization than is generally supposed, and that its influence in causing, continuing and even curing disease has been too much disregarded. It is by this system that all impressions are perceived, and all knowledge of surrounding objects derived, and by which we can know either pleasure or pain. It is universally distributed to the body—to every organ, to every muscle and to every fibre, endowing these parts with sensation, life and energy, and with the power of acting in harmony.

From the general diffusion of this system and its known uses, we should expect it to have great influence in disease, and that as intelligence and mental cultivation, the excitement of the feelings and passions, all of which affect this system, increase, that an increase of nervous diseases and new affections of this system should be observed. And this we find to be true. Apoplexy, palsy, inflammation of the brain, dropsy of the head, insanity, &c., are far more common now than in past ages, and
are most observed in countries where there is the most mental excitement. We also now witness forms of nervous disease, or affections of the brain and nerves that were nearly unknown half a century since, such as tic doloreux and delirium tremens, which have recently become as common diseases as any we are called upon to remedy. It is therefore incumbent upon the practical physicians and surgeons of the present day, to give increased attention to the study of the nervous system — to ascertain and make known the functions of its various parts, in order to qualify themselves to the best of their ability to remedy or to prevent its diseases.

In the first place, an accurate knowledge of the anatomy of the brain is necessary. Its structure should be carefully examined, and its connection with the nerves, with the skull, the membranes and blood-vessels, be noticed and remembered. Possessed of this knowledge physicians will be less likely to err in prognosis and in the treatment of the diseases of this organ, and above all, they will be able, whenever such diseases prove fatal, to ascertain and to describe to others their exact location, extent, and connection. This knowledge, together with the history of the symptoms, will aid essentially in determining the functions of the parts affected. In this manner every practitioner may do something to lessen the obscurity that now exists respecting the functions of the brain and nerves, and aid in increasing our knowledge of their diseases.

But I regret to say, that generally diseases of the nervous system are not thus investigated. If the brain is examined after death, it is often done in so hurried and coarse a manner, and so little is known of its healthy appearance, and structure, and connections, that important facts are overlooked. If considerable effusion into the lateral ventricles is observed, this is frequently deemed the cause of death and no further or minute examination is made. Attempts to elucidate the diseases of the spinal marrow by autopsical examination are quite rare, and of those of the ganglionic system still more so. I am aware that such neglect of the nervous system is not absolutely general, but I am convinced it is nearly so throughout most of the country.*

I am the more anxious to remedy this neglect of examining the condition of the brain and nerves, because I look to this method — to facts derived from the examination of the diseased appearance of the nervous system, in connection with the history of the symptoms — as one of the most important methods for obtaining a knowledge of the functions of the various parts of this system.

* We have occasional accounts of autopsical examinations made in the hospitals of large cities, and of some few in private practice; but how small the number of these observations compared with those that would be furnished if such examinations were common throughout the country. There are probably about 20,000 physicians in the United States. If their attention could be earnestly and properly directed to the subject we are considering, how rapidly would our knowledge of the functions of the nervous system and of its diseases be increased. Considering the importance of minutely studying the nervous system, every physician should embrace all the opportunities presented him for this purpose. He should supply himself with a few instruments expressly for autopsical examinations — a few knives, a small saw, hammer and large screw-driver or iron lever, a small giblet and pincers, some copper wire, scales and weights, needles, thread, sponges and comb. These will enable him to make the requisite examination and to restore the parts without disfiguring the body. Attention to this last particular is very important, as it serves to remove most of the objections made by friends to such investigations. It is possible to remove the brain without disfiguring the forehead. This may be accomplished by sawing across the frontal bone, three inches above the eye brows from one temple to the other, and meeting a circular cut through the lateral and posterior parts of the skull.
Every one knows that certain symptoms indicate disease of the brain, or its membranes, or nerves; but until quite recently, and now almost generally, physicians rest satisfied with merely knowing that the disease is located somewhere within the skull. But we should certainly strive to know more than this, and I feel confident that by numerous and careful observations we may be able to determine from the symptoms, not merely that the disease is within the skull, but whether the membranes, or nerves, or the substance of the brain is affected, and often what part of this latter organ and what nerves are diseased. Few physicians are now satisfied with merely knowing that a patient has some disease within the abdomen or thorax; they seek to know what particular organ is affected, and what tissue or portion of the organ is diseased, and this knowledge they can generally obtain by a thorough examination of the case, and comparing the symptoms manifested with those exhibited by others where examination after death revealed the connection between the symptoms and the organic disease. But much of this knowledge — of this ability to determine the exact location of the disease within the abdomen, or chest — is of modern origin; and we have but to pursue the same course as regards diseases of the nervous system, in order to judge from the symptoms what portion of it is affected. This field of investigation is indeed very great, and will require for a long time many laborers, but ultimately, I apprehend, will richly reward those who cultivate it.

SECTION I.

STRUCTURE OF THE BRAIN, &c.

By the brain I mean all the mass contained within the cranium and which it entirely fills. The weight of this mass in adult white males, varies from 3 lbs. 2 oz. to 4 lbs. 6 oz. troy — the weight I uniformly mean, except when avoirdupois is expressly mentioned.

The brain of men greatly distinguished for their intellectual power is usually large. That of Cuvier was one third larger than an ordinary adult brain. It weighed 4 lbs. 11 oz. 4 drachms and 30 grains; that of Dupuyden 4 lbs. 10 oz. According to Desmoulins the brain decreases in weight after the age of seventy. The female brain is lighter than that of the male, usually from four to eight ounces. It varies from 2 lbs. 8 oz. to 3 lbs. 10 oz. "I never found," says Tiedeman, from whom the above statements are derived, "a female brain that weighed four pounds."

The following elaborate table by Dr. Simms,† contains the results of examinations instituted to ascertain the average weight of the healthy brain at different periods of life. The estimates it will be noticed are by avoirdupois.

*On the brain of the negro compared with that of the European and the orang-outang. By Professor Tiedeman, of Heidelberg. Philosophical Transactions for 1835. Part II.
The inference from this table is, that the average weight of the brain goes on increasing from one year old to twenty, between twenty and thirty there is a slight decrease in the average, afterwards it increases and arrives at a maximum between forty and fifty; after fifty to old age the brain gradually decreases in weight.

This account respecting the increase and decrease in the weight of the brain is, I presume, in the main correct, though sometimes the head continues to increase in size, long after the period mentioned. Of this I have been assured by those who have measured at different periods after adult age, the heads of men distinguished for intellectual power and energy. Dr. Spurzheim informed me that he measured the heads of several distinguished men, during his visit to England in 1814, and twelve years after re-measured them, and found they had increased considerably. Some of these individuals were above forty years of age at the time of the first measurement, but had devoted themselves with ardor to intellectual pursuits during the interval.

"This phenomenon," says M. Itard,* "is not rare in the adult, especially among men given to study, or profound meditation, or who devote themselves, without relaxation, to the agitations of an unquiet and enterprising spirit. Bonaparte may be cited as an example. His head was not large in early life, but acquired in after years a development nearly enormous."

The adult negro brain is generally a little less than that of the white. Professor Tiedeman appears to deny this; yet from his own examinations and admeasurements, it seems that the negro brain is something narrower in the anterior portion of the hemispheres than is usually the case in Europeans, that the average weight is less, the dimensions inferior and the average capacity of the skull not so large in the negro as in the European. The following table results from summing up his measurements of the cerebrum of negroes and whites.

| Average length of brain in 4 negroes | 5 11 |
| 7 European males | 6 2/4 |
| 6 " females | 5 10 1/2 |

| Average breadth of brain in 4 negroes | 4 8/4 |
| 7 European males | 5 1/4 |
| 4 " females | 5 4/4 |

| Average height of brain in 3 negroes | 2 11/4 |
| 7 European males | 3 4 |
| 4 " females | 2 9/4 |

I have weighed the brains of nine negroes none of which exceeded 3 lbs. 6 oz. In one instance of a large, well-formed negro, whose head was unusually large and

* Dictionnaire des Sciences Medicales, Vol. 22, Art. Hydrocephale. This statement of M. Itard, Physician to the Institution for the Deaf and Dumb at Paris, was written about the time of the abdication of Napoleon and is unquestionably correct.
well-developed, the skin was found uncommonly thick even for a negro, and the brain weighed 3 lbs. 8 oz. I was not able to learn any thing respecting his intellectual powers.

I have this day weighed the brain of a negro, apparently fifty years old, five feet ten and a half inches in height, large chest and head. The whole brain, including cerebrum and cerebellum, weighed 3 lbs. 6 oz. The cerebellum weighed a few grains less than 6 oz. I have not found the skull of the negro to be thicker than that of Europeans, but the scalp uniformly more so. But though the negro brain is usually a little smaller than that of Europeans, yet this difference may be owing to the greater amount of mental culture which the white race has for centuries received. In idiots the brain is usually small, varying, not uncommonly, in size with their intellectual powers. I have noticed that frequently there is no increase in the size of their heads after the age of eight or ten. Sometimes, however, their heads are of full size, or unnaturally large. In some instances the skull is much thicker than natural. The skull of an idiot, whose head was not badly formed, nor of unnatural size, who died in the Alms House of this city, was three quarters of an inch in thickness. The convolutions of the brain were small and compressed, and the whole brain quite diminutive.

The brain is divided into two portions, a superior and inferior, or the greater and lesser brain. The greater is called the cerebrum, the lesser the cerebellum. These are separated, to a considerable extent, by a thick strong membrane, stretched horizontally across from one side of the skull to the other, and which is but a fold of the dura mater, or of that membrane that lines the interior of the skull. The membrane which thus separates the greater from the lesser brain, is called the tentorium and serves to protect the lesser brain, the medulla oblongata and the upper part of the medulla spinalis from the weight of the upper or greater brain. Both the cerebrum and the cerebellum are divided into halves or hemispheres to a considerable extent. They are thus separated by a perpendicular fold of the dura mater called the falx, and which may serve to protect one side of the brain from the weight or concussion of the other. The external surface of the brain is convoluted or furrowed — that is, numerous clefts and divisions cut up apparently the outer portion of the brain into many irregular parts called convolutions. These convolutions covered by a thin membrane and net-work of blood-vessels, are all that we see on looking at the brain when the head is opened by removing the superior part of the skull, or when the brain is removed from the skull and placed on its base before us. On reversing the brain and looking at its base, or the under side of this organ we observe a very different aspect. We notice great irregularity produced by the form of the skull and which gives occasion to divide the brain into an anterior, middle and posterior portion. We also now see the union of the greater and the lesser brain and their connection with the spinal marrow. The upper portion of the spinal marrow, or that which lies within the cranium, is seen much enlarged, and is called the medulla oblongata. At the upper part of the medulla oblongata is seen a large, thick, white band, nearly an inch in width, called the pons Varolii, and which unites the two portions of the cerebellum.

Above this band we also see two rounded fibrous bodies coming through the pons Varolii and diverging from each other into the hemispheres of the cerebrum. These are called the crura cerebri.

Having thus alluded to the external appearance of the brain we will now briefly notice some of the internal ar-
rangements of this organ. On cutting into, or cutting off a portion of the brain, the first thing attracting attention is the difference of color between the external and internal parts of the brain. The outer part is of a grey color and of a soft and pulpy texture, and appears to encircle the inner, which is white and fibrous. The outer is called the grey, the cineritious, or the cortical part of the brain; the inner is called the medullary, or white. The cineritious part envelopes all the convolutions, and by this arrangement — this folding up as it were, of the outer surface of the brain — its extent is greatly augmented beyond what it would be if the surface was uniform and smooth. This cineritious portion seems to receive a larger supply of blood than the white, and while the latter is very similar in appearance and structure to the nerves, the cineritious bears no resemblance to any other part of the system.

There are also some partial cavities called ventricles, within the brain. There is a large one in each hemisphere of the cerebrum. These are called the lateral ventricles, and are frequently found distended with fluid after death from disease of the brain. On dissecting the brain in various ways, parts have been seen which from some resemblance to other objects, have received names accordingly. These appearances and the names given to them will be found in anatomical works, to which I refer the reader for more minute accounts of the structure of the brain.*

On looking at the base of the brain we notice many white cords or threads, apparently coming from the brain, and in pairs, or one from each hemisphere. These are called the cerebral nerves, and are numbered First,

* I would particularly recommend the work of Mr. Solly on "The Human Brain, its Configuration, Structure," &c. London, 1836.
nected with the medulla spinalis are thirty-one pairs of nerves. Each of these nerves is attached to the spinal cord by two sets of filaments, or roots, called the anterior and the posterior roots of the spinal nerves.

Premising these few anatomical facts respecting the brain, the spinal marrow and the nerves, let us now proceed to ascertain what are the functions of these organs.

SECTION II.

FUNCTIONS OF THE BRAIN—METHODS ADOPTED FOR DETERMINING.

But how shall we proceed? Is there any method by which we can determine the functions of the different parts of the brain? If we were to judge from the vast labor and thought that have been bestowed upon this inquiry and consider how little has been ascertained, we might almost despair of succeeding by any further researches; but when we call to mind that within a few years some new and important facts have been made known, far more than for centuries previous, we ought to be encouraged to continue our inquiries.

The methods resorted to for the purpose of determining the functions of the brain have been various, but I believe they may be noticed under the seven following heads.

1. Chemical analysis.
2. Dissection of the brain.
3. Experiments on living animals.
4. Comparative anatomy.
5. The fetal condition and growth of the brain.
6. Pathological observations.
7. External examination of the cranium.

We will now examine these methods and learn how far each has contributed, or may be made to contribute, to extend our knowledge of the functions of the brain.

1. Chemical analysis. From the composition of some parts of the body we may perhaps infer something of their use. Thus we should know something of the use of the bones, the chyle and the blood, if we knew their component parts; but nothing has been learned by analysing the brain that has added to our knowledge of its functions. It has, however, been carefully performed. M. John* is, I believe, the only chemist who has analysed separately the cinderous and the medullary portions of the brain. The following comparative analysis was made by him of the brain of an insane person who died at Salpetriere.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Grey Sub.</th>
<th>White Sub.</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>77.0</td>
<td>73.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Albumen</td>
<td>2.6</td>
<td>9.8</td>
<td>7.5</td>
</tr>
<tr>
<td>White fatty matter</td>
<td>7.2</td>
<td>13.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Red fatty matter</td>
<td>3.1</td>
<td>0.9</td>
<td>3.7</td>
</tr>
<tr>
<td>Osmazone, lactic acid and salts</td>
<td>2.0</td>
<td>1.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Earthy phosphate</td>
<td>1.1</td>
<td>1.3</td>
<td>1.2</td>
</tr>
</tbody>
</table>

From this analysis it seems that the white portion of the brain contains more fatty matter than the grey, and he observes that its albumen is firmer. These differences may result, however, from disease, as it will be recollected that his analysis was of the brain of an insane patient.

Though I have said that the brain is composed of two substances, the grey and the white, yet there is a small

* Journal de Chimie Medicale, August, 1835.
portion of it, called the pineal gland, which has derived distinction from Descartes having considered it the seat of the soul, and which differs in composition from the other parts of the brain. This body situated near the base of the brain, usually contains some gritty matter. This has been analysed by M. Wurzer, of Marburg, and found to consist of carbonate and phosphate of lime, iron and manganese.

Though it is not probable that any important facts would be learned by further analysing the brain, yet it is to be desired that the different portions of the healthy brain of the new-born, the child, the adult, the aged and the male and the female, be analysed and compared.

2. Dissection of the brain. By dissecting and examining the structure of some parts of the system we may conjecture with considerable certainty their use. The examination of the heart and blood-vessels, for instance, would guide us considerably in our inquiries respecting their functions. But as relates to a knowledge of the functions of the brain, dissecting this organ affords us no light. We find by this method cavities and parts variously arranged and differing in color, but we learn nothing of their use. We may infer from the soft and delicate structure of the brain, that it cannot perform any of the functions of other organs; and from its great size, its vast supply of blood, (according to the estimates of Malpighi and Haller, one third of the whole is sent to the brain,) and the extreme care with which it is protected by a bony envelopment, we may conclude its office is of great importance.

The difference in situation and appearance of the cerebrum and the cerebellum, the one much larger and placed above the other; the greater having large and irregular convolutions, the lesser being lamellar, or having its folds lie in regular plates, affords good ground for supposing a difference of function, though anatomical examination and knowledge of the structure of the brain does not teach us what those functions are.

Again, the division of both the greater and lesser brain into halves deserves attention. It supports the opinion that whatever may be the functions of the brain, that each half is capable of executing them. An affection deeply seated in the brain sometimes destroys the sight of one eye, while the other is not affected. So we may not unreasonably suppose, from the double appearance of the brain, that its functions may be performed by either portion. So the difference in color and structure, noticed between the grey and white substance of the brain, leads us to infer, that their functions are different, as difference in structure indicates difference of function, yet the appearance of neither teaches us any of their uses.

The substance of the brain has been examined with great care by the aid of magnifying glasses. The most celebrated researches of this kind have been made by Sir Everard Home* and his coadju tor M. Bauer, and more recently by Professor Ehrenberg.† According to the microscopical observations of Sir E. Home and M. Bauer, the brain is composed of an elastic, transparent, viscid jelly, an aqueous albuminous fluid, blood-vessels and globules; that the globules are spherical and vary in size from $\frac{1}{8}$ of an inch to $\frac{1}{16}$ of an inch in diameter. They are of a semi-transparent white color, and arranged in threads or fibres of single globules, and apparently

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* Sir Everard Home's two Croonian lectures read to the Royal Society in 1829 and 1833 and published in their Transactions.
held together by the viscid mucus or jelly. These fibres form bundles connected in the same way. The cortical substance differs from the white, chiefly in the smaller size of its arteries and veins, and also by containing a yellow fluid resembling the serum of the blood.

The microscopical discoveries of Professor Ehrenberg are not only the most recent, as to the minute structure of the brain, but are considered altogether the most important. The glasses used by him had a magnifying power of 350 to 360 diameters, though he frequently employed, as means of testing the accuracy of his observations, glasses that magnified to the extent of 3000 diameters. But he found that glasses of the greatest attainable magnifying power rendered the inner figure less definite and clear.

Professor E. claims to have discovered in the brain and nervous system two sets of tubes, both hollow, the one presenting at short intervals globular expansions resembling a string of beads, these he calls varicose or articulated tubes and claims to have proved that they contain a peculiar matter which he calls nervous fluid. These are found chiefly in the brain, some in the spinal marrow and in the three soft nerves or those of proper sensation, the Olfactory, Optic and Auditory, but in none of the other nerves except in the middle of the great sympathetic.

Another set of tubes which are straight and uniform he calls cylindrical, they are larger than the articulated tubes and contain a viscid white, but rather turbid matter to which he has given the name of medulla. These cylindrical tubes are formed mostly in the nervous trunks and cords, but are not found in the nerves clearly devoted to sensation. He has however traced the cylindrical tubes of the motorious nerves into the cortical substance, and found them continuations of the articulated tubes.

Hence he considers the nervous matter as well as the brain to consist everywhere of articulated tubules, conveying nervous fluid, and cylindrical tubules conveying true nervous medulla. He observes “the articulated nerve-tubes void of medulla according to their proportion of the human organism, and their distribution in the animal kingdom, constitutes the more important and noble part of the nervous system, ministering directly to sensation.”

The cortical portion of the brain appears by his researches to differ from the medullary, by wanting for the most part, the cylindrical tubes, and having the articulated tubes contained in a thick vascular net-work. This part also contains a very fine grained soft substance, in which here and there are deposited larger grains in contact with the articulated tubes. This fine grained matter is confined to the grey portion of the convoluted surface of the brain. In concluding his researches Professor E. inquires, “Would not therefore, seemingly the nervous energies be a secretion from the blood of a material, and especially of these granis; which first, in the form of a tough fluid, is collected in the articulated tubes, and gradually in that of nervous medulla is accumulated in the cylindrical tubes, advancing tardily and imperceptibly, till at their ends, it again, as excreted matter, passes into the general absorption. The distillation of the nervous medulla from the blood, appears then to be immediately the developement of that mysterious mental process which indicates itself, as sensation, and which, growing with the growth of the body, augments to complete consciousness. The circumstance, that man, by reason of the extent and the convoluted disposition of the largest surface of the brain, presents consequently the
most extensive secretion of nervous fluid, may bear a
direct relation to his mental energy."

Though these curious discoveries have been to some
extent verified by others, yet the microscope has too
often led us into error, to command now implicit con-
didence. It is however to be hoped that these researches
will be continued, as they may yet serve to throw impor-
tant light upon the functions of the nervous system,
though we can hardly be permitted to say that they have
yet done so.

3d. Experiments on living animals.
The method of determining the functions of the brain
by vivisection has been resorted to by many Physiologists,
especially by those on the continent of Europe, by Hal-
er, Lorry, Finn, Rolando, Magendie, Serres, Ponder,
Flourens, Bouillaud, and many others.

These distinguished Physiologists have seemed to sup-
pose they might ascertain the functions of the brain by
removing portions of this organ from living animals, and
otherwise mutilating it, and noticing the effects produced.

With this object in view they have tortured and killed
innumerable animals, and I regret to say nothing impor-
tant has been satisfactorily established by their sacrifice.

Undoubtedly it is sometimes proper to have recourse
to experiments on living animals, but it appears to me that
such as torture and kill them, should not be resorted to
without the advantages likely to result are obviously im-
portant. I cannot justify such procedure without any
more definite object in view, than the mere hope that
something may be learned by mutilating and torturing
animals.

As respects the elucidation of the subject we are now
discussing, experiments on animals cannot be of much
avail. An insuperable objection in my mind is, that we
cannot cut away a part of the brain without effecting
the portion that remains, and of giving such a shock to
the whole nervous system that but little can be inferred
from the actions of animals after such operations. We
know that very different sensations and symptoms
follow from operations on men. One individual endures
an operation without complaining, another complains
greatly; one is scarcely affected in body or mind, another
is prostrated as respects both. Go into the office of a
Dentist and notice the conduct of those who have teeth
extracted. One endures the operation without mani-
festing any disturbance of mind or body, another faints,
another is convulsed, and another for a time is delirious.
The lower animals, even those of the same species, dif-
fer as regards sensibility also. This every one convers-
ant with them must have observed. One is extremely
timid, easily affected, complaining bitterly of injuries,
while another nothing can daunt, and no injury cause to
complain. Some will remain quiet after operations, and
move or eat reluctantly, while others appear active and
eat readily.

Owing considerably if not chiefly to this difference in
the sensibility of animals, we find that those who have
performed similar experiments upon them, witnessed
and described different results. Still I do not intend to
say that no light has been thrown upon the physiology
of the brain by these experiments, for some of them
appear to me to be satisfactory to a considerable extent,
and tend to confirm results obtained by other methods
of investigation.

The most important experiments relating to the func-
tions of the brain have been performed by Flourens
Bouillaud and Serres. M. Flourens' consisted princip-
ally in removing as far as he was able the part of the
brain, the particular function of which he wished to as-
certain.
“M. Flourens has prick'd the *hemispheres* without producing either contractions of the muscles or any apparent pain to the animal; he has removed them by slices. He has performed the same operation on the *cerebellum*. He has at the same time removed the hemisphere and the cerebellum; the animal has remained impassive. The *corpora striata*, the *thalami nervorum opticorum* were attacked and removed without any effect. Contraction of the iris did not take place, neither was it paralysed.

“But when he irritated the *quadrigeminal tubercles*, shiverings and convulsions commenced; and this shivering and these convulsions increased as he penetrated deeper into the medulla oblongata.

“The irritation of these tubercles as well as that of the optic nerves, produced violent and prolonged contractions of the iris.”

“In his language, M. Flourens concludes that ‘the medulla oblongata and quadrigeminal tubercles are irritable;’ which, in our language, signifies that they are conductors of irritation, as are the spinal marrow and nerves; but that the cerebrum and cerebellum have not this property.

“The author also concludes that these tubercles are the continuation and termination of the spinal marrow and medulla oblongata; and this conclusion is in accordance with what their anatomical relations and connexions indicate.”

“After the effects of ablation of the brain, properly so called, M. Flourens examines those of the extirpation of the quadrigeminal tubercles. The removal of one of the two, after a convulsive action which immediately ceases, produces blindness of the opposite eye, and an involuntary whirling round; that of the two tubercles renders the cecity complete and the whirling more violent and more prolonged. Yet the animal retains all its faculties, and the iris is still contractile. The entire extirpation, or a section of the optic nerve alone, paralyses the iris; from which circumstance M. Flourens concludes that extirpation of the tubercle produces the same results as a section of the nerve; that this tubercle is as regards vision only a conductor; and that the cerebral lobe alone is the limit of the sensation, and the place where it is consummated by becoming converted into perception. After all it must be observed that in too deeply extirpating these tubercles we interfere with the medulla oblongata, and then violent convulsions, which last long, make their appearance. What appears to us to be most curious and unheard of in M. Flourens’ experiments, concerns the functions of the cerebellum. During the ablation of the first slices, only a little weakness and a want of harmony in the movements occur. At the removal of the middle slices an almost general agitation is the result. The animal, continuing to hear and to see, only executes abrupt and disorderly movements. Its faculties of flying, walking, standing up, &c. are lost by degrees. When the cerebellum is removed, the faculty of performing regulated movements has entirely disappeared. Placed on its back the creature could not get up; yet it saw the blow that threatened it, it heard noises, it endeavoured to avoid danger, and made many efforts to do so without accomplishing its object. In a few words, it retained the faculties of perception and of volition, but it had lost the power of making its muscles obey its will. It was with difficulty that a bird stood up, resting upon its wings and tail. Deprived of its brain, it was in a dormant state; deprived of its cerebellum, it was in a state of apparent drunkenness.”

*Report made to the Royal Academy of Sciences of the Institute on the Memorial of M. Flourens, 1822.*
M. Bouillaud* repeated these experiments and came to nearly the same conclusions, though he believes the regulating power of the cerebellum extends only to the muscles of locomotion. "Mutilations of the cerebellum," says he, "were not accompanied by paralysis or convulsions, properly so called, but merely by disorder of the locomotive functions; the faculties of equilibrium and progression were destroyed. The animals mutilated were still capable of reflection, of hearing, of moving their limbs in all directions, and most frequently these movements were executed with extraordinary quickness and violence; from which it follows," says M. Bouillaud, "that we must admit the existence in the cerebellum of a force which presides over the association of the movements composing the different acts of locomotion and of station, a force essentially distinct from that which governs the simple movements both of the trunk and limbs, although there exists the most intimate connection between the two.

"In this view of the subject it is impossible not to adopt the opinion of M. Flourens, namely, that in the cerebellum resides the power of co-ordinating the actions of walking, running, flying, standing, &c. But M. Flourens appears to have fallen into an error when he says, that the cerebellum is the co-ordinator of all the movements called voluntary.

"Up to this time experiments only warrant our saying that the cerebellum is the central nervous organ which gives to vertebrated animals the faculty of preserving their equilibrium and of exercising the various acts of locomotion."

* "Bouillaud: M. Bouillaud* admits these facts, but thinks they prove that the cerebellum is the central seat of sensibility, that it is because sensibility is destroyed, because the animal does not feel the ground it treads upon, nor the objects it runs against, nor is sensible of its own muscular movements, that it fails to keep its equilibrium.

"The opinion advanced by some physiologists," says M. Foville, "that the cerebellum is the regulator of the voluntary movements, if we attentively consider the reasoning on which it rests, seems to me to strengthen the idea which places the central seat of sensibility in the cerebellum. After having injured the structure of the cerebellum extensively, we have observed that animals preserved the power of moving their limbs, but had lost that of co-ordinating the movements of these in a manner convenient to station, progression, flight, &c. But when we will to perform, and actually perform, certain movements, do we not distinctly feel that we execute them? The man who, with his eyes shut, moves his hand or his arm, does he not also as distinctly feel that he moves these parts as if he followed them with his eyes? whilst the paralysed man who, with his eyes shut, is desired to move the paralysed limbs, may be very willing to do so, though incapable, and perfectly aware of his incapability of obeying; nor would it be possible to persuade the individual so circumstanced that he did move his limbs.

"If this be true, (and no one, I think, will doubt it,) how can we expect that an animal deprived of the faculty of perceiving the sensation of the movements which it executes should execute them in the ensemble with harmony and in accordance with a proposed end? How
can we expect it to walk deliberately and keep its equilibrium, if it does not feel the ground upon which it stands, if it is ignorant of the position in which its limbs are placed? Sir Astley Cooper, with whom I conversed on this subject towards the end of the year 1830, cited to me the case of a man completely deprived of the faculty of sensation in one arm and hand, the muscular power of which was, however, preserved. When this man was desired to take hold of and to lift anything, he did so very well; but if, whilst holding the object, his attention was taken away from the hand, irregular contractions of the limb commenced, and very soon the object he held fell to the ground: as soon as the patient ceased to follow the contractions of his fingers with his eyes, nothing remained to inform him that he held the object, when, of course, it escaped from his grasp.

M. Serres, from some experiments and cases, is of the opinion that the cerebellum, especially its median lobe, is the exciter of the genital organs. He says, "Oxen knocked down by a blow in the occiput, which tears the cerebellum, have the penis considerably affected," and states that a stallion manifested decided erection, when a knife was plunged into the median lobe of the cerebellum. M. Segala, induced erection in a guinea pig, by plunging a knife deep into the cerebellum, so as to arrive at the upper part of the spinal marrow. Other experimenters have obtained somewhat different results. Magendie found that a duck would only swim backward after the cerebellum was removed, and that if the right crus of the cerebellum was cut through, the animal whirled round incessantly, from left to right, for twenty-four hours. If both were divided no movement occurred. Pogore found that the removal of a part of the cerebellum was followed by motion backward.

If we admit the correctness of the results alluded to from these experiments, they teach us but little. About all that we may infer from them, is, that the hemispheres of the cerebrum are the seat of consciousness, of memory, and the intellectual faculties, and that the cerebellum is connected with the locomotive powers and the function of generation, and essential to their healthful and orderly manifestation. It is well known that Gall located the function of generation in the cerebellum, but supposed it might have other. "We should never forget," says he, "that one and the same part may have its general vital function, and its particular animal function besides. The cerebellum may participate in the vital function of the medulla spinalis and medulla oblongata, and, at the same time, have a particular animal function."

We must therefore have recourse to other methods of investigation than those of vivisection, to satisfy ourselves respecting the functions of the brain.

4. Comparative Anatomy. — Examining the brain of the lower animals, and comparing them with those of man, in connection with the mental powers manifested, has been resorted to by some with the view of ascertaining the functions of the human brain. This method can be of no avail only for a part of the mental faculties, as man exhibits many that other orders of animals do not. But the examination and comparison so far as it has been carried, satisfactorily shows this increased development of the brain is always accompanied by increased mental power.

The animal kingdom, like to the vegetable and the mineral, has been divided by naturalists into sub-kings, classes, orders, &c. The arrangement of Cuvier, *On the Functions of the Brain and each of its parts, &c. Boston edition Gall's Works, Vol. 3d, p. 244-5.
though not founded on any fixed principles, has been generally adopted. These sub-kings are,

1. Radiated.
2. Articulated.
4. Vertebrata.

Other naturalists considering the superior importance of the nervous system, have sought to establish the grand divisions of the animal kingdom in its modifications. Lamarck proposed three great divisions founded on the intellectual manifestations of animals—Apathic, or Automatic, the Sensitive, and the Intelligent.

Professor Grant, of the London University, has made divisions which though founded upon the differences in the nervous system, corresponds to the divisions of Cuvier, as follows:

1. Cyclo-neurose of Grant is Radiated of Cuvier.
2. Diplo-neurose Articulated.
3. Cyclo-gangliated Mollusca.

1st. In the lowest class of animals, the Radiated, we do not always find the nervous system sufficiently distinct to be demonstrated. Whenever it is perceptible, it is found in delicate circular filaments about the mouth. Founded upon this condition of the nervous system the name of Cyclo-neurose has been given to this class of animals. The Foriífera, or sponges, Asterias, or star-fish, and Physalia, the Portuguese man of war, are of this division.

2d. The Articulated of Cuvier, and Diplo-neurose of Grant, including the tape-worm, earth-worm, leech, lobster, spider and insects, are endowed with a more extended nervous system, consisting of a double nervous cord, or column extending along the whole vertebral surface of the body.

3d. The Mollusca of Cuvier is the Cyclo-gangliated of Grant, and has the nervous system more abundant in the vascular, digestive, and glandular apparatus, and more concentrated around the entrance of the alimentary canal, where it usually forms transverse series of ganglia, disposed around the cesophagus, hence the term Cyclo-gangliated. The snail and the oyster are examples of this division of animals.

4th. Vertebrata of Cuvier. The Spini-cerebrata of Grant, have a lengthened dorsal, nervous cord, developed anteriorly into a brain, and protected by a vertebreal column and cranium. In this division are classed the Fishes, Amphibia, Reptiles and the Mammalia.

Thus it will be seen that the First primary division of animals is but slightly endowed with a nervous system, a few filaments around the mouth to endow them with taste or feeling, and enabling them to reject or receive whatever presents itself at the mouth.

The Second division has a larger nervous system, one that extends down the anterior part of the body. The Third has a still larger, and it is more concentrated around the alimentary organs, giving more perfection to the digestive, circulatory, and glandular system. Some of them have ganglia so large and concentrated as to nearly entitle them to the name of brain; in fact the brain of the higher order of animals appears to be a collection and concentration of ganglia. The Fourth division is characterized by a far superior nervous system, consisting of a nervous cord protected by the vertebral column and expanded into more or less of a brain protected by a cranium.

But if we direct our attention to this last division, the Vertebrata, we find many marked differences in the nervous system, especially in the formation of the brain of the animals of the different classes into which it has been
subdivided, viz: Fishes, Amphibia, Reptiles, Birds and Mammalia.

In Fishes — we find the spinal portion of the nervous system very similar to that of man; the nerves arise from it by anterior and posterior filaments, the posterior having a small ganglion connected with them, the same as in man. But the brain in fishes scarcely deserves the name, as it is but a slight enlargement of the spinal cord. About \( \frac{1}{2} \) of the average proportion of the weight of the brain to the body of an adult man, while in a fish the weight of the body, in comparison with the human brain, predominates immensely. The brain of the shark, for instance, is but as one to two thousand four hundred and ninety-six, compared with the weight of its body. Still the rudiments of the hemispheres, or lobes of the cerebrum, and a structure corresponding to the cerebellum, though small, may be distinguished, and these superior nervous endowments undoubtedly confer upon them higher intellectual powers, such as memory, than are possessed by animals belonging to the inferior divisions. In the nervous system of the Amphibia, or vertebrated animals with cold blood, and most of them undergoing a metamorphosis, or change of condition, having relation to a transition from an aquatic to an atmospheric medium of respiration, we find the condition of the brain in their early or pisiform state very similar to that of Fishes. But when they pass into the Reptile state the brain receives additional development in a very short time — the hemispheres become enlarged laterally and superiority, and they now manifest higher intellectual powers than before their metamorphosis.

The nervous system of Reptiles is very similar to that of the Amphibia after they have passed from their early and imperfect condition; and by many the Amphibia are considered not a distinct class, but an order of Reptiles.

**Birds.** — The nervous system of Birds is developed to a much higher degree than that of any class of animals we have alluded to. “The brain of the bird differs from that of the reptile in the superior size of the cerebrum, and the more complex structure of the cerebellum. It differs from the brain of a mammal in the smaller size of the cerebellum, resulting from the want of the lateral lobes, and in the absence or rudimentary condition of the fornix; and it differs from the brain of every other vertebrated class, in the lateral and inferior position of the optic lobes, or bigeminal bodies.”

The superior size of the cerebral lobes of birds corresponds to their advance in intellect on the other classes mentioned, still these lobes present a smooth surface, as they are without convolutions which we find in the higher order of animals, the mammalia, and by which arrangement the cingular neurine is much increased.

**Mammalia.** — “The advance which the brain makes in this class of animals is very striking. The spinal cord no longer competes with it in point of dimensions. The hemispheres, except in the very lowest members of the class, begin to take on a convoluted appearance, and the optic tubercles, instead of remaining merely a single pair, have, appended to their posterior surface, two additional and smaller masses of medullary neurine, called the testes. But still we do not find any sudden transition from one form of brain to another; there is no great chasm between the brain in Birds and that of the Mammalia, for when we direct our attention to the brain of the Rodentia, or gnawing animals, we find almost as much difference between its anatomy in them and in man, as between that of the feathered race and the lord of the creation. The upper surface of the hemi-

* R. Owen, Esq. Cyclopedia of Anatomy and Physiology.
spheres in the rat, mouse, marmot, beaver, and even in the rabbit, is as smooth as in birds; the hemispheres in most of these animals do not cover the cerebellum, and in some instances not even the optic tubercles."

Among this large class of animals we observe great disparity of intellect, but uniformly find an increase of brain accompanying the manifestation of superior intellect. Those animals that nearest approach man in regard to mental powers, as the orang-outang, have a brain bearing a closer resemblance to that of man than other animals. For a striking instance of this connection between cerebral development and mental power I need but refer to the anatomical structure of the brain of the Porpoise.

"This creature, which to the vulgar is no more than a large fish, the enlightened physiologist admits into the same grand division of the animal kingdom to which man himself belongs. Bringing forth its young in a state requiring long after birth the protecting care of the mother, higher moral and intellectual endowment are implied than we can expect in fishes and reptiles, whose spawn is generally abandoned by the parent as soon as it is shed; and in accordance with these manifestations of higher powers, we find the cerebral mass developed upon the same plan and presenting nearly the same appearances and arrangement of parts as some of the most perfect of the terrestrial mammals, and even as the brain of man himself."

But from the examination of the brain of animals, comparing them with that of man, and watching their mental manifestations, about all we learn is that enlargement of the brain, especially of the anterior and superior portions, is ever accompanied by an augmentation of mental power. In many of the lower animals the base of the brain and the spinal marrow differs but little from that of man.

It is therefore not unreasonable to conclude that the upper or superior part of the brain, which man possesses, and which other animals do not, enables him to exhibit superior mental powers.

It may be proper here to notice some other methods resorted to for ascertaining the mental capacity of the different classes of animals. One is by considering the size of the brain as the sole evidence of mental power, and then comparing the brains of different animals.

But it has been proved, that if this was true man should have inferior intellect to the elephant and whale, both of which have brains larger than that of man. Again it was said man had the largest brain in proportion to the size of his body, but this was found not to be correct, as some monkeys, the canary bird, &c., have larger brains in proportion to the size of their bodies than man.

Others said that the brain of man in comparison to the size of the spinal marrow was larger than in any other animal, and this accounted for his superior powers of mind. But this according to Cuvier is not a fact, as the Dolphin and some other animals are exceptions.

Let us here briefly allude to, the celebrated "facial angle," of Camper, which may be considered another method of determining the intellectual powers, and which consists in comparing the brain with the size of the bones of the face. This angle is formed by a line drawn horizontally from the roots of the incisor teeth of the upper jaw to the meatus externus, and then intersected by a line drawn perpendicularly from the same point at the teeth to the most elevated point of the forehead. Of course the more the forehead projects, the greater will be the angle, hence when the anterior lobes of the brain are greatly developed, the angle is increased. There is to be sure some little truth in this method of comparison.
But as a guide to determine the difference of the mental powers it is very defective. The facial angle of the infant is generally greater than that of the adult, and in the most stupid of the white race superior to that of the most intelligent of negroes; and besides, in three quarters of the animals of various degrees of intelligence, says Blumenbach, the facial angle is the same.

5. The fetal condition and growth of the Brain.

This is perhaps, entitled to be considered another method of determining the functions of the brain. It consists in watching the early development and growth of the brain and marking the mental manifestations at different stages. This study is most curious and interesting, though perhaps of little utility in relation to the subject we are investigating. Meckel, Tiedemann, Serres, Geoffroy St. Hilaire and others have examined the growth of the fetal brain with great attention, and their observations are exceedingly curious. According to these authorities the brain of the human fetus in the earliest months of its existence resembles that of some of the lower order of animals; when a few months older it receives additional parts, which cause it to resemble that which animals of a higher order always retain; but that it is not until the time of birth or afterwards that parts are added which distinguish it from the brain of other animals. The most important conclusions which may be drawn from these investigations are thus summed up by Mr. Anderson.* "Nature follows an uniform plan in the creation and evolution both of the brain of the human fetus and that of vertebral animals.

proportion to cerebral development, especially of the anterior and superior portions of the cerebral lobes.


Let us now direct our attention to one other method of investigating the functions of the brain, a method which as I have already intimated, we shall be richly repaid for pursuing. The method I allude to, is that of Pathological investigation — to careful dissection of the brain of those who have died from affections of this organ, and noticing the symptoms manifested during life. Sir Everard Home, some years since directed the attention of medical men to this manner of investigating this subject. "The various attempts," says he, "which have been made to procure accurate information respecting the functions that belong to individual portions of the human brain, having been attended with very little success, it has occurred to me, that were anatomical surgeons to collect, in one view, all the appearances they had met with, in case of injury of that organ, and of the effects that such injuries produced upon its functions, a body of evidence might be formed, that would materially advance this highly important investigation."

We have already learned something of importance by this method of investigating the subject.

First, we have, it appears to me, ascertained from Pathological observations that the functions of the cineritious and the medullary portions of the brain are quite different — that the cineritious portion of the brain is more particularly concerned in intellectual operations, while the office of the medullary part is to conduct sen-

*Philosophical Transactions, for 1814.

sation and volition; that when the medullary part is alone affected, disturbance of motion occurs, but not of the intellect, and that when the cineritious portion is diseased, the intellect is alone affected. The following statements tend to establish these views.

In the writings of medical men we find numerous cases of delirium arising from inflammation which is confined principally to the membranes of the brain. These membranes surely have nothing to do with the manifestations of intellect, but the disease which affects them, extends to the cortical substance of the brain, and thus occasions derangement of the mind.

"The fact of delirium occurring so frequently in inflammation of the membranes of the brain, is of considerable importance, as showing, not that membranes of the brain have any thing to do with intelligence, but as supporting the opinions of those who believe the periphery of the brain to be the seat of the intellectual faculties, and here is a fact, which, as far as it goes, is in favor of the doctrines of phrenology. If we compare those cases of cerebral disease in which there is delirium, with those in which it does not occur, we shall find that it is most common in cases where disease attacks the periphery of the brain, as in atheritis. The cases in which we observe great lesions of the brain without delirium, are generally cases of deep-seated inflammations of a local nature, or inflammation of those portions of the brain which the phrenologists consider not to be subservient to the production of mental phenomena. This fact, also, would seem to confirm the truth of the opinion of the difference in function between the medullary and cortical parts of the brain. It is supposed that the cortical part of the brain is the organ of intelligence, while the medullary portion performs a different function. It is, however, a curious fact that in delirium the inflammation is generally confined to
the surface of the brain, and that in cases of deep-seated inflammation, the most important symptoms are those which are derived from the sympathetic affections of the muscular system."

From the manner in which the membranes of the brain and the contiguous cerebral substance are supplied with blood, both from the same source, it is evident that the one could not be much inflamed, and the other remain unaffected. "It is impossible," says Lallemand, "that the arachnoid should be inflamed without the surface of the brain in contact with it being also affected; but its tissue not being altered, there merely results from this vicinity, exaltation in its functions." This makes it exceedingly difficult if not impossible to say with certainty what symptoms indicate inflammation of the one and not of the other. "Our knowledge of the subject," says Abercrombie, "is not sufficiently matured to enable us to say with confidence what symptoms indicate inflammation of the substance of the brain, as distinguished from inflammation of its membranes."

M. M. Bayle, Martinet, and others, have published cases of what they call arachnitis, for the purpose of establishing the diagnosis and pathology of inflammation of the arachnoid membrane. But on examining these cases we find most of them presented marks of the inflammation having extended to the cerebral substance, the vessels of the pia mater being injected and the external surface of the brain exhibiting abundant proof of having participated in the disease.

But as such cases do not present any deep-seated affection of the brain, as the medullary portion is not altered, they may be properly referred to as evidencing that the cortical substance of the brain is the seat of intelligence.

It has also been noticed that inflammation of the membranes covering the convexity of the brain is accompanied with early and violent delirium, but that in inflammation of the membrane at the base of the brain on the peduncles and pons Varoli, the symptoms are more insidious, attended with convulsions and coma and often without delirium. Dr. Stokes referring to this subject observes: "According to the researches of some celebrated French pathologists, there are a number of facts to show that there is a remarkable difference between the symptoms of arachnitis of the convexity and of the base of the brain. This conclusion, which after a most careful series of investigations was adopted by them, is borne out by the results of my experience, and appears to me to be established on the basis of truth. They have discovered that arachnitis of the convexity of the brain is a disease characterized by prominent and violent symptoms, early and marked delirium, pain, and sleeplessness, and then coma. But in arachnitis of the base of the brain, the symptoms are of a more latent and insidious character; there is some pain, and the coma is profound, but there is often no delirium."

Cases illustrative of these facts are to be found in several authors. The two first are from Andral.*

CASE I. — A postilion, thirty-three years of age, of strong constitution, received, on the 2d February, 1822, on the right side of the neck, a very heavy sack of oats, which fell on him from the height of several feet. He,

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*Dr. Stokes. Lectures on Cerebral Diseases.
†Pathological and Practical researches on Diseases of the Brain and the Spinal cord.

*Clinique Medicale, or Reports of Medical Cases, by G. Andral. Translated by D. Spillan, M. D.
however, continued his customary occupation till the 7th. He felt a painful tension on the right side of the neck, at which part the skin assumed an erysipelatous appearance; fever came on, and the patient kept his room. The fever continued on the 8th, 9th, and 10th, and the erysipelatous spread. On the 11th he entered the hospital, when the fever was very high; the neck was covered with leeches. Desquamation commenced at several points of the skin of the neck; but on the right, behind the sterno-mastoid muscle, an obscure fluctuation was observed; this muscle also seemed more prominent than that of the opposite side; no other morbid symptom; no stool for three days. At one o'clock in the morning the patient suddenly became delirious. On the 12th, at eight o'clock, the delirium still continued; eyes haggard, constantly rolling; pupils very much contracted; violent screams; free motion of the limbs; pulse frequent and very weak; tongue moist and red; burning thirst; no stool; some leeches applied the preceding day, still bleeding; (blister to one thigh, sinapisms to the legs, purging enema, acid drink.) Three hours after the visit he expired.

Post mortem. — Arachnoid and pia mater natural in every respect, except for the space of three fingers breadth in length and two in width, near the anterior extremity of the upper surface of the left hemisphere of the brain. There the membranes were thick and red. A small quantity of limpid serum in each lateral ventricle; the posterior part of the two lungs infarcted; the mucous membrane of the stomach presented, at the pyloric portion, a slight brownish tint; the spleen very soft; a great quantity of pus infiltrated the cellular tissue beneath the sterno-mastoid muscle of the right side.

Remarks. — This is a very remarkable case. It is probable that the partial arachnitis, ascertained in the dead body, commenced only with the delirium; the disturbance of the intellect, and a striking contraction of the pupils, were the only two phenomena occasioned by this inflammation; at times these very slight inflammations of the meninges are sufficient to disturb the intellect. We may note also, that here the inflammation was seated at the anterior and superior part of one of the cerebral hemispheres, where, in fact, several physiologists more particularly place the seat of intellect.

Compare with this.

CASE II. — A laboring man, of middle age and strong constitution, on entering the hospital complained of nothing but a violent headache, which commenced five or six days previous, and was for the first two days accompanied with a painful vomiting. The temples were the seat of the pain; they seemed as if compressed in a vice; at intervals he felt acute lancinating pains either at the temple, or the occiput, and occasionally the back of the neck became so painful that the patient could not move: he then presented all the symptoms of wry neck — he felt easy only when perfectly at rest; appetite gone; and what he ate, he said, gave him no strength; since the invasion of the headache had been but once at stool. We saw him first on the 3d of July, when he presented the following state; — Face pale and dejected; look quite vacant; eyes very sensible to strong light; intellect clear; pulse and skin natural. The head-ache the only important symptom in this case; (bleeding to sixteen ounces; sinapisms to legs; purging oyster:) the blood formed in a soft coagulum, with little serum and no buff. 4th July. He complained aloud of the violent pain of his head; he fancied his skull beaten in as it were with a hammer. Still his forehead was cool, and his face paler than the day before,
the pupils, intellect, circulation, natural. Thus the bleeding produced no diminution of the headache — (a second bleeding.) On the 5th thirty leeches were applied to the neck. On the 6th headache less; but he answered questions with difficulty; he lies on his back and remains motionless, and resembles a person going to sleep, or whose eyelids are struggling against sleep. He still retains his intellect, but appears to use it in spite of himself; countenance very pale; features drawn, and as it were fatigued. (Two blisters to the legs.) On the 7th he appears in a profound sleep, will not answer questions; when bid he puts out his tongue readily, which remains white and moist. On being pinched he shows that he still retains all his sensibility; pupils sensible to light; pulse sixty; heat of skin natural. 8th and 9th. Profound coma; he refuses to open his eyes, and appears not to hear the questions put to him; pupils natural; some sensibility still retained; (strong synapsisms to the lower extremities.) On the 10th. Coma still; complete loss of sensibility; yet, notwithstanding this annihilation of the functions of the life of relation, described by the ancients under the name of lethargy, the functions of organic life are still perfect; pulse, temperature of skin, and respiration natural. On the 12th, for the first time, the respiration appeared affected; sometimes very much accelerated, at other times so slow that the respiratory movement just made, seemed not likely to be succeeded by another. On the 13th. Respiration still accelerated; in the course of the day the tracheal rattle set in, and the patient died in the night.

Post mortem. — The upper part of the brain and meninges being minutely examined, no morbid appearance was detected; but on examining the lower surface, the pia mater covering it was infiltrated with a purulent layer from seven to eight lines thick.

The following from the conjoint work of Parent Duchatelet and Martinet,* is an interesting case, though the treatment appears to have been very inefficient.

CASE III. — Depurs, three and a half years of age, after enjoying good health, was taken on the 14th July, 1817, with spontaneous vomiting of greenish matter, which continued more or less until the 24th of the same month, accompanied with prostration of strength, a slight degree of drowsiness, and smart paroxysms of fever without delirium or restlessness. During all this time there was obstinate constipation and violent headache. The child frequently screamed out, and there were some convulsive movements about the eyes. The intellect did not seem disturbed. He was transported to the Hospital des Infans, on this day, the 11th of the disease, and the following symptoms were noted. The child lay on his back, the trunk immobile, head turned backwards, eyelids heavy and closed, pupils little dilated, features altered, eyes turned upwards. The child was sensible when spoken to, and complained of great pain in the occipital region — drowsiness constant, pulse feeble, irregular, and frequent; respiration slow, unequal and apparently difficult; tongue coated yellow; constipation. Mustard pediluvia, lavements, lemonade, nitric ether mixture. In two hours some convulsive movements, screaming, complains of violent pain in the back of the head, to which part the child was constantly applying his hand. Twelfth day, (second in hospital.) Piercing cries during the whole night; strabismus; features greatly altered. Lemonade with a grain of emetic tartar, lavements,

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mustard pediluvia; blister to the nape of the neck and behind the ears; ice to the head. In two hours a strong paroxysm; much crying during the day; loss of intellectual and sentient faculties. Thirteenth day, a general remission of all the symptoms; pulse very irregular; great irritability of temper. Same treatment. Fourteenth day, (third stage of the disease,) pupils dilated and immovable; profound somnolency; pulse irregular, feeble, small and extremely quick; eyes prominent, affected with strabismus, and half open; head inclining to any position which the laws of gravity dictated; the intellect not much affected. Blisters to vertebral column. Fifteenth day, same state, but the intellect more disturbed. Sixteenth day, profound coma; gradual extinction of the vital and natural functions; death.

Dissection. — Arachnoid inflammation at the base of the brain, about the decussation of the optic nerves, and over the tuber annulare; the membrane itself covered, in many places, with an albuminous exudation, penetrating into the fissura magna sylvii. Eight ounces of serous effusion in the ventricles. No other morbid appearance in any part of the body.

The researches of M. Foville,* respecting the state of the brain in cases of insanity, have thrown considerable light on this subject. Few men have enjoyed so good opportunities for investigating diseases of the brain as M. Foville. In conjunction with his friends Delaye and P. Grandchamp, he carried on his inquiries for a considerable time at the great Hospital of the Salpetriere, where it was under the superintendence of M. Esquirol, and more recently at the extensive Hospital for the Insane at St. Yon, in the department of the Lower Seine, which for several years has been under his superintendence. His observations are entitled to the greater weight, from his having adopted the judicious practice of examining at the same time the brain of one who died without any disease of this organ, and the brain of one who died insane.

In acute cases of insanity he found the cimeritious portion of the brain, particularly the anterior part of the cerebral lobes, intensely red, but without adhering to the membranes. But in chronic cases he found the cortical substance indurated and adherent to the membranes. In some instances, in cases of long standing, he found the convolutions lessened. He has also found the white portion of the brain injected and hardened, and he conceives that the fibres of the medullary substance have in chronic cases contracted adhesions to each other. In nearly all cases of insanity accompanied with general paralysis he has noticed these adhesions and has also observed hardness of the medullary substance. Similar appearances he has also found in the brains of aged men whose voluntary motions had become impaired.

M. Foville refers to the opinion advanced by M. Calmiel, that paralysis occurring in the insane, was connected with disease of the cimeritious substance of the brain. This he has shown to be incorrect by reference to numerous cases of alteration of the cimeritious portion, without the least affection of movement. "I might speak," he says, "of the many hundreds of observations of this sort which I have made myself, or with my colleagues Delaye and P. Grandchamp, and in which marked alterations of the cortical substance of the brain were not connected with any other phenomenon than disorder of the intellect."

Cases in corroboration of these opinions of M. Foville have been furnished by other writers. The following remarks and cases from Bouillaud are to the purpose.
"If we reflect that disturbance of the intellect can exist independently of every other derangement of the cerebral functions, if we reflect moreover that disturbance of the intellect appears to coincide constantly with an alteration of the cortical substance of the brain, we shall be obliged to admit as very probable this double opinion, namely, that the injury of the intellect depends upon that of a distinct part of the cerebral mass, and that the distinct part of the brain the injury of which produces derangement of the intellect is the cortical substance of that organ."

Case IV. — Mainton, 43 years of age, house-painter, married, entered the 18th of November, 1823, the hospital of La Charite: six years ago he left the military service, and had only been in Paris two months. Since two years he had shown signs of imbecility, and had completely lost all memory. Whilst he was a military man, he had shown at different periods derangement of the intellectual faculties. Last year, at Versailles, he had symptoms of acute meningitis: two months ago, these same symptoms having re-appeared, a seton was inserted in the nape of the neck: besides, for two years he has complained of constant pain of the head and at the root of the nose, with a smell of putrefaction in this cavity. For a twelvemonth he has been weak in his legs. He has always had a good appetite. After having taken cold-baths for a month when he was in the hospital of St. Michel, he fell in a state of great exhaustion, and experienced lypothymie.

"The 17th of November he lost his mind, had repeated attacks of convulsions, with loud and unequal respiration. The 18th, at ten in the morning, general convulsions; eyes wandering; white froth from the mouth; rigidity of the limbs; sometimes grinding of the teeth and contortion of the mouth; sensibility remaining in the upper extremities, which he draws back when pinched, and makes grimaces; no motion in the lower extremities when pinched, but they are less rigid than the upper. Total loss of intelligence; respiration rattling; pulse pretty strong, full, regular and slow. (Thirty leeches to the neck, ice to the head, sinapisms to the inferior extremities, a purgative enema.) The agitation continued the remainder of the day; the convulsions are universal; the face is red and tumefied, the mouth is deformed, the lips projecting anteriorly. With the ice, the head is exceedingly hot; the fore-arms are strongly flexed; intellect is entirely lost. He was in the same state during the night. The 19th, in the morning, the right arm is almost without motion, the left alternately rigid and convulsed; eyes shut; he shuts his jaws when he is desired to drink, and appears to feel a little when the left arm is pinched very hard: slight heat of skin; pulse 112, full and regular, (Venassect, ad. 12 ounces purgative enema, sinapisms, &c.) In the course of the day the patient died in the greatest agony.

"Autops. cadav., — twenty-four hours after death. The arachnoid is adhering in eight or ten places in the superior surface of the brain; in removing it the cortical substance comes away with it in pieces of about the size of a franc, and about a line in thickness; the medullary substance is a little injected. The left lung is a little hard posteriorly, deprived of air, and somewhat hepatised. The right is red, and congested in about the same place. The mucous membrane of the stomach is red in its splenic portion. All the other organs are healthy."

Case V. — "Antoine Broussart, 65 years of age, having experienced great losses in commerce, and being reduced to great misery, gave himself, on the 6th of January, in the morning, many blows on the head with a
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Other writers incidentally alluding to the diseases of the brain have advanced opinions that confirm the views of M. Foville. Sir Everard Home in his Croonian Lecture, read to the Royal Society, Dec. 7th, 1820, says, “That the cortical part of the brain is the seat of memory, is an opinion I have long entertained, from finding that any continued undue pressure upon the upper anterior part of the brain entirely destroys memory, and a less degree materially diminishes it. Pressure upon the dura mater, where the skull has been trepanned, puts a temporary stop to all sense, which is restored the moment that pressure is removed, and the organ appears to receive no injury from repeated experiments of this kind having been made. In hydrocephalus, when the fluid is in large quantities, and there only remains the cortical part of the brain, and the pons varolii connecting it to the cerebellum, all the functions go on, and the memory can retain passages of poetry, so as to say them by heart; but a violent shake of the head produces instant insensibility. Pressure in a slight degree upon the sinciput, produced in one case complete derangement, with violent excesses of the passion of lust, both of which went off upon removing, by the crown of the trepan, the depressed bone.”

Larrey* has also furnished cases of injury of the anterior and superior portions of the brain, producing some intellectual derangement but not affecting motion, and other cases of wounds confined to the base of the brain producing different paralytic affections, but no mental aberrations.

The opinion of M. Foville respecting the functions of the medullary portion of the brain, that it is connected

* Clinique Chirurgicale, &c. Par Le Baron Larrey.
with the motive powers and not with the intellectual, is also supported by pathological facts.

Case VI.—The following case seems to fully establish this opinion, and it is on other accounts one of the most instructive on record; I do not know of any one more so. It was that of an Idiot, who died during the clinical course of M. Esquirol, in 1823. The right side of the body was exceedingly atrophied. The limbs of this side were reduced almost to skin and bone, and not capable of the least motion. They were also considerably shorter than the limbs of the opposite side, which were well developed and capable of motion. In short the left side of the body was in a natural and healthy condition, while the right was paralytic, emaciated and of diminutive length.

The cause of this singular appearance was sought for after death with great diligence and the autopsy was witnessed by a large number.

No disease was found on examining the body, except that of the brain. The head was quite small, though the bones of the cranium exhibited nothing remarkable. The hemispheres of the brain presented no appearance of convolutions. The cineritious substance was wanting on both sides. But the condition of the medullary part of the brain was most interesting. On the right side it was natural, as the disease appeared to have extended only to the surface of the right hemisphere; but in the left hemisphere it was almost entirely wanting, and its place filled by a semi-transparent fluid. It is evident from this condition of the brain, that the paralysis and atrophy of the right side of the body was owing to the absence of the medullary portion of the left side of the brain, and that motion cannot be dependent on the cineritious portion of the convolutions for this was wanting on both sides. The

absence of the cineritious substance may however account for the idiocy.*

As I have said, I do not know of a case deserving of more consideration than this, not merely as relates to the confirmation of the views advanced respecting the functions of the cineritious and medullary parts of the brain, but as showing that the healthy and full development of the muscles, limbs, and other parts of the body, is dependent upon the healthy condition of the nervous system; a fact to which I shall again refer.

The conclusions drawn by M. Foville from his observations are, 1st. Morbid alterations of the cineritious portion of the brain are directly connected with derangement of the intellect. 2d. Morbid alterations in the medullary portion are connected with disorder in the motive powers.

My own observations, have convinced me of the general correctness of these observations. I have repeatedly examined the brains of those who died after long continued insanity. In every such case I have witnessed some disease of the cineritious portion of the hemispheres,† sometimes slight and apparently as if produced by extension from the diseased membranes which adhered to the brain. In some cases the medullary portion was harder than natural, but the most marked appearances of disease were in the convolutions of the cerebral lobes, and in none was any disorder of motion manifested. I have also seen extensive disease of the brain, producing convulsions and coma, without mental derangement. The fol-

† "Some writers," says Dr. Armstrong, "say they could find no marks of disease in the heads of those who died insane. I must believe their examinations were not critical." I concur in this opinion.
Case VII. — Mr. C., of Berkshire Co., Mass., aged 30, in the winter of 1818, was supposed to have fallen from a scaffold in his barn, as he was found on the floor in nearly an insensible state. He was however soon aroused, and by the aid of his wife walked to his house. I saw him the same day, no visible injury of the head, complained of pain in the forehead, and was drowsy, but rational, and not in the least paralytic. He was bled and took cathartic medicines, and the next day appeared a little better, but complained of feeling bad. He was able to walk about his room, but with staggering steps as if intoxicated. His countenance had a very anxious appearance, though his intellect was not disturbed. The following night he had a violent convulsive attack, resembling a severe epileptic fit, and was again bled. He now began to be paralytic and comatose, had convulsions every two or three hours, until his death, which occurred on the fifth day.

Dissection. — No appearance of injury externally. On examining the brain no other injury was found than a fracture across the base of the cranium from one ear to the other, and above it three or four ounces of blood extravasated.

Cases similar, or of extensive disease of the base of the brain without producing derangement of the intellect, but causing paralysis and convulsions, are to be found in medical works, some of which will be referred to when treating of the cerebral nerves.

The opinions advanced on this subject are also supported by anatomical facts and argument as follows:

"A circumstance bearing upon the present question is, that the grey matter increases in quantity in the exact ratio of the nervous energy. We learn from a comparative examination of the brain, that the intellectual operations become diversified and energetic in proportion as the grey substance is accumulated; and that it is in this respect, especially, more than in that of relative volume, that the brains of the lower animals differ when compared with each other, or with the human cerebrum, the great peculiarity of which consists of the very large proportion of its grey matter, when contrasted with the nerves attached to its base. A very accurate test of the intelligence possessed by different animals, and even by different individuals of the human species, is thus afforded by the development of the convolutions, or, in other words, of the grey substance; for the so-called convolutions of the brain are only another illustration of that principle, so beautifully displayed in the formation of the glands, according to which the largest possible quantity of materials is contained in the smallest possible space.

But the condition of the cerebro-spinal axis, at the time of birth, affords, perhaps, the most satisfactory evidence on this point. At that period, the grey matter of the cerebrum is well known to be very defective, so much so, indeed, that the convolutions are, as it were, in the first stage of their formation, being only marked out by superficial fissures, almost confined to the surface of the brain; whilst at this identical period, the spinal cord, owing to the imperfect development of its fibrous part, (which, as will be subsequently shown, is allied with the exercise of sensation and volition,) contains a larger quantity, proportionally, of grey matter than it does in the adult; in consequence of which, according to the remark of Professor Arnold, that matter, which in the adult is placed so deeply in the interior, approaches much nearer the external surface. Now at this particular time, the true cerebral functions, consisting of the intellectual faculties, sensation and volition, are almost entirely, if not for a brief period totally wanting; whilst the true spinal functions are in full activity. It is impossible to adduce any more striking
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proof than this, to demonstrate that the extent of the power inherent in the nervous system, depends on the quantity of the grey matter.

Professor Tiedemann, in his valuable work on the development of the brain, has incidentally mentioned a fact which bears on this inquiry; he has found that in the torpedo, there is a mass of grey substance placed in connection with the fifth and eighth nerves supplying the electrical organs, larger in size than the cerebellum itself, whilst in the common skaiete no such mass exists. An exactly analogous fact is furnished by the comparative anatomy of the lobe of the olfactory nerve; for, in animals distinguished by the acuteness of their smell, that body is remarkably large when contrasted with those in which that sense is less perfect. The object of such formation cannot be mistaken; it is evidently to generate power.

Lastly, it may be mentioned in corroboration of the opinion here advanced, that the grey matter is only met with in those parts of the nervous system which are known to be the seat of power; that is to say, in the encephalon, the spinal cord, and the ganglions; it is wanting, notwithstanding the assertions of Munro to the contrary, in those parts—namely, the nerves—which are proved not to have the capability of originating power. *

Secondly. — We also learn from pathology that the cerebellum is not connected with the operations of the intellect, but is with voluntary motion; and probably is essential to its proper and regular manifestations. It also appears to be connected with the sensual propen-


sities, and I have observed that its sympathy with the stomach is greater than between the cerebrum and the stomach, though this may arise from its connection with the Par vagum. Cases are to be found in the writings of Morgagni, Lallemand, Abercrombie, Andral, and in the medical periodicals of late years, of disease of the cerebellum, without any disturbance of mind, but in nearly all of them some disorder of motion occurred; though it is true that in most of these cases the disease did not affect both lobes.

In speaking of the cases of softening of the cerebellum which had come to his knowledge, Andral observes, "Whilst the changes of intelligence were variable, inconstant, and of little importance, the lesions of motion on the contrary were observed in all the cases except one, and in this it is not quite certain that motion was not interfered with."

The following case quoted by Abercrombie, confirms the above view.

CASE VIII. — "A woman of 35; fixed pain in the back of the head; walk tremulous and unsteady, like a person balancing a burden on the head; much throbbing in the head; hysterical symptoms. Remarkable remission of all the symptoms after the formation of an abscess in the axillia; but the pain returned when it healed, and increased to tremendous severity, and with remarkable remissions. From two o'clock in the morning till two in the afternoon she was in the greatest agony, lying with her eyes closed, the eyebrows contracted, the hands clenched, and the head immovable in one position, unable to bear the least noise, or to move a muscle. After two P.M. the symptoms gradually remitted;"

*Clinique Medicale.